Chapter-3

BUTTON MUSHROOM CULTIVATION

Chapter Contents

White Button Mushroom

1. WHITE BUTTON MUSHROOM (*Agaricusbrunnescens* Peck.)

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 Agaricon—with a Scythian people called Agari who were knowing the use of medicinal plants and employed a fungus called ¯ agaricum ?, probably a polypore in the genus *Fomes*. *Brunnescens*means brown in latin, as the colour changes to brownish after bruising . It is also called as *A. bisporus*because of the two sporedbasidium.

Description:

White button mushroom (A . *brunnescens*) 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. Cap is whitish, cream coloured or brown. Cap surface smooth to appressed and dry. The stem is short, thick adorned with a persistent membranous annulus from a well developed partial veil. Spores chocolate brown in mass, basidia bipolar (twospored) forming diploid spores, secondarily homothallic, clamp connection absent. Mating of compatible dikaryons typically results in development of strain which is more vigorous and high yielding. Mycelium is dingy white, moderately rhizomorphic.

White button mushroom (*A. bisporus*) cultivation

Nutritional Value : Button mushrooms contain 90-92 % water and only 8-9% dry matter. Also contains 3.92 % protein, 1.09 % crude fibre, 1.25 % ash, 0.19 % fat and 56 mg. niacin / 100 g 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 ± 1ºC 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

Composting: Compost can be prepared by two methods:

1. Long method of composting
2. Short or pasteurization method of composting

1. Long Method of Composting:

A) Formula developed by Mushroom Research Laboratory, Solan

Wheat straw	—	1,000Kg or
Paddy straw	—	1,250Kg

CAN	—	30Kg
Super phosphate	—	25Kg
Urea	—	12Kg
Muriate of Potash	—	10Kg
Wheat bran	—	100Kg
Molasses	—	16.6litres
Gypsum	—	100Kg
Folidol dust	—	750 g

B) Formula developed by IIHR, Bangalore

Paddy straw	—	150Kg
Maize stalks	—	150Kg
Ammonium sulphate	—	9Kg
Super phosphate	—	9Kg
Urea	—	4Kg
Rice bran	—	50Kg
Cotton seed meal	—	15Kg
Gypsum	—	12Kg
Calcium carbonate	—	10 Kg

Long method of composting was first advocated in India by Mantel *et al.* (1972). To begin with the composting process, clean the composting yard thoroughly and wash it with 2% formalin solution. Wheat straw or any other base material to be used is spread in a thin layer of 8-10 inches thickness over the floor of composting yard. Sprinkle water over the straw with a hose pipe and wetting of straw is done repeatedly at least 2-3 times a day for 2 days with the help of forks. Before mixing with the wet wheat straw, the ingredients like urea, CAN, super phosphate,wheat bran etc. (except insecticides and gypsum) are thoroughly mixed , wetted with water and then covered with damp gunny bags 14-16 hours before use.



Fig. 5.2 & 5.3 Fresh Wheat straw and Paddy straw stored for compost preparation Fig 5.4 Chicken manure stored for substrate preparation

Preparation :

- **Day 0:** On this day fertilizer mixtures are spread evenly on the pre- wetted straw. This mixture is made into a stack with the help of wooden boards or pile formers . Dimensions of pile should be 5x5x adjustable length. Height and width of the pile should not be more than this otherwise pile may become too hot due to high temperature and the anaerobic conditions may prevail in the centre which may not yield good quality compost.
- **Day 1-5:** Start monitoring the temperature of the heap. Temperature should start rising after 24-48 hours of stacking and reach 65-70°C in central core. If the moisture of the mixture is less, than water can be sprayed. Watering should be stopped as soon as leaching starts from the bottom of pile. If water starts leaching in large quantity then it should be collected in a guddy pit and put on the top of the pile.

a b c

- **Long method of composting -** stacking the heap on Day-0 with the help of pile formers (a & b) and a rectangular shaped compost heap raised after completion of the pile forming process (c)
- Diagram of a Pile Forming Board for stacking heap of compost during compost making in mushroom cultivation (a& b)
- **Day 6: First turning:** On this day first turning is given to the stack. The aim of turning is that every portion of the pile gets equal aeration and water for proper decomposition of the base material. The correct method of turning is as follows :
- Remove about 1 feet compost from top and side of pile, shake thoroughly so that excess of ammonia is released and it is exposed to the air properly, and keep this portion on one side. Now remove the central and bottom portion of the pile, shake these with the forks and keep them separately. Now the new pile is made with the help of boards keeping the central portion at the bottom. Top and sides portion should be placed at the centre while bottom part comes on the top and sides. During pile formation watering is done ,if required.
- **Day- 10: 2nd turning.** Break open the stack, remove it as indicated above, water may be added if required and restack it .
- **Day-13: 3rd turning:** Restack and add required quantity of gypsum

- **Day-16:** 4th turning
- **Day-19:5th turning**
- Day-22:6th turning
- **Day-25:7th turning** : add required quantity of Folidol dust
- **Day 28: Filling day.**Break open the pile and check for the smell of ammonia , if it still persists, give an additional turning after 3 days. This way compost is prepared by long method in 28-30 days.

1. Short or Pasteurization Method of Composting:

Formula given by Mushroom Research Laboratory , Solan

Wheat straw (chopped)	—	1000 Kg
Chicken manure	—	400 Kg
Brewer's grain or wheat bran	—	72 Kg
Urea	—	14.5 Kg
Gypsum	—	30 Kg

- This is done in two phases. **Phase- I** is done in the composting yard while **phase II**, inside a closed chamber called pasteurization chamber or tunnel (bulk chamber) with the help of aerated steam for pasteurization and conditioning of compost.
- **Phase I:** Phase - I involves pre-wetting of straw and mixing of ingredients in the straw as in long method. But in this case turning is given after every 48 hours (2nd day). During third turning or on 6th day total amount of gypsum is added in the compost. After 4th turning on 8th day, the compost is filled in pasteurization tunnel on 10th day.

Phase –I of composting ——— first turning after mixing urea and pile being formed with the help of a Pile Former (1) third turning being given by breaking the heap and adding water (2), picture of a front loader tractor (3) and compost turning machine (4) for mechanical composting

Phase II: (Pasteurization)

- After filling partially decomposed compost in pasteurization chamber or tunnel, a temperature of 48-50 ° C is maintained for next 2-3 days by circulating the inside air. Then with the introduction of steam, temperature of the tunnel is raised to 58-60ºC for 6 hours.
- Fresh air is then allowed to enter the room so as to bring down the temperature to 50-52°C which is maintained for 3-4 days for conditioning. When ammonia smell gets eliminated, then fresh air is introduced in the tunnel to cool down the temperature of the compost to 25-28°C. By pasteurization method, compost is prepared within 18-20 days.

Qualities of a good Compost

- Compost should be dark brown in colour with profuse fire fangs.
- Compost should have moisture percentage of about 68-70 percent.
- pH of the compost should be in the range of 7.2-7.8.
- There should not be any smell of ammonia.
- It should not be sticky or greasy.
- It should be free from insects and nematodes.

This method has got certain advantages over long method of composting as detailed below:

- More compost per unit weight of ingredients is produced .
- Total period of composting is reduced
- The yield is almost doubled
- All the harmful fungi, competitor moulds, insects, nematodes and other pathogens get killed during pasteurization which otherwise cause reduction in yield
- Most part of Ammonia liberated is converted into microbial protein which otherwise go waste in long method of composting.
- Conditions inside a pasteurization chamber favour proper temperature and aeration resulting in the preparation of good quality compost free from all types of harmful microorganisms .

2. Bulk pasteurization method:

It is similar to the short or pasteurization method of composting but in a modified form of technology. Here after phase -1 of composting, compost is treated / pasteurized in bulk inside

a specially built chamber known as the chamber or tunnel in Phase –II .

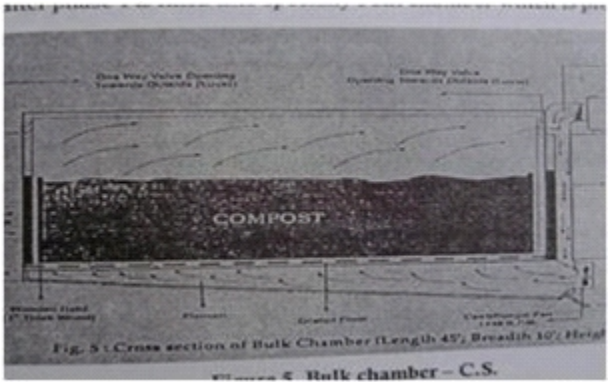

Fig. 5 : Cross section of Bulk Chamber (Length 45', Breadth 10', Heig

Bulk chamber – C.S.

The diagram of a Bulk Pasteurization Chamber (Tunnel) showing the compost after Phase-1, filled in the chamber having ducts for fresh air entry and the slanting floor with grated plenum and blower fitted underground

1

2

Pasteurization chamber/Tunnel of a Bulk Pasteurization Chamber showing grated panel (1) and compost after phase-I being filled in the chamber for pasteurization process or Phase II (2)

3

4

Showing the outer part of a bulk pasteurization chamber with its door closed and air handling unit (3) and the blowers fitted outside the pasteurization chamber.

The bulk pasteurization method is again having some advantages over the short or pasteurization method of composting :

- More compost per unit size of the room can be treated at a time.
- Facilitates the preparation of best quality compost.
- The cost of pasteurization is reduced.
- Yield per unit weight of compost is much higher

- Labour cost is reduced.
- The heat generated by compost is utilized for its further pasteurization, hence cost of diesel, electricity or fuel is reduced.
- Spawn running can also be done in the tunnel itself thus reducing the cost and saving of time

Environmental pollution is very much reduced

Cultivation technique

A . Filling:

The compost is filled in wooden trays or shelves or in polythene bags at different rates. The hard- compressed bags / beds attain more compost as compared to slightly compressed bags. The dry weight of substrate per square foot of cropping surface largely determines total yield. During summer the compost is slightly pressed while filling so that due to the metabolism of the growing mycelium, bed temperature may not rise as enough of heat is generated during that period. Similarly it is hard-pressed during winter season. Nutrients from the farthest point of the compost bed are transported to the growing mushroom mycelium. Filling of the trays / bags 6-8 inches deep with compost, stacking them closely, with their upper end covered with polythene or newspaper in a closed room, has been found to provide conditions for efficient spawn run and the heat generated can be managed easily. Moreover, it will add to the ideal temperature (25±1° C) required for rapid colonization of the compost with mycelium.

B .SPAWNING AND SPAWN RUNNING:

a) **Spawning:** Mixing the mushroom seed or spawn in the compost is called as spawning. There are different methods of spawning which are as follows:

1. **Surface spawning:** Grain spawn is scattered all over the surface of the compost in trays or racks which is then covered with 2 cm thin layer of compost.
2. **Double layer spawning:** Usually done under unfavourable environmental conditions at low temperature. The trays are half filled with compost, spawn is scattered over it, then trays are filled completely with compost and again spawned in the same manner. Finally a thin layer of compost is spread on the spawn covering it completely.
3. **Through spawning:** The desired quantity of spawn is mixed thoroughly in the required quantity of compost which is then filled in racks, trays or bags. This type of spawning is done mainly in bag cultivation.
4. **Spot spawning:** Trays are filled with compost. Spawning is done in 1-2 inches deep hole made in the compost about 4-5 inches apart in rows. A tea spoonful spawn is filled in the holes which are later covered with compost. After spawning, trays or racks are covered with old newspaper sheets and watered lightly with the help of water sprayer. In Polythene bag cultivation, its mouth is tied with the help of thread.

5. **Active spawning:** Here in place of grain spawn, fresh compost after complete colonization by mushroom mycelium is used as spawn. In this method spawn run is very quick but care should be taken to avoid use of contaminated compost.

b) Spawn running:

The temperature of the mushroom house, where trays or bags are kept for incubation should be maintained between 22-25°C. The humidity should remain at 80-85% RH level. This can be maintained by frequently spraying water on walls and floor of the mushroom house. During spawn running , fresh air is not required, hence room should be kept closed to create darkness. Higher CO_2 concentration than the normal level in the air favours mycelial growth of the mushroom. Under favourable environmental conditions within 14-15 days of spawning, the compost surface is covered with the cottony growth of the white mycelium. This condition is called spawn run. If temperature is lower than optimum level, it prolongs the spawn run period even up to 22 days while higher temperature retards mycelial growth.

Fig. 6.1 Pasteurized compost filled in polythene bags after spawning and kept in the spawn running room on the shelves for spawn run.

a) Supplementation at spawning:

In order to get additional increase in yield, some selected nutrients are added in the compost at the time of spawning. They are designed to become available to the mushroom mycelium during the early flushes.

These supplements are specially formulated nutrients encapsulated in a denatured protein coat.The application rate is 5-7 % of the dry weight of the substrate. One has to be careful as these materials enrich the substrate, making it more suitable to contaminants, if factors predisposing to their growth are present.These type of supplements may cause 5-10 per cent increase in yield.

Cultivation Technique (Contd..)

C. CASING

What is casing?

Covering the top of mushroom beds after completion of spawn run with a layer of appropriate soil mixture is known as casing. Mushroom growers in different countries use different types of casing materials depending upon their availability . Different materials used in India as casing mixture are:

1) Loam soil + Sand (4:1)
2) Two year old farm yard manure + loam soil (1:1)
3) Two year old spent compost + sand + lime (4:1:1)
4) Two year old spent compost + loam soil + FYM (2:1:1)
5) Paper mulch + 2 year old spent compost
6) Two- three year old spent compost + FYM (1:1)

Why Casing is necessary?

Casing of mushroom beds or spawn run compost is necessary because:

- Casing soil is a nutrient deficient medium, which helps in converting the vegetative phase into fruiting.
- Fruit bodies are formed in abundance and thus production is economical.
- It helps in conserving the environment in mushroom beds

Characteristics of a good casing :

- Good water holding capacity and more pore space percentage.
- Capable to release harmful gases during cropping.
- Free from harmful microorganisms.
- pH should be slightly alkaline.
- Should be properly decomposed.
- Free from heavy metals and ions.

Treatment of casing soil:

For killing various pests and disease propagules present in casing mixture, casing soil is treated with chemicals or pasteurized with steam.

1. Chemical treatment of casing mixture:

Casing can be disinfected with formaldehyde treatment.The formaldehyde solution is prepared by mixing 2 litre of formalin (4O% a .i) in 40 litres of water to obtain 2% solution . Casing mixture, made up into a rectangular pile, is drenched thoroughly with this solution and then covered with a polythene sheet or tarpaulin sheet. The treatment should be given

at least 2 week before casing is to be done. In other words, casing should be prepared and treated immediately after compost has been spawned. It should be ensured that casing mixture should not have traces of formalin when applied on the beds.

2. Pasteurization of casing mixture:

In farms where facilities for pasteurization of compost with steam are available, casing can also be pasteurized. For pasteurization of casing mixture, casing soil is filled in trays and trays in turn are stacked in the pasteurization room. Steam is introduced to bring the temperature of casing mixture to 65-70°C and which is maintained for 6-8 hours. All the harmful microorganisms, including mushroom nematodes are killed at this temperature. Useful bacteria like *Pseudomonas* which play a positive role in introduction of fruit bodies are not killed and survive at this temperature for 7-8 hours. Casing soil pasteurized in this manner gives best result.

Fig. 6.5 Heap of loam soil used as one of the casing ingredients

CASING APPLICATION AND MYCELIAL COLONIZATION :

Fig. 6.6 to 6.9 Mycelium threads from grain spawn spreading in the compost filled in polythene bags.

Application of Casing:

- When spawn run is completed, the casing is done over spawn run compost after removing newspaper sheet from the trays on racks or after opening mouth of the poly bags. Spawn run compost is slightly pressed and covered on the surface with 4-5cm thick layer of casing soil. After casing, the temperature of the mushroom house is maintained at 24-25 °C for another 8- 10 days and water is sprayed over casing soil. Within 8-10 days,white mycelium spreads in the casing soil. Thereafter temperature of the mushroom house is lowered down to 18 °C and maintained between 14-18°C during rest of the fruiting period. Whenever required ,watering is done with the help of sprayer and RH is maintained at 80-85% throughout the cropping period.

D) CROP MANAGEMENT:

- The casing medium harbours some beneficial bacteria and activated charcoal like material which help in initiation of fruiting bodies on the casing surface. Casing mixture also helps in conserving moisture in the beds and gives support to the fruiting bodies .
- As soon as the white cottony growth of the mycelium appears on the casing surface, fresh air should be introduced inside the cropping room and bed temperature lowered to 16-18 °C which is to be maintained throughout the cropping period . The CO_2 level is also lowered to below 1000 ppm. Under such conditions, the initiation of fruiting bodies i.e.pinning takes place within 6-7 days of aeration which reaches to the harvesting stage within next 4-5 days. The individual fruit bodies are harvested carefully without disturbing the adjoining pinnings and before the cap opens. The cropping period lasts for 40-60 days. Mushrooms appear in flushes provided optimum conditions like bed temperature (16-18º C) , relative humidity (80-90 %) by spraying water with misty nozzle, about 4-5 air changes every hour resulting into less than 1000 ppm in the cropping room with no light at all , are maintained.
- The environmental factors like temperature, relative humidity, light , air flow in the cropping room etc; all play vital roles which together determine the nature of further mushroom development. The mushroom crop grows in cycle called ¯Flushes? or " Breaks ". Depending on the species being grown, day intervals with each successive flush bearing fewer mushrooms. These flushes normally appear in 7-10 days.

a b

Fig. 6.10 & 6.11 Button mushroom beds in cropping stage
Fig. 6.12 & 6.13 Photograph of a Hygrometer for measuring humidity (a) and water being sprayed on the cropping beds with the help of a foot sprayer pump having a fine spray nozzle (b)

a b

Fig. 6.14 & 6.15 Showing the compost bags kept on shelves for spawn run, the air duct and the Air Handling Unit in the cropping room (a) the ventilator for entry of fresh air and the controlling board fitted outside a cropping room (b)

E) HARVESTING:

Timing is the most important factor in button mushroom harvesting. Mushrooms should be picked before the veil breaks and the stem elongates. Damage to pinheads and disturbance of the casing soil must be minimized during picking. The standard harvesting technique consists of grasping the base of the stem, pull it with a twisting motion being careful not to disturb adjacent pinheads. The stem base, with mycelia and casing particles adhered to it, is trimmed with the help of a short bladed knife. All trimmings should be kept in a plastic bag and removed from the cropping area. Mushrooms growing in clusters should be broken apart and harvested individually. Immature mushrooms should be left attached to the casing for further development.

Fig. 6.16 - 6.18 Harvesting of mushrooms with the help of two fingers and a thumb and cutting of stem root with a knife

F) Yield :

- The cropping stage lasts for 40-60 days and production comes to 12-25 Kg / 100 Kg compost depending upon the quality of spawn, compost, casing mixture and prevailing environmental conditions in the mushroom house.