

E content for

EXP 401 - EXPERIENTIAL LEARNING – II - 0+5

COMMERCIAL MUSHROOM PRODUCTION



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Practical Manual cum Record

This material has been prepared by teaching staffs of Tamil Nadu Agricultural University for academic purpose only

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EXP 401 Experiential learning

Commercial Mushroom Production (0+5)

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Name: -----

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Ex. No: 1 STUDYING THE GENERAL CHARACTERS OF MUSHROOM
Date:

A mushroom is the fleshy, spore-bearing fruiting body of a Basidiomycetous or Ascomycetous fungus, typically produced above ground on the soil or below ground as mycorrhizal fruiting bodies like *Tuber melanosporum* and *T. regium* that grow in association with oak trees. They may also be wood degraders as that of *Pleurotus* and *Lentinus* spp. Some of the mushrooms are humicolous as that of *Agaricus* and *Calocybe* spp. Basically the structure of a fruiting body consists a stem (stipe), a cap (pileus) and gills (lamellae, sing. lamella) on the underside of the cap. However, "mushroom" can also refer to a wide variety of fungi, with or without stems. More practically, the edible fruiting bodies are called mushrooms while the poisonous ones are referred as toadstools. Forms deviating from the standard fruiting body architecture are usually known with specific names, such as "puffballs", "stinkhorn", "morel" etc., Mushrooms and toadstools are included under the phylum Basidiomycotina and Ascomycotina (Class: Discomycetes, Order: Pezizales and Family: Morchellaceae) also produce fleshy fruiting bodies which are used as food. They are commonly called as Morels and Truffles. Their fruiting bodies appear in all seasons although mostly, during rainy season, on all types of soils, pastures, forests, wastelands and in cultivable lands

There are about 700 edible and medicinal mushrooms explored worldwide. However, the following mushrooms are preferred for large-scale cultivation.

1. Button mushroom - *Agaricus* spp
2. Shiitake mushroom - *Lentinus* spp
3. Oyster mushroom - *Pleurotus* spp.
4. Paddy straw mushroom - *Volvariella* spp.
5. Jew's ear mushroom - *Auricularia* sp
6. Milky mushroom - *Calocybe* spp.

Mushroom Biology, Mushroom Science and Mushroom Technology

Although it sounds similar, Mushroom biology deals with the morphology, life cycle and breeding methods systems in mushrooms; mushroom science deals with the theory, cultural requirements and concepts for growing various mushrooms; while, mushroom technology deals with the actual production, processing and value addition of mushrooms inclusive of backward and forward linkages of the industry.

Prospects of Mushroom Growing:

1. Highly nutritious food

Mushroom is the safest complete food that could be consumed by all age groups including children, adults and age old. It is one of the good sources of protein, low calorie food with minimum fat in the form of ergosterol a supplement to fatty acid requirement. The protein consumption in India is far below the International level and most of the people in rural India suffer due to protein malnutrition. In recent years, the importance of mushroom as a good source of protein is well received and lot of emphasis is given for popularization of commercial mushroom growing to support large scale protein harvest.

Proximate composition of the 3 mushroom species (Chang and Miles, 2004)

A. Contents	<i>A.bisporus</i>	<i>L. edodes</i>	<i>Pleurotus spp</i>	<i>C.indica</i>
Moisture	84.5	90.9	82.0	85.6
Crude protein	29.3	15.5	20.5	32.3
Crude fat	4.8	6.5	1.9	0.7
Total carbohydrate	57.0	72.8	69.7	59.8
N-free carbohydrate	48.8	65.1	61.6	48.6
Total dietary fibre	9.2	7.7	8.1	41.0
Ash	9.9	5.4	7.9	8.9
Energy value	348	389	356	368

Note: All data are presented as percentage of dry weight, except moisture (percentage of fresh weight) and energy value (Kcal per 100g dry weight).

Comparative statement on Protein (%) in various food sources

Mushroom	-	2.9
Peas	-	2.6
Cabbage	-	1.5
Carrot	-	1.1
Cauliflower	-	2.7
Potatoes	-	2.1
Apple	-	0.3
Banana	-	1.1
Rice	-	0.7
Wheat	-	1.3
Soybean	-	3.9
Milk	-	2.5

2. Recycling of farm residues

Mushroom cultivation is much useful in recycling of organic waste like paddy straw and other farm residues for better utilization as substrates for growing mushrooms. The spent waste of the substrates is used as very good manure enriched with the nutrients. In addition, the mushroom spawn can be successfully used for decomposing coir pith as enriched manure. The straw substrate after harvesting mushroom can be better utilized as a nutritive cattle feed.

3. Additional income

Mushroom culture is one of the important components of Integrated Farming System and farmer/ farmwomen can get additional income from the mushroom culture by utilizing the lean seasons/ leisure hours to increase his economic status.

4. Solves unemployment Problems

The mushroom culture serves as a low investment venture for the Unemployed graduates. Mushroom cultivation can be started with a very minimum capital investment and it does not need any sophisticated equipment/ techniques. So it is a very profitable venture for the persons interested in self-employment.

5. New food products development

The mushroom cultivation encourages the development of new food products and gives chances of employment for the people involved in the new industries/ commercial units. The some of the new food products developed using the mushroom are canned mushrooms, Mushroom soup powder, papads, noodles and pickles etc.

6. Increases foreign revenues

The potential for export of new food products of mushroom is really felt by the mushroom growers and a large quantities of button mushroom is exported to foreign countries like U.S.A. and other European countries to get foreign exchanges. In addition, great demands for the mushroom pickles and mushroom papads are noticed in other countries.

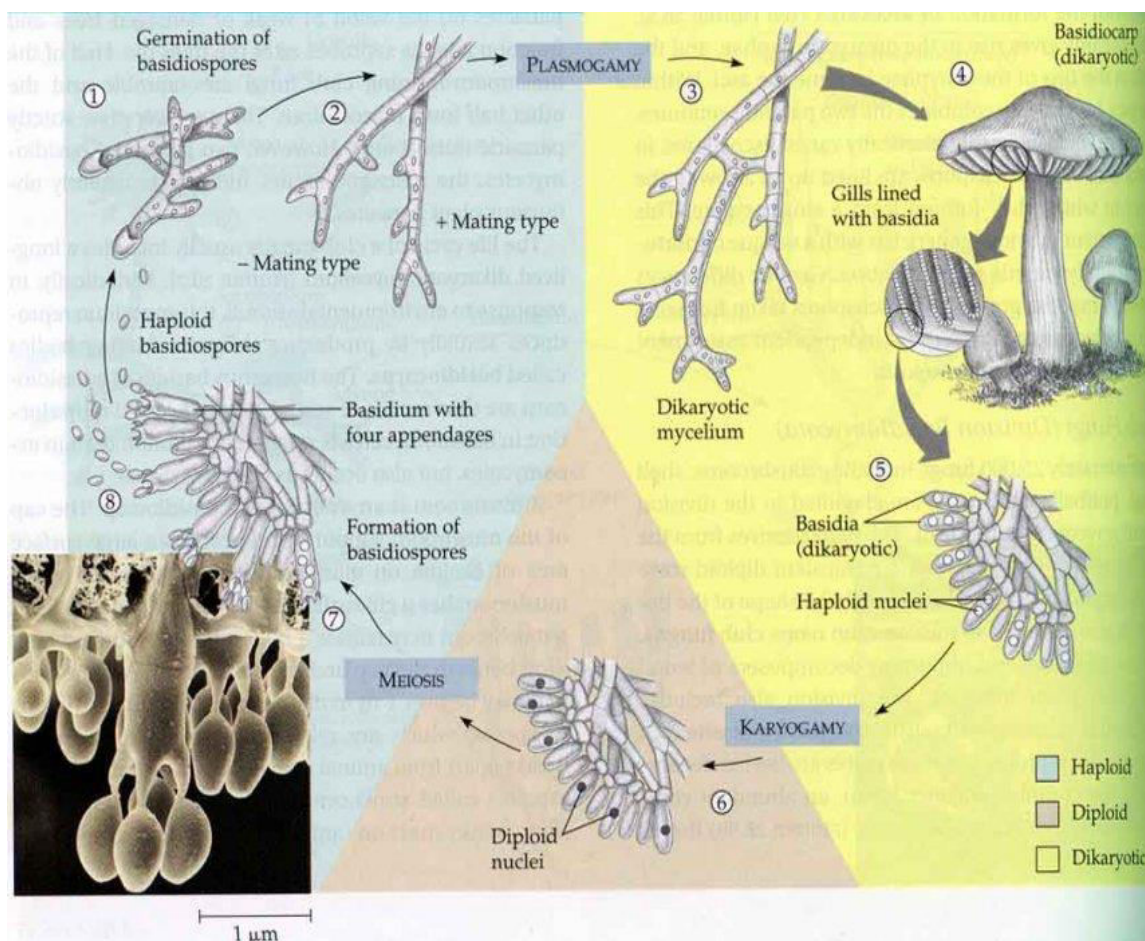
7. Used as medicines

Because of very low fat content, it is very good food for hypertension patients. It also serves as a very safe food for Diabetic people because of its low carbohydrate content. In addition it cures peptic ulcers and constipation because of the more fibre content in the mushrooms. The continuous uptake of *L.edodes*, *F.velutipes* and *A.bisporus* critically reduces

the blood cholesterol level. Several alkaloids and extracts obtained from the mushrooms act as medicines for curing several ailments. Anti tumour principles are reported to present in *Agaricus bisporus*, *Lentinus edodes*, *Pleurotus ostreatus* and *Flamulina velutipes*. The alkaloids from *Agaricus campestris* also act as anti bacterial compounds, some of the extracts like 'Lentinan' and 'rentinan' from *L. edodes* cures cancer and it also reported that the continuous use of this mushroom is very effective in reducing the HIV population to recover from AIDS syndrome. It is also used as a liver protectant.

LIFE CYCLE OF MUSHROOM

In the phylum Basidiomycotina, three types of mycelia viz., primary, secondary and tertiary, are noticed. The primary mycelium is monokaryotic and is formed by germination of basidio-spores. These are of different mating types and give rise to secondary mycelium by somato-gamy or fusion of two basidiospores. The secondary mycelium forms major portion of the somatic phase and later produces tertiary mycelia, which give rise to fruiting body-basidiocarp (mushroom).



Ex. No: 2

Date:

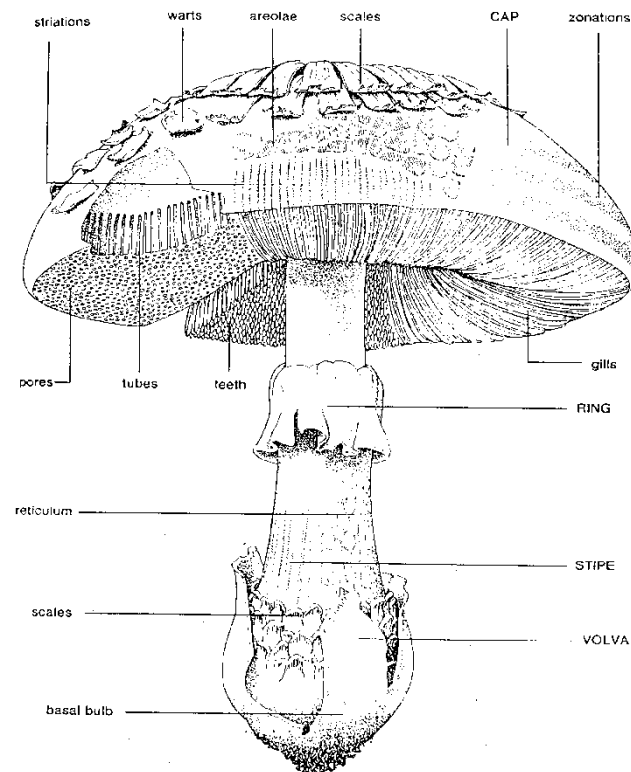
DIFFERENT TYPES OF MUSHROOMS AND THEIR MORPHOLOGY

Mushroom varieties / strains released from TNAU / India for commercial cultivation

Scientific Name	Variety / Strain	Year of Release	Scientists responsible
Oyster mushroom			
<i>Pleurotus sajor caju</i>	M2	1983	Jandaik <i>et al.</i> , 1975
<i>P. florida</i>	Pf	1983	Bano <i>et al.</i> , 1965
<i>P. citrinopileatus</i>	CO1	1986	Sivaprakasam <i>et al.</i> , 1986
<i>P. platypus</i>	Pp	1990	Marimuthu <i>et al.</i> , 1990
<i>P. eous</i> (= <i>P. salmoneo stramineus</i>)	APK 1	2000	Muthusamy <i>et al.</i> , 2000
<i>P. djamor</i>	MDU 1	1996	Geetha <i>et al.</i> , 1996
<i>P. flabellatus</i>	MDU 2	2000	Sivaprakasam <i>et al.</i> , 2000
<i>P. ostreatus</i>	Ooty 1	1995	Mohan <i>et al.</i> , 1995
<i>Hypsizygus ulmarius</i>	CO (OM)2	2004	Krishnamoorthy <i>et al.</i> , 2004
Milky mushroom			
<i>Calocybe indica</i>	APK 2	1998	Krishnamoorthy <i>et al.</i> , 1998
<i>Tricholoma giganteum</i>	CO(TG) 3	2012	Prakasam <i>et al.</i> , 2012
Button mushroom			
<i>Agaricus bisporus</i>	AB1(Ooty1)	1998	Mohan <i>et al.</i> , 1998
<i>Agaricus bisporus</i>	AB1(Ooty2)	2005	Ramaraj <i>et al.</i> , 2005

Morphology of Mushroom

Two important parts of the mushroom are the thread like structures called mycelium and the fruit bodies or sporocarps formed under suitable growth conditions. The typical mushroom may represent following different parts.



The cap or pileus: This part is thick, membranous or corky with some variation in its shape, size and colour. The surface of the pileus may be scaly, hairy, rough or smooth.

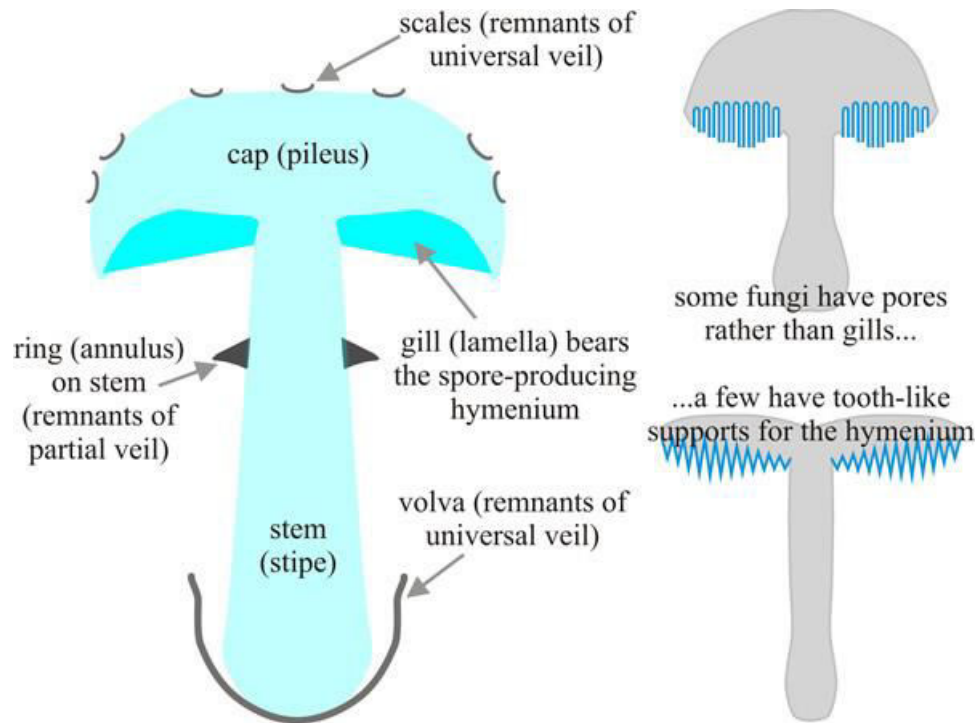
The gills or lamellae: These are usually situated below the cap from the mushroom starting from the apex of the stalk to the margins of the pileus or cap. Gills also called as lamellae, bear the spores in most cases.

The veil: The veil covers the gills and extends from the margin of the cap to the stalk. When fruiting body matures, the veil expands along with the cap and breaks away resulting in some of its part commonly attached to the margin of cap.

The annulus: A ring is formed around the stipe, known as annulus. Annulus may be present or absent in different varieties.

The stipe or stalk: Stipe or stalk may be present or absent in different species of mushrooms. In most of the genera, it remains centrally attached to the cap. In some others, it may be cylindrical or spindle shaped in morphology with or without bulbous structure at the base.

The volva: In many varieties, fruiting bodies remain covered by a veil. With the development of fruiting body, this veil breaks and one of its parts may remain present at the base forming a cup like structure known as volva. It usually surrounds the base of the stalk. The presence or absence of volva is an important factor in classification of mushrooms.



Exercise:

- Draw the diagram of Oyster mushroom , Milky mushroom, Button mushroom and paddy straw mushroom fruiting body and label the parts
- Take section of gills from oyster mushroom/ milky mushroom and observe under microscope

Ex. No. 3:**IDENTIFICATION OF EDIBLE AND POISONOUS MUSHROOMS****Date:**

So far no well perfected technique is available to distinguish edible mushrooms from poisonous ones. Some of the criteria suggested by mycologists for general classification is given below. The above said characters may not be fully correct to identify the edible / poisonous mushrooms as some of the edible mushrooms are also brightly coloured with some ornamentations, scales and pleasant odour. Similarly, some of the white coloured ones are also poisonous, without scales and having pleasant smell. Some of the edible mushrooms also have a prominent volva. Hence, lots of practical experience is needed for perfect identification.

EDIBLE MUSHROOMS

Character	Edible mushroom	Toadstool
Colour	White or Grey	Ornamental
Scales	Absent	Present
Smell / Odour	Pleasant smell	Unpleasant smell
Cooking:		
Using silver spoon	No change in the color of spoon	Color of spoon changes to black
Cooking with onion	No color change in onion	Color of onion changes to black
Presence of Latex	Absent	Present
Presence of tough volva	Absent	Present

Mycophagy is the art of hunting and eating wild edible mushrooms.

S.No.	Common name	Scientific Name
1.	Paddy straw mushroom, Tropical straw mushroom, Chinese mushroom	<i>Volvariella volvacea</i> <i>V. diplasia</i> , <i>V. bombycina</i>
2.	White button mushroom, European mushroom	<i>Agaricus bisporus</i> <i>A. arvensis</i> <i>A. campestris</i>
3.	Tropical button mushroom,	<i>A. bitorquis</i>
4.	Oyster mushroom, Dhingri mushroom	<i>Pleurotus sajor – caju</i> <i>P. citrinopileatus</i> , <i>P. djamor</i> <i>P. eous</i> , <i>P. pulmonarius</i> <i>P. sapidus</i> , <i>P. eryngii</i> <i>P. fossulatus</i> , <i>P. opuntiae</i> <i>P. membranaceus</i> , <i>P. cystidiosus</i>
5.	Milky mushroom, Dhuthi chitta (Indian origin)	<i>Calocybe indica</i> <i>C. gambosa</i>

6.	Winter mushroom, Velvet stem mushroom	<i>Flammulina velutipes</i>
7.	Nameko mushroom	<i>Pholiota nameko</i>
8.	Jew's ear mushroom, wood ear mushroom	<i>Auricularia auricula</i> , <i>A. polytricha</i> , <i>Lentinus edodes</i>
9.	Shiitake mushroom, Black mushroom, Black forest mushroom	<i>L. conatus</i> <i>Straphaeria rugosa- annulata</i>
10.	Giant mushroom, Brown cap, Giant of Garden	<i>Tremella fuciformis</i>
11.	Silver ear mushroom, White jelly mushroom	<i>Amanita caesarea</i>
12.	Caesar's mushroom	<i>Armillaria mellea</i>
13.	Honey fungus , Boot lace fungus	<i>Boletus edulis</i>
14.	Pore fungus, Penny bun	<i>Cantharellus cipharius</i>
15.	Chantarelle mushroom	<i>C. infundibuliformis</i> , <i>C. auranticus</i>
16.	Fairy ring mushroom	<i>Marasmius orcadeus</i>
17.	Matsutake mushroom, Pine mushroom	<i>Tricholoma caligatum</i> , <i>T.matsutake</i>
18.	Inky caps, dung mushroom, shaggymane, Lawyer's wig	<i>Coprinus lagopus</i> , <i>C. comatus</i> (unopened white buttons are edible)
19.	Bamboo sprouts, Lady veil mushroom, Flower of the fungi, King of dried foods	<i>Dictyophora duplicata</i>
20.	Maitake mushroom, Hen-of-the Woods	<i>Grifola frondosa</i>
21.	Termite mushroom	<i>Termitomyces clypeatus</i> <i>T. microcarpus</i> , <i>T.robustus</i> <i>Hericeum erinaceous</i>
22.	Monkey head, Bear's head mushroom	<i>Morchella esculenta</i> , <i>M. conica</i> ,
23.	Morels, Gucchi, (Ascomycetous mushroom)	<i>M. hybrida</i> , <i>M. angusticeps</i> , <i>M. deliciosa</i> , <i>M. crassipes</i>

POISONOUS MUSHROOMS

In fact only a very few mushrooms are deadly poisonous. Sometimes even the commonly available edible mushrooms may show allergic reactions in isolated cases. It is

always better to use only known species for food purpose. It is advisable to take a little quantity to check the edibility of a new mushroom. Moreover, use only freshly collected undamaged mushrooms for eating. The list of some deadly poisonous mushrooms is given below:

Sl.No.	Poisonous Mushroom	Name of Toxins
1.	<i>Amanita phalloides</i> (Death cap)	Amatoxin, phallin, phalloidin, phallolysin Amatoxin
2.	<i>A. pantherina</i> (The Panther)	Muscarine, musaridine, muscimol
3.	<i>A. muscaria</i> (Fly agaric)	Virotoxin, phalloidin
4.	<i>A. verosa</i> (Destroying angel)	Amatoxin
5.	<i>A. brunnescens</i>	Muscarine
6.	<i>A. gemmata</i>	α - amanitin , β -amanitin
7.	<i>A. verna</i>	Muscarine
8.	<i>Inocybe patouillardii</i> , <i>I. fastigata</i>	Amanitin
9.	<i>Cortinarius speciosissimus</i>	Muscarine
10.	<i>Clitocybe dealbata</i> , <i>C. rivulosa</i>	Gyrimitrin
11.	<i>Gyromitra esculenta</i>	Psilocybin
12.	<i>Paxillus involutus</i>	Psilocybin, psilocin
13.	<i>Russula livides</i>	Psilocybin, psilocin
14.	<i>Psilocybe semilanceata</i> , <i>P. argentipes</i>	

MYCETISMUS (Mushroom poisoning) is mainly due to presence of some toxic principle in those mushrooms and can be broadly grouped under four categories. Among them the protoplasmic poisoning is the most dangerous one.

1. Protoplasmic toxins: Some of the species of *Amanita* like *A. phalloides* and *A. virosa* contain the complex toxins. They may be grouped as amatoxins and phallotoxins. The 'Death Cap', *A. phalloides* contains six related phallotoxins and five amatoxins leading to complex symptoms like abdominal pain, diarrhea and vomiting. If proper treatment is not given, it leads to severe kidney and liver damage with ultimate death of the patient.

2. Muscarine poisons: This group of toxins attacks central nervous system, resulting in profuse sweating, vomiting and convulsions. Some of the examples are *A. muscaria*, species of *Clitocybe* and *Inocybe*.

3. Gastro- intestinal irritants: These toxins cause digestive disorders. Important symptoms are abdominal pain, vomiting and frequent urination. Species of *Boletus*, *Hygrophorus*, *Lepiota* and *Paxillus* are some important mushrooms of this group.

4. Hallucinogenic effect: Some species of mushroom are known to cause hallucinogenic diseases when consumed. Species of *Panaeolus* and *Psilocybe* are known to contain the toxic chemical, “Psilocybin”, which affects the neuro transmitter function, leading to confusion, anxiety, aggression, violence and finally giddiness.

The mushroom poisoning is very common among children. The next affected group includes drug addicts who consume wild mushroom for ritualistic and hallucinogenic effects. The other group includes the amateurs who used to collect and consume wild mushrooms. In the case of mushroom poisoning, proper diagnosis and clinical course could be immediately taken up, if the suspect mushroom is readily available and can be identified with a help of a competent mycologist. Diagnosis and treatment could be possible by analyzing the mushroom dish consumed or from the vomitus or gastric contents of faeces, if the suspect species is not available.

Collecting fungi for identification

Collecting fungi for identification is an important stage of this process and attention must be paid. For collecting specimens one will need some consumables and suitable equipment.

First of all suitable paper bags or plastic boxes are needed to store the specimens when collecting in the field. Plastic bags are not recommended as mushrooms tend to disintegrate or change features. Alternatively aluminum foil may be used to carefully wrap the basidiomata, gathered for identification. If the specimens could not be processed on the same day, they might be kept for a certain time in a fridge, but freezing is not suitable. When collecting mushrooms for identification, basidiomata and ascomata of different ages should be collected, when this is possible, as in many fungi there might be striking differences between young and mature mushrooms. As in some of them certain characters might be ephemeral and disappear in a few hours, taking photographs in the field is most recommended. A small tag containing GPS data, date of collection and place should be placed near the mushroom and photographed.

When the specimens are once taken, the next important step is to carefully take notes on vital characters, which are important for achieving correct identification. Taking notes of as much characters as possible, e.g., features of the pileus (size, colour, surface, shape, margin), stipe (size, shape, colours), veil (presence or absence, type, remnants), flesh (colour, colour changes, surface, smell, in certain cases the taste might be important, but one should never taste any unknown mushroom as to avoid poisoning), hymenophore (type, colour, colour changes, shape, attachment, etc.), is very important for subsequent identification as explained in Morphology. In many cases, for arriving at the correct identification, the micromorphological characteristics of specimens should be examined with the aid of a microscope. Anatomical features (e.g. spores, cystidia, basidia, basidioles, hyphal systems, hyphal walls, septations, hyphal branching, hyphal inflations and specialized hypha) could be thus evaluated.

Finally, a spore-print should be prepared. After all this is done, one may proceed with the identification using suitable guides and identification handbooks. In many cases precise identification may be only achieved after the study of fungal specimens under a microscope. In certain cases, specimens may be stored, especially when a scientific study is intended. Specimens are dried either in open, or in dryers, and it is recommended that drying temperature do not exceed 45 °C. After drying the samples are kept in a dry place, in paper packages, labelled with the name of the species, if known, the locality of collection, the date and the name of the collector.

Exercise:

- **Prepare a spore print of oyster mushroom**
- **Dry the given oyster mushroom sample and store it**
- **Draw four edible mushroom (other than oyster, milky, paddy straw , shitake and Jews ear) and four poisonous mushrooms using colour wherever needed**

Ex. No. 4:

Date:

**MORPHOLOGICAL CHARACTERS OF *PLEUROTUS*, *AGARICUS*
VOLVARIELLA AND *CALOCYBE***

1	BUTTON MUSHROOM (<i>Agaricus bisporus</i>) - Ooty 1 and Ooty 2 • Temperate mushroom -Highly suitable for hills • Deep purplish brown free gills • Homothallic , 2 spored basidia • Cap/ pileus- round , stipe equal to cap size • stipe centrally situated • Distinct annulus on stipe • Edible types -Cream or white coloured • Temperature : 20- 22°C • Substrate: Compost	
2	OYSTER MUSHROOM (<i>Pleurotus</i> sp.) • Sub tropical mushroom • Genus – more than 50 species • Short stipe , colour of stipe & pileus same • distinct shell shape, soft ,mostly white – or pink, dull white, grey, yellow • stipe laterally attached to pileus, decurrent gills • Heterothallic, 4 basidiospores • Cultivated in thatched sheds • Temperature : 25- 28°C and RH – 85 %	
	a. <i>Pleurotus florida</i> PF • Dull white in colour • Pileus dia: 5-7 cm ,stipe :2cm • Keeping quality 48 h under refrigeration • Substrate: Paddy straw • Bioefficiency: 140 -160 % • cropping cycle: 40-45 days	
	b. <i>Pleurotus eous</i> -APK1 • Pileus smooth, dry, pink coloured, leathery 2.5cm • Short stipe: 1.5cm • More fibre content- shelf life 2 days normal + 1 day refrigerated • Bioefficiency: 120- 130% • Cropping cycle: 23-26 days	

	c. <i>Pleurotus sajorcaju</i> M2 • Grey to dull white in colour, fleshy • Also highly suitable for coir pith decomposting • Bioefficiency: 80- 110 % • cropping cycle: 40-45 days	
	d. <i>Hypsizygus ulmarius</i> -CO(OM)2 • Buds grey in colour initially, fading to white at maturity • Stipe fleshy, long 3.5- 4cm long, • Margin of pileus curved back • shelf life : 3 days • Bioefficiency- 145-160% • Cropping cycle:45-50 days	
3.	MILKY MUSHROOM - <i>Calocybe indica</i> - APK 2 • Pure milky white colour • similar to button mushroom in appearance • Long stipe, sub bulbous at the base, centrally attached to stipe, no annulus or volva • Pileus/ cap- smooth, convex later expanded • Adnate to decurrent gills • Spores- hyaline broadly ellipsoidal • Long shelf life: more fibre(41%) • Cultivated in polysheds	
4	TRICHOLOMA GIGANTEUM var.Co 2 • Similar to milky mushroom in appearance • Stipe is sub bulbous • sinuate attachment of gills to stipe • No annulus or volva • Pileus fleshy, dry, glabrous and fibrillose • Bioefficiency : 150 -165 %	

5	PADDY STRAW MUSHROOM – <i>Volvariella volvacea</i> • Volva distinct character • Pileus initially bell shaped, later umboniform • Stipe colour white & long (5-12 cm), pileus light brownish red • Homothallic mushroom • Cultivated in poly sheds and outdoor cultivation • Temp:30-35°C ,RH- 85%	
6	JEWS EAR MUSHROOM – <i>Auricularia polytricha</i> • Gelatinous fruiting bodies • Stipe not visible, no gills, ear shaped • Sporophore dark coloured, • Slightly hairy on the surface, velvety • Heterothallic mushroom • High medicinal values • Temperature : Mycelial growth :25-30°C fruiting : 23 - 25°C	
7	SHIITAKE MUSHROOM - <i>Lentinus edodes</i> • Stipe white/reddish brown scales at joints, long, pileus light yellowish brown • pileus fleshy, convex, depressed, umbonate when old, scales darker in centre coriaceous, tough and hard when old • Gills decurrent ,easily separable from stipe & free • High medicinal values • Spores-white ,cylindrical • Different temperature (18-28 ° C) and RH requirements of 70 to 80 % at various growth stages	

Exercise: Observe the different morphological characters of mushrooms and draw mushrooms (use colour where ever needed) in the space given above

Ex. No. 5:

Date:

CULTURE MEDIA PREPARATION AND TISSUE CULTURE & THEIR OPERATION

The following equipments are the essentials needed for culture media preparation and tissue culture.

1. Autoclave/ Pressure cooker

Autoclave is a container used for sterilizing liquid media as well as other substrates employing super heated steam under pressure. It is double – walled equipment, packed with glass wool in between to maintain the heat, fixed with heating elements in the bottom. A safety valve is also fixed to protect the equipment from high-pressure development and an outlet to release air and steam before pressure built up. The pressure cooker also works on the same principal but the pressure built inside the vessel cannot be measured as Pressure gauge is missing. For small scale cultivation, pressure cookers can be used, but autoclaves should be engaged for large scale commercial cultivation.

2. Hot Air Oven

It is a hot air chamber mainly used to sterilize glass wares like petri dishes, flasks, beakers, test tubes etc. The above materials are sterilized by maintaining the temperature ranging from 120° to 180°C for a specified time.

4. Culture room (Inoculation Chamber)/ Laminar Air Flow Chamber

Culture room is a most essential facility required for preparation of fungal cultures and spawn production. The size of room may be 3mX3mX3m with air tight false roofing and a tight fitting door. A clean platform may be constructed or otherwise a laminated table may be placed inside the chamber. An Ultra Violet (UV) light should be fixed for sterilizing the chamber for sterilizing the room before operation. A fluorescent light may also fixed inside for using at the time of working inside the chamber. A gas cylinder and a Bunsen burner are the other items necessarily kept inside the unit. In addition, a small plastic tray may be kept inside to keep razor blades, inoculation needles, forceps etc.,

Airflow chambers of different dimensions are available readily for use. In this chamber, the atmospheric air taken in and sterilized air is gently flow inside the work chamber while operating. An UV lamp is fixed inside the work chamber for sterilizing before using the equipment.

Operation of Equipments:

a) Operation of autoclave:

Clean the equipment using clean water

|

Fill water to a level to immerse the heating coils fixed in the bottom

|

Keep the perforated trays / plate supplied with the equipment to avoid direct contact of the material with the heating element

|

Arrange neatly the materials / media to be sterilized, over the perforated tray

|

Close the top lid by tightening the knobs/ bolts given at the top

|

Connect the power cable to the electrical power box and switch on

|

Open the air outlet and allow the air to come out. The air outlet should be closed immediately on noticing the escape of steam with a hissing noise

|

Allow the pressure to build up and maintain the required pressure for a required period

|

Switch off the power and allow the equipment to cool, gently open the lid and take the sterilized material out for further use

b. Operation of Pressure cooker:

Wash the cooker with clean water and keep the perforated plate at bottom

|

Fill water to a height of 3-5 cm for short-term sterilization, i.e. 15- 30 minutes. For long time sterilization, fill water to a height of 9-10 cm

|

Arrange the materials and close the lid

|

Heat the cooker and place weight after release of air and steam with hissing noise

|

Keep the burner in low flame position after two whistling, note the time and continue heating for a required period of time

|
Put off the flame after required time and allow the cooker to cool

|
Open the lid gently and take out the material

3. Operation in Culture room:

Using an antiseptic lotion or 1 % dettol clean the table/ platform

|
Keep all the materials to be used inside the chamber and switch on the UV light from outside

|
Switch off the UV light after a period of 20 minutes and use the sterilized room after 5 minutes

|
Clean the room after use with antiseptic lotion and keep always free of dust

Note: Fungal cultures or mother spawns should not be kept inside while using the UV light. Do not enter when UV light is on and avoid looking at the UV light while glowing.

Exercise:

- **Draw the diagrams of Autoclave, Laminar Air Flow Chamber, etc.**
- **Collect informations related to commercial suppliers of laboratory equipments and scientific suppliers.**

Ex. No: 6

Date:

EQUIPMENTS REQUIRED FOR SPAWN PREPARATION AND THEIR OPERATION

The following equipments are essential for spawn preparation.

Autoclave/ Pressure cooker

Autoclave is a container used for sterilizing liquid media as well as other substrates employing super heated steam under pressure. It is double – walled equipment, packed with glass wool in between to maintain the heat, fixed with heating elements in the bottom. A safety valve is also fixed to protect the equipment from high-pressure development and an outlet to release air and steam before pressure built up. The pressure cooker also works on the same principal but the pressure built inside the vessel cannot be measured as Pressure gauge is missing. For small scale cultivation, pressure cookers can be used, but autoclaves should be engaged for large scale commercial cultivation.

Culture room (Inoculation Chamber)/ Laminar Air Flow Chamber

Culture room is a most essential facility required for preparation of fungal cultures and spawn production. The size of room may be 3mX3mX3m with air tight false roofing and a tight fitting door. A clean platform may be constructed or otherwise a laminated table may be placed inside the chamber. An Ultra Violet (UV) light should be fixed for sterilizing the chamber for sterilizing the room before operation. A fluorescent light may also fixed inside for using at the time of working inside the chamber. A gas cylinder and a Bunsen burner are the other items necessarily kept inside the unit. In addition, a small plastic tray may be kept inside to keep razor blades, inoculation needles, forceps etc.,

Airflow chambers of different dimensions are available readily for use. In this chamber, the atmospheric air taken in and sterilized air is gently flow inside the work chamber while operating. An UV lamp is fixed inside the work chamber for sterilizing before using the equipment.

Sorghum grains: Sorghum grains are essential for preparation of mother and bed spawn production.

Calcium carbonate: Calcium carbonate (CaCo₃) is used for spawn preparation (CaCo₃ - 20g per kg of sorghum grains is added).

Hessian cloth rolls: These are essential for drying boiled straw as well as cooked sorghum grains.

Polypropylene bags: Polypropylene bags of size, 27 cm x 12 cm with a thickness of 200 gauge are used for spawn preparation.

Cotton wool: Non –absorbent cotton wool is used for plugging spawn bags. Absorbent cotton rolls are required for cleaning the culture room/ inoculation table etc.,

Miscellaneous items: Gas stove, Small balance (1 Kg capacity), plastic trays, jute thread balls, cotton thread balls, conical flask of different capacity, Petri plates, test tubes, boiling test tubes, funnel, muslin cloth, pH indicator papers, Hydrochloric acid, Sodium hydroxide, antiseptic lotions, waste newspapers, glass/ iron rods, match boxes, permanent marker pens etc.,

Ex. No: 7
Date

EQUIPMENTS REQUIRED FOR SUBSTRATE STERILIZATION & THEIR OPERATION

The following equipments are the essentials for substrate sterilization.

Autoclave

Autoclave is a container used for sterilizing liquid media as well as other substrates employing super heated steam under pressure. It is double – walled equipment, packed with glass wool in between to maintain the heat, fixed with heating elements in the bottom. A safety valve is also fixed to protect the equipment from high-pressure development and an outlet to release air and steam before pressure built up. For autoclaves should be engaged for large scale commercial cultivation.

Chaff cutter

It is needed for chopping paddy straw into small bits of 2-3” for easy handling and bed preparation. Hand operated chaff cutters are available for small units and motor operated cutters can be used in large commercial units.

Other essentials:

Paddy straw: Freshly harvested and well-dried paddy is highly preferable. Paddy straw. Spoiled/ moulded paddy straw or cattle thrashed paddy straw are not suitable.

Cement trough or tank: This is used for soaking paddy straw before sterilization. Instead of this, G.I. drums/ barrels can be used for this purpose.

G.I. drums: G.I. drums of different capacities (50, 100 and 200 litres) are necessary. The paddy straw can be soaked in big drums and for boiling the straw, small one are preferable.

Chullah: It is used for boiling paddy straw, in the place of gas cylinder.

Wire baskets: Big sized wire baskets are necessary for draining excess water after soaking or boiling.

Exercise : Draw the diagram of chaff cutter

Ex. No: 8 PREPARATION OF CULTURE MEDIA – POTATO DEXTROSE AGAR (PDA),
Date : OATS MEAL AGAR (OMA), MALT EXTRACT AGAR MEDIUM (MEA)

Culture media are essential for isolation of mushroom fungus and maintaining them in a pure culture either in test tubes or in Petri plates. The fungal cultures may be grown in liquid media (Broths) or on Solid Agar media. (Agar Agar is a solidifying material obtained by purifying some seed weeds like *Geladium* sp., which melts on boiling and solidifies upon cooling).

Some of the commonly used media are listed below:

i) Potato Dextrose Agar (PDA):

Potato	: 250 g
Dextrose	: 20 g
Agar Agar	: 20 g
Distilled water	: 1000 ml. (pH : 7)

ii) Oatmeal Agar (OA)

Oatmeal	: 30 g
Agar Agar	: 20 g
Distilled water	: 1000 ml. (pH : 7)

iii) Wheat Meal Agar (WMA)

Wheat grain:	30 g
Agar Agar	: 30 g
Distilled water	: 1000 ml. (pH : 7)

iv) Malt extract Agar (MEA)

Malt extract :	25 g
Agar Agar	: 20 g
Distilled water	: 1000 ml. (pH : 7)

v) Yeast Potato Dextrose Agar (YPDA)

Yeast granules	: 1 g
Potato	: 200 g
Dextrose	: 20 g
Agar Agar	: 20 g (pH : 7)

Potato Dextrose Agar (PDA):

Potato Dextrose Agar medium is very commonly used for isolation of fungus as well as for its maintenance.

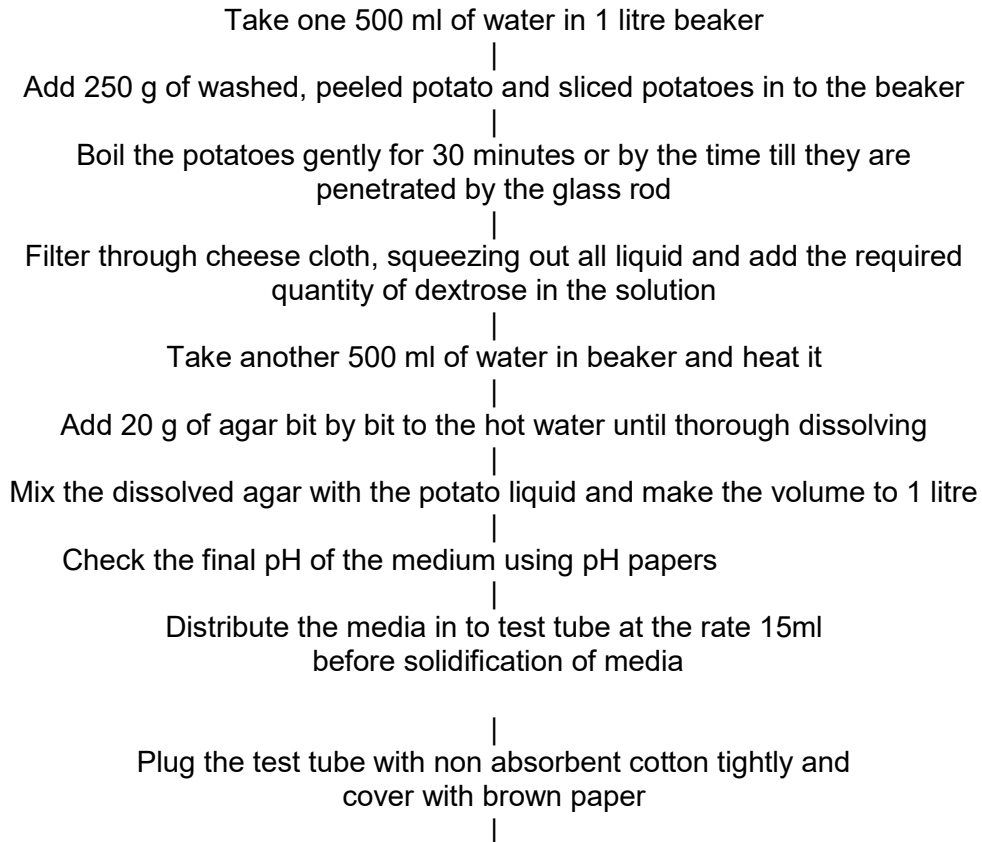
Requirements for preparation of PDA media

Potato, dextrose, agar, distilled water, conical flask (250 ml and 1 litre capacity), test tube, beaker 1 litre capacity, potato peeler, knife, muslin cloth distilled water, auto clave or pressure cooker, nonabsorbent cotton etc.,

Composition for one litre

Peeled potato tubers	:	250g
Dextrose	:	20g
Agar	:	20g
Distilled water	:	1 litre
pH	:	7.0

Procedure



Sterilize the flask with media in autoclave or pressure cooker at 121°C at 15 lb/inch² for 15 minutes

Take out the sterilized tubes after releasing the steam and keep them in a slanting position to get Agar slants

After solidifying, the tubes are arranged in a wire basket and stored in a clean room for further use

Procedure for checking pH:

Stir the medium with a glass rod and take a small bit of pH indicator paper and dip it in the medium. Take it out and compare the colour development with the colour chart given on the cover sheet of the filter paper book. If pH is above 7, add a few drops of 0.1N Hydrochloric acid (HCl), stir well and again check the pH for neutral. If needed this procedure may be continued till obtaining neutral pH. Contrastingly, if the pH of the medium is below 7, add a few drops of 0.1N Sodium hydroxide (NaOH) to increase the pH to 7. This may be continued till neutral pH is obtained. (Dilute 8.3 ml. of concentrated Hydrochloric acid with distilled water to 1 litre to get 0.1 N HCl: Dissolve 42 g of sodium hydroxide in 1 litre of distilled water to get 0.1N NaOH).

Sterilization techniques

Sterilization can be done using either physical or chemical agents to destroy the microbes present in the material to be cleaned.

1. Physical methods

Some of the commonly used sterilization techniques using physical agents are discussed below:

a) Dry Heat:

i) Flame heating: Objects, which are not easily affected by heat, are sterilized by exposing them into flame without allowing becoming red heat.

ii) Red Heat / incineration: Small instruments like inoculation needles, razor blades, scissors, scalpels and forceps can be sterilized by holding them in a Bunsen flame till they become red hot.

iii) Hot air: Glasswares like petri plates, test tubes, pipettes etc., can be sterilized in a hot air oven at 180°C for 1 hr. The apparatus should not be too closely packed to allow the air to circulate. It is best wrapped or in containers (Copper jackets) to retain sterility after treatment.

b) Moist Heat: Sterilization with a help of high pressure steam is the principle used in autoclaves / pressure cookers.

2. Chemical methods:

Several chemicals viz., ethyl alcohol, mercuric chloride, sodium hypochlorite, phenols, iodine, formalin, potassium permanganate etc., are normally used for surface sterilization. The duration of treatment varies depends on the nature of the material to be treated and concentration of the agent used. Ethyl alcohol is normally used at 50 % concentration. Mercuric chloride and sodium hypochlorite are used at 0.1 % concentration. Usually potassium permanganate and formalin are mixed at 1:2 ratio for fumigating culture rooms or mushroom sheds. After mixing the rooms should be closed tightly to avoid escape of fumes from the room and open after 24 hr.

3. Sterilization by filtration:

This principle is used in airflow chambers wherein working near the filtered air will prevent the entry of undesirable microbes into the chamber. In this chamber, motor fixed filter the particles in air up to the size of 0.33 mm in diameter and sterilized air is gently flow inside the work chamber.

Practical Exercise:

a) Prepare 1 litre of Potato Dextrose Agar medium and work out the cost for preparation of one agar slant.

b) Observe the tubes after 5 days of sterilization and record information:

i) Date of preparation of medium :

ii) Name of the medium prepared :

iii) No. of tubes/ flasks prepared :

iv) Date of observation for contamination :

v) Number of tubes/ flasks contaminated :

vi) Nature of contamination :

Fungi :

Bacteria :

Ex. No: 9
Date

PURE CULTURE TECHNIQUE – TISSUE ISOLATION

Base / Nucleus culture:

Tissue culture technique is used to bring the edible mushroom to pure culture so that the mushroom fungus can further be used to prepare spawn, which is an essential material for mushroom cultivation. This nucleus culture is grown on Potato Dextrose Agar medium in test tubes. A small tissue from a well-grown mushroom is aseptically transferred to agar medium in a test tube in a culture room. The test tubes are incubated under room temperature for 10 days for full white growth of fungal culture. This is further used for preparation of Mother spawn.

Procedure:

Select well grown, disease free oyster mushroom early in the morning and keep it on a clean paper for 2-3 hr. to get certain amount of moisture present in the mushroom to get evaporated

Clean the culture room/ laminar flow chamber with antiseptic solution

Keep the sterilized PDA slants, razor blades, forceps etc. inside the chamber and put on the UV light

After 20 minutes put off the UV light and start working after 5 minutes

Sterilize all the instruments to be used by exposing to Bunsen burner

Take in the mushroom and split open the mushroom longitudinally into two halves

Using a new, sterilized blade cut a small piece of tissue from the centre of the split mushroom at the junction of pileus and stipe

Remove the cotton plug of the agar slant and the tissue is aseptically placed inside the slant by using a sterilized forceps and close it immediately

After transferring tissues from the mushroom, the tube are arranged in a wire basket and kept in a clean room at room temperature for the growth of the fungus

Observe the tube at periodical intervals and remove the contaminated ones.

The tubes will be ready for further use within another ten days. The base spawn is used for preparation of mother spawns

Precautions to be observed:

- Wash the hands with antiseptic lotion before start working inside the chamber. If possible, it is better to use hand gloves while operation.
- It is better that the maximum of two persons may work inside the room at a time. Avoid unnecessary talking while working inside the room.
- While separating the tissue from the centre of the mushroom it should not touch the bottom or sides of the mushroom.

Exercise: Draw diagram of tissue culture technique

Ex. No: 10

Date:

**PURE CULTURE TECHNIQUE-TISSUE ISOLATION IN PDA, OMA
AND MEA MEDIUM**

Tissue Isolation in PDA, OMA and MEA Medium:

Procedure:

Select well grown, disease free oyster mushroom early in the morning and keep it on a clean paper for 2-3 hr. to get certain amount of moisture present in the mushroom to get evaporated

Clean the culture room/ laminar flow chamber with antiseptic solution

Keep the sterilized PDA slants, razor blades, forceps etc. inside the chamber and put on the UV light

After 20 minutes put off the UV light and start working after 5 minutes

Sterilize all the instruments to be used by exposing to Bunsen burner

Take in the mushroom and split open the mushroom longitudinally into two halves

Using a new, sterilized blade cut a small piece of tissue from the centre of the split mushroom at the junction of pileus and stipe

Remove the cotton plug of the agar slant and the tissue is aseptically placed inside the slant by using a sterilized forceps and close it immediately

After transferring tissues from the mushroom, the tube are arranged in a wire basket and kept in a clean room at room temperature for the growth of the fungus

Observe the tube at periodical intervals and remove the contaminated ones.

The tubes will be ready for further use within another ten days. This is called as a Pure culture or mother culture.

Precautions to be observed:

- Wash the hands with antiseptic lotion before start working inside the chamber. If possible, it is better to use hand gloves while operation.
- It is better that the maximum of two persons may work inside the room at a time. Avoid unnecessary talking while working inside the room.

- While separating the tissue from the centre of the mushroom it should not touch the bottom or sides of the mushroom.

Practical exercise:

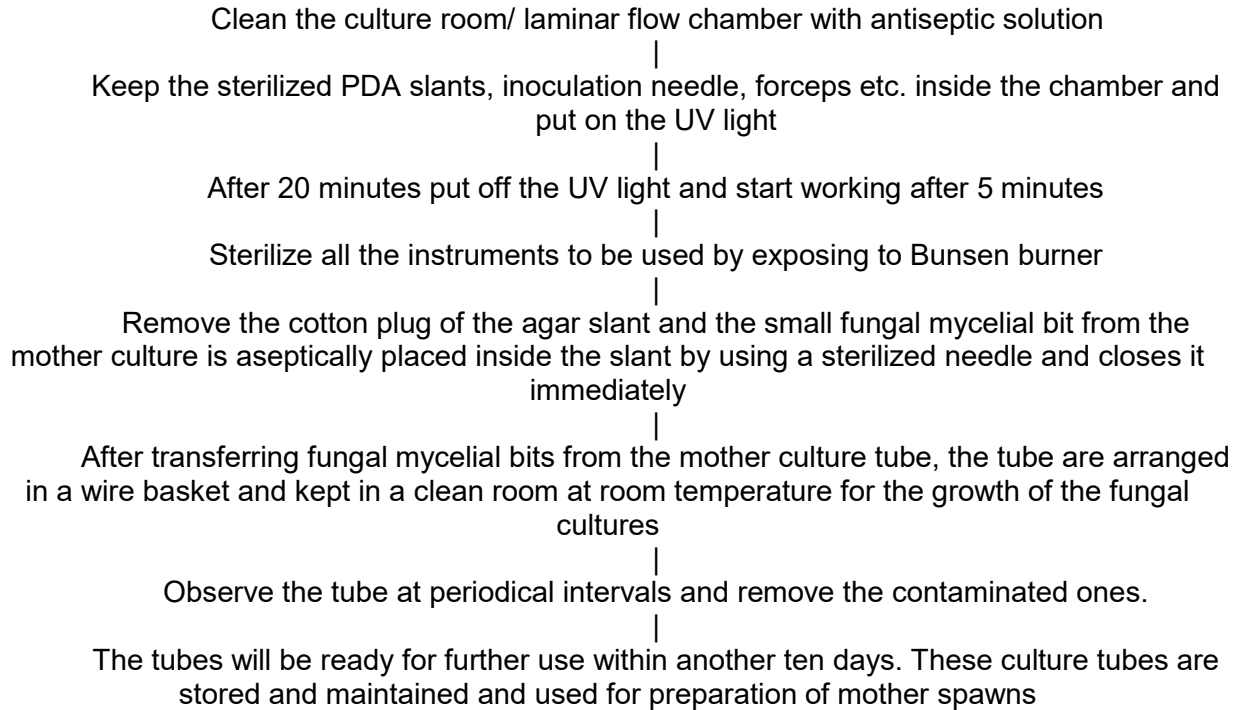
a) Prepare 50 base culture tubes

b) Observe the tissue culture tubes after 5 days and note the following information:

- i) Name of the mushroom species/ strain used :
- ii) Date of culturing :
- iii) Nature of the mushroom : Fresh / Dried
- iv) Nature of tissue used : Cap/ Stalk/ Junction
- v) Number of tubes cultured :
- vi) Number of tube with contamination :
- vii) Nature of contamination :
 - Fungi :
 - Bacteria :
- viii) Time taken for complete growth in slant :
- x) Number of tubes with pure culture :

Ex. No: 11
Date :

SUB CULTURING OF FUNGAL CULTURES AND MAINTENANCE



Ex. No: 12 SPAWN PREPARATION- LABORATORY REQUIREMENTS,
Date : ESSENTIALS,RAW MATERIALS REQUIRED FOR MOTHER SPAWN AND
BED SPAWN PREPARATION AND THEIR USAGE

1. Autoclave/ Pressure cooker

Autoclave is a container used for sterilizing of substrates of sorghum grains employing super heated steam under pressure. It is used for mother spawn and bed spawn preparation.

2. Culture room (Inoculation Chamber)/ Laminar Air Flow Chamber

Culture room is a most essential facility required for preparation of mother spawn and bed spawn.

3. Gas cylinder and a Bunsen burner are the other items necessarily kept inside the unit of laminar air flow chamber.

Others

In addition, a small plastic tray may be kept inside to keep razor blades, inoculation needles, forceps etc.,

Ex. No: 13 OYSTER MUSHROOM: MOTHER SPAWN PREPARATION - PROCESSING OF SUBSTRATES

Mother spawn:

Mother spawn is nothing but the mushroom fungus grown on a grain based medium. Among the several substrate materials tested by TNAU, Coimbatore, sorghum grains are the best substrate for excellent growth of the fungus. Well-filled, disease- free sorghum grains are used as substrate for growing the spawn materials. The various steps involving in preparation of mother spawn are listed below here under.

Wash the sorghum grains in water thoroughly to remove chaffy and damaged grains

|

Cook the grains in an autoclave / vessel for 30 minutes just to soften them

|

Take out the cooked grains and spread evenly over a Hessian cloth on a platform to remove the excess water

|

Mix Calcium carbonate (CaCO_3) thoroughly with the cooked, dried grains
@ 20 g /Kg

|

Fill the grains in polypropylene bags up to $3/4^{\text{th}}$ height (approximately 300-330g / bag), insert a PVC ring , bold the edges of the bag down and plug the mouth tightly with non-absorbent cotton wool

|

Cover the cotton plug with a piece of waste paper and tie tightly around the neck with a jute thread

|

Arrange the bags inside an autoclave and sterilize under 20-lbs. pressure for 2 hours

Note: The purpose of mixing Calcium carbonate is i) to remove the excess moisture present in the cooked grains, ii) to neutralize the pH of the grains and iii) to avoid caking of grains after sterilization.

Precaution to be observed:

- Avoid over cooking of sorghum grains, as over cooking lead to splitting of grains.
- Don't dry the cooked grains on the floor. Always dry over hessian cloth spread on a raised platform
- Use only recommended dose of CaCo_3 for mixing with the cooked grains. Mixing over dose reduces the fungal growth in the inoculated bags.

Ex. No: 14
Date :

OYSTER MUSHROOM : MOTHER SPAWN PREPARATION - INOCULATION

Prepare the bags and arrange the bags inside an autoclave and sterilize under 20-lbs pressure for 2 hours
|
After sterilization completed
|
Take out the bags after cooling and keep them inside the culture room and put on the UV light
|
After 20 minutes put off the UV light and start working in the culture room
|
Cut the fungal culture into two equal halves using a inoculation needle and transfer one half portion to a bag
|
Similarly, transfer another half portion of the culture to an another bag
|
Incubate the inoculated bags in a clean room under room temperature for 10 days. This is called as a mother spawn.

Practical Exercise:

- a) Prepare 50 mother spawn bags and work out the cost for production of one mother spawn bag.
b) Observe the spawn bags after 10 days and record the following information:

- i) Name of the mushroom species /strain used :
ii) Date of preparation :
iii) Number of bags prepared :
iv) Number bags with contamination :
v) Nature of contamination :
Fungi :
Bacteria :
vi) Days for complete growth of spawn :

Ex. No: 15 OYSTER MUSHROOM: PREPARATION OF FIRST GENERATION SPAWN
Date:

The various steps involving in preparation of first generation of bed spawn are listed below here under.

Wash the sorghum grains in water thoroughly to remove chaffy and damaged grains

|

Cook the grains in an autoclave / vessel for 30 minutes just to soften them

|

Take out the cooked grains and spread evenly over a Hessian cloth on a platform to remove the excess water

|

Mix Calcium carbonate (CaCO_3) thoroughly with the cooked, dried grains
@ 20 g /Kg

|

Fill the grains in polypropylene bags up to $\frac{3}{4}$ th height (approximately 300-330g / bag), insert a PVC ring , bold the edges of the bag down and plug the mouth tightly with non-absorbent cotton wool

|

Cover the cotton plug with a piece of waste paper and tie tightly around the neck with a jute thread

|

Arrange the bags inside an autoclave and sterilize under 20-lbs pressure for 2 hours

Ex. No: 16
Date:

**OYSTER MUSHROOM: FIRST GENERATION SPAWN PREPARATION-
INOCULATION**

Sterilized bags are placed inside the culture room and put on the UV light
|
After 20 minute put off the UV light and take in the well-grown mother spawn
|
Transfer spawn from the mother spawn to sterilized bags @ 10 g per bag
|
After inoculation the spawn bags are kept in a clean room for fungal growth
(This is first generation of bed spawn)
|
Use the bed spawn after 10 days of inoculation for bed preparation

Ex. No.17
Date:

SPAWN CONTAMINANTS IDENTIFICATION

Nature of contamination:

Two types of contamination

1. **Fungal Contamination:** Different colours of fungal mycelial mat

Aspergillus flavus (Light Green), *Aspergillus niger* (Black), *Trichoderma spp* (Green)
Rhizopus sp.(Fluffy greyish),*Neurospora sp.* (Orange) etc.

2. **Bacterial Contamination:** Slimy growth with rotting smell

Pseudomonas, *Bacillus*, etc

Exercise:

- Work out the percentage of spawn contamination
- Draw different types of spawn contaminants

Ex. No: 18
Date:

**OYSTER MUSHROOM: PREPARATION OF SECOND
GENERATION SPAWN**

The various steps involving in preparation of second generation of bed spawn are listed below here under.

Wash the sorghum grains in water thoroughly to remove
chaffy damaged grains

|

Cook the grains in an autoclave / vessel for 30 minutes just to soften them

|

Take out the cooked grains and spread evenly over a Hessian cloth on a platform to
remove the excess water

|

Mix Calcium carbonate (CaCO_3) thoroughly with the cooked, dried grains
@ 20 g /Kg

|

Fill the grains in polypropylene bags up to $3/4^{\text{th}}$ height (approximately 300-330g / bag), insert a
PVC ring , bold the edges of the bag down and plug the mouth
tightly with non-absorbent cotton wool

|

Cover the cotton plug with a piece of waste paper and tie tightly around the neck
with a jute thread

|

Arrange the bags inside an autoclave and sterilize under 20-lbs pressure for
2 hours

Ex. No: 19
Date:

**OYSTER MUSHROOM: PREPARATION OF SECOND
GENERATION SPAWN**

Sterilized bags are placed inside the culture room and put on the UV light

|

After 20 minute put off the UV light and take in the well-grown mother spawn

|

Transfer spawn from the first generation of bed spawn to sterilized bags @ 10 g per bag

|

After inoculation the spawn bags are kept in a clean room for fungal growth

(This is second generation of bed spawn)

|

Use the second generation of bed spawn after 10 days of inoculation for bed
preparation

Exercise:

- Work out the percentage of spawn contamination
- Mention the different types of contaminants
- Work out the cost of preparation of one spawn bag

Ex. No: 20
Date:

**PREVENTION AND MANAGEMENT OF CONTAMINANTS IN
MOTHER SPAWN AND BED SPAWN**

Steps to be followed to avoid contaminanation in mother and bed spawn:

- Purchase of good quality bold white sorghum grains ie. free from pest and diseases
- Proper cleaning of the sorghum grains
- Avoid over cooking of sorghum grains
- Add recommended dose of Calcium carbonate (20g/kg of seed)
- Proper sterilization and inoculation techniques
- Proper storage and maintainence of temperature (27-28 °C)

Mushroom cropping house :

a) Thatched : For cultivation of mushroom, thatched shed is mostly suitable in Plains whereas asbestos sheds are highly preferred in hilly areas. The erection of thatched houses is a must for the successful cultivation of oyster as well as milky mushroom because the required optimum temperature and relative humidity are easily maintained with minimum efforts. The sheds should have a door, ventilators with fly-proof nets, false roofing and racks/ plastic thread hang system (Uri method) for placing the beds. River sand may be filled to a height of 6" on the floor. It is better to construct mushroom sheds with separate rooms for spawn running and cropping. One or two low voltage electric bulbs may be fixed inside the shed.

The shed may be constructed in East-west direction to avoid direct effect of sun and to reduce the temperature inside the shed. The height of thatched shed should be around 4 metres and with a false ceiling at a height of 2.5 metres. The size of door may be 2.25 x 0.75 metres. The ventilators size may 0.6 x 0.3 metre and 2 ventilators for 8 square metre shed is essential for proper air circulation.

Cultivation of oyster mushroom requires a separate spawn running and croppin house facility.

i) Spawn running room:

Spawn running room is one where the newly prepared beds are kept for proliferation of mycelium in the bed. Preferably, a separate room can be erected inside the thatched shed for this purpose. The spawn running room does not require light but sufficient provision for air ventilation is necessary. Normally, the optimum temperature of 22-25° C and a relative humidity of 80-85% should be maintained inside the spawn running room.

ii) Cropping room:

Cropping room is one where the completely spawn run beds are kept for production of mushroom. This room requires a relatively cooler atmosphere than the spawn running room.

The temperature should be around 20-23 °C with a relative humidity of 85-90%. Cropping room should have good ventilation and diffused light.

The size of the may vary according to the cost of the project. The approximate size of spawn running and cropping rooms required for the production of mushrooms of required quantity are indicated below.

Mushroom Production (Kg/ day)	Size of Spawn running room	Size of cropping room
5	10 x 6 ft = 60 sq.ft	10 x 11 ft =110 sq.ft
20	10 x 15 =150 sq.ft	50x10 ft = 1000 sq.ft

* Instead of single room of above size, small rooms with size of 8 Sq. m. may be erected for easy operation and maintenance.

Exercise: Draw the structure of oyster mushroom cropping house

Ex. No: 22
Date:

CULTIVATION OF OYSTER MUSHROOM :PROCESSING OF SUBSTRATES

Pleurotus spp. can be grown indoors and any well-ventilated room would be suitable. A thatched shed with false roofing is an ideal room for successful cultivation of this mushroom, as the required temperature of 20-25° and relative humidity of 80-85 % can easily be maintained.

Preparation of substrate:

For the cultivation of oyster mushroom, most cellulosic farm waste is used as substrate. These include paddy straw, corncobs, bagasse, banana leaves, leaf litters of various kinds, waste paper, cotton waste etc. Among them, paddy straw is found to be the best substrate giving more bio efficiency. Paddy straw is chopped into bits of size 2-3" for easy handling and operation.

Sterilization of substrate:

There are three methods with which the chopped straw can be sterilized. Any one method can be adopted based on the facilities available.

1. Hot water treatment/ Boiling method:

Soak the chopped paddy straw in cold water for 4 hr in a G.I. Drum
|
Drain the water and add fresh water and cover the drum with gunny sac
|
Boil the contents over the flame for one hr
|
After boiling, take out the straw and drain the excess water by keeping then in wire baskets
|
Spread the straw as thin layer on a hessian cloth, spread on a raised platform
|
Shade dry the straw to get 60-65 % moisture capacity

2. Steaming:

Soak the chopped paddy straw in cold water for 4 hr in a G.I. Drum
|
Drain the water and take straw out and fill it in big wire baskets
|
Keep the wire baskets in an autoclave and put on the autoclave and allow it

to steam for 1 hr
|
After steaming, take out the straw and drain the excess water by keeping then in wire baskets
|
Spread the straw as thin layer on a hessian cloth, spread on a raised platform
|
Shade dry the straw to get 60-65 % moisture capacity

Precautions to be followed :

- i) The straw should not be dried on a floor.
- ii) The hessian cloth should be disinfected dettol or any disinfectant before use.
- iii) In the case of chemical treatment, the doses of the chemical should not exceed the recommended level.
- iv) The 60 % moisture content in the straw can be judged by taking a handful of straw and squeeze it tightly. The water should not drip out and the palm can feel the wetness of the straw.

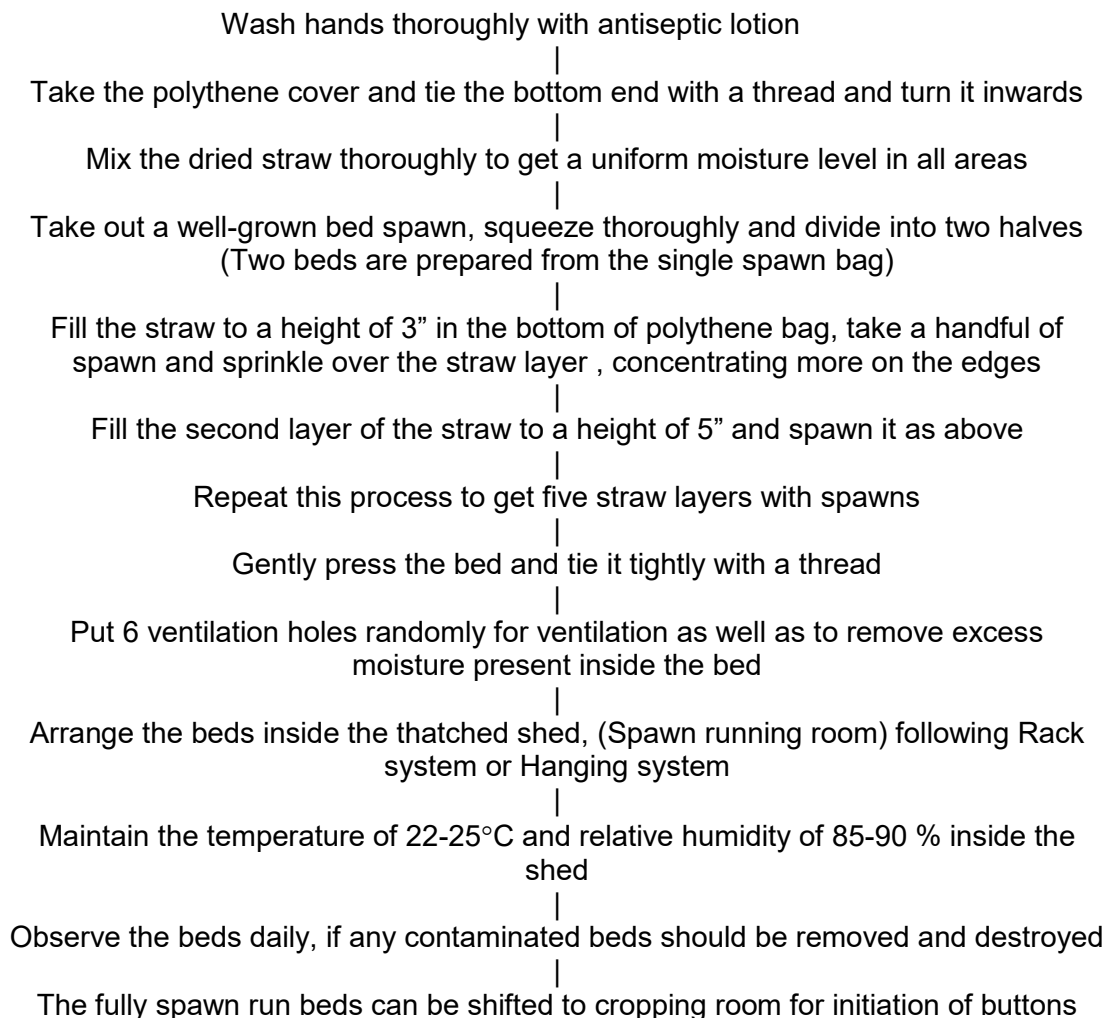
Ex. No: 23

CULTIVATION OF OYSTER MUSHROOM - BED PREPARATION

Date:

The cultivation of oyster mushroom is usually carried out in transparent polythene covers. The size of the cover should be 60 x 30 cm, with a thickness of 80 gauge.

Procedure:



Polypropylene (PP) bottles as an alternate to Polypropylene Bags for mushroom cultivation

PP bottles can be used instead of PP bags for oyster mushroom cultivation. PP bottles have to be thoroughly cleaned and filled with alternate layers of steamed/ boiled paddy straw substrate and spawn similar to bag method of cultivation. Six to eight holes of 7 mm size is to be made in the bottles. The mouth of PP bottle has to be kept closed initially until spawn run. After

complete spawn run the mouth of PP bottle can be opened and the bottles should be placed in appropriate conditions for initiation of sporophores

Precautions to be followed :

- Keep the spawn running room dark so that spawn running will be faster.
- Periodically place Rat-baiting to kill rats as they are attracted by the spawn.
- Periodically sprinkle water on sand layer to maintain the required conditions.
- Never spray any insecticides on the mushroom beds.

The fully spawn run beds should be transferred to cropping room in the thatches shed, where the diffused light and good ventilation are necessary for the button development.

There are different methods to handle the spawn run bed to initiate button development.

They are

- Open bed method, wherein the polythene cover is completely removed and allowed for cropping.
- Closed bed method, wherein the polythene cover is intact and buttons will come out through the holes made of pierce through the cover.
- Half cover open method, wherein the one half of the polythene cover is removed for cropping and second half after first harvest.
- Stripe method, wherein the polythene cover as longitudinal strips of 5-cm breadth at 4-5 places in the bed.
- Tear method, wherein the polythene cover is teared longitudinally at several places.
- Round opening method, wherein the round shaped openings of 5 cm diameter are made at random.

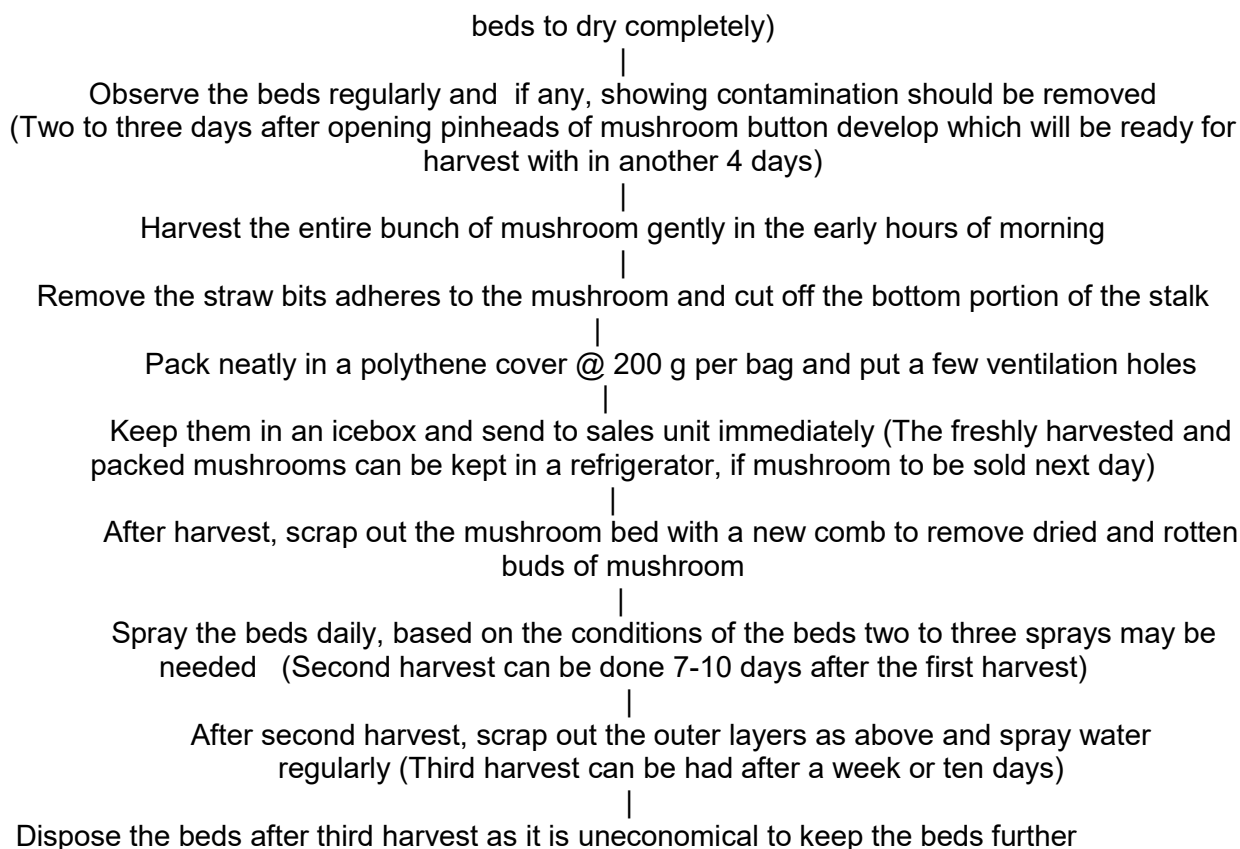
However, among all the methods of opening of beds, complete removal of the polythene cover is found to give more yields than others. The steps followed in full opening of bed are described below:

Procedure:

Use a new blade and cut the polythene covers and remove fully

Allow the bed to dry for a day, as freshly opened beds contain more moisture

Spray water on the beds from second day of opening using an atomizer
(Based on the condition, two to three sprays are necessary daily and never allow



Precautions to be observed:

- Always maintain the optimum temperature of 23-25°C and relative humidity of 80- 85% inside the shed.
- Never pour water on the beds, which leads to complete rotting of young developing buds.
- Spray water on the beds only after harvesting the mushroom.
- Always harvest the mushroom in the morning and pack them immediately.
- If the closed bed system or other partial opening methods is followed, it is better to wet the sand layer frequently to maintain the temperature and relative humidity)

Practical Exercise:

- a) Prepare beds using straw sterilized by three different methods of sterilization
- b) Compare the yield of mushrooms in the different methods of sterilization.
- c) Draw neat sketch showing different layering of spawn in the mushroom bed.

Ex. No: 24
Date:

**CULTIVATION OF OYSTER MUSHROOM : MAINTENANCE OF BEDS,
HARVEST AND STORING**

The fully spawn run beds should be transferred to cropping room in the thatches shed, where the diffused light and good ventilation are necessary for the button development.

There are different methods to handle the spawn run bed to initiate button development. They are

1. Open bed method, wherein the polythene cover is completely removed and allowed for cropping.
2. Closed bed method, wherein the polythene cover is intact and buttons will come out through the holes made of pierce through the cover.
3. Half cover open method, wherein the one half of the polythene cover is removed for cropping and second half after first harvest.
4. Stripe method, wherein the polythene cover as longitudinal strips of 5-cm breadth at 4-5 places in the bed.
5. Tear method, wherein the polythene cover is teared longitudinally at several places.
6. Round opening method, wherein the round shaped openings of 5 cm diameter is made at random.

However, among all the methods of opening of beds, complete removal of the polythene cover is found to give more yields than others. The steps followed in full opening of bed are described below:

Procedure:

- i) Use a new blade and cut the polythene covers and remove fully.
- ii) Allow the bed to dry for a day, as freshly opened beds contain more moisture.
- iii) Spray water on the beds from second day of opening using an atomizer.(Based on the condition, two to three sprays are necessary daily and never allow beds to dry completel
- iv) Observe the beds regularly and bed, if any, showing contamination should be removed.(Two to three days after opening pinheads of mushroom button develop which will be ready for harvest with in another 4 days)

- v) Harvest the entire bunch of mushroom gently in the early hours of morning
- vi) Remove the straw bits adheres to the mushroom and cut off the bottom portion of the stalk
- vii) Pack neatly in a polythene cover @ 200 g per bag and put a few ventilation holes.viii) Keep them in an icebox and send to sales unit immediately.(The freshly harvested and packed mushrooms can be kept in a refrigerator, if mushroom to be sold next day)
- viii) After harvest, scrap out the mushroom bed with a new comb to remove dried and rotten buds of mushroom.
- ix) Spray the beds daily, based on the conditions of the beds two to three sprays may be needed. (Second harvest can be done 7-10 days after the first harvest)
- x) After second harvest, scrap out the outer layers as above and spray water regularly. (Third harvest can be had after a week or ten days).
- xi) Dispose the beds after third harvest as it is uneconomical to keep the beds further.

Precautions to be observed:

- i) Always maintain the optimum temperature of 23-25°C and relative humidity of 80- 85% inside the shed.
- ii) Never pour water on the beds, which leads to complete rotting of young developing buds.
- iii) Spray water on the beds only after harvesting the mushroom.
- iv) Always harvest the mushroom in the morning and pack them immediately.
- v) If the closed bed system or other partial opening methods is followed, it is better to wet the sand layer frequently to maintain the temperature and relative humidity)

Practical Exercise:

- a) Try different methods of opening of beds and compare the yield parameters and cost-benefit ratio.
- b) Draw neat sketches showing different methods of opening of beds.
- c) Work out the cost of production of one kg of mushroom.

INSECT PESTS:

Many insect pests attack the mushrooms. Small larvae of flies, beetles, springtails are very commonly noticed. Absolute cleanliness is a must to prevent the infestation of the insect pests in mushroom sheds.

a) Flies:

Phorid fly: *Megaselia halterata* and *M. tamilnadolensis*

Sciarid fly: *Lycoriella mali*

Damage:

The larvae feed on the mycelium and show rotting patches in the beds. Young buds are also eaten by the larvae. They also tunnel into grown up mushroom and cause rotting of the mushrooms. The flies spread the disease from one bed to others.

b) Beetles:

Black beetle: *Scaphisoma nigrofaceatum*

Brown beetle: *S. pictum* Motschulsky – golden lines seen on the body of the insect.

Both feed on young buds and grown up mushrooms by scrapping the tissues. They mainly transmit the bacterial blotch disease from one bed to other.

c) Spring tails / Columboles:

Tiny insects with stout antennae feed on the mycelium and buds. *Lepidocyrtus cyaneus* and *Isotoma simplex*.

d) Nematodes:

Nematode infestation is more severe in button mushrooms. The following two nematodes are very commonly noticed: *Ditylenchus mycelophagus* and *Aphelenchoides compositicola*

d) Mites:

In addition to insect pests, two mites are very severely feed on the mushroom spawn as well as on mushroom buttons. They are

i) **Tarsonemid mite** - *Tarsonemus myceliophagus* and *T. floriculus* feed on mycelium and transmit the diseases.

ii) **Tryoglyphid mite** - *Tyrophagus lintneri*

Integrated Pest Management:

- Bed moisture content should be around 60- 65%
- Fix insect proof nets in the windows.
- In button mushroom, newspaper should be treated with 0.1 % formalin
- Fix insect trap to attract the flies.
- Spray Neem oil 1% in the floor and sides to kill the flies and beetles, never spray on the mushroom beds and buttons.

Exercise: Observe and draw the various types of damages caused by insect pests make neat sketches showing infestation.

WEEDS, MOULDS AND DISEASES:**a) Weeds:****i) Ink Cap:**

Coprinus comatus is a common weed on mushroom beds. It is favoured by high moisture content of the beds, more compaction of beds and poor ventilation with more of ammonia inside the cropping room.

It produces dark blue to violet coloured buds with a long white thin stalk, which opens in a few days and disintegrate as black mass of tissues, covering the entire bed, thus arresting the growth of spawn, development of young buds. The entire bed becomes black in color showing rotting of the spawn.

Management:

- Avoid using damaged and old straw for bed preparation.
- Remove and destroy the infected beds immediately
- Avoid preparing beds with more than 70 per cent moisture
- Avoid chemical method of sterilization as this process leads to more weed growth.

b) Green moulds:

Mainly *Trichoderma viride* is severe both in beds and on mushroom buds. In addition, *Penicillium* and *Aspergillus* spp. may also cause mouldy growth on the beds. The infection leads to development of green color patches in the beds, which spreads quickly and the entire bed is covered fully with green growth, which completely arrests the spawn running. This is due to improper sterilization of straw and bed preparation with more moisture.

Management:

- Avoid using damaged and old straw for bed preparation.
- Remove and destroy the infected beds immediately
- Avoid preparing beds with more than 70 per cent moisture

c) Fungal diseases

In addition to the above fungal diseases, some other diseases in the mushroom beds are

i) **Dry bubble** - *Verticillium malthousei* and *V. psalliotae*

The disease is characterized by the deformation of the young mushrooms and the formation of muddy brown and sunken spots on the cap of the mushroom. A grayish white mouldy growth may be seen on the pileus resulting in dryness and leathery appearance of the mushroom. Some mushrooms attacked during the early stage never develop beyond a small dry bubble like them.

Management:

1. Maintain proper temperature, ventilation and humidity as this disease is favoured by temperature above 23°C, poor ventilation and high humidity.
2. Perfect sanitary conditions should be maintained in growing houses and when the disease appears, the temperature should be lowered to below 28°C.

ii) **Truffle** - *Pseudobalsamia microspora*

The disease is characterized by the appearance of cottony-weft of mycelium on the bed surface. These wefts soon become denser and develop into small, reddish brown and wrinkled stromatic bodies resembling a truffle. The infected beds usually have a peculiar disagreeable odour. The yield of the mushroom crop is reduced significantly.

Management:

1. Soil used should be well sterilized. After casing, excessive moisture in bed, temperature above 20°C, poor ventilation and high humidity should be avoided.
2. Proper temperature, moisture, ventilation and humidity should be maintained in cropping houses.

iii) **Mildew/ Cobweb** - *Dactylium dendroides*

A white silky growth usually grows over the surface of the casing soil. It sometimes climbs up and covers some mushroom in its pith. The older mycelium of the pathogen changes from silky to granular white. The infected mushrooms become discoloured and granular white. The infected mushrooms become discoloured and soft. Later on, such diseased mushrooms are engulfed in a cottony ball of mycelium. The disease is serious where year round cropping is practiced.

Management:

Proper sterilization of casing soil is significantly important. As soon as the disease spots are located, complete soil related with infected spots should be removed and destroyed. Other hygienic conditions should be maintained to prevent the spread of the disease.

Exercise: Observe and draw the various types of damages caused by moulds and disease management make neat sketches showing infestation.

Ex. No.27 VISIT TO OYSTER MUSHROOM FARM (SPAWN LAB AND MUSHROOM FARM)

Date:

Visit to nearby oyster mushroom farm (spawn lab and mushroom farm) units and discuss with the growers the prospects and problems in spawn production, mushroom cultivation and marketing of the oyster mushroom.

Exercise:

- **Interact with mushroom grower and give economics for spawn production unit and mushroom production unit (any size you have seen)**

Ex. No.28

Date:

**VISIT TO MARKETS (FARMERS' MARKET) AND OBSERVING THE
MARKETING PATTERN OF OYSTER MUSHROOM**

To visit nearby markets and observing the marketing pattern of oyster mushroom.

**Exercise: Discuss on the marketing pattern and give your suggestions for
further improvement**

Ex. No.29
Date:

MILKY MUSHROOM: MOTHER SPAWN PREPARATION- PROCESSING OF SUBSTRATES

Preparation of Mother spawn substrate :

Mother spawn is nothing but the mushroom fungus grown on a grain based medium. Among the several substrate materials tested by TNAU, Coimbatore, sorghum grains are the best substrate for excellent growth of the fungus. Well-filled, disease free sorghum grains are used as substrate for growing the spawn materials. The various steps involving in preparation of mother spawn are listed below here under.

Wash the sorghum grains in water thoroughly to remove chaffy and damaged grains

|
Cook the grains in an autoclave / vessel for 30 minutes just to soften them
|

Take out the cooked grains and spread evenly over a Hessian cloth on a platform to remove the excess water

|
Mix Calcium carbonate (CaCO_3) thoroughly with the cooked, dried grains
@ 20 g/kg
|

Fill the grains in polypropylene bags up to $\frac{3}{4}$ th height (approximately 300-330g/bag), insert a PVC ring, bold the edges of the bag down and plug the mouth tightly with non - absorbent cotton wool

|
Cover the cotton plug with a piece of waste paper and tie tightly around the neck with a jute thread
|

Arrange the bags inside an autoclave and sterilize under 20-lbs. pressure for
2 hours

Ex. No.30

MILKY MUSHROOM: MOTHER SPAWN PREPARATION - INOCULATION

Date:

Inoculation of mother spawn

Take out the bags after cooling and keep them inside the culture room and put on the UV light

After 20 minutes put off the UV light and start working in the culture room

Cut the fungal culture into two equal halves using an inoculation needle and transfer one half portions to a bag

Similarly, transfer another half portion of the culture to an another bag

Incubate the inoculated bags in a clean room under room temperature for 10 days. This is called as a mother spawn.

Note: The purpose of mixing Calcium carbonate is i) to remove the excess moisture present in the cooked grains, ii) to neutralize the pH of the grains and iii) to avoid caking of grains after sterilization.

Practical Exercise:

a) Prepare 50 each in milky mother spawn and bed bags and work out the cost for production of one each in milky mother spawn.

b) Observe the spawn bags after 10 days and record the following information:

i) Name of the mushroom species /strain used :

ii) Date of preparation :

iii) Number of bags prepared :

iv) Number bags with contamination :

v) Nature of contamination :

Fungi :

Bacteria :

vi) Days for complete growth of spawn

Ex. No.31
Date:

**MILKY MUSHROOM: PREPARATION OF FIRST GENERATION SPAWN -
PROCESSING OF SUBSTRATES**

The various steps involving in preparation of first generation of milky bed spawn are listed below here under.

Wash the sorghum grains in water thoroughly to remove chaffy and damaged grains

|

Cook the grains in an autoclave / vessel for 30 minutes just to soften them

|

Take out the cooked grains and spread evenly over a Hessian cloth on a platform to
remove the excess water

|

Mix Calcium carbonate (CaCO_3) thoroughly with the cooked, dried grains
@ 20 g /Kg

|

Fill the grains in polypropylene bags up to $\frac{3}{4}$ th height (approximately 300-330g / bag),
insert a PVC ring , bold the edges of the bag down and plug the mouth tightly with non-
absorbent cotton wool

|

Cover the cotton plug with a piece of waste paper and tie tightly around the neck
with a jute thread

|

Arrange the bags inside an autoclave and sterilize under 20-lbs pressure for
2 hours

Ex. No.32

IDENTIFICATION AND MANAGEMENT OF SPAWN CONTAMINANTS

Date:

Management

- Avoid over cooking of sorghum grains, as over cooking lead to splitting of grains.
- Don't dry the cooked grains on the floor. Always dry over hessian cloth spread on a raised platform
- Use only recommended dose of CaCO_3 for mixing with the cooked grains. Mixing over dose reduces the fungal growth in the inoculated bags.
- Avoid further sub culturing of the second-generation bed spawns. This leads to lose of virulence of the spawn lead to reduced yield and repeated sub culturing lead to complete lose of virulence wherein the fungal growth may be noted in the beds but no buttoning is completely arrested.

Exercise:

- **Work out the percentage of spawn contamination**
- **Draw the spawn contaminants**

Ex. No.33
Date:

MILKY MUSHROOM: FIRST GENERATION SPAWN PREPARATION - INOCULATION

Sterilized bags are placed inside the culture room and put on the UV light

|

After 20 minute put off the UV light and take in the well-grown mother spawn

|

Transfer spawn from the mother spawn to sterilized bags @ 10 g per bag

|

After inoculation the spawn bags are kept in a clean room for fungal growth
(This is first generation of bed spawn)

|

Use the bed spawn after 10 days of inoculation for milky mushroom bed preparation

Practical Exercise:

a) Prepare 50 each in first generation of bed spawn and bed bags and work out the cost for production of one each in first generation of bed spawn.

b) Observe the spawn bags after 10 days and record the following information:

i) Name of the mushroom species /strain used :

ii) Date of preparation :

iii) Number of bags prepared :

iv) Number bags with contamination :

v) Nature of contamination :

Fungi :

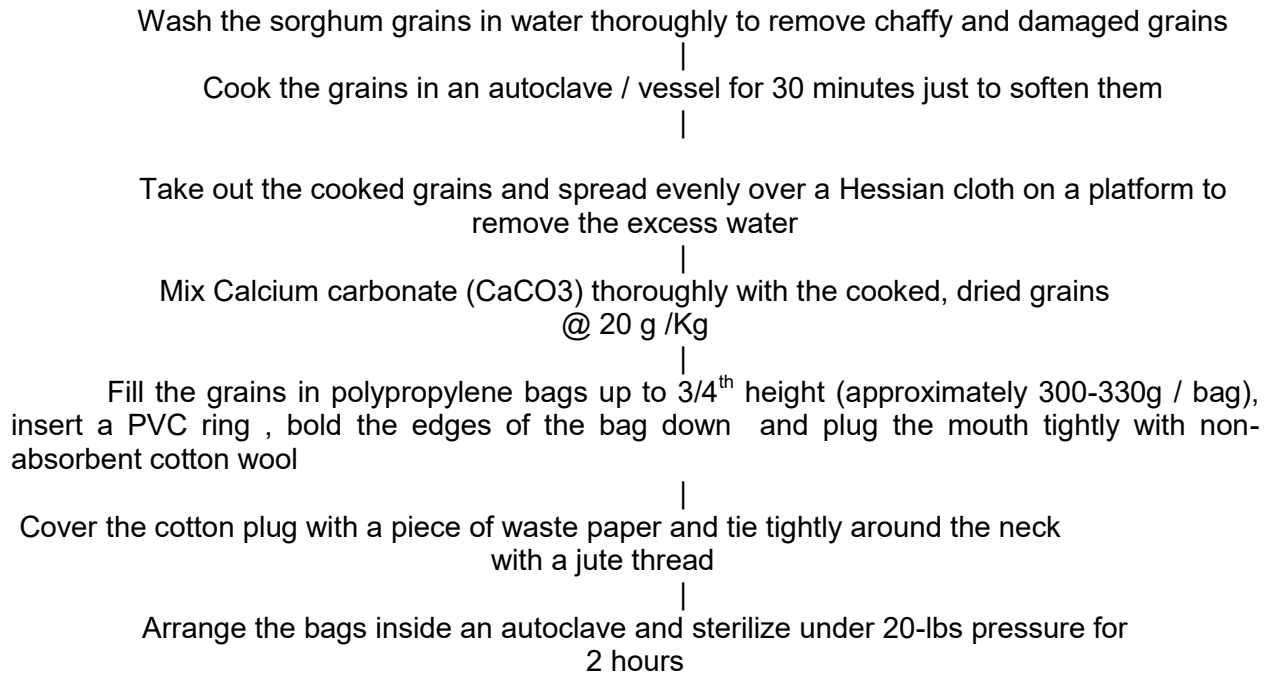
Bacteria :

vi) Days for complete growth of spawn :

Ex. No.34
Date:

**MILKY MUSHROOM: PREPARATION OF SECOND GENERATION SPAWN -
PROCESSING OF SUBSTRATES**

The various steps involving in preparation of second generation of milky bed spawn are listed below here under.



Exercise:

- **Work out the percentage of spawn contamination**
- **Work out the cost of preparation of one spawn bag**

Ex. No.35

MILKY MUSHROOM: PREPARATION OF SECOND GENERATION SPAWN- INOCULATION

Date:

Procedure:

The sterilized bags are placed inside the culture room and put on the UV light
|
After 20 minute put off the UV light and take in the well-grown mother spawn
|
Transfer spawn from the mother spawn to sterilized bags @ 10 g per bag
|
After inoculation the spawn bags are kept in a clean room for fungal growth
(This is first generation of bed spawn)
|
Use the bed spawn after 10 days of inoculation for bed preparation
|
Sub culture the first generation bed spawn as mother spawn to produce one
more generation, which is second generation bed spawn

For milky mushroom beds have to be placed in thatched sheds for spawn running and in blue poly houses for pinhead formation until harvest.

Mushroom Sheds:

a) Thatched sheds: The erection of thatched sheds is a must for the successful cultivation of milky mushroom because the required optimum temperature and relative humidity are easily maintained with minimum efforts. The sheds should have a door, ventilators with fly-proof nets, false roofing and racks/ plastic thread hang system (Uri method) for placing the beds. River sand may be filled to a height of 6" on the floor. It is better to construct mushroom sheds with separate rooms for spawn running and cropping. One or two low voltage electric bulbs may be fixed inside the shed.

The shed may be constructed in East-west direction to avoid direct effect of sun and to reduce the temperature inside the shed. The height of thatched shed should be around 4 metres and with a false ceiling at a height of 2.5 metres. The size of door may be 2.25 x 0.75 metres. The ventilators size may 0.6 x 0.3 metre and 2 ventilators for 8 square metre shed is essential for proper air circulation.

Beds are placed in Spawn running room / shed where proliferation of mycelium takes place in the bed. Preferably, a separate room can be erected inside the thatched shed for this purpose. The spawn running room does not require light but sufficient provision for air ventilation is necessary. Normally, the optimum temperature of 22-25° C and a relative humidity of 80-85% should be maintained inside the spawn running room.

b.Poly house/ Cropping room:

Cropping room is one where the completely spawn- run beds are kept for production of mushroom. This room requires a relatively cooler atmosphere than the spawn running room. The temperature should be around 30-35° C with a relative humidity of 80-85%. Cropping room should have good ventilation and diffused light.

The size of the shed may vary according to the cost of the project. The approximate size of spawn running and cropping rooms required for the production of mushrooms of required quantity are indicated below.

Exercise: Draw the diagram of milky mushroom poly house/ shed

Ex. No.37
Date:

MILKY MUSHROOM CULTIVATION – PROCESSING OF SUBSTRATES FOR BED PREPARATION

Preparation of substrate:

In the cultivation of milky mushroom, most cellulosic farm waste is used as substrate. These include paddy straw, corncobs, bagasse, banana leaves, leaf litters of various kinds, waste paper, cotton waste etc. Among them, paddy straw is found to be the best substrate giving more bio efficiency. Paddy straw is chopped into bits of size 2-3" for easy handling and operation.

Sterilization of substrate:

There are three methods with which the chopped straw can be sterilized. Any one method can be adopted based on the facilities available.

i. Hot water treatment/ Boiling method:

Soak the chopped paddy straw in cold water for 4 hr in a G.I. Drum
|
Drain the water and add fresh water and cover the drum with gunny sac
|
Boil the contents over the flame for one hr
|
After boiling, take out the straw and drain the excess water by keeping then in wire baskets
|
Spread the straw as thin layer on a hessian cloth, spread on a raised platform
|
Shade dry the straw to get 60-65 % moisture capacity

ii. Steaming:

Soak the chopped paddy straw in cold water for 4 hr in a G.I. Drum
|
Drain the water and take straw out and fill it in big wire baskets
|
Keep the wire baskets in an autoclave and put on the autoclave and allow it to steam for 1 hr
|
After steaming, take out the straw and drain the excess water by keeping then in wire baskets
|
Spread the straw as thin layer on a hessian cloth, spread on a raised platform
|

Shade dry the straw to get 60-65 % moisture capacity

Precautions to be observed:

- i) The straw should not be dried on a floor.
- ii) The hessian cloth should be disinfected dettol or any disinfectant before use.
- iii) In the case of chemical treatment, the doses of the chemical should not exceed the recommended level.
- iv) The 60 % moisture content in the straw can be judged by taking a handful of straw and squeeze it tightly. The water should not drip out and the palm can feel the wetness of the straw.

Ex. No.38

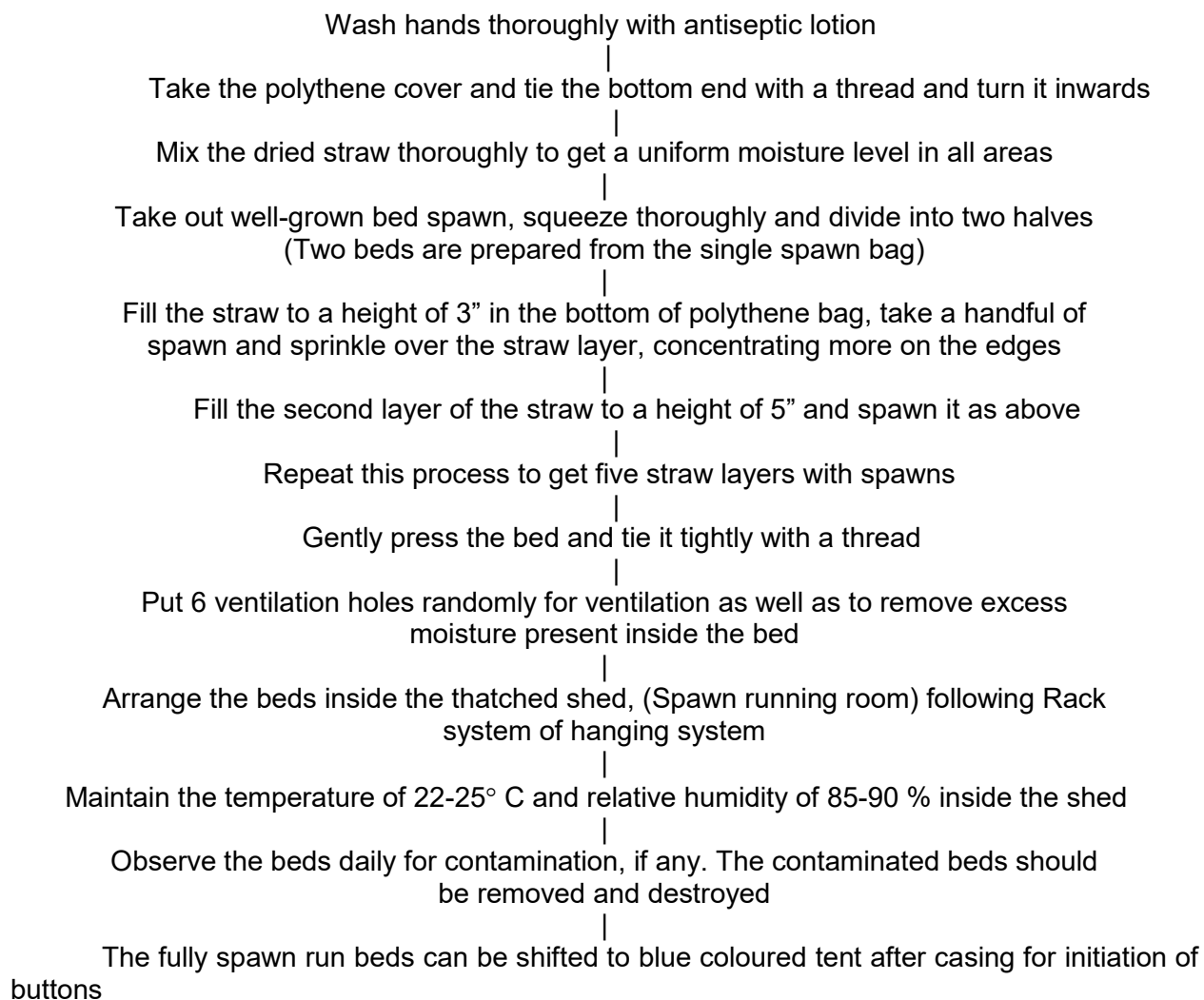
MILKY MUSHROOM CULTIVATION – BED PREPARATION

Date:

The cultivation of milky mushroom is usually carried out in transparent polythene covers.

The size of the cover should be 60 x 30 cm, with a thickness of 80 gauge.

Procedure:



Practical Exercise:

- Prepare beds using straw sterilized by two different methods of sterilization
- Compare the yield of mushrooms in the different methods of sterilization.
- Draw neat sketch showing different layering of spawn in the mushroom bed.

Date:

In the case of milky mushroom, an extra process called casing has to be done to induce button formation. After casing operation the beds should be arranged inside the Blue polythene covered pit tent for the growth of the mushroom. The fungus requires an optimum temperature of 30-35° C and relative humidity of 80-85 per cent for the better growth and production of sporocarp. In addition, the fungus needs a light intensity of 2500- 3000-lux for production of buttons, and the cased beds should be kept inside the blue tent.

Casing:

Casing nothing but application of thin layer of sterilized soil on the surface of mushroom bed to induce buttons formation. For casing, garden land soil rich in calcium is preferable. Instead of that soil and river sand, mixed in equal proportion can also be used. Sometimes the soil is mixed with Calcium carbonate @ 100 g/ kg and used as a casing medium. The soil used for casing process should be free of stones and stubble and has to be sterilized before casing. The soil is taken in a mud pot or a vessel and steamed in an autoclave or pressure for 45 minutes. (Soil can also be mixed with a little quantity of water and sterilized for this purpose). The soil is used for casing after cooling.

Procedure:

Take the fully spawn run bed and cut horizontally into two equal halves
|
Compact the beds as much as possible by pressing firmly with hand
|
Apply casing soil to a height of 1 cm and press it gently
|
Spray the water sufficiently to wet the cased soil
|
Place the beds inside the blue tent
|
Observe the beds daily and spray water, if necessary, to keep the beds wet
|
Watch for any contamination and insect pests. If noticed take necessary steps
(Ten after casing the small pin head buttons develop and with in another 7days mushrooms are ready for harvest)
|
Harvest the mushroom, clean it and pack it in a polythene bag for sales
|
Stir the top of the bed after first harvest and spray water regularly
(Second harvest can be obtained in another 10 days)

|
Disturb the topsoil after second harvest and spray water as regular
(Third harvest can be done after 10 days and for commercial
cultivation maximum of three harvests is recommended)

The mushroom yield of 350 –400 g can be obtained from 250 g dry weight of the straw, providing all optimum conditions inside the mushroom shed.



Practical Exercise:

- a) Select a well spawn run bed and do the casing operation.
- b) Record the following observations:
 - i) Days to complete spawn run after casing :
 - ii) Days for developing pin head buttons :
 - iii) Days for first harvest after casing :
 - iv) Total yield of mushroom :
 - v) Work out the bio efficiency :
- c) Estimate the cost for production of 1 kg mushroom :
- d) Draw a neat sketch of the casing technique practiced.

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(Third harvest can be done after 10 days and for commercial
cultivation -maximum of three harvests is recommended)

The mushroom yield of 350 –400 g can be obtained from 250 g dry weight of the straw, providing all optimum conditions inside the mushroom shed.



Exercise:

- Work out the cost of production of one kg of milky mushroom

Date:

INSECT PESTS:

Many insect pests attack the milky mushrooms. Small larvae of flies, beetles, springtails are very commonly noticed, in addition to mites and nematodes. Absolute cleanliness is a must to prevent the infestation of the insect pests in mushroom sheds.

Beetles:

a.Black beetle: *Sacphisoma nigrofaceatum*

b.Brown beetle: *S. pictummotschulsky* – golden lines seen on the body of the insect.

Both feed on young buds and grown up mushrooms by scrapping the tissues. They mainly transmit the bacterial blotch disease from one bed to other.

c. Spring tails / Columboles:

Tiny insects with stout antennae feed on the mycelium and buds. *Lepidocyrtus cyaneus* and *Isotoma simplex*.

d. Nematodes:

Nematode infestation is more severe in button mushrooms. The following two nematodes are very commonly noticed: *Ditylenchus mycelophagus* and *Aphelenchoides compositicola*.

Integrated Pest Management:

- Bed moisture content should be around 60- 65%
- Fix insect proof nets in the windows.
- In button mushroom, newspaper should be treated with 0.1 % formalin
- Fix white insect trap to attract the flies.

Exercise :Observe and draw the various types of damages caused by insect pests make neat sketches showing infestation.

Ex. No.42
Date:

MILKY MUSHROOM CULTIVATION – MANAGEMENT OF MOULDS AND DISEASES

MOULDS AND DISEASES:

Green moulds: Mainly *Trichoderma viride* is severe both in beds and on mushroom buds. In addition, *Penicillium* and *Aspergillus* spp. may also cause mouldy growth on the beds. The infection lead to development of green color patches in the beds, which spreads quickly and entire bed is covered fully with green growth, which completely arrests the spawn running. This is due to improper sterilization of straw and bed preparation with more moisture.

Management:

- Avoid using damaged and old straw for bed preparation.
- Remove and destroy the infected beds immediately
- Avoid preparing beds with more than 70 per cent moisture

c) Fungal diseases

In addition to the above fungal diseases, some other diseases in the mushroom beds are

i) Dry bubble - *Verticillium malthousei* and *V. psalliotae*

The disease is characterized by the deformation of the young mushrooms and the formation of muddy brown and sunken spots on the cap of the mushroom. A grayish white mouldy growth may be seen on the pileus resulting in dryness and leathery appearance of the mushroom. Some mushrooms attacked during the early stage never develop beyond a small dry bubble like them.

Management:

- Maintain proper temperature, ventilation and humidity as this disease is favoured by temperature above 23°C, poor ventilation and high humidity.
- Perfect sanitary conditions should be maintained in growing houses and when the disease appears, the temperature should be lowered to below 28°C.

Truffle - *Pseudobalsamia microspora*

The disease is characterized by the appearance of cottony-weft of mycelium on the bed surface. These wefts soon become denser and develop into small, reddish brown and wrinkled stromatic bodies resembling a truffle. The infected beds usually have a peculiar disagreeable odour. The yield of the mushroom crop is reduced significantly.

Management:

- Soil used should be well sterilized. After casing, excessive moisture in bed, temperature above 20°C, poor ventilation and high humidity should be avoided.
- Proper temperature, moisture, ventilation and humidity should be maintained in cropping houses.

iii) **Mildew/ Cobweb** - *Dactylium dendroides*

A white silky growth usually grows over the surface of the casing soil. It sometimes climbs up and covers some mushroom in its pith. The older mycelium of the pathogen changes from silky to granular white. The infected mushrooms become discoloured and granular white. The infected mushrooms become discoloured and soft. Later on, such diseased mushrooms are engulfed in a cottony ball of mycelium. The disease is serious where year round cropping is practiced.

Management:

Proper sterilization of casing soil is significantly important. As soon as the disease spots are located, complete soil related with infected spots should be removed and destroyed. Other hygienic conditions should be maintained to prevent the spread of the disease.

d) Bacterial blotch / bacterial pit / brown blotch:

This disease is caused by a bacterium, *Pseudomonas tolaasi*. It produces pale-yellow spots on the surface of the pileus, which later turn brown. Pits are often found just below surface. These diseases also cause considerable damage in storage and transit. The incidence is more when the mushrooms are watered heavily in the early bud stage. Because of very high humidity film of water always present on the surface of buttons leading to browning and rotting, emitting a fowl smell. Possibly the tryoglyphid mite mites carry the pathogen from one bed to other. In addition, the water splash from the infected bed also carries the bacterial inoculum.

Management:

- Keep the population of tryoglyphid mite under control
- Avoid pouring excess water to the beds.
- Remove the infected beds periodically to avoid further spread.
- Spray water mixed with bleaching powder @ 2 g / 10 litres of water.

e) Viral diseases:

Complex viruses cause a disease variously called the Brown disease/ watering stipe / X-disease / die back disease. It is difficult to diagnose the disease on the basis of symptoms-drumstick like mushroom and premature opening of veils - because similar symptoms can also

be caused by certain environmental and cultural conditions. Even the virus infection may be symptomless. Reduction in yields of mushroom did perhaps the most reliable symptom. The other symptom commonly associated with the infected crop is the slow and depressed growth of the mycelium isolated from infected mushroom. Transmission of virus is through mushroom spores and spawn. In addition, phorid larvae and tarsonemid mites are also act as vectors for this complex disease.

Management:

- Steam the compost for 12 hours at temperature of 70°C. At emptying, take away the compost quickly.
- Spray the wood with 2% sodium penta-chloro-phenate to which 0.5-1.0% sodium carbonate has been added. After drying, spray and wash with water.
- Disinfect doors, little holes in the floor, shutters, racks, floors and walls with formaldehyde solution. Also clean the manure yard and adjacent patches of ground with formaldehyde.

Exercise: Observe and draw the various types of damages caused by moulds and disease management and make neat sketches showing infestation.

Ex. No.43

VISIT TO MILKY MUSHROOM FARM PRODUCTION UNITS

Date:

Visit to nearby Milky mushroom units and discuss with the growers the prospects and problems in spawn production, mushroom cultivation and marketing.

Exercise

- **Interaction with mushroom grower and calculate the economics for spawn and mushroom production units**

Date:

VISIT TO MARKETS AND OBSERVING THE MARKETING PATTERN OF MILKY MUSHROOM

To visit the nearby markets and observing the marketing pattern of milky mushroom

Exercise : Discuss on the marketing pattern and offer your suggestions

Ex. No.45

**VISIT TO BUTTON MUSHROOM PRODUCTION UNIT-LEARNING TISSUE
ISOLATION**

Date:

To visit nearby button mushroom production units and to gain practical knowledge on tissue isolation technique and method of spawn preparation.

Exercise: Visit to button mushroom unit and learn spawn preparation methods

Ex. No.46

Date:

**VISIT TO BUTTON MUSHROOM UNITS AND LEARNING COMPOST
PREPARATION METHODS**

To visit nearby button mushroom units and learn the different methods of
compost preparation.

Exercise: Visit to button mushroom unit and learn different compost preparation methods

Ex. No.47

**VISIT TO BUTTON MUSHROOM UNITS AND LEARNING CULTIVATION,
HARVESTING AND STORAGE TECHNIQUES**

Date:

Aim: Visit to nearby button mushroom units and learning the techniques of cropping, harvesting and storage techniques

Exercise:

- **Interact with mushroom grower and derive the economics for the establishment of spawn production and mushroom production units**

Ex. No.48

**VISIT TO MARKETS AND OBSERVING THE MARKETING
BUTTON MUSHROOM**

PATTERN OF

Date:

Visit to nearby markets and observing the marketing pattern of button mushroom.

Exercise:

- **Discuss about the marketing pattern and offer your suggestions.**

Ex. No.49
Date:

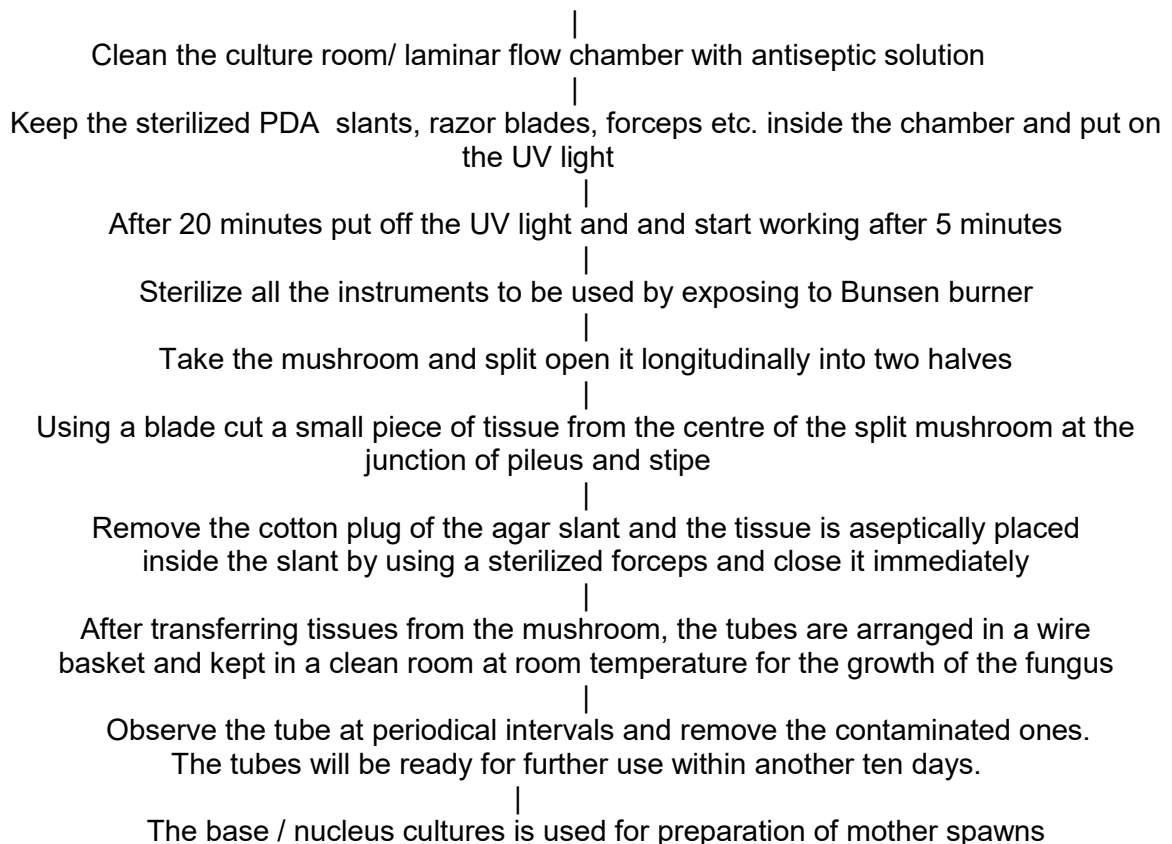
PADDY STRAW MUSHROOM – TISSUE ISOLATION

Base / Nucleus culture:

Tissue culture technique is used to bring the edible mushroom in pure culture so that the pure culture can further be used to prepare spawn, which is an essential material for mushroom cultivation. This nucleus culture is grown on Potato Dextrose Agar medium in test tubes. A small tissue either from pileus or stipe of a wellgrown mushroom is taken aseptically and transferred to agar medium in Petri plate in a culture room. The plates are incubated under room temperature for 10 days for full white growth of fungal culture. This is further used for preparation of Mother spawn.

Procedure:

Select well grown, disease free paddy straw mushroom early in the morning and keep it on a clean paper for 2-3 hr. to get certain amount of moisture present in the mushroom evaporated



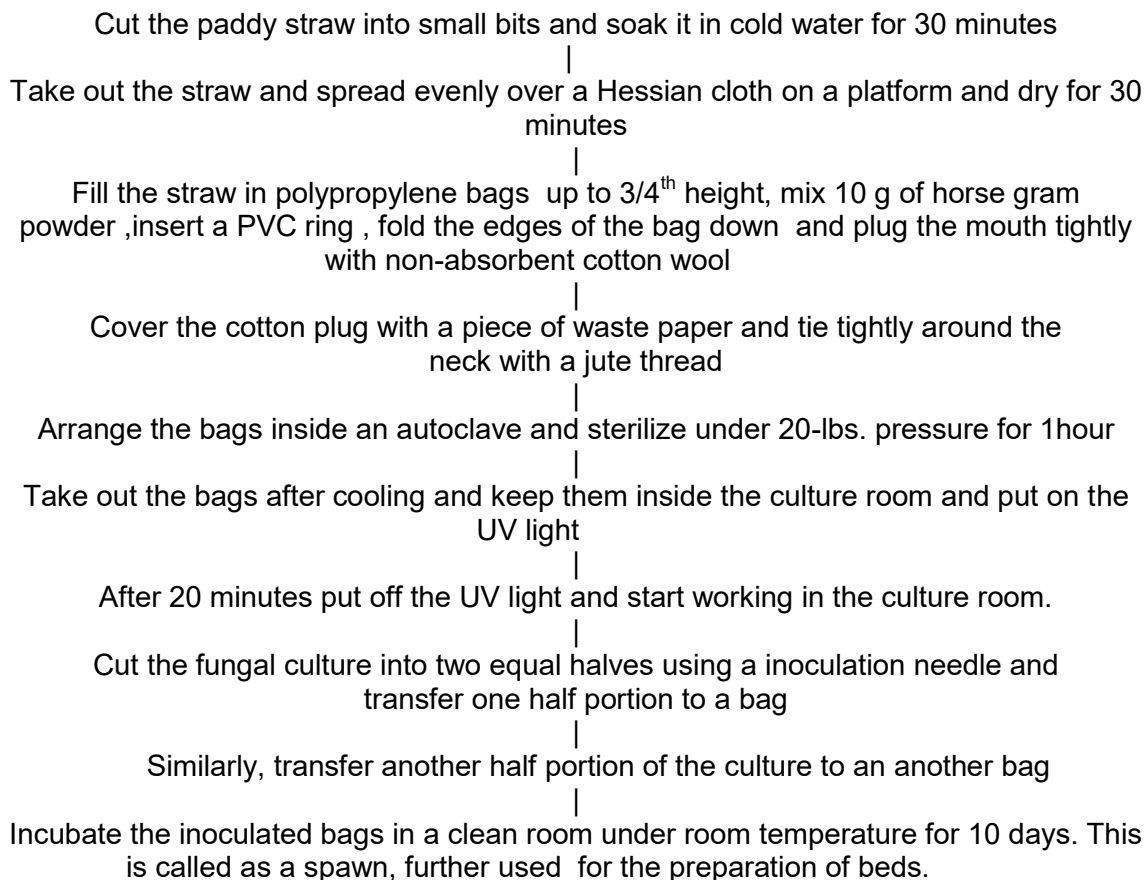
Ex. No.50

PADDY STRAW MUSHROOM: SPAWN PREPARATION

Date:

Preparation of spawn:

Mother spawn is nothing but the mushroom fungus grown on a substrate medium. In this case instead of sorghum grains chopped paddy straw as such are used for spawn preparation. The various steps involving in preparation of spawn are listed below.



Precautions to be observed

- Avoid over soaking of paddy straw.
- Don't dry the straw on the floor. Always dry over hessian cloth spread on a raised platform.
- Avoid further sub culturing of the second-generation bed spawns. This leads to lose of virulence of the spawn lead to reduced yield and repeated sub culturing lead to complete

lose of virulence wherein the fungal growth may be noted in the beds but buttoning is completely arrested.

Practical Exercise

a) Prepare 50 each in mother and bed spawn and work out the cost for production one mother spawn as well as one bed spawn.

b) Observe the spawn bags after 10 days and record the following information:

i) Name of the mushroom species /strain used :

ii) Date of preparation :

iii) Number of bags prepared :

iv) Number bags with contamination :

v) Nature of contamination :

Fungi :

Bacteria :

vi) Days for complete growth of spawn :

Ex. No.51 CULTIVATION OF PADDY STRAW MUSHROOM: SUBSTRATE PREPARATION
Date:

A variety of waste materials have been used for cultivation of the paddy straw mushroom, which includes paddy straw, water hyacinth, banana leaves & saw dust, cotton waste, sugarcane bagasse, oil palm bunch, oil palm pericarp waste etc. Paddy straw mushroom prefers high cellulose, low lignin containing substrate and produces a family of cellulolytic enzymes.

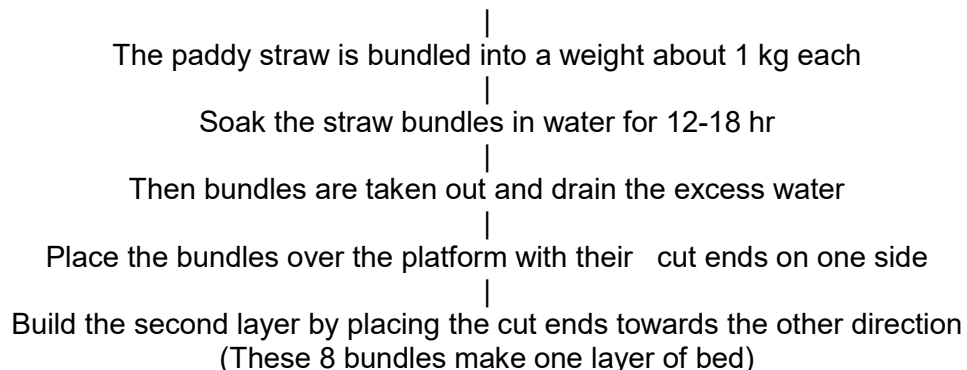
Paddy straw is the most common substrate for this mushroom hence it is known as paddy straw mushroom. It should be dry, clean, without any mould contamination, and should not have been exposed to rain. The mould infected paddy straw may contain the fungal mycelium and spores which contaminate the mushroom beds. In order to overcome the loss caused by these moulds, the paddy straw must be collected right after harvest and stored in a good place.

Approximately ten to fifteen kilogram of paddy straw is necessary for preparing one bed. In recent years, it is cultivated inside plastic film houses to maintain the temperature of around 25 -35°C and relative humidity of 75-80 %.

Substrate preparation

The cultivation of paddy straw mushroom can be done in a thatched house and also under the shade of a tree. Fresh, disease free paddy straw is an ideal substrate. Ten to fifteen kg paddy straw is necessary for preparing one bed. In recent years, it is cultivated inside plastic film houses to maintain the temperature of around 25 -35°C and relative humidity of 75-80 %.

The mushroom beds are usually prepared on a raised bamboo platform inside a thatched hut the size of the platform is 1m length and 0.75 m breadth



Place the a small quantity of spawn 8-12 cm away from the margin at an interval o10- 15 cm
all along the periphery

Apply a spoonful of coarsely powdered dhal powder before placing spawn

Place the straw bundles at right angles to the previous layer in a cris-cross fashion
to make the third layer

Place the straw bundles with opposite cut ends to make fourth layer

Spawn this layer as stated above

Place another layer of straw bundles over this and do not apply spawn

Pressure the bed to make it as compact as possible and cover it with a
transparent polythene sheet

Keep the beds undisturbed for a few days

Ex. No.52

PADDY STRAW MUSHROOM CULTIVATION : BED PREPARATION

Date:

Paddy Straw bundle method

Procedure:

Prepare a raised platform of about 1 m in length and 0.75 m in breadth with ideal wood flanks and keep it over a support by arranging bricks on all four corners

The paddy straw is bundled to weigh about one kg each

Soak the straw bundles in water for 12-18 hr

Then bundles are taken out and drain the excess water

Place the bundles over the platform with their cut ends on one side

Build the second layer by placing the cut ends towards the other direction
(These 8 bundles make one layer of bed)

Place the a small quantity of spawn at a distance of 8-12 cm inside the margin at an interval of 10-15 cm all along the periphery

Apply a spoonful of coarsely powdered dhal powder (Horse gram/redgram) before placing spawn

Place the straw bundles at right angles to the previous layer in a cris-cross fashion to make the third layer

Place the straw bundles with opposite cut ends to make fourth layer

Spawn this layer as stated above

Place another layer of straw bundles over this and do not apply spawn

Pressure the bed to make it as compact as possible and cover it with a transparent polythene sheet

Keep the beds undisturbed for a few days

Note: Usually the bed will have the necessary humidity, if the straw bundles are properly soaked. If moisture is found to be less, it may be watered using a rose can. On the other hand, if the moisture is found to be excess, polythene cover is to be partly to regulate the moisture. The success of cultivation depends upon the temperature and moisture in the bed. The optimum temperature of 30- 35 ° C is necessary for developing buttons.

The mushrooms start appearing from all sides in 6-10 days as tiny buttons, which can be harvested in another 4- 5 days. The harvesting is to be done at the button stage itself, since the opened sporocarp will be more fibrous. Usually, 1-2 kg of mushroom can be harvested from 10 kg substrate.

Paddy straw twist method: Instead of bundled straw, twisted paddy straw can also be used for cultivation

Procedure:

- i) Make the straw into twists of about 5-8 m long and 5-10 cm diameter.
- ii) Immerse the twists in water for 12 hr.
- iii) Take out the straw and drain the excess water.
- iv. Place them lengthwise over a platform on a zigzag manner.
- v) Place a second over this in an opposite direction.
(This forms the first layer of the bed)
- vi) Sprinkle the coarsely powdered dhal and place small bits of spawn all along the periphery as above.
- vii) Build another layer as described above and spawn the layer.
- viii) Build up 4-5 layers and spawn as usual.
- xi) Compact the bed by pressing and cover it with a polythene sheet.

Practical exercise:

Prepare the bed and take the following observations:

Date of preparation	:
Weight of the bed	:
Quantity of spawn used	:
Days to First Harvest	:
Bio efficiency of the mushroom	

Cropping room

We can select a thatched shed or a concrete building as a cropping room. Bamboo platform is the most preferred structure to keep the straw bundles .

Maintenance of beds

Usually the bed will have the necessary humidity, if the straw bundles are properly soaked. If moisture is found to be less, it may be watered using a rose can. On the other hand, if the moisture is found to be excess, polythene cover is to be partly to regulate the moisture. The success of cultivation depends upon the temperature and moisture in the bed. The optimum temperature of 30- 35 ° C and relative humidity 85-90 % is necessary for developing buttons.

Harvesting

The mushrooms start appearing from all sides in 6-10 days as tiny buttons, which can be harvested in another 4- 5 days. The harvesting is to be done at the button stage itself, since the opened sporocarp will be more fibrous. Usually, 1-2 kg of mushroom can be harvested from 10 kg substrate. Mushroom production continues for a period of 2-4 weeks.

Harvesting

1. Paddy straw mushroom is harvested before the volva breaks or just after rapture.. This mushroom grows at high temperature and moisture; therefore, its growth is very fast. So, for harvesting of straw mushroom at good condition it has to be harvested twice or thrice in a day (morning, noon & afternoon).
2. This mushroom usually takes 9-10 days from spawning to first harvest of crop and the first flush normally lasts for 3 days, which constitutes about 70 to 90% of the expected mushroom yield.
3. The intervening period of 3 to 5 days requires thorough watering and maintenance of optimum conditions inside the cropping rooms. The next flush will again lasts for 2-3 days and yields less mushroom than the first flush. The second flush adds only 10 to 30% of the total crop.
4. The mature fruiting bodies should be carefully separated from the beds/substrate by lifting and shaking slightly left or right and then twisting them off.

5. The mushrooms should not be cut off by knives or scissors from the base of the stalk, because the stalk left behind on the bed/substrate will rot and be attacked by pests and contaminated by moulds, which in turn will destroy the mushroom bed.
6. Usually, 1-2 kg of mushroom can be harvested from 10 kg substrate.

Storage

1. Straw mushroom is more perishable than other edible mushrooms and cannot be stored at 4°C as it undergoes autolysis at this temperature.
2. This mushroom can be stored at a temperature of 10 to 15°C for 3 days and little more at 20°C or under controlled atmosphere storage.
3. The loss of moisture in 4 days stored mushroom could be as high as 40-50% in unpacked mushroom, while it can be reduced to 10% on packaging in perforated polythene bags.

Ex. No.54
Date:

PEST AND DISEASE MANAGEMENT IN PADDY STRAW MUSHROOM

INSECT PESTS:

Many insect pests attack the mushrooms. Small larvae of flies, beetles, springtails are very commonly noticed. Absolute cleanliness is a must to prevent the infestation of the insect pests in mushroom sheds.

a) Flies:

Phorid fly: *Megaselia halterata* and *M. tamilnadolensis* (The larvae are creamy white legless maggots with a pointed head which is not black)

Sciarid fly: *Lycoriella mali* (The larva is white and legless maggot and 1mm to 8mm in length)

Damage:

The larvae feed on the mycelium and show rotting patches in the beds. Young buds are also eaten by the larvae. They also tunnel into grown up mushroom and cause rotting of the mushrooms. The flies spread the disease from one bed to others.

b) Spring tails / Columboles:

They are tiny and can not be seen with the naked eye. Tiny insects with stout antennae feed on the mycelium and buds. *Lepidocyrtus cyaneus* and *Isotoma simplex*.

Diseases:

Not much research work has been carried out on the disease's aspect paddy straw mushroom. However, competitors like *Coprinus sp.* damages the crop to the greatest extent being having the same growth requirements as of the *Volvariella spp.* The other competitor moulds which have been recorded are the *Trichoderma sp.*, *Penicillium sp.* and *Mucor sp.*, which mainly come because of the improper pasteurization of the substrate or because of the use of contaminated spawn.

1. Inkycap : *Coprinus sp*

The straw mushroom has several competitors, but *Coprinus* is the most frequently encountered. *Coprinus* completes its life cycle in a much shorter duration (1week) than the straw mushroom, which takes around 9 to 10 days. Hence, *Coprinus* becomes a very strong competitor of straw

mushroom. The pileus of *Coprinus* fruiting body opens quickly and then overnight the mushroom undergoes auto-digestion, leaving spores as a black ink of fluid. It leads to a strong odour in the residue and followed by the growth of green mould. That is usually *Trichoderma* sp.

Management

- Keeping C: N ratio of the compost in the range of 40:1 to 50:1.
- The moisture content should be maintained in the range of 60 to 65% to obtain high temperature fermentation.
- The wet compost will decay fast and will promote the growth of *Coprinus*.

Observe and draw the various types of damages caused by insect pests and make neat sketches showing infestation.

Abiotic disorders

There are a large number of abiotic agents which create unfavourable environment for the proper growth of mushrooms, resulting in the quantitative as well as qualitative loss. These abiotic agents include low or high moisture in the substrate, unusual pH, low or high temperature, low or high CO₂ concentration in the room, wind velocity, fumes and unsuitable relative humidity.

Common problems encountered in Paddy straw mushroom cultivation

Poor growth of the fungi: Insufficient food, inadequately beaten or too compact compost bed or poor-quality spawn.

Presence of contaminants: Temperature might not have been enough high 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 fruitbody: 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 CO₂, sharp temperature fluctuations or diseases caused by fungi or virus.

Growth of Coprinus: Excessive nitrogen, poor quality straw or excess heat of the compost bed.

Ex. No. 56
Date:

INTEGRATED PEST AND DISEASE MANAGEMENT IN MUSHROOMS

Integrated Pest Management:

- Bed moisture content should be around 60- 65%
- Fix insect proof nets in the windows.
- In button mushroom, newspaper should be treated with 0.1 % formalin
- Fix white insect trap to attract the flies.
- Spray malathion @ 1 ml./ lit. or dichlorvas 0.5 ml/lit. in the floor and sides to kill the flies and beetles, **never spray on the mushroom beds and buttons.**
- Spray Neem oil – 1ml / lit of water in the floor and sides to kill the flies and beetles, never spray on the mushroom beds and buttons.

Ex. No. 57

BIODEGRADATION OF AGROWASTES USING MUSHROOM SPAWN-I

Date:

Pleurotus spp. belongs to white rot fungi and secretes extracellular lignolytic enzymes and cellulolytic enzymes suitable for biodegradation (composting) of agrowastes. -Five spawn packets of *Pleurotus* (2 kg) and 5 kg of urea are needed for composting 1 tonne of agro-waste.

Method of coir pith Composting(1 Ton)

1. Select a sheltered place preferably under a tree
2. Spread uniformly 100 kg. of coir pith in an area of 5 m X 3 m.
3. Apply one *Pleurotus* spawn packet (350 -400 gm) evenly over it
4. Cover with 100 kg. of coir pith and apply 1 kg. of urea evenly over it.
5. Spread 100 kg. coir pith again
6. Repeat the sandwiching process till the spreading of 1 ton Coirpith and the heap reaches one meter in height
7. Moisten the heap daily by sprinkling sufficient water (not to flood)
8. The compost heap should be turned once in 10 days
9. Allow the heap to decompose for 60 - 70 days

The same coir pith composting procedure can be adopted for biodegradation of other agrowastes (with suitable modification if needed)

Exercise: Collect farm waste and make a demonstration on the biodegradation

Ex. No. 58

BIODEGRADATION OF AGROWASTES USING MUSHROOM SPAWN-II

Date:

Exercise: After 50-60 days of decomposition, the manure is analysed for C:N ratio and other nutrients.

Raise as nursery bed of vegetable seedlings (Chilli, Tomato) and apply the decomposed manure. Compare the germination percentage with untreated nursery bed

EX. NO. 59
DATE:

MUSHROOM AS A COMPONENT IN INTEGRATED FARMING SYSTEM

Integrated Farming Systems (IFS) has enabled us to develop a framework for an alternative development model to improve the feasibility of small sized farming operations in relation to larger ones. In this system an inter-related set of enterprises used so that the “waste” from one component becomes an input for another part of the system, which reduces cost and improves production and/or income.

- The following farming system in wetland is beneficial Rice- fish – poultry- mushroom farming system
Cultivation of mushroom requires high degree of humidity and therefore its cultivation near wetland rice cultivation and also near the fish pond would be advantageous .
- Upon rice cultivation, the leftover/waste material such as straw would be used for mushroom cultivation .
- Upon mushroom cultivation, the leftover/waste material such as spent mushroom substrate can be used as compost/fertilizer for soil application. Another way, the clean spent mushroom substrate (without contamination) may also be used as a feed supplement (upto 5% of the total requirements) for fish, poultry, pigs, and cows.
- Other two components in this farming system such as poultry and fishery also inter-related. The paddy grains from rice cultivation and spent mushroom substrate are used as feed for poultry.
- Poultry litter (wastes) is used as manure for fish culturing.

Thus inclusion of mushroom cultivation in wetland rice cultivation with fish pond and poultry is considered beneficial.

Exercise:

- **Having studied the cultivation practices of different mushrooms, work out an IFS model including mushrooms as one of the component in agricultural system.**

EX. NO. 60
DATE:

**INTERACTION WITH SPAWN PRODUCERS – TNAU
COMMUNITY RADIO**

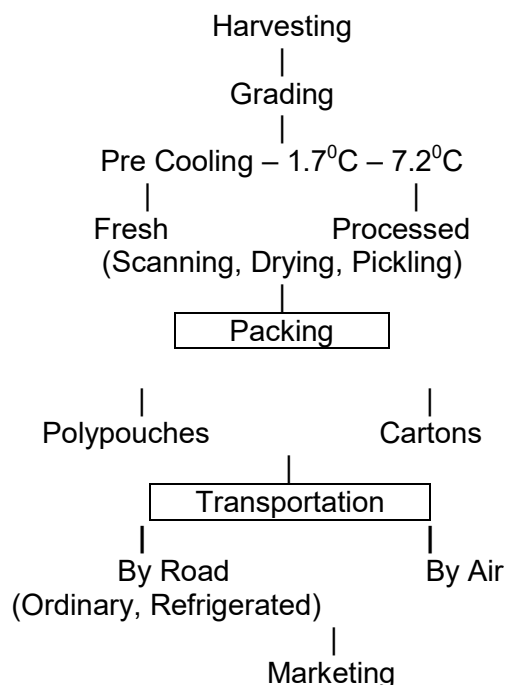
Exercise: Make an interaction with successful spawn producer through TNAU community Radio and carry out the transfer of technology

EX. NO. 61
DATE:

**INTERACTION WITH MUSHROOM PRODUCERS – TNAU
COMMUNITY RADIO**

Exercise: Make an interaction with successful oyster and milky mushroom producer through TNAU community Radio and carry out the transfer of technology

Post Harvest Practices of Mushrooms



Short term post harvest processing of oyster mushroom **to extend the shelf-life for a few days**
Basic processing procedures, followed for short term storage of fruits and vegetables such as grading, washing and cooling are actually not needed for oyster mushroom. Because oyster mushroom usually forms uniform-sized basidiocarps directly from the myceliated clean paddy straw bed without casing soil. So grading and washing steps are not needed.

Thus, the two important methods in short-term post harvest processing of oyster mushrooms are

1. Cooling /refrigeration
2. Irradiation

Cooling / refrigeration

The temperature of the mushrooms increases through respiration after picking and the respiratory rate increases with the increase in the storage temperature. It has been estimated that mushrooms at a temperature of 10°C have 3.5 times higher respiratory capacity than those

at temperature of 0°C, which necessitates immediate shifting of mushrooms to the refrigerated zone.

The size and shape of the packs also play an important role in cooling room. Packs with more than 10 kg mushrooms or with 15 cm thick layers of mushroom causes problem. Vertical flowing of air is more suitable for cooling. The mushrooms should not be stored in the same cooler along with fruits as the gases produced by fruits e.g. ethylene cause discoloration of mushrooms. This forced-chill air-cooling system is time consuming and vacuum cooling is becoming more popular.

The choice of the cooling system depends upon the quantity to be handled, which may be a refrigerator for a small grower to a cold room with all facilities for a commercial grower. Using evaporative cooling, hydro-cooling, forced-chill air, ice bank or vacuum cooling systems, mushrooms can be cooled up to 2-4°C.

Fresh mushrooms are usually packed in poly packs of less than 100 gauge t thickness. Generally, packs measuring 200 g and 400g should be made for retail sale. Poly packs should be properly sealed by sealing instrument. Poly packs so made, should be stored at low temperature (below 5°C) till they are consumed or sold. These poly packs should not be stored even at this temperature for more than 3 days. Higher storage temperature usually results in blackening, cap opening, weight loss and microbial spoilage of mushrooms. In addition to poly bags, oyster mushroom can be filled in brown paper bags with 4-10 small ventilation holes, or small plastic trays over-wrapped with see-through PVC films and stored in refrigerator.

Vacuum cooling

In vacuum cooling, the water in cell walls and interhyphal spaces of mushrooms is evaporated under low pressure and the evaporative cooling lowers the temperature from ambient to 2°C in 15 to 20 minutes. Vacuum cooling is a uniform and faster process, where mushrooms are subjected to very low pressure and water evaporates giving off the latent heat of vaporisation, thus cooling itself. The vacuum-cooled mushrooms have superior colour than conventional-cooled mushrooms. The major drawback of the system is the high capital cost; and an inevitable loss of fresh weight during the process of cooling. Filling and emptying the cooling chamber introduces another operation and expenses into the marketing chain. Air spray moist chillers can also cool the mushrooms rapidly. The temperature can be lowered by 16-18°C in an hour without any moisture loss.

Ice-bank cooling

With a view to reduce the weight loss during the conventional vacuum cooling, ice bank cooling of mushrooms is now in vogue in some countries wherein a stack of mushrooms is passed through forced draft of chilled but humidified air from the icebank.

Irradiation

Gamma irradiation method is recently followed for preservation of foods and this method of food preservation was accepted by several international bodies such as FAO, International Atomic Energy Agency etc. Low dosages of gamma radiation reduces the microbial contamination (gamma irradiation kills the bacteria and nematodes) and extend the shelf-life of mushrooms. Irradiation should be given immediately after harvest for optimum benefits. This method should be used wherever the facilities are available since low dose of gamma irradiation does not affects the nutritional value of the mushroom.

Long term storage

In event of the difficulties in the sale of fresh mushroom in the peak season and also to avail the high price during the off-season, long term preservation methods have been evolved in order to meet the demand of reserved mushrooms.

For long term post harvest processing of oyster mushroom for long term storage, the following four processing methods are followed.

1. Drying
2. Steeping
3. Pickling
4. Canning

1. Drying

Drying is the oldest technique for preservation of food commodities for long duration. It is the process of removal of moisture from the product to a low/minimum level at which microbial and biochemical activities are arrested due to reduced water content. Oyster mushrooms contain about 90 per cent moisture at the time of harvest and are dried to a moisture level down below 10-12 %.

Sun-drying

It is the cheapest method among various drying methods. Mushrooms are spread over the trays or sheets and kept in open under the sun. The suitable atmospheric conditions are 25°C to 35°C; RH less than 50 % and high wind velocity. Sun dried product contains more than 10-12 % moisture and should therefore be oven dried at 55-60°C for 4-6 h to further reduce the moisture to 7-8 % to avoid any spoilage during storage. At a drying temperature of 55-60°C, the insects and microbes on the mushrooms will be killed in a few hours, which gives us the dehydrated final product of lower moisture content with longer shelf-life.

Cabinet air drying/tray-drier

Cabinet air drier consists of series of trays placed in the plenum chamber and hot air at constant air flow rate (55-60°C) is allowed to pass through this plenum chambers. Whereas, the conventional oven-drying

method results in dark brown coloured product because there is no air circulation. Cabinet air dryer has special advantages over sun drying such as

1. The rate of drying can be controlled by adjusting the temperature of hot air ventilating through the mushroom.
2. Mushrooms can be dried irrespective of weather conditions.
3. requires less space.
4. no losses to insects, birds and rodents in the process.

Dehumidified air-cabinet drying

It is the same as cabinet air drying with added advantage of removal of moisture by sucking onto the condenser or using the silica gel that absorb the moisture.

Osmo-air drying

It refers drying in the presence of salts. It is a method of partial removal of

water from mushroom by immersing it in a hypertonic solution (salt). The process is facilitated by the osmotic pressure difference between the food material (hypotonic

medium) and concentrated osmotic solution (hypertonic medium). It is a two-stage process: first step consists of keeping mushroom in a concentrated salt solution called osmotic syrup; in the second stage, osmosed mushroom are hot air dried to a desired moisture level (< 10%).

Freeze-drying/

It is also known as lyophilisation or cryodesiccation. The water in the mushroom is frozen (-20°C) into ice crystals and then the ice crystals are evaporated directly to vapor (process called sublimation).

Fluidized-bed drying

Fluidized-bed drying is the process of removing moisture by exposing commodities into a high velocity of hot air. The velocity of the hot air should be such that it should not throw out but keep the material in the fluidized condition.

3. Pickling of oyster mushrooms

Mushroom pickling is another method of mushroom preservation. This method is gaining popularity as it is the simplest and cheapest method of preservation. This method can easily be practiced by small growers also. Generally, the mushrooms are blanched or fried before normal pickling procedures. Now the mushrooms are used in making the pickles as per normal pickling procedures. Vinegar and other preservatives are generally essential in making the mushroom pickle. Mushrooms preserved as pickles can be stored up to 6-12 months.

4. Canning

Canning is technique by which the mushrooms can be stored for longer periods up to a year. The canning process can be divided into various unit operations namely cleaning, blanching (boiling the mushroom at 95-100 C for 5-6 mins), filling, sterilization, cooling, labeling and packaging. In order to produce good quality canned mushrooms, these should be processed as soon as possible after the harvest. In case a delay is inevitable, mushrooms should be stored at 4 to 50°C till processed.

5. Steeping preservation

This method is simple and economical and the mushrooms can be preserved for short period by steeping them in solution of salt or acids. The common practice is that cleaned mushrooms are washed in water or chemical added water and filled in large plastic containers. Blanching in brine solution for 5 minutes is generally done before filling them in cans. Brine solution is then added into the cans or containers. Steeping of water blanched mushrooms in 1% potassium meta bisulphite (KMS) along with 2% citric acid (overnight), before drying improves color, texture and reconstitution properties. Solution consisting of 2% sodium chloride, 2% citric acid, 2% sodium bicarbonate and 0.15% KMS is used for steeping preservation of blanched mushrooms for 8-10 days at 21-28°C. Chemical solution of 2% salt, 2% sugar, 0.3% citric acid, 0.1% KMS and 1% ascorbic acid is also used for steeping preservation of mushrooms. It helps to extend shelf life of mushrooms.

Ex. No. 64

PACKING METHODS OF OYSTER MUSHROOMS

Date:

Packing & Packaging

The mushrooms are packed for transporting them to the market. While a good package sells a product, a mediocre package can interfere with sale of an otherwise excellent product. For the local markets in India, mushrooms are packed in retail packs of 200 g or 400 g in simple polythene packs of less than 100 gauge thickness. Large quantity packing of mushrooms is done using polythene or pulp-board punnets, which will withstand long distance transport. These punnets are over-wrapped with differentially permeable PVC or polyacetate films. These over-wrappings help in creating modified atmosphere in punnets with 10% CO₂ and 2% O₂ and mushrooms maintain their fresh look for 3 days at 18°C.

Types of container materials used for various types of packaging

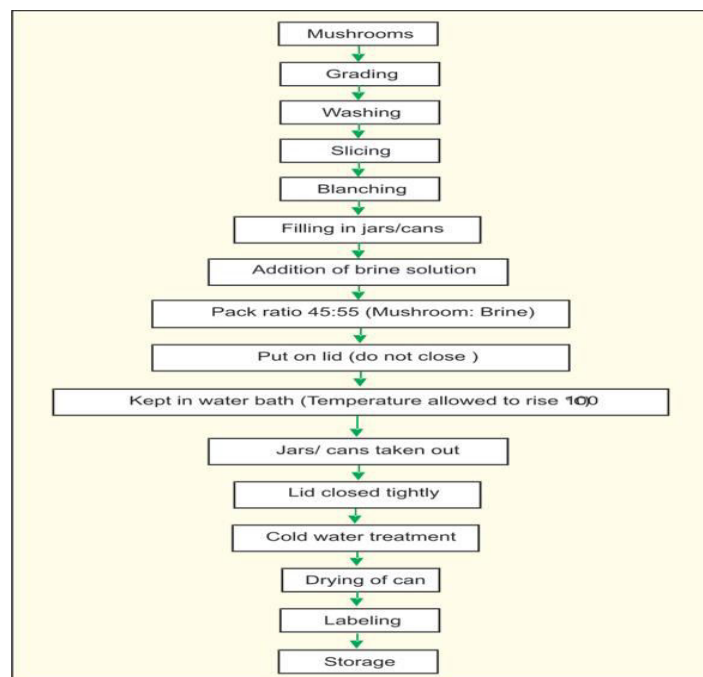
S.No.	Materials	Size (mm)	Capacity (kg)
1.	Plastic punnets	130 x130 x 72	0.40
2.	Cardboard chips	305 x 125 x 118	1.82
3.	Plastic tray	330 x 280 x 145	2.30
4.	Expanded polystyrene	400 x 333 x 167	4.56

In the recent years controlled atmosphere packaging (CAP) and modified atmosphere packaging (MAP) are catching up fast for all types of fruits & vegetables. These packaging techniques have to be effectively used for packing mushrooms to have improved shelf life. If simple polythene bags are used, it is important to make desired number of holes for proper humidity control.

Packaging of Mushrooms

Packaging plays an important role in marketing and exports of fruits and vegetables including mushrooms. Improper packaging often results in rejections and under-valuation of the produce affecting price realization. Therefore, following precautions should be taken in packaging of the produce.

1. With a view to compete in the highly sophisticated and discriminating markets especially abroad, the packages should be attractive and distinctive.
2. Packaging of mushrooms in India is primitive as they are unlabelled and simple in appearance. Polyethylene or polypropylene pouches are preferred for retail sale. Bulk packaging is not in existence.
3. In developed countries, packaging is given due importance. Modified atmosphere packaging (MAP) and controlled atmosphere packaging (CAP) are in vogue there.
4. Retail packs are mostly made of polystyrene or card board punnets over wrapped with differentially permeable films which create a modified atmosphere of CO_2 and O_2 within the punnets extending shelf-life. Such packaging increases the consumers' confidence in the product.
5. Bulk packaging for upper market includes polystyrene containers and easy-to-carry card board boxes of different sizes.
6. Besides the packaging of processed mushrooms. Dried oyster mushrooms are being packed in poorly printed poly pouches which besides giving shabby appearance result in breaking up of the dried fruit bodies.
7. Laminates can also be used for packing mushroom pickles. But future is going to be ruled by 'environment-friendly' recyclable and biodegradable packaging materials.



Oyster Mushroom (*Pleurotus* Spp.)

The oyster mushrooms are harvested and the straw adhered to mushroom is removed and are packed in polythene bags of less than 100 gauge thickness with perforations having vent area of about 5%. Though these perforations cause slight reduction in weight during storage, it helps in maintaining the freshness and firmness of the produce. Rough handling should be avoided. Storage of oyster mushroom at very low temperatures especially in non-perforated polybags results in condensation of water with increased sliminess and softening of the texture. Cooling with positive ventilation is desirable i.e. cold air should be directed through the packed produce. For transporting 'dhingri' (oyster mushroom), the fruit bodies are stacked in trays or baskets. Few poly pouches containing crushed ice are kept along with mushrooms. The tray is then covered with thin polythene sheet with perforation. The pre packed polythene packs with perforations may also be transported in this way.

Various commonly followed packing methods are

1. Perforated polythene bags

The cleaned mushrooms are packed in polypropylene bags of about 100 gauge thickness with perforations having vent area of above 5 per cent.

2. Brown paper bags

The cleaned mushrooms are packed moisture absorbing brown paper bags (used for seed sample collection) with perforations having vent area of above 5 per cent. This packing is not good for transportation.

3. Trays over wrapped with see-through films

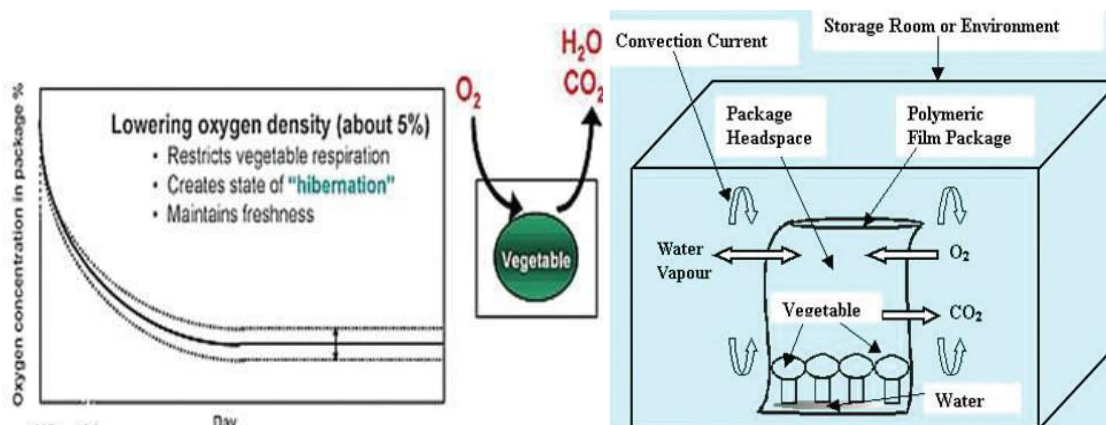
For transportation of oyster mushroom, the fruitbodies are stacked in plastic trays or baskets over wrapped with see-through films/polythene sheets.

Polystyrene or pulp-board punnets or card board box for long distance transport, mushrooms should be packed in polystyrene or pulp-board punnets or card board box. Both pulp-board and card board boxes absorb moisture, thus condensation in the package does not occur

Advanced packing methods

Modified atmosphere packaging (MAP)

Modified Atmosphere Packaging is a method by which a modified atmosphere is created in a sealed package of a fresh product by respiratory gas exchange, namely oxygen (O_2) intake and carbon dioxide (CO_2) evolution. When the rate of gas permeation through the packaging material equals respiratory gas exchange, equilibrium concentrations of O_2 and CO_2 are consequently established. The equilibrium depends on: temperature, respiration rate of specific product, product weight, O_2 and CO_2 permeabilities of the packaging material, free volume in the package and film area. Thus modified atmosphere packaging (MAP) helps in extending the shelf life and maintenance of quality of perishable produce by way of creation of appropriate gaseous atmosphere around the produce packed in plastic films. In this technique, the natural process of respiration of the produce in conjunction with the restricted gas exchange through a polymeric film such as low density polyethylene (LDPE), normal and oriented polypropylene (PP) is used to control the in-pack oxygen and carbon dioxide. General principle of MAP for vegetables and the conceptual model of the MAP for mushroom are given.



Principle of MAP

Conceptual model of MAP

Modified atmosphere can be created by two methods: active and passive modifications. In passive modification, the product is just sealed in a polymeric package and due to the respiration of the fresh product and permeation of gases into the package, the atmosphere is modified. In active modification, air is flushed into the package initially, so that the steady state

atmosphere is reached quickly after packaging. In passive modification, it takes a long time to reach the steady state conditions within the package.

Modified atmosphere packaging (MAP) of mushrooms has been shown successfully to delay senescence and maintain quality after harvest. Shelf life of mushrooms can be increased by over wrapping them with PVC films. Thickness of 100 gauge polythene bags with 0.5% venting area are recommended for packing mushroom in case of refrigerated storage. For transporting mushroom to long distance, polystyrene or pulp-board punnets should be used instead of using polythene bags (Fig. 22.2). The punnets are over-wrapped with differentially permeable Poly Vinyl Chloride (PVC) or poly acetate films. They create modified atmosphere in punnets producing an atmosphere of about 10% CO₂ and 2% O₂. The optimum atmosphere for storage of mushrooms is found to be 2.5-5% CO₂ and 5-10% O₂. In modified atmospheric packaging, the packaging material plays a vital role in modifying the inside atmosphere around the product and the product quality as well.

Among the various packaging materials viz., polyvinylidene chloride coated, oriented nylon, anti-fogging, wrap or vacuum packing film, the antifogging film maintained the quality of mushrooms for 24 days. The best packaging material polyethylene extends the shelf life of fresh mushrooms to 15 days under MAP conditions.

Modified humidity packaging

Most polymeric films used in conventional packing have lower water vapour transmission rates relative to transpiration rates of fresh produce. This leads to nearly saturated conditions within packages. The high in-package-relative-humidity (IPRH) can cause condensation of water vapour within a package and allow microbial growth. This may either increase or decrease the spoilage depending on the product, depending on their transpiration coefficients and water potentials.

To obtain the desired IPRH, there are two possible approaches: perforation of the package, which precludes the possibility of achieving modified atmosphere conditions within the package, and use of in-package water absorbing compounds like calcium chloride, which can maintain the required RH. MAP in combination with MHP further improved the shelf-life of fresh mushrooms. An IPRH of 87-90% is desirable for best colour in mushrooms during storage.

Controlled atmospheric storage

In this method, the oxygen and carbondioxide concentrations are altered inside the package and respiration rate gets altered. Controlled atmospheric package reduces brown discolouration (enzymatic browning) and the shelf life is extended. The calcium chloride added to the irrigation water improves the yield and colour of the canned mushroom product. Mushrooms exposed to lower airflow rates in the growing room remain whiter than those exposed to higher airflow rates. Addition of proprietary form of stabilized chlorine dioxide (oxine, 200 ppm) to preharvest watering applications on mushrooms had lower incidence of blotch and mushrooms retained whiter colour during storage. Commercially available food grade moisture absorbers such as montmorillonite clay and silica gel can be used to extend the shelf life of mushrooms in packs. Mushrooms treated with honey (0.5 and 1 percent) for 18 hours, air dried to remove surface moisture, packed in 100 gauge polythene pouches with 0.5% venting area, increased the shelf life by more than a week over control at 3-5°C and 2-3 days at ambient temperature.

Exercise: Try different packing and storage of mushrooms at different temperatures and give your comments?

EX. NO. 65. SHORT TERM POST HARVEST PROCESSING OF MILKY MUSHROOM

DATE:

Milky Mushroom (*Calocybe indica*)

Milky mushroom is the new introduction from India to world and its production is catching up fast in different parts of the country during the summer months and the mushroom has revolutionized the so called off-season mushroom growing. Fresh mushroom market is largely catered by seasonal growers who do not have cold-chain storage and transport facilities. They sell the produce in highly localized market. This mushroom has very good shelf life of 3-4 days without loss of color and appearance. Washing, packaging, pre-cooling and refrigeration, transports and storage of fresh milky mushroom, if needed, are almost same as for the button mushroom.

Short term post harvest processing methods described in oyster mushroom also holds good for short term post harvest processing of milky mushroom

Fluidized bed dryer



Dehumidified air dryer



Freeze dryer



Cabinet dryer

EX. NO. 66. LONG TERM POST HARVEST PROCESSING OF MILKY MUSHROOM

DATE:

Long term post harvest processing methods described in oyster mushroom also holds good for long term post harvest processing of milky mushroom

Long term storage

In event of the difficulties in the sale of fresh mushroom in the peak season and also to avail the high price during the off-season, long term preservation methods have been evolved in order to meet the demand of reserved mushrooms.

For long term post harvest processing of oyster mushroom for long term storage, the following four processing methods are followed.

1. Drying
2. Steeping
3. Pickling
4. Canning

1. Drying

Drying is the oldest technique for preservation of food commodities for long duration. It is the process of removal of moisture from the product to a low/minimum level at which microbial and biochemical activities are arrested due to reduced water content. Oyster mushrooms contain about 90 per cent moisture at the time of harvest and are dried to a moisture level down below 10-12 %.

Sun-drying

It is the cheapest method among various drying methods. Mushrooms are spread over the trays or sheets and kept in open under the sun. The suitable atmospheric conditions are 25°C to 35°C; RH less than 50 % and high wind velocity. Sun dried product contains more than 10-12 % moisture and should therefore be oven dried at 55-60°C for 4-6 h to further reduce the moisture to 7-8 % to avoid any spoilage during storage. At a drying temperature of 55-60°C, the insects and microbes on the mushrooms will be killed in a few hours, which gives us the dehydrated final product of lower moisture content with longer shelf-life.

Cabinet air drying/tray-drier

Cabinet air drier consists of series of trays placed in the plenum chamber and hot air at constant air flow rate (55-60°C) is allowed to pass through this plenum chambers. Whereas, the conventional oven-drying

method results in dark brown coloured product because there is no air circulation. Cabinet air dryer has special advantages over sun drying such as

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2. Mushrooms can be dried irrespective of weather conditions.
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Dehumidified air-cabinet drying

It is the same as cabinet air drying with added advantage of removal of moisture by sucking onto the condenser or using the silica gel that absorb the moisture.

Osmo-air drying

It refers drying in the presence of salts. It is a method of partial removal of

water from mushroom by immersing it in a hypertonic solution (salt). The process is facilitated by the osmotic pressure difference between the food material (hypotonic

medium) and concentrated osmotic solution (hypertonic medium). It is a two-stage process: first step consists of keeping mushroom in a concentrated salt solution called osmotic syrup; in the second stage, osmosed mushroom are hot air dried to a desired moisture level (< 10%).

Freeze-drying/

It is also known as lyophilisation or cryodesiccation. The water in the mushroom is frozen (-20°C) into ice crystals and then the ice crystals are evaporated directly to vapor (process called sublimation).

Fluidized-bed drying

Fluidized-bed drying is the process of removing moisture by exposing commodities into a high velocity of hot air. The velocity of the hot air should be such that it should not throw out but keep the material in the fluidized condition.

3. Pickling of oyster mushrooms

Mushroom pickling is another method of mushroom preservation. This method is gaining popularity as it is the simplest and cheapest method of preservation. This method can easily be practiced by small growers also. Generally, the mushrooms are blanched or fried before normal pickling procedures. Now the mushrooms are used in making the pickles as per normal pickling procedures. Vinegar and other preservatives are generally essential in making the mushroom pickle. Mushrooms preserved as pickles can be stored up to 6-12 months.

4. Canning

Canning is technique by which the mushrooms can be stored for longer periods up to a year. The canning process can be divided into various unit operations namely cleaning, blanching

(boiling the mushroom at 95-100 C for 5-6 mins), filling, sterilization, cooling, labeling and packaging. In order to produce good quality canned mushrooms, these should be processed as soon as possible after the harvest. In case a delay is inevitable, mushrooms should be stored at 4 to 50°C till processed.

5. Steeping preservation

This method is simple and economical and the mushrooms can be preserved for short period by steeping them in solution of salt or acids. The common practice is that cleaned mushrooms are washed in water or chemical added water and filled in large plastic containers. Blanching in brine solution for 5 minutes is generally done before filling them in cans. Brine solution is then added into the cans or containers. Steeping of water blanched mushrooms in 1% potassium meta bisulphite (KMS) along with 2% citric acid (overnight), before drying improves color, texture and reconstitution properties. Solution consisting of 2% sodium chloride, 2% citric acid, 2% sodium bicarbonate and 0.15% KMS is used for steeping preservation of blanched mushrooms for 8-10 days at 21-28°C. Chemical solution of 2% salt, 2% sugar, 0.3% citric acid, 0.1% KMS and 1% ascorbic acid is also used for steeping preservation of mushrooms. It helps to extend shelf life of mushrooms.

EX. NO. 67

PACKING METHODS OF MILKY MUSHROOM

DATE:

Packing methods described in oyster mushroom also holds good for packing of milky mushroom

Packing & Packaging

The mushrooms are packed for transporting them to the market. While a good package sells a product, a mediocre package can interfere with sale of an otherwise excellent product. For the local markets in India, mushrooms are packed in retail packs of 200 g or 400 g in simple polythene packs of less than 100 gauge thickness. Large quantity packing of mushrooms is done using polythene or pulp-board punnets, which will withstand long distance transport. These punnets are over-wrapped with differentially permeable PVC or polyacetate films. These over-wrappings help in creating modified atmosphere in punnets with 10% CO₂ and 2% O₂ and mushrooms maintain their fresh look for 3 days at 18°C.

Types of container materials used for various types of packaging

S.No.	Materials	Size (mm)	Capacity (kg)
1.	Plastic punnets	130 x130 x 72	0.40
2.	Cardboard chips	305 x 125 x 118	1.82
3.	Plastic tray	330 x 280 x 145	2.30
4.	Expanded polystyrene	400 x 333 x 167	4.56

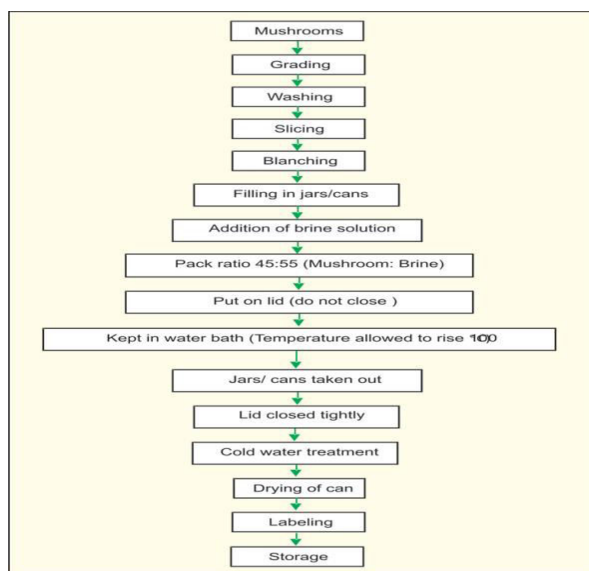
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Packaging of Mushrooms

Packaging plays an important role in marketing and exports of fruits and vegetables including mushrooms. Improper packaging often results in rejections and under-valuation of the

produce affecting price realization. Therefore, following precautions should be taken in packaging of the produce.

1. With a view to compete in the highly sophisticated and discriminating markets especially abroad, the packages should be attractive and distinctive.
2. Packaging of mushrooms in India is primitive as they are unlabelled and simple in appearance. Polyethylene or polypropylene pouches are preferred for retail sale. Bulk packaging is not in existence.
3. In developed countries, packaging is given due importance. Modified atmosphere packaging (MAP) and controlled atmosphere packaging (CAP) are in vogue there.
4. Retail packs are mostly made of polystyrene or card board punnets over wrapped with differentially permeable films which create a modified atmosphere of CO_2 and O_2 within the punnets extending shelf-life. Such packaging increases the consumers' confidence in the product.
5. Bulk packaging for upper market includes polystyrene containers and easy-to-carry card board boxes of different sizes.
6. Besides the packaging of processed mushrooms. Dried oyster mushrooms are being packed in poorly printed poly pouches which besides giving shabby appearance result in breaking up of the dried fruit bodies.
8. Laminates can also be used for packing mushroom pickles. But future is going to be ruled by 'environment-friendly' recyclable and biodegradable packaging materials.



Oyster Mushroom (*Pleurotus* Spp.)

The oyster mushrooms are harvested and the straw adhered to mushroom is removed and are packed in polythene bags of less than 100 gauge thickness with perforations having vent area of about 5%. Though these perforations cause slight reduction in weight during storage, it helps in maintaining the freshness and firmness of the produce. Rough handling should be avoided. Storage of oyster mushroom at very low temperatures especially in non-perforated polypacks results in condensation of water with increased sliminess and softening of the texture. Cooling with positive ventilation is desirable i.e. cold air should be directed through the packed produce. For transporting 'dhingri' (oyster mushroom), the fruit bodies are stacked in trays or baskets. Few poly pouches containing crushed ice are kept along with mushrooms. The tray is then covered with thin polythene sheet with perforation. The pre packed polythene packs with perforations may also be transported in this way.

Various commonly followed packing methods are

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The cleaned mushrooms are packed in polypropylene bags of about 100 gauge thickness with perforations having vent area of above 5 per cent.

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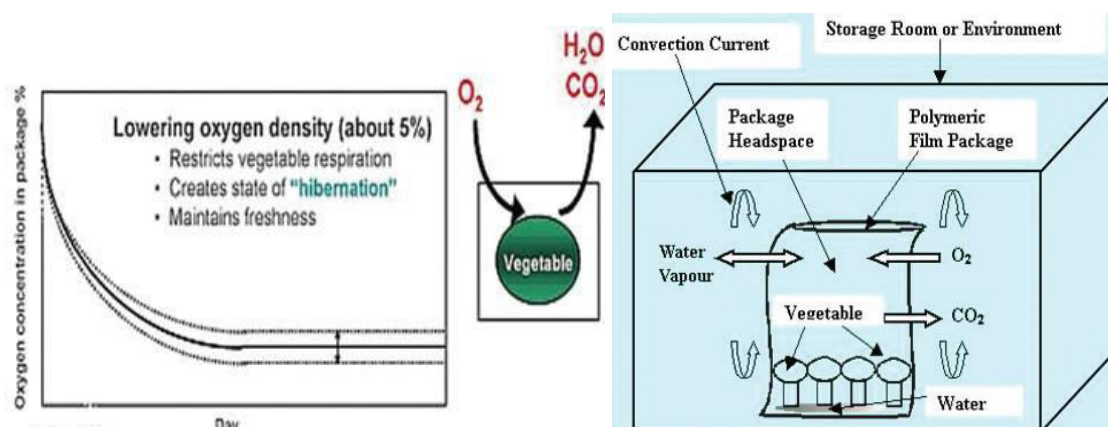
For transportation of oyster mushroom, the fruitbodies are stacked in plastic trays or baskets over wrapped with see-through films/polythene sheets.

Polystyrene or pulp-board punnets or card board box for long distance transport, mushrooms should be packed in polystyrene or pulp-board punnets or card board box. Both pulp-board and card board boxes absorb moisture, thus condensation in the package does not occur

Advanced packing methods : Modified atmosphere packaging (MAP)

Modified Atmosphere Packaging is a method by which a modified atmosphere is created in a sealed package of a fresh product by respiratory gas exchange, namely oxygen (O₂) intake

and carbon dioxide (CO₂) evolution. When the rate of gas permeation through the packaging material equals respiratory gas exchange, equilibrium concentrations of O₂ and CO₂ are consequently established. The equilibrium depends on: temperature, respiration rate of specific product, product weight, O₂ and CO₂ permeabilities of the packaging material, free volume in the package and film area. Thus modified atmosphere packaging (MAP) helps in extending the shelf life and maintenance of quality of perishable produce by way of creation of appropriate gaseous atmosphere around the produce packed in plastic films. In this technique, the natural process of respiration of the produce in conjunction with the restricted gas exchange through a polymeric film such as low density polyethylene (LDPE), normal and oriented polypropylene (PP) is used to control the in-pack oxygen and carbon dioxide. General principle of MAP for vegetables and the conceptual model of the MAP for mushroom are given.



Principle of MAP

Conceptual model of MAP

Modified atmosphere can be created by two methods: active and passive modifications. In passive modification, the product is just sealed in a polymeric package and due to the respiration of the fresh product and permeation of gases into the package, the atmosphere is modified. In active modification, air is flushed into the package initially, so that the steady state atmosphere is reached quickly after packaging. In passive modification, it takes a long time to reach the steady state conditions within the package.

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transporting mushroom to long distance, polystyrene or pulp-board punnets should be used instead of using polythene bags (Fig. 22.2). The punnets are over-wrapped with differentially permeable Poly Vinyl Chloride (PVC) or poly acetate films. They create modified atmosphere in punnets producing an atmosphere of about 10% CO₂ and 2% O₂. The optimum atmosphere for storage of mushrooms is found to be 2.5-5% CO₂ and 5-10% O₂. In modified atmospheric packaging, the packaging material plays a vital role in modifying the inside atmosphere around the product and the product quality as well.

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Modified humidity packaging

Most polymeric films used in conventional packing have lower water vapour transmission rates relative to transpiration rates of fresh produce. This leads to nearly saturated conditions within packages. The high in-package-relative-humidity (IPRH) can cause condensation of water vapour within a package and allow microbial growth. This may either increase or decrease the spoilage depending on the product, depending on their transpiration coefficients and water potentials.

To obtain the desired IPRH, there are two possible approaches: perforation of the package, which precludes the possibility of achieving modified atmosphere conditions within the package, and use of in-package water absorbing compounds like calcium chloride, which can maintain the required RH. MAP in combination with MHP further improved the shelf-life of fresh mushrooms. An IPRH of 87-90% is desirable for best colour in mushrooms during storage.

Controlled atmospheric storage

In this method, the oxygen and carbondioxide concentrations are altered inside the package and respiration rate gets altered. Controlled atmospheric package reduces brown discolouration (enzymatic browning) and the shelf life is extended. The calcium chloride added to the irrigation water improves the yield and colour of the canned mushroom product. Mushrooms exposed to lower airflow rates in the growing room remain whiter than those exposed to higher airflow rates. Addition of proprietary form of stabilized chlorine dioxide (oxine, 200 ppm) to preharvest watering applications on mushrooms had lower incidence of blotch and mushrooms retained

whiter colour during storage. Commercially available food grade moisture absorbers such as montmorillonite clay and silica gel can be used to extend the shelf life of mushrooms in packs. Mushrooms treated with honey (0.5 and 1 percent) for 18 hours, air dried to remove surface moisture, packed in 100 gauge polythene pouches with 0.5% venting area, increased the shelf life by more than a week over control at 3-5°C and 2-3 days at ambient temperature.

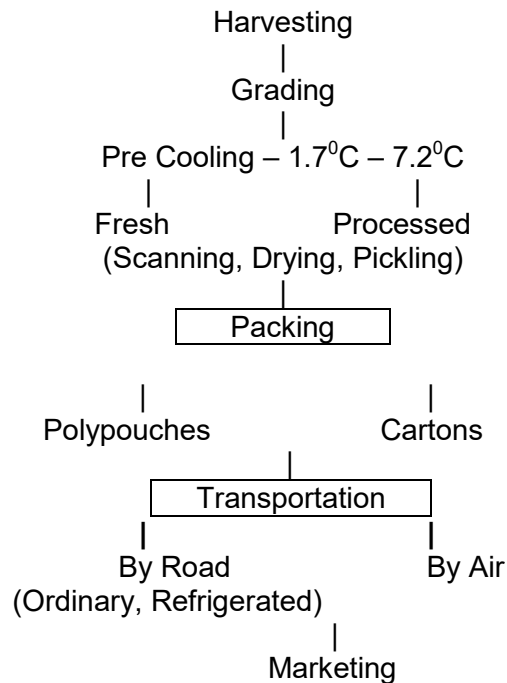
Exercise: Try different packing and storage of mushrooms at different temperatures and give your comments?

Ex. No. 68
Date:

SHORT TERM POST HARVEST PROCESSING OF BUTTON MUSHROOM

Short term post harvest processing methods described in oyster mushroom also holds good for short term post harvest processing of button mushroom

Post Harvest Practices of Mushrooms



Short term post harvest processing of oyster mushroom **to extend the shelf-life for a few days**
Basic processing procedures, followed for short term storage of fruits and vegetables such as grading, washing and cooling are actually not needed for oyster mushroom. Because oyster mushroom usually forms uniform-sized basidiocarps directly from the myceliated clean paddy straw bed without casing soil. So grading and washing steps are not needed.

Thus, the two important methods in short-term post harvest processing of oyster mushrooms are

1. Cooling /refrigeration
2. Irradiation

Cooling / refrigeration

The temperature of the mushrooms increases through respiration after picking and the respiratory rate increases with the increase in the storage temperature. It has been estimated that mushrooms at a temperature of 10°C have 3.5 times higher respiratory capacity than those at temperature of 0°C, which necessitates immediate shifting of mushrooms to the refrigerated zone.

The size and shape of the packs also play an important role in cooling room. Packs with more than 10 kg mushrooms or with 15 cm thick layers of mushroom causes problem. Vertical flowing of air is more suitable for cooling. The mushrooms should not be stored in the same cooler along with fruits as the gases produced by fruits e.g. ethylene cause discoloration of mushrooms. This forced-chill air-cooling system is time consuming and vacuum cooling is becoming more popular.

The choice of the cooling system depends upon the quantity to be handled, which may be a refrigerator for a small grower to a cold room with all facilities for a commercial grower. Using evaporative cooling, hydro-cooling, forced-chill air, ice bank or vacuum cooling systems, mushrooms can be cooled up to 2-4°C.

Fresh mushrooms are usually packed in poly packs of less than 100 gauge t thickness. Generally, packs measuring 200 g and 400g should be made for retail sale. Poly packs should be properly sealed by sealing instrument. Poly packs so made, should be stored at low temperature (below 5°C) till they are consumed or sold. These poly packs should not be stored even at this temperature for more than 3 days. Higher storage temperature usually results in blackening, cap opening, weight loss and microbial spoilage of mushrooms. In addition to poly bags, oyster mushroom can be filled in brown paper bags with 4-10 small ventilation holes, or small plastic trays over-wrapped with see-through PVC films and stored in refrigerator.

Vacuum cooling

In vacuum cooling, the water in cell walls and interhyphal spaces of mushrooms is evaporated under low pressure and the evaporative cooling lowers the temperature from ambient to 2°C in 15 to 20 minutes. Vacuum cooling is a uniform and faster process, where mushrooms are subjected to very low pressure and water evaporates giving off the latent heat of vaporisation, thus cooling itself. The vacuum-cooled mushrooms have superior colour than conventional-cooled mushrooms. The major drawback of the system is the high capital cost; and an inevitable loss of fresh weight during the process of cooling. Filling and emptying the cooling chamber introduces another operation and expenses into the marketing chain. Air spray

moist chillers can also cool the mushrooms rapidly. The temperature can be lowered by 16-18°C in an hour without any moisture loss.

Ice-bank cooling

With a view to reduce the weight loss during the conventional vacuum cooling, ice bank cooling of mushrooms is now in vogue in some countries wherein a stack of mushrooms is passed through forced draft of chilled but humidified air from the icebank.

Irradiation

Gamma irradiation method is recently followed for preservation of foods and this method of food preservation was accepted by several international bodies such as FAO, International Atomic Energy Agency etc. Low dosages of gamma radiation reduces the microbial contamination (gamma irradiation kills the bacteria and nematodes) and extend the shelf-life of mushrooms. Irradiation should be given immediately after harvest for optimum benefits. This method should be used wherever the facilities are available since low dose of gamma irradiation does not affects the nutritional value of the mushroom.

Ex. No. 69
Date:

LONG TERM POST HARVEST PROCESSING OF BUTTON MUSHROOM

Drying of button mushroom causes blackening and irreversible changes of its texture. Any method of drying especially with heating such as sun drying, oven drying, cabinet air drying. However, freeze drying method is followed for increasing button mushroom shelf-life.

Long term storage

In event of the difficulties in the sale of fresh mushroom in the peak season and also to avail the high price during the off-season, long term preservation methods have been evolved in order to meet the demand of reserved mushrooms.

For long term post harvest processing of oyster mushroom for long term storage, the following four processing methods are followed.

1. Drying
2. Steeping
3. Pickling
4. Canning

1. Drying

Drying is the oldest technique for preservation of food commodities for long duration. It is the process of removal of moisture from the product to a low/minimum level at which microbial and biochemical activities are arrested due to reduced water content. mushrooms contain about 90 per cent moisture at the time of harvest and are dried to a moisture level down below 10-12 %.

Sun-drying

It is the cheapest method among various drying methods. Mushrooms are spread over the trays or sheets and kept in open under the sun. The suitable atmospheric conditions are 25°C to 35°C; RH less than 50 % and high wind velocity. Sun dried product contains more than 10-12 % moisture and should therefore be oven dried at 55-60°C for 4-6 h to further reduce the moisture to 7-8 % to avoid any spoilage during storage. At a drying temperature of 55-60°C, the insects and microbes on the mushrooms will be killed in a few hours, which gives us the dehydrated final product of lower moisture content with longer shelf-life.

Cabinet air drying/tray-drier

Cabinet air drier consists of series of trays placed in the plenum chamber and hot air at constant air flow rate (55-60°C) is allowed to pass through this plenum chambers. Whereas, the conventional oven-drying

method results in dark brown coloured product because there is no air circulation. Cabinet air dryer has special advantages over sun drying such as

1. The rate of drying can be controlled by adjusting the temperature of hot air ventilating through the mushroom.
2. Mushrooms can be dried irrespective of weather conditions.
3. requires less space.
4. no losses to insects, birds and rodents in the process.

Dehumidified air-cabinet drying

It is the same as cabinet air drying with added advantage of removal of moisture by sucking onto the condenser or using the silica gel that absorb the moisture.

Osmo-air drying

It refers drying in the presence of salts. It is a method of partial removal of

water from mushroom by immersing it in a hypertonic solution (salt). The process is facilitated by the osmotic pressure difference between the food material (hypotonic

medium) and concentrated osmotic solution (hypertonic medium). It is a two-stage process: first step consists of keeping mushroom in a concentrated salt solution called osmotic syrup; in the second stage, osmosed mushroom are hot air dried to a desired moisture level (< 10%).

Freeze-drying/

It is also known as lyophilisation or cryodesiccation. The water in the mushroom is frozen (-20°C) into ice crystals and then the ice crystals are evaporated directly to vapor (process called sublimation).

Fluidized-bed drying

Fluidized-bed drying is the process of removing moisture by exposing commodities into a high velocity of hot air. The velocity of the hot air should be such that it should not throw out but keep the material in the fluidized condition.

3. Pickling of oyster mushrooms

Mushroom pickling is another method of mushroom preservation. This method is gaining popularity as it is the simplest and cheapest method of preservation. This method can easily be practiced by small growers also. Generally, the mushrooms are blanched or fried before normal pickling procedures. Now the mushrooms are used in making the pickles as per normal pickling

procedures. Vinegar and other preservatives are generally essential in making the mushroom pickle. Mushrooms preserved as pickles can be stored up to 6-12 months.

4. Canning

Canning is technique by which the mushrooms can be stored for longer periods up to a year. The canning process can be divided into various unit operations namely cleaning, blanching (boiling the mushroom at 95-100 C for 5-6 mins), filling, sterilization, cooling, labeling and packaging. In order to produce good quality canned mushrooms, these should be processed as soon as possible after the harvest. In case a delay is inevitable, mushrooms should be stored at 4 to 50°C till processed.

5. Steeping preservation

This method is simple and economical and the mushrooms can be preserved for short period by steeping them in solution of salt or acids. The common practice is that cleaned mushrooms are washed in water or chemical added water and filled in large plastic containers. Blanching in brine solution for 5 minutes is generally done before filling them in cans. Brine solution is then added into the cans or containers. Steeping of water blanched mushrooms in 1% potassium meta bisulphite (KMS) along with 2% citric acid (overnight), before drying improves color, texture and reconstitution properties. Solution consisting of 2% sodium chloride, 2% citric acid, 2% sodium bicarbonate and 0.15% KMS is used for steeping preservation of blanched mushrooms for 8-10 days at 21-28°C. Chemical solution of 2% salt, 2% sugar, 0.3% citric acid, 0.1% KMS and 1% ascorbic acid is also used for steeping preservation of mushrooms. It helps to extend shelf life of mushrooms.

Ex. No. 70

PACKING METHODS OF BUTTON MUSHROOM

Date:

Packing methods described in oyster and milky mushroom also holds good packing of button mushroom

Packing & Packaging

The mushrooms are packed for transporting them to the market. While a good package sells a product, a mediocre package can interfere with sale of an otherwise excellent product. For the local markets in India, mushrooms are packed in retail packs of 200 g or 400 g in simple polythene packs of less than 100 gauge thickness. Large quantity packing of mushrooms is done using polythene or pulp-board punnets, which will withstand long distance transport. These punnets are over-wrapped with differentially permeable PVC or polyacetate films. These over-wrappings help in creating modified atmosphere in punnets with 10% CO₂ and 2% O₂ and mushrooms maintain their fresh look for 3 days at 18°C.

Types of container materials used for various types of packaging

S.No.	Materials	Size (mm)	Capacity (kg)
1.	Plastic punnets	130 x130 x 72	0.40
2.	Cardboard chips	305 x 125 x 118	1.82
3.	Plastic tray	330 x 280 x 145	2.30
4.	Expanded polystyrene	400 x 333 x 167	4.56

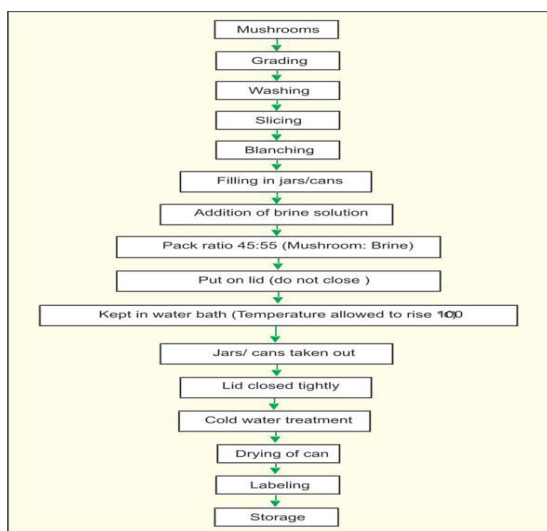
In the recent years controlled atmosphere packaging (CAP) and modified atmosphere packaging (MAP) are catching up fast for all types of fruits & vegetables. These packaging techniques have to be effectively used for packing mushrooms to have improved shelf life. If simple polythene bags are used, it is important to make desired number of holes for proper humidity control.

Packaging of Mushrooms

Packaging plays an important role in marketing and exports of fruits and vegetables including mushrooms. Improper packaging often results in rejections and under-valuation of the

produce affecting price realization. Therefore, following precautions should be taken in packaging of the produce.

1. With a view to compete in the highly sophisticated and discriminating markets especially abroad, the packages should be attractive and distinctive.
2. Packaging of mushrooms in India is primitive as they are unlabelled and simple in appearance. Polyethylene or polypropylene pouches are preferred for retail sale. Bulk packaging is not in existence.
3. In developed countries, packaging is given due importance. Modified atmosphere packaging (MAP) and controlled atmosphere packaging (CAP) are in vogue there.
4. Retail packs are mostly made of polystyrene or card board punnets over wrapped with differentially permeable films which create a modified atmosphere of CO_2 and O_2 within the punnets extending shelf-life. Such packaging increases the consumers' confidence in the product.
5. Bulk packaging for upper market includes polystyrene containers and easy-to-carry card board boxes of different sizes.
6. Besides the packaging of processed mushrooms. Dried oyster mushrooms are being packed in poorly printed poly pouches which besides giving shabby appearance result in breaking u of the dried fruit bodies.
7. Laminates can also be used for packing mushroom pickles. But future is going to be ruled by 'environment-friendly' recyclable and biodegradable packaging materials.



Oyster Mushroom (*Pleurotus* Spp.)

The oyster mushrooms are harvested and the straw adhered to mushroom is removed and are packed in polythene bags of less than 100 gauge thickness with perforations having vent area of about 5%. Though these perforations cause slight reduction in weight during storage, it helps in maintaining the freshness and firmness of the produce. Rough handling should be avoided. Storage of oyster mushroom at very low temperatures especially in non-perforated polypacks results in condensation of water with increased sliminess and softening of the texture. Cooling with positive ventilation is desirable i.e. cold air should be directed through the packed produce. For transporting 'dhingri' (oyster mushroom), the fruit bodies are stacked in trays or baskets. Few poly pouches containing crushed ice are kept along with mushrooms. The tray is then covered with thin polythene sheet with perforation. The pre packed polythene packs with perforations may also be transported in this way.

Various commonly followed packing methods are

7. Perforated polythene bags

The cleaned mushrooms are packed in polypropylene bags of about 100 gauge thickness with perforations having vent area of above 5 per cent.

8. Brown paper bags

The cleaned mushrooms are packed moisture absorbing brown paper bags (used for seed sample collection) with perforations having vent area of above 5 per cent. This packing is not good for transportation.

9. Trays over wrapped with see-through films

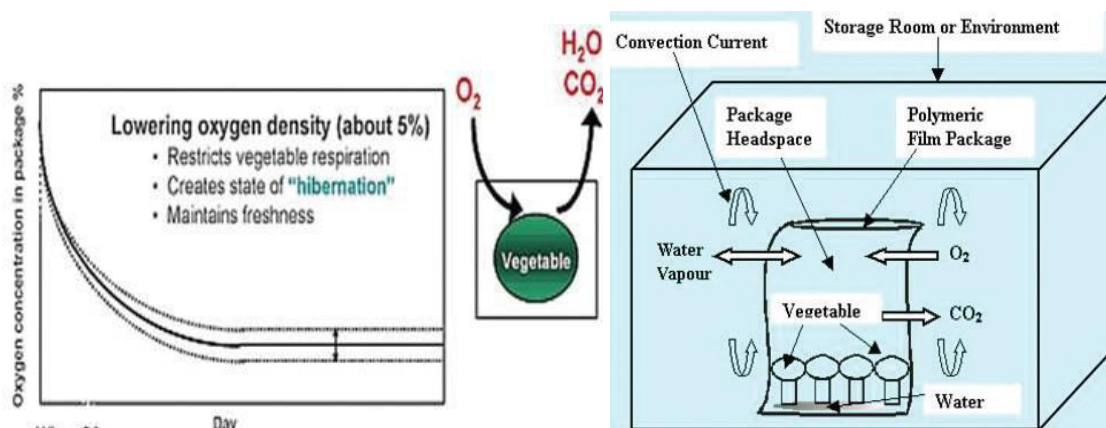
For transportation of oyster mushroom, the fruitbodies are stacked in plastic trays or baskets over wrapped with see-through films/polythene sheets.

Polystyrene or pulp-board punnets or card board box for long distance transport, mushrooms should be packed in polystyrene or pulp-board punnets or card board box. Both pulp-board and card board boxes absorb moisture, thus condensation in the package does not occur

Advanced packing methods

Modified atmosphere packaging (MAP)

Modified Atmosphere Packaging is a method by which a modified atmosphere is created in a sealed package of a fresh product by respiratory gas exchange, namely oxygen (O_2) intake and carbon dioxide (CO_2) evolution. When the rate of gas permeation through the packaging material equals respiratory gas exchange, equilibrium concentrations of O_2 and CO_2 are consequently established. The equilibrium depends on: temperature, respiration rate of specific product, product weight, O_2 and CO_2 permeabilities of the packaging material, free volume in the package and film area. Thus modified atmosphere packaging (MAP) helps in extending the shelf life and maintenance of quality of perishable produce by way of creation of appropriate gaseous atmosphere around the produce packed in plastic films. In this technique, the natural process of respiration of the produce in conjunction with the restricted gas exchange through a polymeric film such as low density polyethylene (LDPE), normal and oriented polypropylene (PP) is used to control the in-pack oxygen and carbon dioxide. General principle of MAP for vegetables and the conceptual model of the MAP for mushroom are given.



Principle of MAP

Conceptual model of MAP

Modified atmosphere can be created by two methods: active and passive modifications. In passive modification, the product is just sealed in a polymeric package and due to the respiration of the fresh product and permeation of gases into the package, the atmosphere is modified. In active modification, air is flushed into the package initially, so that the steady state atmosphere is reached quickly after packaging. In passive modification, it takes a long time to reach the steady state conditions within the package.

Modified atmosphere packaging (MAP) of mushrooms has been shown successfully to delay senescence and maintain quality after harvest. Shelf life of mushrooms can be increased

by over wrapping them with PVC films. Thickness of 100 gauge polythene bags with 0.5% venting area are recommended for packing mushroom in case of refrigerated storage. For transporting mushroom to long distance, polystyrene or pulp-board punnets should be used instead of using polythene bags (Fig. 22.2). The punnets are over-wrapped with differentially permeable Poly Vinyl Chloride (PVC) or poly acetate films. They create modified atmosphere in punnets producing an atmosphere of about 10% CO₂ and 2% O₂. The optimum atmosphere for storage of mushrooms is found to be 2.5-5% CO₂ and 5-10% O₂. In modified atmospheric packaging, the packaging material plays a vital role in modifying the inside atmosphere around the product and the product quality as well.

Among the various packaging materials viz., polyvinylidene chloride coated, oriented nylon, anti-fogging, wrap or vacuum packing film, the antifogging film maintained the quality of mushrooms for 24 days. The best packaging material polyethylene extends the shelf life of fresh mushrooms to 15 days under MAP conditions.

Modified humidity packaging

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To obtain the desired IPRH, there are two possible approaches: perforation of the package, which precludes the possibility of achieving modified atmosphere conditions within the package, and use of in-package water absorbing compounds like calcium chloride, which can maintain the required RH. MAP in combination with MHP further improved the shelf-life of fresh mushrooms. An IPRH of 87-90% is desirable for best colour in mushrooms during storage.

Controlled atmospheric storage

In this method, the oxygen and carbondioxide concentrations are altered inside the package and respiration rate gets altered. Controlled atmospheric package reduces brown discolouration (enzymatic browning) and the shelf life is extended. The calcium chloride added to the irrigation water improves the yield and colour of the canned mushroom product. Mushrooms exposed to lower airflow rates in the growing room remain whiter than those exposed to higher airflow rates.

Addition of proprietary form of stabilized chlorine dioxide (oxine, 200 ppm) to preharvest watering applications on mushrooms had lower incidence of blotch and mushrooms retained whiter colour during storage. Commercially available food grade moisture absorbers such as montmorillonite clay and silica gel can be used to extend the shelf life of mushrooms in packs. Mushrooms treated with honey (0.5 and 1 percent) for 18 hours, air dried to remove surface moisture, packed in 100 gauge polythene pouches with 0.5% venting area, increased the shelf life by more than a week over control at 3-5°C and 2-3 days at ambient temperature.

Exercise: Try different packing and storage of mushrooms at different temperatures and give your comments?

Ex. No. 71

CANNING OF BUTTON MUSHROOMS

Date:

Canning:

Canning is adopted on a very large scale, especially for preservation of button mushrooms. For canning purpose, the mushrooms should be harvested at an early stage. The mushrooms of uniform size are selected and stalks are cut before processing.

Procedure:

Wash the mushroom in clean water to remove dirt and other foreign materials

|

Dip the mushroom in boiling water for 2 minutes, take it out and dip in cold water for 2 minutes

|

Fill the mushrooms in the specially made cans upto $\frac{3}{4}$ capacity

(Approximately 220-g mushrooms are filled in 1-lb cans)

|

Add salt solution consisting of 2 per cent common salt, 2 per cent sugar and 0.3 per cent citric acid just to fill up to the brim (Before adding, the salt solution should be boiled and filtered through muslin cloth) (Approximately 125 ml. solution is needed for 1 lb can)

|

Place the lid on the can and keep the cans in boiling water or steam till the temperature in the centre of the cans reaches 80-85°C

|

Seal the can on a steamer to get a air tight steam

|

Sterilize the cans in an autoclave at 10 lb. pressure for 20-25 minutes

|

Keep the cans immediately after sterilization in clean cool water for cooling.

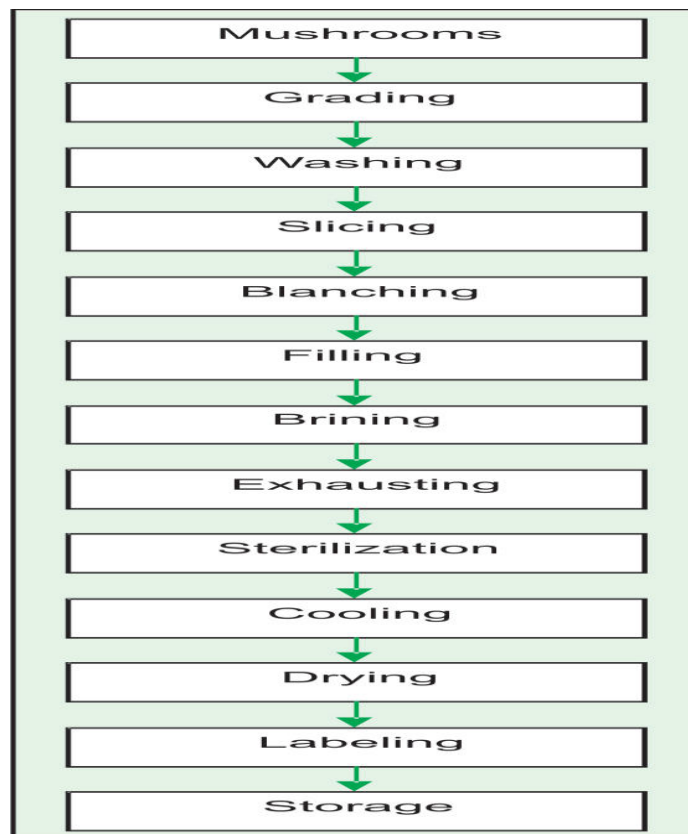
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Wipe the cans with a dry cloth and store in a cool dry place

|

This process extends the storage life up to 12 months

Flow chart of canning



Canning

Canning is the technique by which the mushrooms can be stored for longer periods up to a year and most of the international trade in mushrooms is done in this form. The caning process can be divided into various unit operations namely cleaning, blanching, filling, sterilization, cooling, labelling and packaging. In order to produce good quality canned mushrooms, these should be processed as soon as possible after the harvest. In case a delay is inevitable; mushrooms should be stored at 4 to 5°C till processed. The mushrooms with a stem length of one cm are preferred and are canned whole, sliced and stems and pieces as per demand. Well graded fresh mushrooms white in color, without dark marks on either caps or stems are preferred for canning. Whole mushrooms are washed 3-4 times in cold running water to remove adhering substances. Use of iron free water with 0.1% citric acid prevents discoloration. Thereafter blanching is normally done to inhibit poly phenol oxidase enzymes activity and to inactivate microorganisms. It also removes the gases from the mushroom tissue and reduces bacterial counts. The mushrooms are blanched in stainless steel kettles filled with

a boiling solution of 0.1% citric acid and 1% common salt. The blanching time ranges from 5-6 minutes at 95-100°C. The mushrooms after blanching are filled in sterilized tin cans (A-2½ and A-1 tall can sizes containing approximately 440 and 220 g drained mushroom weight, respectively). Brine solution (2% salt with 0.1% citric acid or 100 ppm ascorbic acid) is added to the mushroom-filled cans after bringing its temperature to 90°C. After filling, the cans are exhausted by passing them in exhaust box for 10-15 minutes, so that temperature in the centre of cans reaches up to 85°C. Then the cans are sealed hermetically with double steamer and kept in upside down position. After exhausting of cans, sterilization of cans is needed. Sterilization is the process of heating the cans up to 118°C to prevent the spoilage by microorganisms during storage. The cans cooled immediately after sterilization process to stop the over-cooking and to prevent stack burning. Cooling can be done by placing the cans in a cold-water tank. Thereafter the clean and dry cans are labeled manually or mechanically and packed in strong wooden crates or corrugated cardboard cartons. The cans are stored in cool and dry place before dispatching to market. In a hot country like India, where the ambient temperature is high during the several months in a year, basement stores are useful, especially during the summer months.

Ex. No. 72 RECIPE AND VALUE ADDED PRODUCTS FROM OYSTER MUSHROOM-I
Date:

A variety of mushrooms are available in its fresh stage as well as in different preserved forms. Different types of dishes can be prepared by using mushrooms with a little amount of imagination and planning. Mushrooms will go along with a variety of vegetables and other materials adding up to their food value and flavor. The lists of recipes made out of mushroom are listed below:

1. Mushroom soup
2. Mushroom pulavu
3. Mushroom vermicelli
4. Mushroom tomato puree
5. Mushroom fry
6. Chilli mushroom
7. Ginger mushroom
8. Mushroom omelet
9. Mushroom puff
10. Mushroom pickle
11. Mushroom samosa
12. Mushroom prawn masala
13. Mushroom mutton fry
14. Mushroom fish fry
15. Mushroom kabbab
16. Mushroom rolls
17. Mushroom cutlet
18. Mushroom kuruma

Practical Exercise:

Prepare the following two common recipes using oyster mushroom.

a) Mushroom soup

Mushroom chopped	: ½ cup
Small onion	: 3
Pepper powder	: ½ teaspoon
Maida	: 1 tablespoon
Egg	: 1
Milk	: ½ cup
Water	: 1 cup
Ghee	: 2 teaspoon
Bread	: 1 slice

Fry chopped onions in little ghee, add mushrooms, pepper powder, and fry till it turns to brown. Add maida and again roast. Add milk and water and bring to boil. When it starts thickening add beaten egg and salt to taste and remove from fire. Fry bread pieces to brown and add to soup before serving.

b) Mushroom puff/ Mushroom hajji:

Mushroom shredded : 2 cups
Bengal gram flour : ½ cup
Turmeric powder : pinch
Chilli powder : 1 tsp
Sodium bicarbonate : pinch
Oil : ½ litre
Salt to taste

Bengal gram flour is made into a thick paste with all the ingredients. Dip the mushroom in the batter and fry it in oil.

Ex. No. 73
Date:

**RECIPE AND VALUE ADDED PRODUCTS FROM OYSTER
MUSHROOM -II**

VALUE-ADDED PRODUCTS

Indian mushroom industry is still predominantly production and trade of the fresh produce; processing too is restricted to the preservation rather than the real value-addition. Almost entire domestic trade is in the fresh form while all the export is in the preserved form (canned or steeped). Current era is characterized by greater awareness about quality and, above all, with the demand for the readymade or ready-to-make food products. As mushrooms contain high moisture and are delicate in texture, these cannot be stored for more than 24 hours at the ambient conditions of the tropics —weight loss, veil opening, browning, liquefaction and microbial spoilage often make the product totally unsalable. Effective processing techniques will not only diminish the postharvest losses but also result in greater remuneration to the growers as well as processors. Value can be added to the mushrooms at the various levels and to varied extent, right from grading to the readymade snacks or the main-course item. Improved and attractive packaging is another important but totally neglected area in mushrooms—it is still unprinted plain poly pouches whereas attractive and labeled over-wrapped trays are in vogue in the developed countries. Real value-added product in the Indian market is the mushroom soup powder. Technologies for production of some other products like mushroom based biscuits, nuggets, preserve, noodles, papad, candies and readymade mushroom curry in retort pouches have been developed but are yet to be popularized. Attractive packaging of the value-added products is yet another area which may be called the secondary value-addition. While small growers may add value by grading and packaging, industry may go for the processed products for better returns as well as improvement in the demand which shall have cascading positive effect on the production.

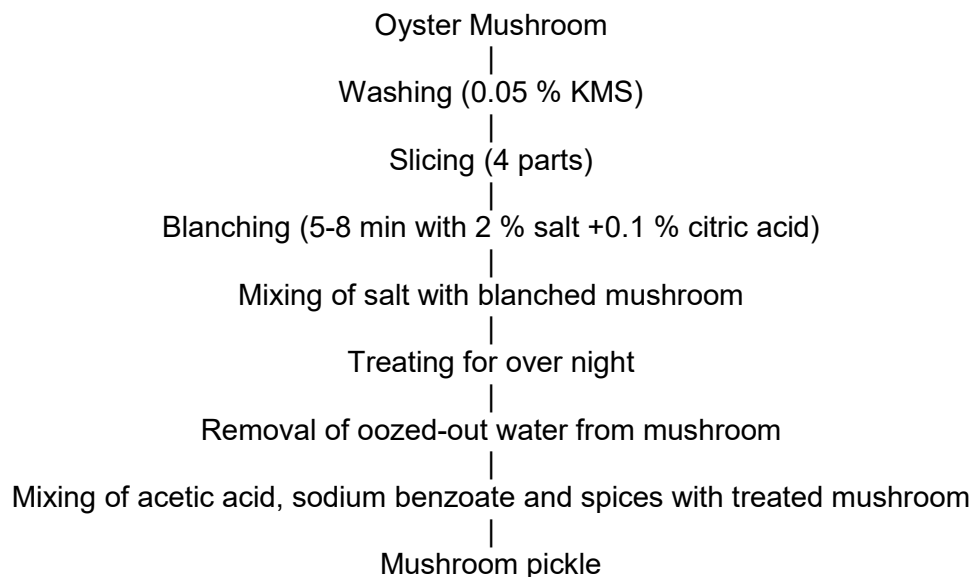
Pickling is a method of long-term storage to preserve mushrooms in an economically viable way. These pickles are good appetizers as well as they add palatability to the meal. It is also a process by which one can store to relish them during the off-season when the price of mushrooms is very high. Mushrooms for pickling are either blanched or fried in oil till brown depending upon taste; various condiments as per local preferences and practices are also

ground or fried in oil separately and added to the mushroom. The contents are mixed thoroughly and cooked slightly for few minutes. It is allowed to cool and then filled in the jars (lugs) of desired size. Vinegar may be added for taste and longer storage and the contents in the bottle or the container should be topped up with oil.

Ingredients for oyster mushroom pickle

Ingredients	g/kg
Black mustard seed powder	35
Turmeric powder	20
Red chili powder	10
Cumin seed powder	1.5
Fennel seed powder	1.5
Carom seed	10
Nigella seed	10
Oil	200 ml
Salt	

Procedure:



Mushroom biscuit

Very delicious and crunchy mushroom biscuits were prepared at NRCM, Solan using mushroom powder (both button and oyster) and ingredients viz., maida, sugar, oil, baking powder, ammonium bicarbonate, salt, vanilla, milk powder and glucose. Fat in the form of oil is used in biscuits to remove hardness and to improve the softness of the biscuits – that is to lower

the forces necessary to break and crush the biscuits. The main sweetening agent is sugar and it also leads to enhanced colour in the baked biscuit because of the Maillard reaction and polymerization. Sugars also affect the heat denaturation of flour proteins. Ammonium carbonate is an aerating agent and it has the advantage that it leaves no residue and evolves a greater volume of gas per unit weight than any of the other aerating agents but, in the absence of phosphate and sodium ions, it leaves a new taste in the biscuits.

Ingredients for oyster mushroom biscuits

Ingredients	Parts g)
Maida	100
Sugar	30
Fat	4 5
Baking powder	0.6
Ammonium bicarbonate	0.3
Salt	0.6
Vanilla essence	0.02
Milk powder	1.5
Glucose/Fructose	1.5
Water	12 to 22 %

All the ingredients have to be mixed in a mixer for 3 to 5 min. The added to the prepared paste and round balls of 2-4 cm dia are made out of the paste. The prepared balls are spread over a steel tray and are dried by sun-drying method and thus the mushroom nuggets are prepared. dough is kept at 30°C in oven for 90 min and then spread to a thickness of 2 to 4 mm over a cleaned platform and cut into circular or rectangular shapes (required shape) and baked for 10-12 min at 210°C in laboratory baking oven.

Ex. No. 74 RECIPE AND VALUE ADDED PRODUCTS FROM MILKY MUSHROOM-I
Date:

Prepare the following two common recipes using milky mushroom.

a) Milky Mushroom soup

Mushroom chopped	: ½ cup
Small onion	: 3
Pepper powder	: ½ teaspoon
Maida	: 1 tablespoon
Egg	: 1
Milk	: ½ cup
Water	: 1 cup
Ghee	: 2 teaspoon
Bread	: 1 slice

Fry chopped onions in little ghee, add mushrooms, pepper powder, and fry till it turns to brown. Add maida and again roast. Add milk and water and bring to boil. When it starts thickening add beaten egg and salt to taste and remove from fire. Fry bread pieces to brown and add to soup before serving.

b) Milky Mushroom puff/ Mushroom bajji:

Mushroom shredded	: 2 cups
Bengal gram flour	: ½ cup
Turmeric powder	: pinch
Chilli powder	: 1 tsp
Sodium bicarbonate	: pinch
Oil	: ½ litre
Salt to taste	

Bengal gram flour is made into a thick paste with all the ingredients. Dip the mushroom in the batter and fry it in oil.

Ex. No. 75

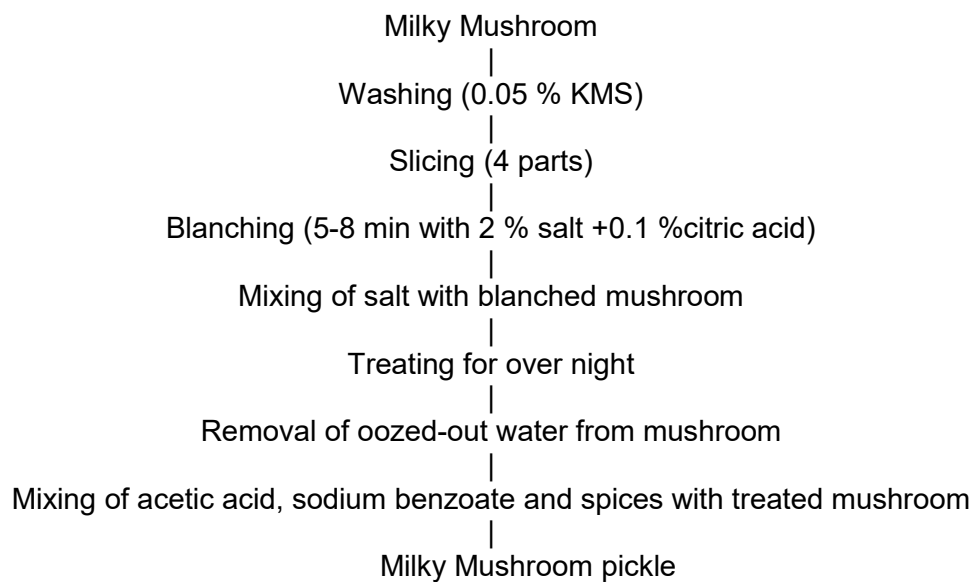
RECIPE AND VALUE ADDED PRODUCTS FROM MILKY MUSHROOM-II

Date:

Ingredients for milky mushroom pickle

Ingredients	g/kg
Black mustard seed powder	35
Turmeric powder	20
Red chili powder	10
Cumin seed powder	1.5
Fennel seed powder	1.5
Carom seed	10
Nigella seed	10
Oil	200 ml
Salt	

Procedure:



Ex. No. 76

Date:

RECIPE AND VALUE ADDED PRODUCTS FROM BUTTON MUSHROOM-I

Prepare the following recipes using button mushroom:

1. Button Mushroom sauce:

Fresh button mushroom	: 500 g
Ginger- ground	: 5 g
Chopped onion	: 20 g
Mace- ground	: 2 g
Fenugreek- coarsely ground	: 10 g
White pepper powder	: 2 g
Red Chillies	: 10 g
Oil	: Sufficient to fry

Clean the button mushroom and put it in a pan, mix salt, pepper, mace and red chillies. Fry onion and ginger in oil to light brown in colour and mix with mushrooms. Add vinegar to the whole mass and cook it for 10 minutes. Store in a glass jar after cooling.

2. Button Mushroom sauce:

Mushroom	: 100 g
Butter	: 100 g
Flour	: 100g
Milk	: 1 litre

Heat the butter and stir the flour gently over the same and mix well. Cook the mixture gently for a while and add the milk, continue cooking over a gentle flame till it is creamy. Fry the cut mushrooms for a while and mix with the stock.

3. Chilli Mushroom:

Mushroom shredded	: 2 cups
Capsicum	: 2 Nos.
Tomato	: 3
Onion	: 2
Maida	: 1 tablespoon
Red colour	: pinch
Pepper powder	: 1 teaspoon

Tomato sauce : 1 tablespoon
Soya sauce : 2 teaspoon
Vinegar : 1 tablespoon
Salt to taste
Oil or vanaspathi for frying

Mix the mushrooms in maida, salt, red colour, vinegar, and pepper and keep for 10 minutes. Slightly fry them in oil and keep aside. Chop onion, capsicum and tomato into pieces. Fry them slightly and mix fried mushroom, tomato sauce and soya sauce. Cook for 3 minutes and serve hot.

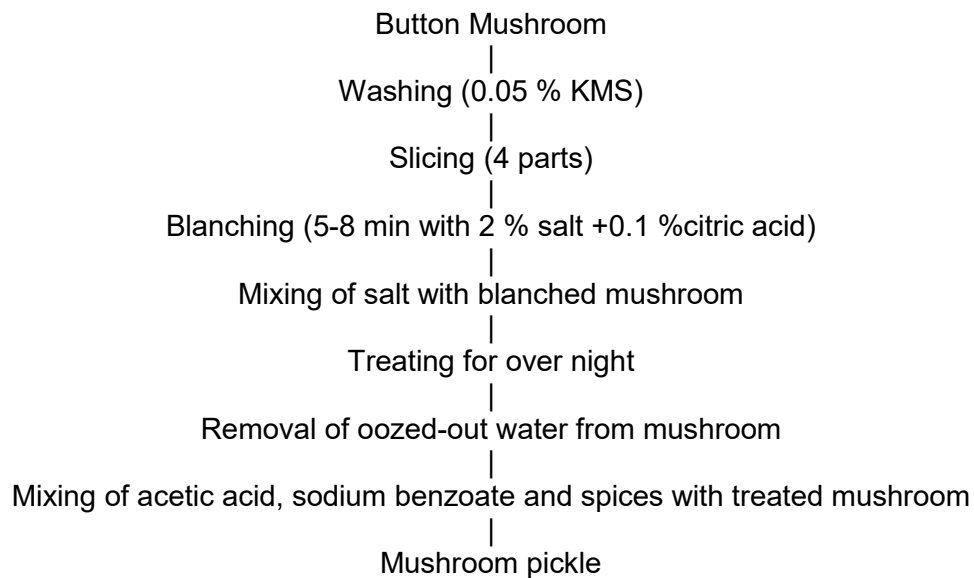
Ex. No. 77
Date:

RECIPE AND VALUE ADDED PRODUCTS FROM BUTTON
MUSHROOM-II

Ingredients for button mushroom pickle

Ingredients	g/kg
Black mustard seed powder	35
Turmeric powder	20
Red chili powder	10
Cumin seed powder	1.5
Fennel seed powder	1.5
Carom seed	10
Nigella seed	10
Oil	200 ml
Salt	

Procedure:



Ingredients for button mushroom biscuits

Ingredients	Parts (g)
Maida	100
Sugar	30
Fat	4 5
Baking powder	0.6

Ammonium bicarbonate	0.3
Salt	0.6
Vanilla essence	0.02
Milk powder	1.5
Glucose/Fructose	1.5
Water	12 to 22 %

All the ingredients have to be mixed in a mixer for 3 to 5 min. The added to the prepared paste and round balls of 2-4 cm dia are made out of the paste. The prepared balls are spread over a steel tray and are dried by sun-drying method and thus the mushroom nuggets are prepared. dough is kept at 30⁰C in oven for 90 min and then spread to a thickness of 2 to 4 mm over a cleaned platform and cut into circular or rectangular shapes (required shape) and baked for 10-12 min at 210⁰C in laboratory baking oven.

Ex. No. 78

Date:

**RECIPE AND VALUE ADDED PRODUCTS FROM PADDY STRAW
MUSHROOM**

Prepare the following two common recipes using paddy straw mushroom.

a) Paddy straw Mushroom soup

Mushroom chopped	: ½ cup
Small onion	: 3
Pepper powder	: ½ teaspoon
Maida	: 1 tablespoon
Egg	: 1
Milk	: ½ cup
Water	: 1 cup
Ghee	: 2 teaspoon
Bread	: 1 slice

Fry chopped onions in little ghee, add mushrooms, pepper powder, and fry till it turns to brown. Add maida and again roast. Add milk and water and bring to boil. When it starts thickening add beaten egg and salt to taste and remove from fire. Fry bread pieces to brown and add to soup before serving.

Ex. No. 79**PROJECT PREPARATION ON OYSTER -SPAWN PRODUCTION****Date:**

To work out the cost economics for oyster mushroom spawn production (100 spawn bags per day)

Economics of Spawn Production (100 spawn bags per day)

Sl. No.	Item	Quantity	Rate (Rs.)	Total (Rs.)
A.	Capital investment			
1.	Autoclave	1	70,000	70,000
2.	Boiler (GL drum 100 lit. Capacity)	2	2,500	5,000
3.	Culture room with work table (low cost)	1	20,000	20,000
4.	UV lamp with fittings	1	2,500	2,500
5.	Tube light fittings	1	1000	1000
6.	Advance for LPG gas	2	3,000	6,000
7.	Spawn storage room	1	30,000	30,000
8.	Bunsen burner	1	300	300
9.	Hear efficient chulah	1	1000	1000
10.	Glass wares & chemicals			5000
	Total			1,40,800
B.	Fixed cost			
1.	Interest on capital investment @ 15%			21,120
2.	Depreciation (Item 3&7 @ 5%)			2,500
3.	Depreciation (Item 1 2,4,5,8 & 9, 10-10%)			9,080
	Total			32,700
C.	Recurring cost (100 spawn x300 days)			
1.	Polypropylene bags	150Kg	140	21,000
2.	Cholas grains	8000Kg	26	2,08,000
3.	Calcium carbonate (commercial grade)	160Kg	25	4000
4.	Non-absorbent cotton (400 g rolls)	600	110/roll	66,000
5.	Electricity & Fuel	--	--	60,000
6.	Labor @ 2 men per day for 300 days	300	360/day	2,16,000
7.	Miscellaneous	--	--	10,000
	Total			5,85,000

Total cost of Spawn production / Year (Rs)—

Working expenditure	:	5,85,000
Total fixed cost	:	32,700
Total Cost	:	6,17,700
Income (Rs.)		
By sale of 30,000 spawn bags @ Rs. 40 per bag	:	12,00,000
Total cost	:	6,17,700
Net income per year	:	5,82,300

Ex. No. 80

PROJECT PREPARATION ON OYSTER MUSHROOM PRODUCTION

Date:

To work out the cost economics for oyster mushroom production (10 kgs per day)

Economics of Oyster mushroom production (10 Kg/day/300 days) Low cost Investment

Sl. no.	Item	Quantity	Rate (Rs.)	Total (Rs.)
A.	Capital Investment			
1.	Thatched House (15' x 25')	1	30,000	30,000
2.	Chaff cutter (Lever type)	1	2000	2,000
3.	Boiler	1	2,000	2,000
4.	Drum	1	1,000	1,000
5.	Spraying systems	1	1,000	1,000
6.	Biomass stove		1,000	1,000
	Total			37,000
B.	Fixed cost			
1.	Interest on A @ 15%			5,550
2.	Depreciation (Item 1 @ 30%)			9,000
3.	Depreciation (Item 2,3,4,5,& 6 @ 10%)			700
	Total			15,250
C.	Recurring Cost			
1.	Paddy straw cost + transport	3.5t	7000	24,500
2.	Spawn @ Rs. 40 / No	2000	40	80,000
3.	Polythene bags for bed & packing	25Kg	135	3,375
5.	Labour @ 1 Per day	300	360/day	1,08,000
6.	Others	--		5,000
	Total			2,20,875

Total cost of mushroom production / Year (Rs.)

Working expenditure	:	2.20.875
Total fixed cost	:	15,250
Total Cost	:	2,36,125

Income (Rs.)	
By sale of 10Kg/day @ Rs. 135 for 300 days	:
Total cost	:
Net Income per year	:

Ex. No. 81**PROJECT PREPARATION ON MILKY SPAWN PRODUCTION****Date:**

To work out the cost economics for milky mushroom spawn production (100 spawn bags per day)

Economics of Spawn Production (100 spawn bags per day)

Sl. No.	Item	Quantity	Rate (Rs.)	Total (Rs.)
A.	Capital investment			
1.	Autoclave	1	70,000	70,000
2.	Boiler (GL drum 100 lit. Capacity)	2	2,500	5,000
3.	Culture room with work table (low cost)	1	20,000	20,000
4.	UV lamp with fittings	1	2,500	2,500
5.	Tube light fittings	1	1000	1000
6.	Advance for LPG gas	2	3,000	6,000
7.	Spawn storage room	1	30,000	30,000
8.	Bunsen burner	1	300	300
9.	Hear efficient chulah	1	1000	1000
10.	Glass wares & chemicals			5000
	Total			1,40,800
B.	Fixed cost			
1.	Interest on capital investment @ 15%			21,120
2.	Depreciation (Item 3&7 @ 5%)			2,500
3.	Depreciation (Item 1 2,4,5,8 & 9, 10-10%)			9,080
	Total			32,700
C.	Recurring cost (100 spawn x300 days)			
1.	Polypropylene bags	150Kg	140	21,000
2.	Cholas grains	8000Kg	26	2,08,000
3.	Calcium carbonate (commercial grade)	160Kg	25	4000
4.	Non-absorbent cotton (400 g rolls)	600	110/roll	66,000
5.	Electricity & Fuel	--	--	60,000
6.	Labor @ 2 men per day for 300 days	300	360/day	2,16,000
7.	Miscellaneous	--	--	10,000
	Total			5,85,000

Total cost of Spawn production / Year (Rs)—

Working expenditure	:	5,85,000
Total fixed cost	:	32,700
Total Cost	:	6,17,700
Income (Rs.)		
By sale of 30,000 spawn bags @ Rs. 40 per bag	:	12,00,000
Total cost	:	6,17,700
Net income per year	:	5,82,300

Ex. No. 82

PROJECT PREPARATION ON MILKY MUSHROOM PRODUCTION

Date:

To work out the cost economics for milky mushroom production (10 kgs per day)

Economics of Milky mushroom production (10 Kg/day/300 days)

Low cost Investment

Sl. No.	Item	Quantity	Rate (Rs.)	Total (Rs.)
A.	Capital Investment			
1.	Thatched House (15'x 20')	1	20,000	80,000
	Blue Poly house- 20'x50' area (1000 sq.ft)	1	60,000	
2.	Chasff cutter (Lever typw)	1	2000	2,000
3.	Boiler	1	2,000	2,000
4.	Drum	1	1,000	1,000
5.	Spraying systems	1	1,000	1,000
6.	Biomass stoce		1,000	1,000
	Total			87,000
B.	Fixed cost			
1.	Interest on A @ 15 %			13,050
2.	Depreciation Item 1 @ 10 %)			8,000
3.	Depreciation (Item 2,3,4,5, & 6 @ 10%)			700
	Total			21,750
C.	Recurring Cost			
1.	Paddy straw cost + transport	3.5 t	7000	24,500
2.	Spawn @ 40 / day	1600	40	64,000
3.	Polythene bags for bed & packing	25Kg	135	3,375
4.	Labour @ 1 per day	300	360/day	1,08,000
5.	Others	--		5,000
	Total			2,04,875

Total cost of mushroom production / Year (Rs.)

Working expenditure	:	2,04,875
Total fixed cost	:	21,750
Total Cost	:	2,26,625

Income (Rs.)

By sale of 10Kg/day @ Rs. 145 for 300 days	:	4,35,000
Total cost	:	2,26,625
Net Income per year	:	2,08,375

Ex. No. 83**PROJECT PREPARATION ON BUTTON -SPAWN PRODUCTION****Date:**

To work out the cost economics for button mushroom spawn production (100 spawn bags per day)

Economics of Spawn Production (100 spawn bags per day)

Sl. No.	Item	Quantity	Rate (Rs.)	Total (Rs.)
A.	Capital investment			
1.	Autoclave	1	70,000	70,000
2.	Boiler (GL drum 100 lit. Capacity)	2	2,500	5,000
3.	Culture room with work table (low cost)	1	20,000	20,000
4.	UV lamp with fittings	1	2,500	2,500
5.	Tube light fittings	1	1000	1000
6.	Advance for LPG gas	2	3,000	6,000
7.	Spawn storage room	1	30,000	30,000
8.	Bunsen burner	1	300	300
9.	Hear efficient chulah	1	1000	1000
10.	Glass wares & chemicals			5000
	Total			1,40,800
B.	Fixed cost			
1.	Interest on capital investment @ 15%			21,120
2.	Depreciation (Item 3&7 @ 5%)			2,500
3.	Depreciation (Item 1 2,4,5,8 & 9, 10-10%)			9,080
	Total			32,700
C.	Recurring cost (100 spawn x300 days)			
1.	Polypropylene bags	150Kg	140	21,000
2.	Cholas grains	8000Kg	26	2,08,000
3.	Calcium carbonate (commercial grade)	160Kg	25	4000
4.	Non-absorbent cotton (400 g rolls)	600	110/roll	66,000
5.	Electricity & Fuel	--	--	60,000
6.	Labor @ 2 men per day for 300 days	300	360/day	2,16,000
7.	Miscellaneous	--	--	10,000
	Total			5,85,000

Total cost of Spawn production / Year (Rs)—

Working expenditure	:	5,85,000
Total fixed cost	:	32,700
Total Cost	:	6,17,700
Income (Rs.)		
By sale of 30,000 spawn bags @ Rs. 40 per bag	:	12,00,000
Total cost	:	6,17,700
Net income per year	:	5,82,300

Ex. No. 84 PROJECT PREPARATION ON BUTTON - MUSHROOM PRODUCTION**Date:**

To work out the cost economics for button mushroom production (25 kgs per day)

Economics of production of Button mushroom

(650. bags having 10 Kg compost in each bag / crop x 4 crops / year)

Sl.No.	Item	Quantity	Rate (Rs.)	Total (Rs.)
A.	Capital Investment			
1.	Composting yard (9m x 12 m) cemented	1	100/sq.m	20,800
2.	Bulk pasteurization chamber	1	150000	2,50,000
3.	Spawn running & Cropping rooms (4.2x4.5x3 m size)	6	25000	2,50,000
4.	Pasteurization unit for casing soil	1	10000	20,000
5.	Boiler, insulation & fittings	--	25000	35,000
6.	Air conditioners	6	20000	1,50,000
7.	Water tank, spraying systems	--	--	70,000
8.	Office room, spawn lab & work room	1	150000	1,50,000
9.	Machines for turning, pile making etc.,	--	50000	70,000
	Total	--	--	10,15,800
B)	Fixed cost			
	Interest on capital @15%			1,52,370
	Depreciation @ 10% (Items 1, 2, 3, 7, 8 & 9)	--	--	96,080
	Depreciation @ 30% (Items 4, 5 & 6)	--	--	16,500
	Total	--	--	2,64,600
C)	Recurring cost			
1.	Compost and its components	25 t	--	70,000
2.	Fungicides, fumigants, chemicals etc	--		20,000
3.	Spawn bags	140 0	15	21,000
4.	Packing cost	--	50 / bed	15,000
5.	Labour @ 2 per day	730	--	36,500
6.	Electricity, fuel etc.,	--	--	1,00,000
7.	Miscellaneous cost	--	--	30,000
	Total	--	--	2,92,500

Total cost of mushroom production / Year

Working expenditure	:	2,92,500
Total fixed cost	:	2,64,600
Total Cost	:	5,57,100

Income

By sale 8000 Kg of mushrooms x Rs.140 per Kg		
(From 25 to of compost @ 35% bio-efficient) :		11,20,000
Total cost	:	4,24,100

Net income per year	:	5,62,900
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