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MUSHROOM PRODUCTION

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COMMERCIAL PRODUCTION OF OYSTER MUSHROOMS IN INDIA

Introduction

The agro-climatic diversity of Indian subcontinent offers excellent prospects for the development of large scale mushroom production units. India is bestowed with varied climatic, geographical and topographical conditions and is highly conducive for producing different varieties of edible mushrooms on a commercial scale. However, oyster mushrooms are highly favoured for commercial production throughout India considering the easiness with which these mushrooms grow and the lesser requirements of resources as compared to other mushroom varieties.

Project summary

The project envisages commercial production of an important mushroom variety called oyster mushrooms (Pleurotus spp.) in any region of the Indian subcontinent. Since oyster mushrooms are rich in protein (up to 35% of dry weight), vitamins and dietary fiber, there is a huge demand for both fresh and dried mushrooms in India as well as abroad. Another major factor that favours commercial production of oyster mushrooms is that they are very easy to grow and take hardly one or two months to complete one cycle of production, starting from spawning to harvesting to marketing.

Project Requirements: Choosing a Substrate

The substrate should be clean and composed of lignin and cellulose and it should be able to hold moisture. Hardwood logs; Hardwood chips and sawdust; seed hulls; leaf litters; paper; cotton wastes; rice straw; wheat straw; and other straws can be used as a substrate for oyster mushroom production. Since straws are considered as the best substrate material for commercial scale production of oyster mushrooms, the same has been considered for this project study.

Choosing a Container

Mushrooms can be grown in open straw bales, plastic bags, plastic tubes, and trays of various sizes. As a rule the container should be able to enclose the substrate during the spawn run and should be able to avoid excessive self-heating. It should also allow the maximum production in the space used. Plastic bags are chosen as containers for this project study.

Purchasing Spawns

Purchase the best quality fresh spawns from reputed suppliers. Always read the label on the spawn bottles before purchasing them. One bottle of grain or sawdust spawn in a 500-ml dextrose bottle is sufficient to inoculate 40 to 50 substrate bags (each bag containing approx. 200 kg straw). As a rule, weight of the spawn should be in the range of 1 to 5% of the dry weight of the substrate.

Facilities Required for Mushroom Production

Most important facilities required for mushroom production are: -

1. Substrate preparation area

2. Compost pits or bunkers

3. Pasteurization area and inoculation area (spawning facility)

4. Mushroom production area or mushroom house

Substrate Preparation Area

Substrate preparation area should be located away from the mushroom production unit. It is better this area has a concrete floor so that substrate can be chopped and mixed well. The substrate preparation area should have: -

1. A hammer mill to chop the straw into small pieces

2. A stock of straw : If straw is used as primary substrate

Compost Pits or Bunkers

Now the chopped substrate must be composted either in compost pits or in big bunkers before it is ready to be used for mushroom production. The composting process requires that the substrate is kept wet for several weeks.

Pasteurization Area

This area is meant for pasteurization process of composted substrate. It is said that anyone can grow mushrooms if properly prepared substrate is used.

Mushroom Production Area or Mushroom House

The most important facility required for commercial production is a window-less, air-tight building. It can be a metal building covered by polyethylene or a concrete building or a bamboo house insulated with straw and polyethylene sheet. A mushroom production unit or building should have following requirements:

1. A temperature of 15 to 20°C (59 to 68°F) and relative humidity of 80 to 95%

2. Good ventilation and Light: mushrooms are formed when carbon di oxide level is low and hence proper ventilation is required to remove carbon dioxide formed inside the building. Centrifugal blowers may be used to supply air circulation. For light requirements, fluorescent lights are generally used.

3. Proper Hygiene and Sanitation: Air inlets and exits should have a filter to let only filtered air circulated within the building. This is particularly helpful to keep pests and disease causing pathogens away.

4. Shelves, made from bamboo or wood: These shelves are strong enough to hold substrate bags and line both sides of the house.

Processes Involved:

Substrate Preparation

Straw should be chopped into small pieces and wet before composting it. The composted straw must be pasteurized before being used for spawning.

Pasteurization Process

Pasteurization is recommended over sterilization for commercial production of oyster mushrooms.

Why Pasteurization Is Better Than Sterilization?

Sterilization kills all microorganisms including the beneficial ones present in the substrate. While pasteurization does not kill all organisms rather it is a process of heating wet material to 55º to 60ºC (131º to 140ºF) for 30 minutes. Since pasteurization does not kill all the organisms, remaining beneficial organisms present in the substrate indirectly accelerates mushroom formation. So the purpose of pasteurization is not to get rid of all organisms, but to get rid of harmful ones while helping to multiply beneficial ones that discourage diseases, consume hemicelluloses, provide nitrogen, and become food for the mushrooms. Pasteurization is very cost-effective also as sterilization process involves expensive high pressure equipments.

Pasteurization Process for Commercial Production

When large quantities of substrate are involved, it is impossible to properly pasteurize substrate in a simple container by using steam. Therefore in large-scale production of oyster mushrooms, mixing machines are used for pasteurization process. Mixing machines allow even heating and control over the amount of water in the substrate. A mixing machine can be used to pasteurize by putting hot water in the machine and then adding substrate, or by adding hot water to the substrate. In a mixing machine, water is required just to wet the substrate. After the water is added, the substrate should remain at 55º to 60ºC (131º to 140ºF) for 30 to 60 minutes.

Thereafter, the pasteurized substrate should be allowed to cool slowly for 16 to 20 hours. It is useful to have cooling take place in a mixing machine. When the substrate is cooled, it is ready to be filled in the plastic bags. Pasteurization is the most critical step in growing mushrooms. The grower must pay close attention to the time and temperature. None of the substrate can be less than 55ºC (131ºF) during the 30 or more minutes when the substrate is pasteurized. The substrate can never be more than 60ºC (140ºF) at any time when it is wet. Very simple equipment can be used with substrates that will allow all excess water to drain off. For large-scale production, automated machines capable of pasteurizing, cooling, spawning and filling the growing containers are available for purchase. Even though these machines are very costly, they provide more protection against diseases and pests, and also save a great amount of human labour.

Inoculation / Spawning Process for Small Scale Production

The process of inoculating well-prepared substrate with the best quality spawns is called inoculation or spawning. It is a good idea to have an inoculation room to prepare spawns before inoculating the substrate bags. If substrate materials are packed in polythene bags, the best method of spawning is either by using grain spawns or by sawdust spawns. If grain spawns are used, spawn bottles are gently shaken to separate mushroom seeds (spores) from mycelia. Thereafter, the bottle is opened carefully and about 2 teaspoon full of spawns is poured into the substrate bag. Soon after inoculation, both the spawn bottles and the substrate bags are covered. To ensure even distribution of spawns throughout the inoculated bag, they are slightly tilted and if sawdust spawns are used, the spawn bottles are broken with an aseptic needle and then a piece of the spawn is transferred carefully to the substrate bags.

Inoculation Process in Industrial Production of Mushrooms

Bulk spawning process is practiced in industrial production of mushrooms. Substrate materials are bulk pasteurized using mixing machines and then allowed to cool to a temperature of 25° C. Now it is time to inoculate the substrate. Considering the bulk quantities of materials involved, care should be taken to carry out the spawning process in an environment with an excellent sanitation facility. All personnel involved in the process are required to be clean; and wear gloves, face mask and head cap. Inoculation room should have good ventilation but air must be filtered, preferably with a High Efficiency Particulate Air (HEPA) filter. Inoculation process is often done in the mixing machines itself. Spawns are poured into the substrate and the substrate is mixed well with the spawn before placing them in the growing containers. Soon after the inoculating process, the containers are closed.

Spawn Run or Incubation Process

Soon after the inoculation process, the spawned substrate bags are transported into a dark mushroom production chambers or mushroom houses. Soon the fungal spores begin to grow and multiply, taking food from substrate materials. The period between the beginning of fungal mycelia growth and the covering of the entire substrate with white-colored mycelium is known as spawn run period. Normally in 20 to 30 days, the entire substrate appears white. During spawn run, both oxygen and carbon dioxide are required for mycelia growth. Excess water should not be present in the substrate. For this, make sure that sufficient drainage holes are provided in the growing containers. As mycelia grow in number, more oxygen may be required by them; so large holes may be provided on the top of the containers to allow more aeration. Optimum temperature that is to be maintained during spawn run is between 15 and 20°. There should be adequate ventilation but light is not required.

Nutrient Application

To increase yield, urea or orchid fertilizer may be used after dissolving it in water @100 grams in 100 liters water. Using a plastic mist sprayer, the solution is sprayed on the surface immediately before fruiting.

Fruiting Process

The substrate bags are kept in the mushroom house for another week or so before they are opened to check the mycelia growth. At the time of opening the bags, the bags are supposed to be full with strong growth of mycelium. Generally, fruiting or formation of primordia starts after 3 to 4 weeks of mycelia growth. It is better to make cross-cuts of about 2.5 cm across the bags to allow the mushrooms to grow out. Temperature inside the mushroom house should be increased to range of 20-28oC in order to promote fruiting. Relative humidity should between 80 - 95%. There should be adequate ventilation inside the room. It is best to place the substrate bags about 10 cm or more above the floor. In doing so, if ventilation is stopped, carbon dioxide accumulated near the floor will not damage the growing mushrooms. It will also restrict the access for insect-pests. Light should be allowed for a few hours a day by keeping doors open. Or else fluorescent lights can be turned on. Light watering of substrate bags using a mist sprayer is recommended daily for higher yields. While watering bags, care must be taken not to overwater the bags. 3 to 4 days after opening the bags, fruiting starts. Fruits or mushroom primordia mature in 2 to 3 days once fruiting process is initiated. Generally only one side of the substrate bag is opened at a time. In rare cases, both the sides are opened at the same time.

Harvesting Process

Mushrooms are harvested as soon as the gills are well formed and while the edge of the mushroom is still curled under. That is, mushrooms must be picked before they release spores. When the edge flattens and spores are released, the mushrooms lose weight and the spores thus released may cause asthma and hay fever in workers. Mushrooms are harvested by gently pulling them from the substrate. Normally, harvesting is done from the top end of the bag while the other end is just opened to initiate the fruiting process. When fruiting is complete at the lower end, harvesting is done from that end. After harvesting from both the ends, longitudinal slits are made along the central portions of the bag in order to initiate fruiting process. After harvesting from the central portions, check the substrate bag for any presence of developing mycelia. As long as white-colored mycelia are present, fruiting will happen; if the bag appears colourless, it is time to remove them from the mushroom house. Generally the second flush (about 10 days after the first harvest), will be the largest; and it is desirable to destroy the remaining substrate after the third flush. This is recommended because each day in the harvest gives disease-causing pathogens and pests more time to get established in the production area. Once they get established, it is very difficult to keep them away from next crop.

Storage Life of Mushrooms

Mushrooms are highly perishable. At room temperature, it stays fresh hardly for a day or two. However in a refrigerator or in a cool place, the mushrooms remain fresh for up to 3 to 6 days.

Yield

Generally 100 kg dry weight of substrate yields 200 Kg mushrooms. That is, yield ranges from about 150-200 % of the dry weight of the substrate depending upon the type of substrate materials and cultural practices.

Cooling Process

Since mushrooms are highly perishable, they must be cooled at 3 – 5°C (37 - 41°F) as soon as they are harvested in order to prolong their shelf life. Cost effective method of cooling is to place freshly-harvested mushrooms in a cool vacuum chamber. Another cooling method is by mechanical refrigeration. Cooling equipments may be used for faster cooling;

Trimming Process

Since mushrooms are harvested by pulling them from substrate materials, it is likely they have a little substrate attached to the stem. Since mushroom stems are not favoured among customers, the best practice to clean the product is by trimming the stem.

Packaging

Mushrooms for retail markets are packed in plastic trays or paper trays in small quantities ranging from 200 gm to 500 gm and overwrapped with a thin plastic film to conserve moisture inside.

Marketing of Mushrooms

Oyster mushrooms are marketed as fresh, freeze-dried and tunnel-dried mushrooms.

Freeze-Dried Mushrooms

Freezing the mushrooms, then placing them in a vacuum where they remain frozen until all water is removed. That process is called freeze-drying and is very expensive, both for energy and for the required equipment.

Tunnel-Dried Mushrooms

A tunnel drier consists of a blower to circulate air, a heater to increase the temperature of the air to approximately 40 to 50°C (104 to 122°F), and a chamber to put the food to be dried. Tunnel drying will give a high quality product.

Preparation for the Next Crop

After the last flush is harvested, the growing room must be cleaned. The traditional method is to inject steam and raise the temperature of the room to 60° and hold it for 4 hours. After that all materials are removed and disposed of.

Oyster Mushroom Production -Expenditure and Economics: Assumptions

1. Growing Containers Used : Long polyethylene bags
2. Number of polythene bags required - 200
3. Cost per polythene bag - INR 10
4. Substrate Materials Used: Paddy straw
5. Total quantity required per year - 200 Kg @50 kg/batch
6. Cost of straw per kg - INR 5
7. Production Unit: A Bamboo House of 250 Square Feet Area
8. Construction cost of bamboo house per square feet - INR 50
9. Production Capacity: 100 Kg mushrooms /batch and Total 4 batches per Year (400 Kg/yr)
10. Market Price of fresh mushrooms : INR 200/Kg
11. Equipments used: sprayer for watering; heating/pasteurization equipments etc
12. Estimated cost of the equipments -INR 25,000
13. Number of labors employed - 20
14. labor charges @ INR 200/day
15. Price per spawn bottle @ INR 10/bottle
16. No. of spawn bottles required per year – 50

Estimated Economics of Mushroom production for 5 years

Expenditure					
Capital Cost	1 yr	2 yr	3 yr	4 yr	5 yr
Bamboo house of 250 Sq.ft area	12500	0	0	0	0
Equipments-pasteurization equipment, sprayers etc	25000	0	0	0	0
Recurring Cost					
A) Polythene bags (200 Nos.)	2000	2000	2000	2000	2000
B) Paddy straw (200 Kg.)	1000	1000	1000	1000	1000
C) Spawn 50 bottles	500	500	500	500	500
Labor charges	4000	4000	4000	4000	4000
E) Miscellaneous: Fuel, electricity, water, etc	10000	10000	10000	10000	10000
TOTAL EXPENSES	55000	17500	17500	17500	17500
Income					
Sales of fresh mushroom (Rs. 200Kg)	80000	80000	80000	80000	80000
NET INCOME (INR)	25000	62500	62500	62500	62500

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