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An overview and comparative study on cultivation of oyster mushroom on different substrates: A sustainable approach of rural development

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Abstract
Cultivation of the oyster mushroom, *Pleurotus ostreatus,* on rice and wheat straw without nutrient supplementation was researched. The effects of straw size-reduction methodology and substance size, spawn inoculation level, and type of substrate (rice straw versus wheat straw) on mushroom yield, natural effectiveness, bioconversion efficiency, and substrate declination were determined. Two size reduction approaches, grinding and dicing, were compared. The ground straw yielded an advanced mushroom growth rate and yield than the hashed straw. The growth cycles of mushrooms with the ground substrate were five days shorter than with the diced straw for analogous particle size.

Mushroom cultivation is a profitable agribusiness manifestation of non-conventional crops in being farming system can ameliorate the profitable status of the farmer. Mushrooms are the greatest source of protein, vitamins, and minerals and are anti-cancerous, anti-cholesterol, and anti-tumorous. Sawdust produced the topmost yield, natural effectiveness, and the number of fruiting bodies recommended as the best substrate for Oyster mushroom cultivation. The cultivation technology of oyster mushrooms is veritably simple and cheap. Theoretically, each crop takes 45 days under controlled conditions and hence there can be 8 crops per cycle. It's the 3rd largest cultivated mushroom in the World. China alone contributes 88 of the total world population. Oyster mushrooms can grow at a moderate temperature ranging from 20 to 300 C and moisture 55-70 for a period of 6 to 8 months in a time. It can also be cultivated in the summer months by furnishing the redundant moisture needed for its growth in hilly areas above 900m. Oyster mushroom is an economically profitable crop with high demand and supply patterns and exports. Its management is simple and easy to maintain in a restricted low ventilation room. Oyster mushrooms can be used in Women's Empowerment, the women of the small village can make money by cultivating oyster mushrooms at their homes.

Keywords: Psychiatric disorders, suicide, suicide attempt, first admission, recurrent admission, schizophrenia, bipolar disorder, depression, substance abuse disorder

Introduction
The mushroom cultivation is a profitable agribusiness and Oyster mushroom (*Pleurotus ostreatus*) is an eatable mushroom having an excellent flavor and taste with a great source of protein. It belongs to class Basidiomycetes, subclass Hollobasidiomycetidae, order Agaricales. It grows wild in the woods of hilly areas and is cultivated in temperate and subtropical regions of the world. The technology of artificial cultivation of mushrooms is kind of recent. The invention, manifestation of nonconventional crops in the subsisting farming system can help in enhancing the social as well as the profitable status of small growers. Mushrooms are the source of redundant ordinary power and virility and are used in the medication of numerous international dishes and have medicinal parcels like Materials and methodologies anti-cancerous, anti-cholesterol anti-tumorous. Mushrooms are useful against diabetes, ulcer, and lungs diseases. (Quimio, 1976) [7]. Mushrooms are a good source of protein, vitamins, and minerals (Khan *et al*., 1981) [5]. Mushrooms contain about 85-95% water, 3% protein, 4% carbohydrates, 0.1% fats, 1% minerals, and vitamins (Tewari, 1986). Mushrooms contain an appreciable amount of potassium, phosphorous, copper, and iron but a low level of calcium. (Anderson and Feller, 1942) [2]. Mushroom protein is intermediate between that of animals and vegetables. (Kurtzman, 1976) [6]. Mushrooms also contain an appreciable amount of Niacin, pantothenic acid, and biotin (Subramanian, 1986) [9]. It can be grown on agricultural and industrial waste. More than the total production from the land remains unused as waste in the form of straws, leaves, stems, roots, etc. (Zadrazil, 1978) [12]. This waste can be recycled into food and the environment may be less endangered by pollution (Hayes, 1978) [4].

What is a Mushroom?

Mushrooms belong to primitive organisms known as fungi (macrofungi). They lack the green matter content (chlorophyll) and grow saprophytically on the dead and decomposed matter. They derive nutrition with the help of the mycelium that penetrates into the substratum (decaying organic matter, rotting wood, or soil) where the conditions are favorable for their growth. When the mycelium has grown profusely by absorbing sufficient food materials, it develops the spore-bearing reproductive structure or fruiting body, generally referred to as the mushroom.

The basic structure of mushrooms consists of an umbrella-like cap or technically called pileus, bearing gills and a stalk or stipe .in 1922 chan and Millan defined mushrooms are macrofungi with outstanding fruiting bodies that can be hypogeous or epigeous large enough to be seen with the naked eye.

All fungi are not mushrooms and all mushrooms are not edible there are 14,000 species of mushrooms reported in the world including 12000 species belonging to three orders Agaricus, Boletales, and Russulales are described from India which contribute 10% of global mushroom diversity. More than 2000 species are considered to be edible, less than 25 species are widely accepted as an item of food and only cultivated. In the north eastern region, a huge diversity of macro fungi is found growing on the forest floor, twigs, branches and rotting plants etc.

Scientific classification

1. Kingdom Fungi
2. Division Basidiomycota
3. Class Agaricomycetes
4. Order Agaricales
5. Family Pleurotaceae
6. Genus Pleurotus
7. Species P. ostreatus

Morphology

Mushrooms have restorative (medicinal) just as nutritional worth and extensively operated as human food from the time immortal. The mushroom has a broad, fan, or oyster-shaped cap spanning 5 – 25 cm; natural samples range from white to greyish or tan to dark brown; the periphery is enrolled when youthful and is smooth and again and again more or less lobed or crimpy. The meat is white, firm, and varies in consistency due to the stripe arrangement. The gill of the mushroom is white to cream and descend on the stalk present. However, the stipe is off-center with a side attachment to wood, If so. The spore print of the mushroom is white to lilac-grey, and best viewed on dark background. The mushroom's stipe is often absent. When present, it's short and thick (Shukla, 2011).

Parts of a mushroom

Mushroom possesses two parts. The underground part is called mycelium. It provides food to the mushroom. Sometimes, it gets expired soon. But it can stay alive for hundreds of years if enough food is provided.

A mushroom possesses an umbrella-shaped body which is called the fruit or sporophore. It can live only for a few days. Like a small button, the fruit starts coming out and it grows into a stalk and a cap. As the stalk or stem has a great ability to absorption a lot of water, it can grow soon. The cap gets unfolded like an umbrella as it becomes larger. Meanwhile, small plates (i.e. gills) emerge under the cap of the mushroom. Small seeds or spores get visible on them. Frequently, these spores fall off the mushroom and get blown away by the wind. A new mycelium germinates when they fall in warm, wet weather. Mushrooms have up to 40 cm in diameter. Mostly, the colors of mushrooms are white, brown, or yellow. Sometimes, it can be very colorful.

Safe and poisonous mushrooms

The word ‘Mushroom’ is utilized for the members of macrofungi which are edible. The name ‘mycology’ was coined to denote the study of mushrooms (Mykes=mushrrom). Whereas, the term, Toadstool is generally used to designate the poisonous ones of the gill of macro-fungi. However, it is not always the word “mushrooms” that means an edible or safe variety and the word “toadstool” means a poisonous or non-edible mushroom. The word toadstool in fact, is a distortion of the german word Toadstool which means death chair.

Many mushrooms can be non-edible and poisonous while some are edible or safe. Mushrooms occupy a prominent place of importance in the biological world in terms of diversity, economic value, and environmental impact. Wild edible mushrooms are not well documented and poorly studied. Identification of mushrooms is an art that is very difficult and time-consuming and requires skills cultured over time. The scientific methods that are available cannot be carried out instantly and are confirmed to the laboratory only. Some prominent distinctions between poisonous and non-poisonous mushrooms are enumerated as follows.

Characteristic features

i. A distinctive feature of poisonous mushrooms is the presence of a ring or annulus in the middle of the stalk or stipe of the mushroom. The presence of a cup or saucer-like structure called volva at the base of the stipe is another characteristic feature.
ii. In poisonous mushrooms, both of these structures are generally found to be present together. Howsoever, any of these structures i.e. either the ring (e.g. Button mushroom) or the volva (e.g. Paddy straw mushroom) may be present or none of these may be present (e.g. Oyster mushroom) in the edible species.
iii. The poisonous mushrooms are comparatively soft and the skin of the pileus (cap) cannot be easily peeled off.
iv. In general, mushrooms which are poisonous are colorful and quite attractive.
v. Oozing out of milk like exudation from the damaged fruit bodies can be seen in some poisonous mushrooms.
vi. Poisonous mushrooms are generally bitter or sour in taste and bear an unpleasant smell.

Benefits of having mushrooms in diet

1. Mushrooms are high in antioxidants, Vitamin B, Selenium, and fiber, making them extremely nutritional.
2. Because they're low in calories, they're excellent for weight loss and the forestalments of metabolic ails. Zinc is an essential vitamin for healthy immunological function as well as applicable growth in babies and children.
3. Mushrooms are high in potassium, a nutrient that helps your body manage the detrimental effects of salt.

Potassium also reduces blood vessel tension, which may assist to lower blood pressure.

4. Mushrooms'-inflammatory properties have been demonstrated to boost the vulnerable system's effectiveness. Mushrooms have been proven to stimulate macrophages in the vulnerable system, perfecting their capability to fight infections.

Objective of our project

The main aim of my project is to cultivate the oyster mushroom in two environmental conditions.

- To cultivate the oyster mushroom fully on home conization
- To understand the benefits of growing oyster mushrooms to the farmer and surroundings and the health benefit of consuming mushrooms.

Different species of Oyster Mushroom

- Pleurotus ostreatus
- Pleurotus florida
- Pleurotus sajor-caju
- Pleurotus sapidus
- Pleurotus eous
- Pleurotus membranaceous
- Pleurotus flabellatus

Importance of mushroom

Mushrooms are significant ingredients of minor wood yield, that develop on the most generous biomolecule of this biosphere, that is, cellulose. By and by mushrooms are viewed as a large-scale parasite with an unmistakable fruiting body which can be either epigeous or hypogenous and sufficiently huge to be seen with the unaided eyes and to be picked by hand (miles, 1992). Just fruiting body of the mushroom can be seen through the remainder of the mushroom stays underground as mycelium (Bilal Ahmad Wani, 18 December 2010) [1]. Mushrooms have been discovered successful against cancer, cholesterol decrease, stress, insomnia, asthma, sensitivities, and diabetes. (Medicinal value of edible fungi, 1983, pp. 203-209) Mushroom as functional food used as nutrient supplement for adding immunity due to the aspects of high protein. Indeed used for diabetic and heart cases due to the aspects of low starch content into it. Used as the anticancer drugs because of polysaccharide content used to combat HIV effectively. (Maitake mushroom the king mushroom, 1993). Organically dynamic admixtures from the mushrooms have antifungal, antibacterial, cancer precluding agent and antiviral parcels, and have been operated as bug sprays and nematicides also. Hence keeping in see the enormous uses of mushrooms, the current examination audits varied perspectives of mushrooms towards human medical advantages, for illustration, food, medicine, minerals, drugs.

Production Technology

Agroclimatic Requirement

The most suitable temperature for the growth of Oyster mushrooms ranges from 20o to 30o C and moisture ranges from 55-70 up to the period of 6-8 months in a time. The cultivation practices during the summer months can be done by delivering redundant moisture needed for its growth and development. The best growing season for oyster mushroom is the month of March/April to September/October. (Reddy, December 28, 2019).

Cultivation Technology

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

i. Preparation or procurement of spawn
ii. Substrate preparation
iii. Spawning of substrate

Spawn Preparation

Marketable strains of clam mushrooms with a reach of fruiting temperatures (15o30o C; 59o-86o F) are accessible. Present day strategies of induce readiness use oat grains (e.g., wheat, millet, rye), which are sanitized in glass holders or polypropylene plastic packs, immunized with a chosen strain, and incubated at befitting temperatures for complete colonization. An optional little compass method utilizes sequent degeneration of basidiospores from a spore print to plan grain produce. Other natural crude materials (e.g., straw, espresso mash, cotton squander, sawdust), alone or joined in various combinations, are additionally used to make generated. (Badshah, 1992).

Substrate Preparation

In the wake of homogenizing molecule size, changing water content (about 70), and pH (5-6), numerous substrates have been demonstrated to be applicable for development (e.g., straw, espresso crush, cotton squander, wood slices, banana pseudo-Stem, cottonseed bodies, squander paper, different factory leaves, cardamom crush, sawdust composites, sludge-cobs, tequila bagasse, crush factory sleazebags, cocoa shell waste, and Cassia side- goods). The immediate application of a portion of these substrates, for example with no farther treatment, for provincial development in the field was considered for from China. (Martínez-Carrera, 1998) [http://books.mcgraw-hill.com]. In any case, many strategies have been created to make substrates more applicable for developing shellfish mushrooms on an enormous or little scope

1) Sterilization, substrates are autoclaved at 1000-1200 C (2120 – 2500 F) for 1-2 hours.
2) Pasteurization, substrates are set in a suitable room or burrow and purified with brume at 60o-1000C (1400 – 2100 F) for 6-24 Hours, or drenched in the heated water at 700-900 C (1580 – 1940 F) for 1-2 hours;
3) Aerobic development, substrates are explosively developed for a couple of days (2-6), and subsequently purified with brume at 600-82oC (140o-180o F) for 12-24 Hours.
4) 4)Semi-anaerobic development, substrates are submerged in water (7-10 days) for inciting lactic sharp aging
5) Xerothermic measure, dry substrates are treated with steam at 1000 C (2100 F) for 1 h in a little passage, and afterward, cool water is included. Supplementation might be conveyed out before treatment to build supplement substances and yields (Lemke, 1994) (Miles, 1989) (Elliott, 1995).

Material and Methodology Used

Seed or planting material of mushroom i.e. spawn consists of mycelia of the fungus multiplied on suitable substrates like cereal grains. The mycelia of mushroom fungus cannot

be propagated as such; hence the mycelia are multiplied on a carrier like cereal grains. Like in all other crop production systems, seed or spawn is the key input in mushroom cultivation. Non-availability of quality spawn is the major constraint in mushroom production.

Good quality spawn conforms to – i) high yield potential, ii) absence of contaminants, iii) better economic benefit. Spawn production primarily depends on the easy availability of spawn substrates. A good source of fruit body supplies and laboratory conditions for a sterile environment is needed. The process requires special technical skills and a laboratory for quality and economic spawn production. The basic steps involved in spawn production are

The methods used during the study are as follows:

The introductory way involved spawn production is

1. Pure culture preparation
2. Mother spawn preparation
3. Spawn multiplication / commercial spawn preparation

Pure culture preparation

Pure culture of mushroom species can be obtained either by spore culture or tissue culture. Although mushrooms are spore-bearing fruit bodies of macrofungi, all spores are seldom vigorous, and the pure cultures obtained show variations because of genetic reasons. In tissue culture, a well-grown mushroom fruit body is collected (usually from the first flush harvest).

The fruit body is longitudinally split open into two halves. A small bit of tissue from the inside of the junction area of the pileus/cap and stalk is taken aseptically with forceps and placed over potato dextrose agar (PDA) or malt extract agar (MEA) media in slants or Petri plates. These are incubated at 25±2°C and after a week's time, the tissue generates mycelium which covers up the entire media surface and the cultures become ready.

Mother Spawn Preparation

Mother spawns are mainly used for the preparation of commercial mushroom spawns. It is the seed of the mushroom which is prepared directly from the pure culture.

Materials Required

1. Paddy grains – Good quality, healthy, and disease-free grains should be used.
2. Calcium Carbonate (CaCO3) – 20g of calcium carbonate is used per kg of seed.
3. PVC ring- It is used for covering the spawn bag
4. Polypropylene bag – Used for the packing of the spawn. (General size – 200-gauge thickness and 30 ×50 cm size.
5. Nonabsorbent cotton – Is used for logging the spawn bag.
6. Permanent marker – Is used for marking the date when the spawn is inoculated.

Instruments/ Devices Required

1. Weighing balance – This is used to measure the number of materials that are being used.
2. Autoclave- This is used for the sterilization of the seed and the materials that are used for the inoculation of the seed.
3. Pressure cooker and gas set – Are used for the boiling of the seeds.
4. Laminar flow and Bunsen burner - Inoculation is carried out in the laminar flow above the flames of the Bunsen burner.
5. Thermometer – This is used to measure the temperature in the spawn room; so that the temperature can be regulated according to the required condition.

Steps for the preparation of mother spawn

Weighing and washing of seed grain - We took good quality, disease-free seeds for the spawn preparation and weigh it. The grains are washed properly, chaffy and the damaged grains, which float the water was removed.

Boiling: Grains are boiled until it splits into two halves; so that internal starch could be exposed to the fungal mycelium and the nutrients can be taken up by the developing fungal.

Drying: The excess moisture that remains after boiling were drained out. The grain spread on a clean sterile surface. Allow it to dry for about 2 hours until it reaches 50% moisture level

Mixing – Calcium carbonate is mixed thoroughly with boiled grain @20g/kg seed. By mixing properly we can avoid the sticking of grains. It also helps to balance the pH.

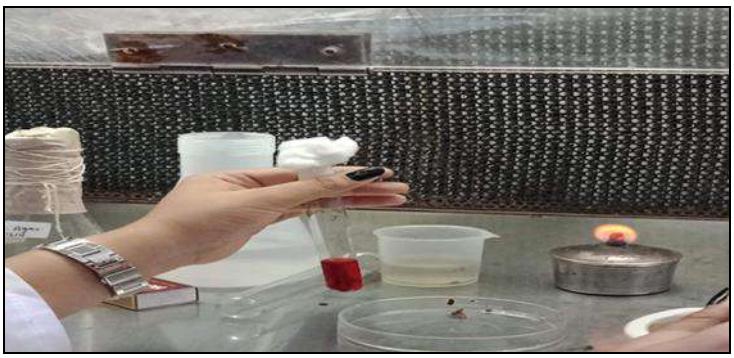
Packing – The grain was put in the polypropylene bag with a clean sterilized hand. About 200g of grain was put in the bag and at last, a PVC ring was put on the neck of the seed bag. The cotton was plugged in the seed bag, by holding the ring.

Sterilization – The grain bags and the materials that are required are in laminar flow, are placed in autoclaves properly. it was autoclaved at 15psi (121 degrees Celsius) for about 2 hours. Then it is allowed to cool down for about 4 hours.

Inoculation

The UV light is turned on; this is done 20-30 minutes ahead of starting the inoculation process. Hand sterilization and the surface sterilization of laminar flow are done with concentrated alcohol. Then a healthy, properly grown pure culture, was divided by using a cork borer or a sterilized blade. Then the divided culture with the help of sterilized forceps or spatula. Inoculation was done above the flame. The bag was plugged again after inoculating. We also wrote the date of inoculation on the inoculated bag, ith permanent marker.





Incubation (Storage)

Then the inoculated bags are transferred to the incubation room. The bags are incubated at a temperature range of 23-2 and 23+2 for 20-25 days. Proper growth of fungal mycelium can be seen on the mother spawn bag, after 20-25 days.

Storage

The temperature of 25±2ºC or at room temperature spawn can be stored up to 30 days, from the date of inoculation. Under refrigerator conditions, spawn can be stored for another 3 months. However, there will be some decrease in the yield of mushrooms with increased storage time above 2 months

Contamination or spoilage

Growth of the mycelia gets restricted in the substrate when bacteria or molds over grow the mycelia and the spawn is getting contaminated or get spoilt. Bacterial contamination in spawn packets is generally found as patches of slimy fluid on the substrate where the mycelium growth ceases. The factors like excess moisture in the grains, bad quality grains, improper sterilization, and high temperature during storage contribute to spoilage of spawn

Desired traits of planting spawn: Spawn should always be procured from reliable and authentic sources as it is the key input for successful mushroom production. Time, labor, and money are lost when good-quality spawn is not used for planting. While procuring spawn few things are to be taken care of like the species of mushroom, generation, and date of inoculation.

Procedure

Step 1	Select healthy and clean cereal grains
	↓
Step 2	Boil grains in water (15-20 min.)
	↓
Step 3	Remove excess water on the sieve
	↓
Step 4	Dry grains in shade (4 h)
	↓
Step 5	Mix $CaCO_3$ (0.5%) and $CaSO_4$ (2%) on dry wt. basis
	↓
Step 6	Fill 300 g grains in glucose/milk bottle
	↓
Step 7	Plug and autoclave at 22 p.s.i. for 1.5 to 2 h
	↓
Step 8	Inoculate growing mycelium of desired strain using laminar flow
	↓
Step 9	Incubate in BOD at 23+20C for 20-25 days (shake bottles after 10 days)
	↓
Step 10	Master spawn is ready

Cultivation Method

Cultivation of mushrooms can be done by different methods and the most important methods are

Polybag Culture / Polythene Bag Method

Fold the poly bags (mushroom bags) of 40 cm x 20 cm size lengthwise twice and perforate with a punch machine at a distance of about 10 cm between the holes.

The sizes of the holes are about 5 mm in diameter. A polybag should have 15-20 no. of holes for proper ventilation.

Tie the closed end of the polybag with a piece of jute thread to give a round flat bottom to the bag.

Cube Culture Method

The commonly followed method is the polythene bag method where the polythene bags can be reused. The method which has been followed by us is also the polybag culture method.

Materials Required For The Polybag Culture Method

Paddy or wheat straw
Trays
Spawn (Mushroom seed)
Water boiling drum
Chaff cutter
Hand sprayer
Transparent polybag (size- 40-45cm *20cm)
Sharp object for making the hole.
Jute thread

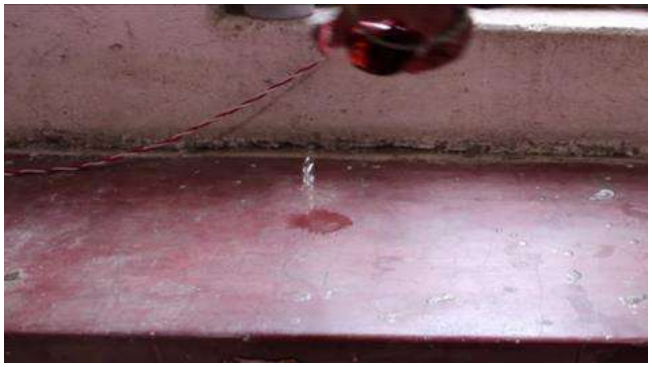
Procedure for Poly Bag Culture

The paddy straw is cut into 1-2 inches size with the help of a chaff cutter.

The straw is prepared by soaking straw for one day in the water.

Next day: the straw was boiled for 1 hr. at 80-degree Celsius, in water boiling drum there are two reasons for boiling straw: the first one is boiling will make straw soft on which mushroom can grow well and the second; the most important is to sterilize straw to kill harmful pathogens present in straw.





The boiling process is completed after 1 hr. The surface we going to spread straw to drain out extra water was cleaned. As we need to protect straws from dust and other infectious agents, an indoor location was selected and wiped the surface with hydrogen peroxide

As we need to protect straws from dust and other infectious agents, so an indoor location was selected and wiped the surface with hydrogen peroxide

Straw was spread on a clean surface to drain extra water. We should not completely dry the straw; it just needs to remove extra water. Straw got ready in 5-6hrs.

After this we took out the spawn in a bowl from the mother culture we have prepared.

We use cotton to sterilize the surface and for making the cotton plug and a polybag in which we arranged straw and spawn. It was sterilized with the help of rubbing alcohol or isopropyl alcohol before putting the prepared straw.


Hands were sterilized properly and then the bottom of the polybag was tied with the rubber band so that it can give a cylindrical shape.

The layering was done; the first layering of straw was of 1 to 1 by half inches
We kept on pressing the straw till we got almost 1 to 1 and a half inches layer then we added spawn in it.

Spawn was crushed a bit and sprinkled at the margins of the polybag to form a ring. The same process was repeated until we got the required layer.

When the last layer was completed then the straw was pressed, and the polybag was tied with the rubber band. After tying the polybag, we make holes so that materials inside will remain well aerated. We used the sharp object which had been wiped with the rubbing alcohol for making holes in the bag and in those wholes cotton plugs were inserted to protect inside materials from dust and infection.

7-8 holes were made and then polybags were placed at an indoor location, which was free from dust and direct sunlight. And the mushroom spawn was ready to grow. After 20 days all media turned white; this stage is known as the spawning stage. To reach this stage it can take 15-25 days and it depends upon the temperature of the places. The cotton plugs were removed to give room for the growth of the mushroom After 20 days all media turned white; this stage is known as the spawning stage. To reach this stage it can take 15-25 days and it depends upon the temperature of the places. The cotton plugs were removed to give room for the growth of the mushroom. And now we wait for the mushroom to grow.

Result and Discussion

The mushroom on which we have worked was the oyster mushrooms. Oyster mushrooms along with being delicious are nutritious and are easy to cultivate. If the mushroom cultivation is done for the first time; doing oyster mushroom cultivation is the best option.

As it is easy and will give the basic idea for the process and other requirements during the mushroom cultivation. This will make it easier to cultivate other species of edible mushrooms like a white button mushroom, paddy straw mushroom, milky mushrooms, etc.

While the growth is on spawning stage that is when inoculated mushroom spawns cover complete media; make sure there should not be any kind of discoloration or blackish growth.

Just after 2 days of removing the cotton plug, there was the growth of a little mushroom. After 3 days the mushrooms got a well-defined shape and were able to see the growth.

Fig 1: The image shows growth after two days

Finally, after 4 days, the mushroom is ready to harvest. Even after the first harvest of mushrooms, we got 2-3 more such harvestings.

For the mushroom harvesting, we need to just twist the mushroom and they will come out easily

After doing the first harvest, we let the small mushrooms grow for the second harvest which we were able to get after 2-3 days.

Management

1) Use good quality and properly dried straw for bed preparation.
2) Avoid decomposed straw or straw exposed to rain.

Data collection and analysis

The mushroom's growth and development were tracked daily. The number of days between inoculation and the production of mycelium, as well as the duration between inoculation and inoculation. The number of days required for the first round of harvesting was noted. Before each harvest, a slide caliper was used to record growth metrics such as stipe length (cm), stipe diameter (cm), pileus diameter (cm), and pileus thickness (cm). At fruiting bodies per harvest time, yield parameters such as the number of bunches and total fresh weight (g) of mushrooms were also measured. With a sharp blade, mature (white in color, with up curved pileus) fruiting bodies were picked. During the experiment, two rounds of mushroom harvesting were carried out across all substrate types. To analyze t and biological yield, the yield was estimated. The efficiency was the mushroom's growth performance on various surfaces. Biological yield (g) was calculated by weighing the entire cluster of fruiting bodies without removing the base of stalks, while economic yield (g) was calculated by weighing all of the fruiting bodies on a substrate after the base of stalks were removed. Finally, biological efficiency (%) is calculated as follows;

$$\%BE = FWm/DWs * 100\%;$$

Where, BE is Biological Efficiency (%); FWm is total fresh weight (g) of mushroom yield across all flushes, and DWs is substrate dry weight (g).

Then, analysis of variance (ANOVA) was computed using SPSS version 20, and mean values of all the parameters and

the standard errors of each parameter were separated using LSD at 5% level of significance.

Result and Discussion

Table 1: Growth of mushroom in Sorghum spawned substrates

Growth	Sugarcane bagasse	Paddy straw	Corn Cob	Corn straw
Mycelial growth	14 Days	14 Days	16 Days	19 Days
Pinhead formation	16 Days	17 Days	24 Days	24 Days
Maturation of fruiting bodies	26 Days	28 Days	36 Days	38 Days

Table 2: The growth of mushrooms in Wheat grains spawned substrates.

Growth	Sugarcane bagasse	Paddy straw	Corn Cob	Corn straw
Mycelial growth	17 Days	17 Days	20 Days	22 Days
Pinhead formation	20 Days	22 Days	29 Days	32 Days
Maturation of fruiting bodies	32 Days	34 Days	40 Days	44 Days

Table 3: Results of yield components of Sorghum spawned substrate

Parameters	Sugarcane bagasse	Paddy straw	Corn cob	Corn straw
No. Of fruiting bodies	33.00	30.12	27.34	26.26
Pileus diameter (cm)	7.85	6.95	5.48	5.02
Pileus thickness (cm)	1.67	1.32	1.05	0.98
Stipe diameter (cm)	5.87	5.23	4.85	4.07
Stripe length (cm)	3.81	2.98	2.09	1.98

Table 4: Results of yield components of Wheat spawned substrate

Parameters	Sugarcane bagasses	Paddy straw	Corn cob	Corn straw
No. Of fruiting bodies	28.50	26.32	24.34	23.26
Pileus diameter (cm)	6.05	5.75	4.48	4.02
Pileus thickness (cm)	0.67	0.52	0.35	0.08
Stripe diameter (cm)	4.87	4.73	3.65	3.07
Stripe length (cm)	2.07	1.88	1.09	0.98

Table 5: Results of biological and economic yield in Sorghum spawned substrates

Substrates	Biological yield (g)	Economic yield (g)
Sugarcane bagasse	398.54	276.24
Paddy straw	350.40	240.16
Corn cob	320.65	220.08
Corn straw	304.87	202.68

Table 6: Results of biological and economic yield in Wheat spawned substrates

Substrates	Biological yield (g)	Economic yield (g)
Sugarcane bagasse	368.44	250.42
Paddy straw	320.30	220.60
Corn cob	300.05	192.98
Corn straw	280.87	187.80

Table 7: Results of biological efficiency of oyster mushroom

Spawns	Sugarcane bagasses	Paddy straw	Corn cob	Corn straw
Sorghum	84.68	80.72	77.68	72.80
Wheat	72.15	70.23	68.65	64.42

Biological efficiency of dry weight of the substrate. The mushroom was determined as the ratio of Biological yield harvested to the The sorghum spawned sugarcane bagasse substrate showed more biological efficiency followed by paddy straw, corn cob, and corn straw. The results are tabulated as follows (Table 7).

Discussion

As per the finding of this study, the growth ofP. ostreatus mycelia was fairly faster on cotton seed and paper waste as compared to the other substrates used (wheat straw and sawdust). On average, it took about 16 days for the mycelia to run on each substrate. This is similar with other analogous studies away. For case, Onuoha *et al*. (2009) reported the completion of spawn running on paddy straw waste to be 15 days, while others reported it to be between 13 and 16 days using analogous substrate (Patra and Pani 1995; Jiskani 1999). Also, Ahmed (1998) reported spawn running ofP. ostreatus to be completed within 17 – 20 days on different substrates.

The variation in the number of days taken for a spawn to complete colonization of a given substrate is a function of the fungal strain, growth conditions and substrate type (Chang and Miles 2004). This variation could, in turn, be attributed to the variations in chemical composition and Carbon to Nitrogen rate (CN) of the substrates used (Bhatti *et al*. 1987). According to Oei (1996), mushroom mycelia bear specific nutrients for its growth; the addition of supplements can, therefore, increase mushroom yield through the provision of these specific nutrients.

Pin- head formation (premordium initiation) was observed following the invasion of substrates by mycelia growth. The time needed for the conformation of leg- heads is similar with other analogous studies away;e.g., Ahmed (1998) reported pin- head formation of oyster mushroom cultivated in different substrates to be between 23 and 27 days from spawning, while Fan *et al*. (2000) reported it to be 20 – 23 days. On the other hand, Shah *et al*. (2004) [29, 50] found that pin- heads appeared in about 6 days. Similar variations in mycelia growth rate, colonization and primordial initiation have been observed when a mushroom species were grown on a range of substrates including sawdust, bagasse, and banana leaves (e.g. Vetayasuporn 2006; Islam *et al*. 2009; Birhanu Gizaw 2010).

Conclusion

From this report, we conclude that the cultivation of mushrooms is important as it would help in reducing the population pressure on the scarce land resource. The generation of additional employment opportunities would be able to ease the unemployment situation, may be in whatever smaller degree. With this in mind the mushroom cultivation was introduced but the growth rate of adoption of this activity did not touch the desired level. Even those farmers who initially adopted this activity, later on abandoned it due to one reason or another. Most important from these were the high technicality involved in mushroom production and this venture being highly capital and labor intensive. It has been observed that farmers have to depend on purchased inputs like spawn and compost, which is sometimes not easily available; the capital requirements may not be easy to meet with. Mushroom cultivation needs thorough knowledge of the complete procedure, prior to the start of the cultivation. Each step in mushroom cultivation determines the yield of final products. Selection of the suitable species according to the region, growing season and availability of the substrate is the first requisite. True culture should be obtained from reliable sources and spawning should be done carefully. Spawning is a tedious job so proper method with all precautions should be employed.

Incubation period depends on species. Generally, it varies from 10 to 25 days. After incubation when growth of mycelium is completed, casing is done. Casing should be done strictly according to the procedure described with suitable material. Time, depth and material of casing are important aspects to be considered. After casing required conditions for the growth *viz* ventilation, temperature, humidity is maintained. Depending on the system employed, cropping period varies from 6 to 12 weeks. The mushrooms are picked up carefully, graded and packed. It is necessary to dispose of the substrate after use. Mushrooms can serve as food, as tonic, and as medicine. A regular intake of mushrooms can make healthier, fitter, and happier. Mushrooms are environmentally very friendly. They biosynthesize their own biosynthesize crop residues, which would otherwise cause health hazards. And their spent composts/substrates can be used as animal feed, biofertilizers and biogas. Mushrooms can serve as agents for promoting equitable economic growth in society. They are a unique group of fungi through which we can pilot a non-green revolution in fungi through, and in the world at large. They demonstrate great potential for generating a great socio-economic impact in human welfare, at local, national and regional local, national biology are closely associated with three aspects of wellbeing - food shortage, closely associated environmental pollution. One of the most significant benefits of mushroom cultivation is their ability to create a pollution free and friendly environment. We also learnt the economic importance and nutrition values, the production technologies of mushroom production and methodologies.

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