



Oct-Nov—2009

## EDIBLE MUSHROOMS : AN ALTERNATIVE FOOD SOURCE

\*Imrana Siddiqui

\*Asstt. Prof. of Chemistry, Govt. Art s& Comm. College, Sagar, M.P.

### ABSTRACT

*Mushrooms, yeasts and algal foods are frequently mentioned as alternative sources for food. Of these, mushrooms are the most preferred items. Modern mushroom culture produces more protein per unit area of land than by any other form of agriculture. Mushrooms also have an excellent ability of recycling many of the farm wastes. Since these are grown indoors, no additional land is required for their culture. Their cultivation is labour intensive and can provide employment to both educated and illiterate persons. They can be produced in large quantities within a short time. All Morchella species (Guchhi in Hindi) are edible, while both edible and poisonous species of mushrooms are encountered in genera like Cantharellus, Lepiota and Boletus. The species of Amanita are deadly poisonous.*

**Introduction :** Mushroom is a simple form of life known as fungus. It lacks chlorophyll and can not therefore make its own food. It grows on dead organic matter or parasitically or symbiotically with other living organisms. The edible part constitutes the fruit body. Its use as food is probably as old as civilization itself. Mushrooms are richer in protein as compared to cereals, pulses, fruits and vegetables on dry weight basis. Their proteins have 60-70% digestibility and contain all the essential amino acids.

Many of these are rich in lysine. In addition to protein (3.7%), they also contain carbohydrates (2.4%), fat (0.4%), minerals (0.6%) and water (91%) on fresh weight basis. They also contain vitamins B, C, D and K and minerals like calcium, phosphorus, potassium, iron and copper. They are completely devoid of starch and hence can constitute of good item in the diet of diabetic persons. Besides this mushrooms contain a high fibre content which is a useful constituent of our diet. The vitamins are well retained during cooking, canning, drying and freezing. It has been reported that 100-200 g (dry weight) of mushrooms can provide nutritional balance in a normal

human being. Some reports indicate their potential as life saving drugs, antibiotics and biologically active substances. They have various industrial uses<sup>1</sup>. More than 2000 species of fungi are reported to be edible throughout the world. In India, about 200 of these are available. Agaricus bisporus (European or white button), Volvariella spp. (Paddy straw or Chinese), Pleurotus spp. (Oyster or tropical), Lentinula edodes (shiitake), Flammulina velutipes (Enokitake) mushrooms are the most popular forms.

### Cultivation Techniques of Edible Mush-

**rooms :** In India, four types of mushrooms viz. White button, oyster, paddy straw and milky mushrooms are being cultivated at commercial level. The brief cultivation techniques of these mushrooms are as follows :

**A) Cultivation of White button mushroom (*Agaricus Bisporus*)<sup>2,3</sup>** Popularly known as European mushroom it requires a temperature of 14-18°C during cropping hence it is cultivated in the cooler hilly regions of our country. One crop can easily be taken during the winter seasons in the plains of north India and maximum two crops can be grown in hilly areas. This mushroom (both fresh and canned) has better market

acceptability. Technical skill of cultivation can be acquired by training.



**Button Mushroom**

The steps involved in its cultivation are given below:

**i) Compost Preparation :** It is grown on a specially prepared substrate called compost. This is prepared by mixing various raw materials in specific proportions, either by long or short method of composting. Straw based compost involves the use of wheat or paddy straw or sugarcane bagasse as base material. Horse dung is used for preparation of natural compost. The base materials are supplemented with some activators like chicken manure, molasses, wheat bran and nitrogen sources- organic/inorganic fertilizers. The nitrogen content is adjusted at 1.5% of the dry weight of the base materials, activators and nitrogenous sources, the following compost formulations are popular in India.

**Formula - I**

Wheat straw	1000 kg
Chicken manure	400 kg
Brewer's grain	73 kg
Urea	14.5 kg
Gypsum	13 kg

**Formula - II**

Wheat straw	500 kg
Horse manure	1000kg
Chicken manure	300 kg
Brewer's grain	60 kg
Gypsum	30 kg
Urea	7kg

Using the above formulations, compost is prepared by two methods.

**a) Long method :** It takes 26-28 days and involves 7-8 turnings at varying intervals. This method is used by small seasonal growers lacking pasteurization facility.

**b) Short method :** It is followed by growers having

pasteurization facility and takes about 16-18 days. The compost is prepared in two phases taking 10 and 7 days respectively. In phase-I free heating of outdoor compost schedule is followed for turning. The phase-II (peak heating or pasteurization) is done after 10 days of outdoor composting. Pasteurization is then carried out. Good compost will be dark brown in colour, free of ammonia smell, pH between 7-7.5, lacking greasiness, moisture content of 68-70% and nitrogen content ranging between 2.2 to 2.3%.

**ii) Spawning and spawn run :** Spawning means seeding of the compost. Pure and productive spawn is procured a few days prior in seeding. Fresh spawn should be used always. Three methods are generally adopted.

**a) Surface spawning:** Spreading the spawn in top layer of compost and it is then covered with thin layer of compost.

**b) Layer spawning:** Spawn is mixed with the compost in 2-3 layers and pressed. Bags are spawned while filling.

**c) Thorough spawning:** Spawn is mixed in the compost thoroughly and then spawned compost is filled in the bags. Rate of spawning is important in getting optimum yield. Generally, 500-750 gm spawn is sufficient for one qt of compost. More spawn is required for layer or thorough spawning than in surface spawning. After spawning the compost is pressed hard to make it compact. The trays are then arranged in cropping room in tiers and are covered with newspapers sheets sprayed with 2% formalin. The temperature during spawn run should be maintained between 22-25°C. The newspapers should be sprinkled with water at least twice daily to prevent drying of compost. The dark brown colour of compost changes to light brown. Little ventilation is required during spawn run.

**iii) Casing :** It means covering the spawn run compost with a layer of sterilized or pasteurized casing soil of any other materials. The following mixtures are used in India. a) Mixture of 2 years old FYM and 2 years old spent compost (1:1) b) Garden soil and sand mixture (4:1 by volume) c) Decomposed FYM and loam soil (1:1 by volume). The pH of casing soil is adjusted between 7-8 with the addition of chalk (calcium carbonate). Casing soil should be porous and allow

good gaseous exchange. The humidity in the room is maintained at 95% and temperature 22-25°C. The beds are kept moist.

**(iv) Cropping :** One week after casing, the room temperature is lowered to 14-18°C and the pinheads start appearing within 7-10 days. Good ventilation is required at this stage. The carbon dioxide concentration in the room should remain below 0.1% and 2-4 air changes per hour are required. More watering is required during the production of flushes. Pinheads appear within 12-15 days of casing. Cropping continues for 6-8 weeks. Mushrooms appear in flushes every 7-10 days.

**v) Harvesting of mushroom and marketing :** Mushrooms are harvested while still in button stage. These are collected in small baskets. Soil particles and mycelial strands sticking to the base of stalk are removed carefully and fruit bodies are cleaned with a soft cloth and washed in EDTA solution (0.125 gm/liter of water) before sending them for marketing. Yield depends on the quality of compost and spawn alongwith other management factors.

**vi) Economics of Cultivation :** Cost of cultivation varies from place to place depending upon the price of raw material, labour wages, environmental conditions at the site and marketing opportunities.

**B) Cultivation of Oyster or Tropical Mushroom (*Pleurotus spp.*)<sup>4,5</sup>** Oyster mushroom is being produced in the States like Orissa, Karnataka, Maharashtra, A.P., M.P., West Bengal, Meghalaya, Manipur, Mizoram, Assam etc. Many species of *Pleurotus* grow wild on dead decaying tree logs, stumps, or dead branches of living trees or on dead decaying organic matter mostly during the rainy season. All these species of oyster mushroom are edible except *P. olearius* and *P. nidiformis*. Commercially cultivated species are *P. sajor-caju*, *P. sapidus*, *P. eystidiosus*, *P. ostreatus*, *P. ervngii*, *P. flabellatus*, *P. fossulatus*, *P. platypus*, *P. florida*, *P. membranaceus*, *P. djamore*, *P. cornucopiae* and *P. tuber-reginum*. Different substrates like wheat and paddy straw, saw dust, maize stalks, dried leaves, waste from food industries and synthetic compost are used for its cultivation. It can also grow on dried logs of soft wood trees and roots of water hyacinth, paper waste and shelled maize cobs. The technology for its cultivation is simple and cheap. The produce has a

longer life, and it can be dried easily. Artificial cultivation involves the following steps:



**Oyster Mushroom**

**i) Preparation of substrate :** The mushroom proliferates equally well on both paddy as well as wheat straw. The straw is steeped in a solution of Bavistin and formalin for a period of 18 hours. Treated straw is put on a sieve for 30 minutes for removal of extra solution. It is then spawned. The substrate can also be sterilized by boiling in water or by bulk pasteurization.

**ii) Spawning and Spawn run :** When the substrate is free from excess of chemical solution and cooled down to 25-30°C it is filled in polythene bags after mixing the spawn (200-300 g in 10 kg). The moisture content of substrate should be 65-70%. Fresh grain spawn not more than a month old should be used. The bags should be perforated at 15 cm regular intervals for gaseous exchange with a nail. 20-25°C temperature and 70-85% RH is maintained for spawn run.

**iii) Removal of bags for production of mushrooms :** When the substrate is fully covered with the mycelium, the polythene bags are removed from the substrate. The spawn run bags are then arranged on a wooden platform or shelves at a distance of 15-20 cm between the bags. Watering is done twice a day or as required to ensure 70-80% RH. Walls and floor of the room are also sprinkled with water. Fresh air is given once or twice a day during cropping. Sufficient amount of diffused light is required for normal fruit body formation. Mushroom pinheads with appear within 7-10 days which can be harvested after 2-3 days. Younger fruit bodies have longer shelflife. Three to four flushes appear within a period of 4-5 weeks.

**iv) Harvesting and Yield :** The fruitbodies may arise single or in clumps and form tiers on the substrate. They should be harvested carefully to avoid any disturbance to other pinheads as much as possible. These are then packed in perforated polythene bags for sale in fresh form. Surplus produce can be sun-

dried or dehydrated at 50-55°C and stored in sealed/ closed polythene bags for later use or can be pickled in absence of market.

**v) Economics of cultivation :** This mushroom can grow on a wide variety of agricultural wastes, which are easily available and cheap, hence its cost of production is lower than that of others.

**C) Cultivation of *Volvariella* spp. (Paddy Straw or Chinese Mushroom)**<sup>6,7</sup> *V. volvaceae* and *V. diplasia* are the two species cultivated in India. It grows on cellulose-rich paddy straw saprophytically. It can be cultivated in rooms, covered sheds or polythene cages. It requires a temperature between 30-35°C for growth. The best season for growing this mushroom in Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Tamil Nadu, Orissa and Maharashtra is from April to October. The humidity should be above 50%, the ideal temperature for optimum spawn run ranges between 30-35°C with relative humidity 80-90%. One crop cycle takes 30-35 days. Hence a number of crops can be taken during the above period.

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**Paddy Straw Mushroom**

Various steps involved in its cultivation are:

**i) Preparation of substrate :** Fresh straw is tied in bundles of ½ to 1 kg weight and upto 25 cm in diameter 1.2 m long. These bundles are then steeped in clean water in a tank or drum for about 12 hours. Then the moistened straw bundles are laid on slightly raised concrete floor or on raised wooden platform in layers. Beds should not be more than 90x90x120 cm size.

**ii) Spawning :** Spawning or seeding of beds is done simultaneously while preparing them. 15-20 g spawn (seed) is used per kg paddy straw. Each layer of bed is spawned by broadcasting the grain spawn or by placing the straw spawn at different spots, 10-15 cm apart leaving 10-15 cm unseeded on the sides. No seeding is done below the uppermost layer. Tur or gram daal powder is sprinkled over the spawn at the rate of 200 g per bed to enhance growth. The beds are subsequently covered with a polythene sheet in order

to raise the temperature and also to maintain high humidity. In no case, the polythene sheet used for covering the beds should come in direct contact with the compost. Fresh and good quality spawn (3-4 weeks old) may be used to get optimum yield.

**iii) Cropping and harvesting :** If the polythene sheets have been used for covering the beds they should be removed as soon as the substrate gets impregnated by the mycelial strands of the fungus which appear as brownish and woolly threads. Good spawn run usually takes about 8-10 days at 30-35°C. Afterwards pinheads start appearing on the beds. They grow very fast and turn into egg-shaped 'button'. These should be harvested before they open. Fruit bodies usually appear in two flushes in 25-30 days. Light sprinkling of water is essential during cropping to avoid drying of beds.

**iv) Diseases and pests :** The straw beds usually show heavy infestation of the competitor moulds like *Sclerotium rolisii* and *Coprinus* spp. Which adversely affect spawn run as seen by poor crop. This can be avoided by taking fresh straw steeping it in hot water (30°C) for 2 hours before use or spraying with Bavistin (0.1%) during heap making. The young fruit bodies of *Coprinus* spp. should be removed and destroyed.

**v) Marketing and consumption :** This mushroom is highly perishable and should be marketed and consumed as soon as possible after harvest. Because of their very high moisture content (90-92%) they lose weight very fast hence they are not suited for storage. The mushroom can be dried, dehydrated and stored for subsequent use.

**(D) Cultivation of Milky mushroom (*Calocybe indica*)**<sup>8,9</sup> The milky mushroom is a potentially new species to the world mushroom growers. It is a robust, fleshy, milky white, umbrella like mushroom, which resembles button mushroom. It grows well at a temperature range of 25-35°C and relative humidity more than 80%. Milky mushrooms can be cultivated throughout the year in the entire plains of India.



**Milky Mushroom**

The cultivation technology is very simple,

involves less cost and no special compost is needed for the cultivation. The milky mushroom has an extended shelf life of 3-5 days compared to other cultivated species, making it more amenable to handling, transportation and storage. The production technology of milky mushroom involves following steps:

**i) Preparation of Substrates :** Milky mushroom can be cultivated on a wide range of substrates like, paddy straw, maize stalks, sorghum stalks, pearl millet stalks, palmarosa grass, vetiver grass, sugarcane bagasse, soyabean hay, groundnut haulms etc. For commercial production paddy straw is the best substrate.

**ii) Pasteurisation :** Polythene bags of 60x30 cm or 75x45 cm size are used for bed preparation. Chaffed paddy straw bits of 3-5 cm length are soaked in cold water for 4-5 hours. After draining the excess water, the straw bits are boiled for 45-60 minutes in a separate drum. Chemical treatment with a solution containing carbendazim and formalin can also be followed. After treatment, the substrate is shade dried to remove excess moisture before bed preparation. At the time of bed preparation the substrate should contain around 60% moisture.

**iii) Spawning and spawn run :** Milky mushroom is also propagated through spawn. Spawn produced with sorghum grain/paddy chaff as substrate is most commonly used. With each bottle of spawn 2 cylindrical beds can be prepared. Cylindrical beds are prepared following layer method of spawning. A layer of straw is laid and sprinkle one tablespoon full of spawn over the filled straw around the peripheral region. A second layer of processed straw is filled and spawned as above. Repeat the process until the soaked straw is

finished. Finally the bag is close tightly with twine and the beds are incubated for spawn running under semi-dark condition in a clean room. Spawn run will be completed in 12-15 days at 30-35°C.

**iv) Casing :** After the completion of spawn run, the cylindrical beds are cut horizontally into two equal halves. Casing soil is applied on to both halves to a height of 1-2 cm. The casing soil is prepared by steaming garden soil for one hour.

**v) Cropping :** After casing, the beds are to be incubated over racks in a partially sunken chamber lined with blue coloured high-density polythene sheet as roofing material. Optimum relative humidity of 80-95%, room temperature of 24-28°C and light intensity of about 1600 -3200 lux should be maintained in the cropping room. Proper ventilation for gaseous exchange is also essential in this chamber. The beds are regularly sprayed with water to maintain 50-60% moisture level on the casing surface. Pinheads appear in 8-10 days after casing and the first harvest can be made in 6-8 days after pinhead formation. After obtaining the first harvest the casing medium is gently ruffled, slightly compacted back and sprayed regularly with water. Second and third harvest may be obtained within 45-50 days of bed preparation.

**vi) Economics of cultivation :** On an average single mushroom weighs 55-60 g and mean yield is 356 g/bed, which accounts to 143% bio-efficiency. Milky mushroom is a rich source of protein with protein content of 32.3% and fetches high market price compared to oyster mushrooms. It is highly suitable for drying, canning, soup powder preparation and pickle making.

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