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Mushroom Cultivation – A Good Entrprenurship

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ABSTRACT

The Economic importance of Mushrooms lies primarily in its use as food for human consumption. Mushroom Cultivation is a new opportunity for small scale farmers, weaker sections of the society and women. Women self help groups have become financially independent through eco -friendly Mushroom Cultivation .

Mushrooms provide an unusual array of nutrients, excellent sources of Vitamin B Complex, minerals like Iron, Potassium, Selenium, Copper, Zinc and heavy fiber. The protein varies between 1.6 to 2.5% and it is an appropriate food for vegetarians . The protein quality lies in between vegetable and animal protein So they are called "Vegetable meat". Mushrooms are popular for their delicacy and flavor. Mushrooms grow easily when compost and agro waste recycling materials are available . Mushrooms are not only a source of healthy vegetable food but also a source of biologically active compounds of medicinal value. They are usedin complementaryand dietary supplements for anticancer, antiviral, immune potentiating, hypocholesterolenic and hepatoprotective.

Mushroom Cultivation increased worldwide due to the above benefits specially in developing countries like China, India, Poland etc. Cultivated Mushrooms play a greater role in the endeavor to increase food protein. Biological efficiency and yield of fresh weight mushroom in proportion to the spawning compost in Agaricus can reach 60 to 100% . Out of about 15000 species, 2000 species are edible and 75 species are cultivated around the world. Nearly 20 species are artificially cultivated . The most popularly cultivated species for this region are white button mushroom Agaricus bisporus, paddy straw mushroom Volvariella volvacea and ,oyster mushroom Pleurotus sogar – caju. Thisnote gives details about the project prospects of Mushroom cultivation.

KEYWORDS :

Introduction

Evolution of food culture have brought mushroom in thelimelight. Its unique nutritional value and taste derivedhuman understanding in civilized societies andcompulsion/ethnic food (as wild and farm-grown),mushroom is becoming popular. Need to feed thebooming billions (humans) in a sustainable way demandscientific intervention for optimum production. One majorproblem and irony of the planet is there is concern for food safety and security on one hand and huge loss fromagricultural waste ~4,500 million tones/yea,. out of whichsub continent India alone produces about 1000 milliontones of crop residues. Though, the major part of the cropresidues is being used as fodder, rest is wasted in different ways. The crop residues constitute mainly ofcellulose, hemicellulose and lignin. Attempts areunderway to utilize them in production of biofuel but thisis long way from being realized. Lignin fraction which isgenerally considered as recalcitrant in nature, does notfind much takers, but in mushroom this fraction hasremained as the material of choice as mushroomspossesses the specific type of hydrolytic enzyme systemwith capacity of utilizing lignin for fruit body production.Mushroom being one of the cheapest sources of protein particularly for the vegetarian, it becomes imperative toproduce more mushroom utilizing the local agro-waste tomeet the protein need of the country. Out of differentmushrooms that can be cultivated on lignin richagricultural wastes, milky mushroom (*Calocybe indica*) is relatively new to the world of mushroom industry. Thismushroom was first reported from West Bengal, India(Purakayasha, 1974) (Purkayastha, 1984; Pandeyand Tewari, 1993). Even though attempts were made togrow C. Indica (Purkayastha and Nayak, 1981);

Chakravarty et al., 1981; Pandey andTewari, 1993) only limited success was achieved inincreasing the bio-efficiency and productivity of thismushroom. Krishnamoorthy et al. (1998) reported a highyielding strain of *Calocybe medica*, APK 2. It grows wellat room temperature between 24oC – 27oC and can becultivated even on unfermented materials. Theadvantages of this mushroom over other mushrooms areeasy method of cultivation, less investment, veryattractive fruiting body, pleasing milk white color, longshelf life, more nutritious and less time to grow. Ingeneral, mushroom cultivation is practiced usingtraditional raw materials whose availability often becomelimiting. In rural areas, plenty of agro-waste and organicmaterials are available, which often end up in waste thuscontributing to the pollution woes. Recycling is the needof modern times and mushroom is an ideal candidate toharness its potentialities. Unique and rich nutritionalstatus of Mushroom and growing demand for functionalfoods warrants innovative growing methods.

Oyster mushrooms are the delicious mushrooms grown in several parts of the world. Cultivation of any type of mushroom implies principles of microbiology, environmental engineering and solid state fermentation in the conversion of domestic agricultural, industrial, forestry wastes into food for humans.

Cultivated Species

At present 3 mushrooms are being cultivated in India. These are : the white mushroom (Agaricus bisporus), the paddy-straw mushroom (Volvariella volvacea) and the oyster mushroom (Pleurotus sajor-caju). Of these, A. bisporus is the most popular and economically sound to grow and is extensively cultivated throughout the world. However, due to its low temperature requirement, its cultivation is restricted to the cool climatic areas and to the winter in the plains of Northern India. In summer, the tropical paddy-straw mushroom is suitable for growing in most parts of India. Even then it is less attractive commercially owing to very low yield per unit weight of the substrate and an extremely short shelf-life. But, as a kitchen-garden crop it is preferred because it is very delicious and nutritious. Oyster mushroom can grow at moderate temperature ranging from 22^0 to 28^0C. therefore, it is suitable for most of the places of India. It is a familiar item in the menu of most hotels in Bangalore where it is being grown commercially. In north India, the climate conditions prevailing during different seasons can be exploited for growing mushroom throughout the year. To this a year-wise production schedule is suggested :

Mid-November to Mid-March	: Agaricus bisporus
February to Mid-April	: Pleurotus sajor-caju

Mid-June to Mid-September	: Volvariella volvacea
September to November	: Pleurotus sajor-caju

There are several species of Pleurotus but only few can be cultivated. Some cultivated species for edible purposes are *(1) Pleurotus ostreatus, (2) Pleurotus florida. (3) Pleurotus eryngil, (4) Pleurotus cystidiosus, (5) Pleurotus flabellatus, (6) Pleurotus cornucopiae, (7) Pleurotus sapidus, and (8) Pleurotus sajor-caju.*

Compared with other edible species of *Pleurotus, Pleurotus sajor caju* which is commonly known as Oyster mushroom is widely cultivated in India. It is relatively easier to grow and has an excellent flavour and texture; therefore, it is being preferred for cultivation on a commercial scale in many countries particularly in the South-East Asia including India. Following are the advantages of growing oyster mush-room.

Nature of Oyster Mushroom

A. Morphology

Oyster mushroom is soft and white in hot weather while greyish in cold weather. The stipe (stem) is usually very short and is of the same colour as the pileus, which is fan-like when young and gradually becomes deeply lobed to form, branches making the mushroom appear as though they are growing in clusters. The pileus is depressed, but at sites where carbon dioxide is abundant, it takes the shape of a wide-mouthed funnel. On the underside of the pileus are the gills, long, medium, short and very short alternatively running from the edge of the pileus down the stipe. Four basidiospores are formed at the tip of the basidium in contrast to two in white button mushroom.

B. Life cycle

Like any other mushroom *Pleurotus sajor caju* on maturity produces enormous number of spores which are released at intervals. These spores are scattered by wind and germinate in a suitable substrate to produce a primary mycelium. The cells of the primary mycelium have only one nucleus. Fusions between primary mycelia of the two separate, but compatible spores result in secondary mycelium.

Each cell of the secondary mycelium possesses two nuclei. The secondary mycelium develops rapidly and forms primordia which in due time develops into fully formed mushrooms. Oyster mushroom is heterothallic and therefore formation of mycelia from two compatible hyphae is essential for, fruit body formation.

C. Nutritional requirements

In nature, Pleurotus species grow on living or dead parts of the plants generally poor in nutrients and vitamins. For both, (the mycelial growth and fruit-body formation) the nutrients available in lignin-cellulosic material such as straw, com cobs, paper, sawdust, vegetable waste, are sufficient. Growth of mycelium may be accelerated by supplementing the substrate with protein-rich matter, soybean flour, wheat or rice bran and sodium or calcium nitrate. For preparation of compost or substrate its ingredients and their proportions, refer booklet No. 441, "Mushrooms: Housing and Composting".

D. Climatic requirements

Among the physical factors temperature exerts minor influence and its variations are tolerated over a wide range. During spawn run, a temperature from 20° to 30°C (depending on the species), is maintained. In *Pleurotus sajor- caju* - the optimum temperature for mycelium growth is 25° centigrade. The primordia of fruiting bodies are initiated at temperature ranging from 15° to 25°C and are most abundant at 22°_26° centigrade. In *Pleurotus ostreatus* the optimum temperature for fruiting body formation is around 16° centigrade.

Cultivation

Pleurotus sajor caju is grown in indoors, in any available room, basement, garage or even an abandoned shed, provided there is adequate light and ventilation. It is a pre-requisite also that the roof is insulated by thatching to protect it from getting heated by direct sun.

A. Spawn production

Spawn production is a highly technical operation and is generally done in laboratory. Here, general information about this process is given.

Spawn is prepared usually on wheat grains although sorghum grains are also suitable. Wash the grains and soak in water overnight. The water should be changed often to prevent fermentation. Once the grains have been prepared, boil them till they become soft but remain firm, then drain the water and spread them on a cheese cloth. Mix 2% calcium carbonate with the grains. Fill these grains in half litre size, empty milk bottles to three-fourths their capacity. Use a non-absorbent cotton plug stopper. Now-a-days the heat resistant polypropylene bags 18 cm x 28 cms. (O.1mm thickness) are becoming popular. Fill half of this bag with prepared grains (Tiwari,2008). Insert the mouth of the polypropylene bag through a 4-5 cm long and about the same diameter aluminium band, then fold down the top of band and fasten with a rubber-band. Plug the opening with non-absorbent cotton-wool and cover the plug with a piece of paper held in place by rubber band.

After the bottles or bags are ready, they are sterilized in an autoclave for an hour at 121°C temperature and 1.01 kg(cm2 pressure. Inoculation is carefully done in total aseptic conditions using pure culture or previously prepared grain spawn. After the inoculation, incubate the bottles or bags in a room at a temperature of 25° centigrade. It will normally take 10-12 days for the mycelium to permeate the entire mass of grains. The spawn which is now ready, should be used as soon as possible, otherwise it will become compact with time and make spawning difficult.

B. Substrate or compost

Most cellulosic farm wastes can be used as substrate. These include cereal straw, com cobs, bagasse, banana leaves and pseudo stems, leaf litter of various kinds, wastepaper, cotton-waste etc. Paddy straw is the most commonly used material for this mushroom. Paddy straw is chopped to about five cm or to a smaller length. The chopped straw is soaked in water overnight. For the best results the straw should be immersed in boiling water for two hours, and the excess water is drained off. If wheat straw is used, it should be softened by composting for a week.

C. Growing Place

Pleurotus sajor caju are usually grown indoors and any well ventilated room would be suitable. In places where climate is humid, such as Meghalaya and adjoining states, houses made of bamboo, thatch and mud-plaster are recommended. In such houses, split-bamboo walls are made and over this a thick plastering of mud mixture containing clay and cowdung is evenly applied. For insulation, an outer wall can be made at 15 cm apart all around and can be plastered with mud from the outside. The floor of such house should be made of cement. The roof is made of thick thatch layers. A false ceiling is essential. Ventilation shafts are made in the room. However, a room of 3 m x 3 m x 3.5 m should have at least two small windows on the rear wall and a door in the front. Inside the room, bamboo shelves are provided in three tiers, at least a meter apart and half-a-meter away from the walls.

D. Spawn run

Spawn is mixed with the prepared substrate (soaked paddy straw) @ 2-5% of the substrate weight. When the conditions are favorable for spawn run, it is recommended to use a smaller quantity of spawn. Over spawning can cause rise in temperature and carbon dioxide concentration within the substrate which can be harmful for the mycelium. The colonized substrate is the 'active mycelium' and can be used as spawn. For more details on spawning refer booklet No. 444 "Mushroom: Cultivation Practices"

E. Filling

Cultivation of *Pleurotus* is usually carried out in transparent polythene bags. It is also possible to grow it in trays which can be stacked vertically one above the other with some space ill between or on shelves. Beds can also be made on shelves. Another popular method is to make blocks of convenient size by using a mould. A wooden-mould of 50 cm x 30 cm x 15 cm size, which is open at both ends is usually used.

Spawned substrate is packed in bags or filled in mould. It is important that the amount of substrate should be such that the temperature within should not exceed 300 centigrade. It has been found that maximum amount should be about six kg (equivalent to 1.5 kg dry straw)

and this should be packed up to two-third in the polythene bag (45 cm x 60 cm) or compressed in the mould of same size. Smaller bags for smaller quantities can also be used. The bags should be perforated by punching holes to permit ventilation within the substrate and to bring down any increase in temperature. If blocks are made, they are loosely wrapped in transparent polyethylene sheets.

F. The crop

The packed bags or blocks are incubated in a well ventilated room in which a uniform temperature of 25°C is maintained. During the spawning the humidity should be 80-85 per cent. The mycelium completely permeates the substrate in 12- 14 days, forming a compact block of substrate. During this period light is not necessary and the incubation takes place in a semi anaerobic condition. After spawning the covering is cut-off and these blocks of compact substrate are arranged on the shelves. Humidity is maintained by sprinkling water on floor and walls frequently(Nagaraja & Patwardhan 1978). The spawn-run blocks of substrate can also be covered with gunny- cloth (taking care it does not touch the blocks). The gunny cloth may be kept wet by frequent watering. Some light (sufficient to read news paper) is necessary for the initiation of fruiting. The pinheads will start appearing two weeks after spawning. The pin-heads will eventually mature into normal mushrooms which are folded and have acquired a lobed appearance. The second crop would appear after 7-10 days. Within 4-5 weeks, 3-4 crops can be expected. But the yield decreases progressively. The spent substrate can be directly used as organic manure in the flower-beds without any further decomposition and has the fertilizer value as that of farmyard manure.

G. Harvesting

This mushroom should be harvested when the cap begins to fold and has attained a diameter-of 8-10 centimeters. Picking is done by twisting the mushroom gently so that it is pulled out without leaving any stub, and also the surrounding fruiting bodies are not disturbed. The base of the stipe, deep within the straw, should be removed by cutting off with a sharp knife. It is possible to get 800-1000 gm fresh mushroom per kilogram of the dry substrate (Chakravarty et.al 1981).

Alternate Methods

Various modifications of the polybag method are also in use. One such method is the modified polybag technique where spawning is done in plastic tubes placed in moulds. Straw is cut into small bits, soaked in water overnight. After draining away excess water, it is packed in moulds, usually of 45 cm x 30 cm x 15 cm size, lined with plastic sheets. Spawning is usually done in two or three layers and the whole mass is compacted. When the mould is completely filled up the plastic sheet can be folded over and above the top, tied up and mould can be removed, these are then incubated. As described earlier, once the spawn run is complete the polythene sheet now being in the form of a tube with the packed straw inside is removed and the solid block is incubated for sporocarps formation. Usually the sporocarps are formed on all the sides of the block. It tan be conveniently kept inside the room or it can be hung up in the air in the mushroom house(Nagaraja & Patwardhan 1978). From one such block an yield of about 2-3 kg fresh oyster mushrooms can be obtained.

The technique followed at the Central Food Technological Research Institute (CFTRI), Mysore, provides a central vent for expelling hot air from the bed. Under this technique, chopped paddy straw is soaked in water overnight. The excess water is drained off and horse gram powder (one per cent the weight of straw) and spawn (three per cent weight of straw) are added. Under high temperature conditions the chopped straw is to be treated with hot water (65 +/- 5°c) for 15-20 minutes followed by soaking in cold water for two hours. Excess water should be drained-off maintaining 90% moisture content (really wet condition). The straw mixed with horse gram powder and should be spawned as mentioned above. The spawned substrate is formed into a bed of convenient size. At the centre of the bed a perforated tube is fixed vertically to expel the hot air formed inside the bed. Depending on the size! area of the bed more than one vent can be fixed. Mixing paddy straw with paper wastes, maize stalk, rice bran, etc., are also recommended for boosting up production in soil bed method(Zadrazil E.,1978).

Beds 60 cm x 15 cm surrounded by soil bunds (15 cm ht. x 20 cm wide) are raised and straw is spread up to 1.25 cm thickness. The layers are spawned at the rate of one bottle for 0.72 sq. m. area. The spawn is again covered by straw (1.25 cm layer). Similarly 3-4 layers of straw and spawns are placed in the bed till the bed is full leaving about 2.5 cm space at the top. This is filled with casing soil. The bed is covered by casing soils and leftover undisturbed for fruiting.

Oyster mushrooms can be grown in mud pots filled with spawned substrate. The mud pots could be of any size. Pots can be used to prepare spawned blocks of straw or any other substrate.Any type of container with few holes for slight aeration is good enough for spawn block formation. Once the mycelium is grown and filled up the whole block, it is taken out of the container and kept for fruiting.

Economics of Cultivation

This mushroom is grown on paddy straw and some other agro-residues. It can be grown in a thatched hut, polyethylene chamber and a mud/pucca house. For a small farm the details are given here. The cost mentioned here is only hypothetical and should not be considered actual as the price vary from place to place.

A. Expenses (Running)

Cost of dry paddy straw (chopped) 100 kg@ Rs. 1.20 per kg Rs.		120/-
Horse warn powder 4 kg @ Rs. 8 per kg Rs.	32/-	
Spawn packet 10 in number @ Rs. 15 per bottle Rs.	150/-	
Polyethylene bag 1 kg @ Rs. 45 per kg Rs.	45/-	
Miscellaneous Rs.		400/-
Total Rs.		747/-

B. Income

Total Yield 35-40 kg (Fresh) 40 x 40 Oyster mushroom sold @ Rs. 40 per kg Rs. 1600/-

Net income in 1.5'-2 months period Rs.1600-747/- Rs. 853/-

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