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Low Cost Cultivation of Oyster Mushroom Using Agriculture Waste

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SUMMARY

Mushroom cultivation is one of the most profitable and environment friendly enterprises, among the various horticultural crops in India. Oyster mushrooms (*Pleurotus* sp) are widely cultivated all over the world. It's a subtropical edible mushroom, is suitable for cultivation in winter, summer and rainy season. Its production is remarkably affected by the environmental conditions like temperature and relative humidity. Mushrooms contain more protein than either fruits or vegetables. They can be eaten, as they are cooked or raw, unlike other protein sources such as soya. Mushrooms are also low in cholesterol. Besides their protein content, mushrooms are also high in certain vitamins such as B, C, D, riboflavin, thiamine, and 5 nicotinic acid. Mushrooms are also a good source of iron, potassium and phosphorus in addition to folic acid, an ingredient known for enriching the bloodstream and prevention deficiencies.

INTRODUCTION

Oyster mushroom' or 'Dhingri' as referred in India is a basidiomycetes and belongs to the genus 'Pleurotus'. It is lignocellulolytic fungus that grows naturally in the temperate and tropical forest on dead, decaying wooden logs, sometimes on drying trunks of deciduous or coniferous woods. It can also grow on decaying organic matter. The fruit bodies of this mushroom are distinctly shell, fan or spatula shaped with different shades of white, cream, grey, yellow, pink or light brown depending upon the species. However, the colour of the sporophores is extremely variable character influenced by the temperature, light intensity and nutrients present in the substrate. The name Pleurotus has its origin from Greek word, 'Pleuro' means formed laterally or lateral position of the stalk or stem. The oyster mushroom is one of the most suitable fungal organisms for producing protein rich food from various agro-wastes without composting. This mushroom is cultivated in about 25 countries of far-east Asia, Europe and America. It is the 3rd largest cultivated mushroom in the world. The major producing countries are China, South Korea, Japan, Italy, Taiwan, Thailand and Philippines. At present, India produces annually 10,000 tons of this mushroom. It is popularly grown in the states of Odisha, Karnataka, Maharashtra, Andhra Pradesh, Madhya Pradesh, Chhattisgarh and West Bengal and in the North Eastern States of Meghalaya, Tripura Manipur, Mizoram and Assam.

Advantages of Growing Oyster Mushroom:-

Variety of Substrates:

Pleurotus mushroom can degrade and grow on any kind of agricultural or forest wastes, which contain lignin, cellulose and hemicellulose.

Choice of Species:

Among all the cultivated mushrooms, Pleurotus has maximum number of commercially cultivated species suitable for round the year cultivation. Moreover, variation in shape, colour, texture, and aroma are also available as per consumer's choice.

Simple Cultivation Technology:

Pleurotus mycelium can grow on fresh and fermented straw and it does not require composted substrate for growth. Substrate preparation for oyster mushroom is very simple. Further this mushroom does not require controlled environmental conditions like A. bisporus as most of the species have very wide temperature, relatively humidity and CO2 tolerance.

Longer Shelf Life:

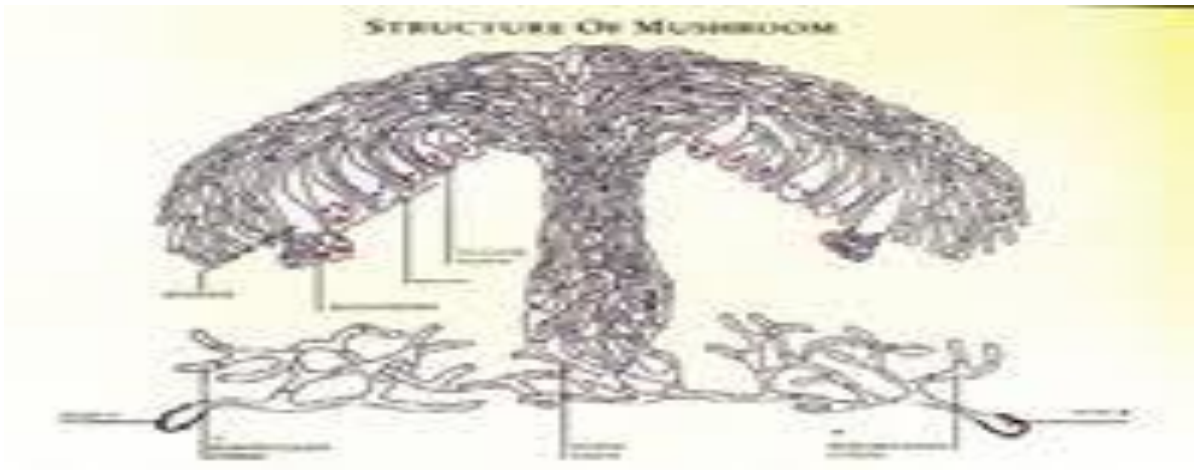
Unlike white button mushroom, the oyster mushroom fruit bodies can be easily dried and stored. Dried oyster mushrooms can be instantly used after soaking in hot water for 5 to 10 minutes or it can be used in powdered form for several preparations. Fresh mushrooms have a shelf life of 24-48 h even at room temperature.

High Productivity:

The productivity of oyster mushroom per unit time is very high as compared to all other cultivated mushrooms. One can harvest minimum of about 500 to 700 kg of fresh oyster mushroom from one ton of dry wheat or paddy straw in 45-60 days, while with the same quantity of straw only about 400-500 kg of white button mushrooms are obtained in 80-100 days (including period needed for compost preparation). Yield of this mushroom can further be increased by supplementing the substrate with suitable nitrogen source viz., soybean and cottonseed meal or by introducing high yielding cultures/strains.

Biology of Oyster Mushroom

Visually the basidiocarps or fruit bodies of an oyster mushroom have three distinct parts - a fleshy shell or spatula shaped cap (pileus), a short or long lateral or central stalk called stipe and long ridges and furrows underneath the pileus called gills or lamellae. The gills stretch from the edge of the cap down to the stalk and bear the spores. If a fruit body is kept on a paper directly (gills facing the paper) a dirty white or lilac deposition of powdery spores can be seen. The spore print colour may be whitish, pinkish, lilac or grey. The spores are hyaline, smooth and cylindrical. The spores are heterothallic and germinate very easily on any kind of mycological media and within 48-96 h whitish thread like colonies could be seen. The mycelium of most Pleurotus sp. is pure white in colour. P. cystidiosus and P. columbinus forms coremia like stalked structures (asexual spores). Basidiospores on germination forms primary mycelium. Fusion between two compatible primary mycelia develops into secondary mycelium, which is having clamp connections and it is fertile. Primary mycelium is clampless and non fertile.



Different Species of Oyster Mushroom:

All the species of oyster mushroom are edible except P. olearius and P. nidiformis which are reported to be poisonous. There are 38 species of the genus recorded throughout the world (Singer). In recent years 25 species are commercially cultivated in different parts of the world which are as follows: P. ostreatus, P. flabellatus, P. florida, P.sajor-caju, P. sapidus, P. cystidiosus, P. eryngii, P. fossulatus, P. opuntiae, P. cornucopiae, P.yuccae, P. platypus, P. djamor, P. tuber-regium, P. australis, P. purpureoolivaceus, P. populinus, P. levis, P. columbinus, P. membranaceus etc

Most Popular types of Oyster Mushroom

Growing Condition:

The oyster mushroom can be grown in ordinary thatched huts or semi permanent structures. The optimum temperature and humidity required about 25^0 C and 85% respectively and it can be easily maintained without any artificial means during the period from june to March with little manual control. Adequate cross ventilation and defused sun light is necessary for spawn run and cropping.

Cultivation

The procedure for oyster mushroom cultivation can be divided into following four steps.

- Preparation of spawn.
- Substrate preparation.
- Spawning of substrate
- Crop management.

Preparation of Spawn:

One should have a pure culture of Pleurotus spp. for inoculation on sterilized wheat grain. It takes 10-15 days for mycelia growth on grains. It has been reported that Jowar and Bajra grains are superior over wheat grains. The mycelium of oyster mushroom grows very fast on wheat grains and 25-30 days old spawn starts forming fruit bodies in the bottle itself. It is therefore, suggested that the schedule for spawn preparation or spawn procurement should be planned accordingly. Sometimes the mushroom farmers are using active mycelium growing on substrate for spawning fresh new oyster mushroom bags. This method can be used on a small scale. There are always chances of spread of contamination through infested straw by active mycelium spawning method so it is not advisable on large scale commercial cultivation.

Substrate Preparation:-

The mycelia growth can take place on a simple water treated straw but there are number of other cellulolytic moulds already present on straw which compete with Pleurotus mycelium during spawn run and also toxic metabolites secreted by these competitors hampers its growth. There are various methods to kill undesirable microorganism present in the straw to favour the growth of Pleurotus mycelium. The substrate can be prepared by adopting different methods like steam pasteurization, hot water treatment, chemical sterilization technique, sterile technique and fermentation or composting. The choice of method will depend upon the scale of cultivation envisages and the facilities available. The growers may adopt any one of these method depending upon their need. The details of different methods are given below:

Steam Pasteurization

In this method, pre-wetted straw is packed in wooden trays or boxes and then kept in a pasteurization room at 58-620 C for four hours. Temperature of the pasteurization room is manipulated with the help of steam through a boiler. Substrate after cooling at room temperature is seeded with spawn. The entire process takes around 3-5 days. This method is adopted on a commercial scale in Germany. There are various minor variations of this methods adopted in Europe. The tunnel prepared for pasteurizing compost/casing of button mushroom can be used for pasteurizing the straw for oyster. However, adequate boiler facility will be must.

Hot Water Treatment

The substrate after chopping (5-10 cm) as such in case of wheat straw is soaked in cold water overnight. The substrate is taken out and excess water is drained. Thereafter the straw is soaked in hot water for one hour where the temperature may be in the range of 65 to 700 C. It will be appropriate to check the temperature and standardize the conditions as per location. Over boiling or over heating may not lead to proper result. Hot water treatment makes the hard substrate like maize cobs, stems etc. This method is not suitable for large-scale commercial cultivation.

Chemical Sterilization Technique

Various species of Trichoderma, Gliocladium, Penicillium, Aspergillus and Doratomycs spp. are the common competitor fungi on the straw during oyster mushroom cultivation which do not allow the growth of mushroom mycelium during mycellial growth and resulting in yield loss or complete crop failure. The technique of chemical sterilisation, which was standardized at DMR, Solan in 1987, is as follows: Ninety litres of water is taken in a rust proof drum (preferably of galvanized sheet) or G.I. tub of 200 litres capacity. Ten kg of wheat straw is slowly steeped in water. In another plastic bucket, Carbendazim (Bavistin) 7.5 g and 125 ml formaldehyde (37-40%) is dissolved and slowly poured on the already soaked wheat straw. Straw is pressed and covered with a polythene sheet. After 15 to 18 hour the straw is taken out and excess water drained.

Sterile Technique

The chopped substrate after soaking in cold water is put in heat resistant polypropylene bags and sterilize in an autoclave at 22 lb. pressure for 1-2 hours (depending upon the size of the bags) followed by spawning under aseptic conditions. This method is more suitable for research work rather than on large-scale commercial production.

Spawning of Substrate:

Freshly prepared (20-30 days old) grain spawn is best for spawning. The spawning should be done in a pre-fumigated room (48 h with 2% formaldehyde). The spawn should be mixed @ 2 to 3% of the wet weight of the substrate. One spawn bottle of 200 g is sufficient for 8 kg of wet substrate or 2 kg dry substrate. Spawn can be mixed thoroughly or mixed in layers. Spawned substrates can be filled in polythene bags (80 x 40 cm) of 125-150 gauze thickness. Ten to 15 small holes (0.5- 1.0 cm dia) should be made on all sides especially two to four holes in the bottom for draining excess water. Perforated bags give higher and early crop (4-6 days) than non-perforated bags. One can also use empty fruit packing cartons or boxes for filling substrate. We can also make a block of the substrate by using compression machine. Polythene sheets of 200-300 gauze thickness of 1.25 x 1.25 m are spread in rectangular wooden or metal box. Spawned substrate is filled and the polythene sheet is folded from all the four sides and compressed to make a compact rectangular block. It is taken out of the box and tied with a nylon rope. The block is incubated as such and after mycelium growth polythene sheet is removed.

Crop Management:

The spawned bags or blocks are kept in incubation room for mycelial growth at desirable temperature. Some of the Pleurotus species fruit at low temperature around 150C whereas other species fruit between 20-300C. The incubation temperature for mycelial spread, however, is around 250C for most of the species.

Incubation:

Spawn bags can be kept on a raised platform or shelves or can be hanged in cropping room for mycelial colonization of the substrate. Although mycelium can grow between 10-30°C but the C) in the°optimum temperature lies between 22-26°C. Higher temperature (more than 30 cropping room will inhibit the growth and kill the mycelium. Daily maximum and minimum temperature of cropping rooms and beds should be recorded. The bed temperature is generally 2- 4°C higher from the room temperature. Mycelium can tolerate very high CO2 concentration of 1.5-2.0%. During mycelial growth the bags are not opened and no ventilation is needed. Moreover, there is no need for any high relative humidity, so no water should be sprayed. However, some chemicals for control of flies can be sprayed on the walls. Similarly, water can be sprayed in the room or on the wall in case the environmental temperature is more than required.

Fruit Body Induction:

Once the mycelium has fully colonized the substrate, it forms a thick mycelial mat and is ready for fruiting. Contaminated bags with mould infestation should be discarded while bags with patchy mycelial growth may be left for few more days to complete the spawn run. In no case bags should be opened before 16-18 days except in case of P. membranaceus and P. djamore var.roseus which forms fruit bodies within 10 days even in closed bags from small holes. Casing is not required in oyster mushroom cultivation. All the bundles, cubes or

blocks are arranged on wooden platforms or shelves with a minimum distance of 15-20 cm between each bag in the tier. They can also be hanged. In case, small long bags are used these can be stacked horizontally or in a inclined manner one above the other. This method helps to accommodate more substrate in less space and therefore getting more production from the same area. Some workers have also used long cylinder for mushroom production. The poly bags can be tied at the base to get a circular base or alternatively bags with side in-folds can be used. Various cultural conditions required for fruiting are as follows.

Temperature:

Mycelial growth of all the Pleurotus spp. can take place between 20-30°C. However, for fruiting different species have different temperature requirement. Depending upon the temperature requirement of a species they can be categorized into two groups-winter or low temperature requiring species (10-20°C) and summer or moderate temperature requiring species (16-30°C). Summer varieties can fruit at low temperature but the winter varieties will not fruit at higher temperature. They need a low temperature shock for inducing fruit body formation. Commercial varieties which can be cultivated during summer are P. flabellatus, P. sapidus, P. citrinopileatus, P. sajor-caju and P. eous. Low temperature requiring species are P. ostreatus, P. florida, P. eryngii, P. fossulatus and P. cornucopiae. The growing temperature not only affects the yield but also the quality of produce. The pileus or cap colour of P. florida is light brown when cultivated at low temperature (10-15°C) but changes to white pale to yellowish at 20-25°C. Similarly fruit body colour of P.sajor-caju when cultivated at 15-19°C is white to dull white with high dry matter content while at 25-30°C it is grayish brown.

Relative Humidity:

All the Pleurotus species require high relative humidity (70-80%) during fruiting. To maintain relative humidity, water spraying is to be done in the cropping rooms. During hot and dry weather conditions, daily 2-3 spray are recommended while in hot and humid conditions (monsoon) one light spray will be sufficient. The requirement of water spray can be judged by touching the surface of the substrate. Spraying should be done with a fine nozzle to create a mist or fog in the cropping room. It is desirable that mushrooms are harvested before water spray. Ventilators and exhausts fans should be operated for air circulation so that the excess moisture from the cap surface evaporates. Sometimes fruit bodies give offensive smell due to the growth of saprophytic bacteria on the wet cap surface; under such conditions 0.05% bleaching powder spray at weekly interval is recommended.

Oxygen and Carbon Dioxide Requirements:

The oyster mushroom mycelium can tolerate high carbon dioxide concentration during spawn run (up to 20,000 ppm or 2%) while it should be less than 600 ppm or 0.06% during cropping. Therefore sufficient ventilation should be provided during fructification. If the CO2 concentration is high the, mushrooms will have long stipe and small pileus. Mushrooms will appear like a mouth of trumpet.

Light:

Unlike green plants mushrooms do not require light for the synthesis of food. They grow on dead organic plant material. Light is, however, required to initiate fruit body formation. For primordia formation light requirement is 200 lux intensity for 8-12 hour. Inadequate light conditions can be judged by long stalk (stipe), small cap and poor yield. The colour of the pileus is also influenced by the light intensity and its duration. Fruit bodies raised in bright light are dark brown, grey or blackish coloured. If the light intensity is less than 100 lux the mushrooms will be pale yellowish. Thus both light and fresh air is necessary for formation of normal fruit body. It is not necessary to give the light and fresh air simultaneously but the required CO2 concentration and light requirement must be met for getting normal fruit body. It may be a good idea to give the fresh air just after water spray as it helps in removal of excess water from the surface of fruit bodies.

Hydrogen Ion Concentration (pH):

The optimum pH during mycelial colonization should be between 7.0 and 8.0. The pH of the water for spraying should be neither too acidic nor alkaline. Water should not contain harmful salts or heavy metals. The

mushrooms tend to accumulate various metals if present in substrate or water used. Rusted iron drums and tubs used for substrate treatment or storing water for spraying delay fructification due to presence of excess iron in the water.

Post Harvest Practices:

Mushrooms should always be harvested before water spray. The right stage for picking can be judged by the shape and size of fruit body. In young mushrooms the edge of the cap is thick and cap margin is enrolled while the cap of mature mushroom as flat and inward curling starts. It is advisable to harvest all the mushrooms at one time from a bag so that the next crop of mushrooms starts early. After harvesting lower portion of the stalk with adhering debris should be cut using a knife. Stipe is kept short or almost non-existent, as it is hard and not liked by many consumers. Fresh mushrooms should be packed in perforated polythene bags for marketing. They can also be sun dried by spreading thinly on a cotton cloth in bright sunlight or diffused light. The dried produce with 2-4% moisture can be stored for 3 to 4 months after sealing properly.

CONCLUSION

The above description of mushroom farming will yield a quality product. There are other techniques used to achieve similar results, but this technique will be the most efficient way to turn a profit with a small scale operation as it uses locally available materials and with a minimal investment. This particular process also accounts for distributing a quality product that creates customer retention..

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