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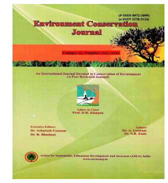

# Cultivation of oyster mushroom to combat pandemics: medicinal and social aspects

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## ABSTRACT

**Mushrooms are the spore bearings fruiting bodies that have been used by human being since ancient times for good health. The aim of the study was to utilize bulk agricultural waste that is wheat and paddy straw to cultivate oyster mushroom as its choicest food of nutrition because it provides important nutrients like proteins, selenium, potassium, riboflavin, Niacin, Vitamin D and more. Wheat straw as a substrate was inoculated with pure culture of *Pleurotus ostreatus* under aspectic and favourable conditions. High yield of mushroom was obtained with a small amount of substrate. Oyster mushroom protect the heart against cardiovascular diseases, helps in lowering the blood pressure, regulate the cholesterol level, improve immune health and have anti cancer, anti inflammatory and other medicinal properties. Thus utilization of agricultural waste appears to be an alternative for oyster mushroom cultivation. Cultivation of oyster mushroom on waste straw not only solve the pollution problem but also improves the economic conditions of farmers.**

## Introduction

The oyster mushroom (Pleurotus sp.), also known as "dhingri," is a member of the order Agaricales and family Agaricaceae. It naturally grows on wood logs in temperate and subtropical forests wood and may also grow on decomposing organic matter. Depending on the species, this mushroom's fruit bodies have a distinctive shell or spatula shape and come in shades of cream, white, yellow, grey, crimson, or light brown (Kerketta *et al.,* 2019). Typically, the term "mushroom" refers to fungi that have a stem (stipe), cap (pileus), gills (lamellae), and pores on the underside of the cap.(Masarirambi *et al.,* 2011). Mushroom spawn (spores) are created on the gills and can fall off the underside of the cap as a thick powder. Most oyster mushrooms have white spore prints, and when grown, they form fruiting bodies. The oyster mushroom, or dhingri, a species of *Pleurotus,* is the second most widely grown fungus in the world. One of these mushrooms' most successfully farmed species, *Pleurotus sajor-caju,* is praised for its flavour. For the commercial production of oyster mushrooms in India, rice and wheat straw are used. Dhingri is grown extensively, which boosts the income of those who live in rural areas. In addition, compared to button mushrooms, its cultivation technique is also quite straightforward (*Agaricus bisporus*) (Sharma and Singh, 2018).The Pleurotaceae family includes the edible oyster mushroom (*Pleurotus sajor-caju*). The majority of fungi that fit the definition of a mushroom have a cap (pileus), hymenium (stipe), and spores on the underside of the cap (Masarirambi *et al.,* 2011). Temperatures between 20 and 30 degrees Celsius and relative humidity levels between 55 and 70 percent are suitable for growing oyster mushrooms. In mountainous places above 900 (masl), the optimal growing season is from March/April to September/October, and in the lower regions from September/October to March/April. It can also be grown throughout the summer months by supplying the additional humidity needed for its growth (Dubey *et al.,* 2019). The oyster mushroom, or

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Pleurotus spp., is a useful lignin-degrading fungus that may thrive on a variety of ligno-cellulosic materials, including agricultural and forestry waste (Biswas and Biswas, 2015). On a variety of agricultural waste, including wheat and paddy straw, sugarcane thrash, and vegetable waste, mushrooms can be produced. Different kinds and quantities of nutrients required for mushroom growth can be found in agricultural waste. Cellulose, hemicelluloses, nitrogen, and lignin are a few of the nutrients. A form of lingo-cellulosic substance known as a mushroom substrate is any material on which mycelium grows and aids the growth and development of mushrooms. The substrate simply needs to be pasteurised, which is less expensive, rather than sterilised. Oyster mushroom cultivation is more profitable because a significant portion of the substrate is converted to fruiting bodies. The fruiting bodies of *Pleurotus ostreatus* require little environmental restrictions, are rarely attacked by diseases and pests, and can be grown in an easy and inexpensive manner. Due to all of this, *Pleurotus ostreatus* cultivation is a superior alternative to other mushroom production (Myachikova *et al.,* 2019).
Although the white oyster mushroom is a member of the consumption mushroom family that feeds on decomposing wood, there are many other species that may be found in nature, each of which has unique traits. It can be separated into dangerous and non-toxic mushrooms based on their natural makeup. Farming white oyster mushrooms, which are regarded as a commodity in the agribusiness sector, represents a business opportunity that is still very much open (Syawal *et al.,* 2019). Mushrooms are recognised to have a wide range of purposes in both food and medicine and are a strong source of protein, vitamins, and minerals. On soil, open fields, farm lands, woods, and roadside, these are frequently discovered as saprophytes. Large enough to be seen with the naked eye are the fruiting bodies. The taste, flavour, and texture of mushrooms are varied. Fresh mushrooms have a moisture content of between 80 and 95 percent, 0.3 to 0.4 percent protein, and 1% vitamins and minerals (Biswas and Biswas, 2015). Pleurotus species have been recognized as mushroom with dual functions to humans; both as food and medicine (Adebayo and Olake, 2017).

Commonly encountered obstacles during oyster mushroom cultivation are: a lack of cultivation space, Insects make attack (flies and cockroach), Equipment deficiencies (Air conditioner, water tank, a sterilisation chamber, and a steel rack etc.), a lack of skilled and knowledgeable labour.Lack of cultivation space can be overcome by utilizing basement rooms and roof top.
Insect make attack can be overcome by pre sanitizing of growing room, and time to time monitoring, gloves should be worn during spawning, insect repeller machine should be installed in cultivation area, homemade herbal sprays (neem spray) can be sprayed in cultivation area . To overcome equipment deficiencies cultivation can be in wintersas temperature is maintained lower naturally, a pressure cooker can be used as a sterilizer machine; a wooden rack can be used in place of steel rack. A lack of skilled and knowledgeable labor problem can be overcome by taking training from KVK (Krishivigyan Kendra) which is provided free by government of India.

**Cultivation Steps**

- Isolation of pure culture (Tissue culture method and spore printing method)
- Preparation of mother culture & Spawn
- Preparation of substrate
- Spawning
- Spawn running
- Fruiting
- Harvesting

**Isolation of pure culture**

Using sterile forceps and a Petri dish containing potato dextrose agar, a pure culture of *Pleurotus ostreatus* was recovered from pileus tissues on (PDA) (Thongklang and Luangharn, 2016). The chosen fresh mushrooms were surface sterilised with 75% alcohol right away. Then, under a laminar flow cabinet, each mushroom stipe (stem) was divided into two parts with a sterilised surgical blade, and small tissues (about 4 mm2) were extracted from the pseudo-parenchymateous tissue of the stipe (Belachew and Workie, 2013). Inoculate the PDA media with tissue from a mushroom stipe that has been cultured for 4-5 days at 25°C ± 1°C. A pure culture was produced by transferring a little piece of the fungus' mycelium, which was visible around the sporophore piece in the slant, to another culture tube and incubating it there for 3–4 days at 25°C ± 1°C (Biswas and Biswas, 2015).

**Preparation of Mother Spawn**

Sawdust was used to prepare the master culture substrate. Sun-dried sawdust was sieved (Miah *et al.,* 2017). The yellow-colored sorghum grain (Sorghum bicolor L), wheat bran, and calcium sulphate (gypsum), in the proportions of 88:10:2, respectively, were used to create the spawn (mushroom seed) of *Pleurotus ostreatus*. The needed amount of sorghum grain was weighed and soaked in enough water for one day. The grains had been rinsed and drained in order to remove the dead and dangling seeds from the water. Gypsum ($CaSO_4.2H_2O$) and the required quantity of wheat bran ($CaSO_4.2H_2O$) have been added to the grain after any excess water has been removed. The mixture was then transferred to 1,000 mL glass bottles (75 percent degree), with a head space above the grain, and autoclaved for 45 minutes at 121°C. After cooling, each bottle was inoculated with 20 agar blocks (1 cm x 1 cm) of a 15-day-old mushroom culture from a Petri dish and incubated at 28°C for 21 days until the substrate was fully colonised. Mycelia invasion and infection were monitored every five days, and the grain spawn was ready for use after 15 days (Getachew *et al.,* 2019).

**Preparation of substrate**

All of the gathered substrates were broken up into small (2-4 cm long) pieces, then soaked overnight in fresh water from the faucet. The following day, the soaked straw was cleansed with clean water three to four times until clear water was obtained. The excess water was then squeezed from the substrates or allowed to run off till the moisture level was reached and the straw was ready for sterilization (Dubey *et al.,* 2019). The bags were filled so that they only filled up to 3/4 of the way, leaving room for air for tying. The filled bags were then autoclaved for 15 minutes at 121°C and 15 PSI of pressure. Before adding the spawn, the bags were allowed to cool after sterilization (Sajid *et al.,* 2018).

**Spawning**

Clear monitoring of the mycelia's growth and the presence of contaminants is made possible by transparent plastic cultivation bags (65 cm long x 45 cm wide). Each substrate (500g), which had been cooled to room temperature, was combined with 10% spawn (dry weight/moist weight basis) under a laminar flow hood, and the polythene bags containing the inoculated material were then tightly sealed with cotton-based string. Once the primordial were formed, the contaminated baggage were kept in a spawn running room at room temperature (23–25°C) in the dark (Getachew *et al.,* 2019). Depending on the size, kind, and state of the bags, they are stored in the incubation chambers for 15 to 25 days. There are numerous ways to organise these bags. Typically, they are arranged in a rack with no bags touching one another (Dulal, 2019).

**Spawn Running**

Once the mycelium mat has fully colonised, it indicates that the mycelium mat is ready for fruiting in the poly bags. To allow the pin-heads to emerge, sterile blades were used to slit the surface of the bags at a distance of 10 cm apart. The bags were subjected to an eight-hour natural light cycle. By spraying the floor with clean borehole water, a relative humidity of 80-85 percent was maintained in the dark room. The floors could not be flooded. To avoid introducing contaminants, the room was kept closed and a footbath with chlorinated water was placed at the doorway. The temperature in the mushroom house was kept between 24 and 25°C (Musara *et al.,* 2018).

**Fruiting**

Fruit body produced under humid conditions (85-90 %) is bigger with less dry matter while those developed at 65 – 70 % relative humidity are small with high dry matter (Table 1).

**Table 1: Environmental setup for different stages**

| Parameters | Spawn phase | Pinhead | Fruiting body |
|---|---|---|---|
| **Temperature (°C)** | 24–25 | 10–15 | 15–21 |
| **Relative humidity (%)** | 90–95 | 95–100 | 85–90 |
| **CO2 (ppm)** | 5000–20,000 | 500-1000 | ≤2000 |
| **Light (lux day−1) - 500-1000** | - | 500-1000 | 500-1000 |

**Harvesting**

The best shape for picking can be determined by the shape and size of the fruit body. Before releasing the spores, the fruit bodies should be harvested by twisting so that the stubs do not remain on the beds (straw). Harvesting can be done manually or mechanically. Mechanically with a knife and manually with clean hands by gently twisting in clockwise and anticlockwise directions. After harvesting the mushrooms, place them in a clean tray and begin post-harvest handling techniques.

**Medicinal worth of Oyster Mushroom**

Oyster mushrooms are white rot fungi with exceptional health benefits. They could be low in calories while being high in protein, nutrients, and minerals. Oyster mushrooms have been used as a medicinal drug in Asian continental regions since ancient times. Currently, some research studies have suggested that mushrooms play a role in a variety of health issues such as hypercholesterolemia, high blood pressure, diabetes, most cancers, infections, and so on.

**Antioxidant Property**

Antioxidants are substances that aid in the reduction of oxidative stress caused by reactive oxygen species within tissues or cells (ROS). Rare oxides, peroxides, and hydroxyl radicals comprise ROS. These, in general, oxidise it. As a result, antioxidants are present to react with these ROS, either by destroying them or rendering them ineffective by converting them to another residue, preventing any harm to the cell or tissue. A variety of degenerative diseases, including cancer and hepatotoxicity, have been linked to oxidative stress. As a result, the presence of antioxidants in Pleurotus sp. can be a powerful method for treating or preventing such situations.

**Vitamins**

Mushrooms are rich in vitamins and considered best sources of vitamins, for example vitamin B (Mattila *et al.,* 2001; Ghosh *et al.,* 2019). Mushrooms have been reported to have a low level of vitamin C, and mushrooms found in the wild have a higher level of vitamin D2 than dark cultivated *A. bisporus* (Sapers, 1999).

**Immunoinflammatory**

Because of its immune-modulatory properties and low cytotoxicity, oyster mushroom has the potential to be useful in the treatment of cancer patients receiving radiation and conventional chemotherapy, as it increases immune resistance while decreasing toxicity (El-Enshasy and Hatti-Kaul, 2013). *P. ostreatus* contains a large number of immunemodulatory components, including lectins, polysaccharides, polysaccharide-peptide complexes, and polysaccharide-protein complexes (Wang and TB, 2000). Deepalakshmi and Mirunalini (2014) reported that water extract from *P. ostreatus* fruit bodies and mycelia increases neutrophil production of reactive oxygen species (ROS) and has immune-modulatory properties involving all immune competent cells.

**Anti microbial potential**

Organic extracts of *P. ostreatus* in methanol and chloroform were found to be effective against Grampositive bacteria and were considered potential sources of antibacterial agents (Karaman *et al.,* 2010). Mirunalini *et al.* (2012) investigated the antibacterial potential of *P. ostreatus* and biosynthesized silver nanoparticles (AgNPs) against several Gram positive bacteria by measuring the diameters of the inhibition zones.

**Social aspects**

**Waste management**

According to Law *et al.* (2012), SMC of *Pleurotus pulmonarius* can reduce around 89 percent of 100mg Pentachlorophenol (PCP). Bioabsorption is another aspect of mycoremediation. *Pleurotus ostreatus* can absorb cadmium from its environment, according to Tay *et al.* (2011). *Pleurotus sajor-caju* has been found to absorb zinc.

**Economy**

Every year, India generates approximately 600 million tonnes of agricultural waste, the vast majority of which is left to decompose naturally or is burned in place. This can be used to produce highly nutritious foods like mushrooms, and the spent mushroom substrate can be converted into organic manure/vermicompost (Chitra *et al.,* 2018). India could produce 3 million tonnes of mushrooms and approximately 15 million tonnes of compost with a 1% conversion of agro-waste to mushroom production. Large size units were the most viable for oyster mushroom production based on the output: input ratio because the output to total cost ratio was the highest (Verma *et al.,* 2014).

## Conclusion

Mushroom cultivation provides both economic opportunities and nutritional and health benefits. According to this global survey, various wastes have been shown to be beneficial for oyster mushroom growth. As a result, each oyster mushroom grower can select the best substrate for their particular species or genera. The substrates could be used to make a valuable protein-rich food. Oyster mushroom cultivation on various agricultural residues provides economic opportunities for agribusiness to examine these residues as valuable resources and use them to produce protein-rich mushroom products.Oyster mushrooms have a prominent place in nutraceutical science because they are high in nutrients and have medicinal properties, particularly as antioxidants, antimicrobials, anti-inflammation, anticancer, immunomodulators, anti-diabetes, antineoplasics, and antihypertensives. According to the above properties, oyster mushrooms can be used to produce antibiotics, anticancer drugs, and immune boosters. Finally, mushroom cultivation can make a significant contribution to sustainable livelihoods for both rural and urban poor people because it is highly compatible with other livelihood activities and requires few physical and financial resources.

## Conflict of interest

The authors declare that they have no conflict of interest.

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