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Oyster mushroom-A viable indigenous food source for rural masses

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■ **Abstract :** Oyster mushroom cultivation is an economically viable process for conversion of various ligno-cellulosic wastes into valuable food. It can be artificially cultivated on various agro-residues, *viz.*, cotton stalks, wheat and rice straw etc. The yield of mushroom varies with the substrate used and it may be around 500 g/kg of raw material.Mushrooms are highly nutritious, environment friendly crops and have numerous benefits. They are a very good source of protein, vitamins and minerals. But the cultivation and adoption of oyster mushroom in India is very limited compare to other crop. This may be due to lack of awareness and appreciation as a food source, monotonous traditional diets and the conservative eating habit of people. The present workaimed to study onvarious oyster mushroom cultivation techniques, their storage and processing methods and substrates used in the production of Pleurotus spp., for oyster mushroom cultivation. Experiments were conducted at GTC, ICAR-CIRCOT, Nagpur for cultivation of oyster mushroom (*Pleurotus florida* and *Pleurotus ostreatus*) using cotton stalks. The results showed 300 g of fresh oyster mushroom could harvest from one kg of dry cotton stalks. The cropping period for cultivation of oyster mushroom in cotton stalks was thirty days.The implication of this study is to facilitate technology adoption of oyster mushroom cultivation using cotton stalks and thereby identify the feasibility of mushroom cultivation in the study area for the betterment of the life of the local community.

■ **Key words :** Oyster mushroom, Rural masses, Spawn quality

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Mushroom are the fleshy sporophores of fungi known to grow in nature on decaying cellulosic materials, dead wood, soil and manure pits. Majority of these fungi belong to the class Baidiomyctoina and a few to the class Ascomycotina. Edible fungi are classified under the order Agaricales and the families Agaricaceae, Polyporaceae and Pluteaeceae have been under commercial cultivation. The edible mushrooms are delicacy in food and form one of the choicest table dishes. They are rich in protein and an excellent source of vitamins and minerals. Most of the mushroom have very low starch content and can form an ideal food for diabetic patients. There are four major edible mushroom are cultivated on a commercial scale. They are, *Agaricus bisporus* (white button mushroom), *Volvariella* spp. (tropical mushroom or paddy straw mushroom), *Lentinus edodes* (Japanese mushroom) and *Pleurotus* spp (Oyster mushroom).The *Pleurotus* genus gathers several species,

such as *P. ostreatus*, *P. pulmonaris*, *P. sajorcaju*, *P. cornucopiae* and *P. ostreatoroseus*. *Pleurotus* is spread all around the world in its natural habitat, mainly in forest environments (Bononi *et al*., 1999). These fungi are also provided with enzymes that degrade lignin present in vegetables.

Pleurotus genus is one of most extensively studied white-rot fungi due to its exceptional ligninolytic properties. The major factors influencing the oyster mushroom cultivation are spawn quality, substrateused, temperature, relative humidity and ventilation. Oyster mushroom fresh fruiting body indicates a high quantity of moisture (90.8%). Mushrooms are an excellent source of minerals and protein and also known as the vegetarian's meat (Khan *et al.*, 1981). The amino acids essential for human body are also present in oyster mushroom (Hayes and Haddad, 1976). For successful growing of oyster mushroom, the substrate has to be processed, *i.e.* cut to about 3-4 cm size and pasteurized at around 80^0 C to ward off the competing moulds.The purpose of this reviewis to understand the use of different agro-residues available in India for oyster mushroom cultivation, employment generation among the rural masses and popularize the oyster mushroom as an essential supplement food for protein and mineral source.

Oyster mushroom status – Global and India :

Oyster mushrooms are the third largest cultivated mushroom. Globally, China is the leading producer of mushrooms.The other countries producing oyster mushrooms include Korea, Japan, Italy, Taiwan, Thailand and Philippines. The present production of oyster mushroom in India is around 1500 tonnes. Punjab is the leading mushroom growing state In India.

With the growing awareness for nutritive and quality food by growing health conscious population, the demand for food including mushrooms is quickly rising. In India, due to varied agro-climate and abundance of farm waste, different types of temperate, tropical and sub-tropical mushrooms can be cultivated throughout the country. In India, about 600 million tonnes of agricultural waste produced, which has potential to be recycled as substrate for mushroom cultivation leading to nutritious food. Therefore there is a great scope for mushroom cultivation in India because of cheap, largely and easily available raw materials needed for this activity. Despite such versatile benefits, in India, the mushroom cultivation technology lacks in adoption. The reason being, there is lack of appreciation about the food and dietary importance of mushrooms, the monotonous traditional diets and the conservative eating habit of people are the main constrains in mushroom cultivation in India. There for promoting technology transfer concerning to mushroom cultivation is urgently required intervention option.

With this rational, ICAR-CIRCOT initiated to investigate the suitability of cotton stalks in this case on production potential (growth performance and yield) of oyster mushroom. The implication of this study is to facilitate technology adoption of oyster mushroom cultivation using cotton stalks and thereby identify the feasibility of mushroom cultivation in the study area for the betterment of the life of the local community.

Factors influencing oyster mushroom cultivation :

For handling Pleurotus species, mushroom requires a fundamental understanding of their physical, chemical, biological and enzymatic properties. Several factors affect the fruiting body formation, yield and duration of oyster mushroom production includes composition of culture media, substrates, Particle size, pH, Moisture, carbon to nitrogen Ratio (C/N), Levels of spawning, spawns quality, light, temperature, humidity, and conditions followed.

Effect of substrates:

Salami *et al.* (2017) carried out a study to determine the proximate and mineral content of mushroom (*Pleurotus florida*) cultivated on the four lignocellulosic substrates (sawdust, corn cobs, oil palm spadix and corn straw) in order to assess its nutritional value, yield and biological efficiency. The result showed that *Pleurotus florida* contained 26.28-29.91% protein, 86.90-89.60% moisture, 0.48-0.91% fat, 19.64-22.82% fibre, 31.37-38.17% carbohydrate and 5.18-6.39% ash. The mineral contents ranged from 342-410 mg/100 g Calcium, 1009-1133 mg/100 g Phosphorus, 17-21 mg/100 g Iron, 277-359 mg/100 g Sodium and 2088-2281 mg/100 g Potassium. Also, the highest yield and biological efficiency were obtained on corn cobs substrate (110 g, 55%), followed by Oil palm spadix substrate (76.05 g, 38%) and least on corn straw substrate (63.12 g, 31.56%). In another study, Mane *et al*. (2007) grew *P. sajor-caju* in several agro-industrial residues: cotton processing

residue, wheat straw, soy straw, pea stalk and peanut stalk. The best result was obtained when using cotton residues, pea stalk and wheat straw as substrates. Bonatti *et al*. (2003) conducted a study where *P. sajor-caju* and *P. ostreatus* were grown in banana tree straw, supplemented with rice bran (5%). Moisture, fat, carbohydrate, ash, protein and raw fibre analyses were performed. There were not found any significant differences in the nutritional facts of both the species. However, *P. sajor caju* presented higher biological efficiency (7.51%) than *P. ostreatus* (6.34%). Ahmed (1998) reported spawn running of *P. ostreatus* to be completed within 17-20 days on different substrate. 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).

The results indicated that different substrate formulas gave a significant difference in total colonization period, characteristics of fruiting bodies, yield, biological efficiency (BE), nutritional composition and mineral contents of two oyster mushrooms. 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. According to Khanna and Garcha (1981), it may take up-to 104 days to harvest yield from oyster mushroom grown on paddy straw. In this regard, other studies came-up with varying results of cropping periods. Khan *et al*. (1981) reported a cropping period between 21 and 28 days using cotton seed, while Tan (1981) reported the harvesting time to be within a month using cotton waste. These variations in cropping periods may emanate from the variations in the growing environment (*controlled versus semi-controlled conditions*) and physiological requirements for mushroom cultivation, for instance, the constant temperature, humidity and light arrangements.

Effect of species :

Pleurotus spp. can be successfully cultivated at temperature of around 30^0C. Studies shows that the two species of oyster mushroom *Pleurotus ostreatus* and *Pleurotus cystidiosus* can be grow better in summer and autumn season in subtropical and tropical regions (Moonmoon *et al.,* 2010). *Pleurotus eryngii* is a popular mushroom due to its excellent consistency of cap and stem, culinary qualities and longer shelf life. In a study, 3 strains of *P. eryngii* such as Pe-1 (native to Bangladesh), Pe-2 (germplasm collected from China) and Pe-3 (germplasm collected from Japan) were cultivated on saw dust and rice straw and their growth and yield parameters were investigated. Pe-1 on saw dust showed the highest biological yield and efficiency (73.5%) than other strains. Also, the mycelium run rate and number of fruiting bodies were higher in Pe-1 than other two strains. The quality of mushroom strains was near about similar. On saw dust, the yield and efficiency were better than those cultivated on rice straw, however, on straw; the mushroom fruiting bodies were larger in size.

Effect of spawn quality :

The successful mushroom cultivation depends on the purity and quality of spawn. Spawn is an essential component of mushroom production and it has a big effect on the sporophores production. Production of quality spawn in minimum days and availability for planting beds of mushroom is a big challenge for mushroom growers. Singh *et al.* (2017) conducted a study with the aim to find out the most favourable sugar for the improvement of spawn quality and production in minimum days and its effect on yield and growth of Oyster mushroom (*Pleurotus djamor*). In his study five different sugars *viz.*, Dextrose, Maltose, Starch, Sucrose and Glucose were mixed as a supplement with wheat grain for spawn production and effects of its spawn on the yield of sporophores and growth of *Pleurotus djamor* were also observed. The results showed that, the maximum mycelial growth (98.00 mm) was found in glucose on 20^{th} days while in case of sporophores production maximum yield (613.33g/kg of dry substrate with 61.33% B.E.) and minimum days for first harvesting (23.00 days) were observed in glucose spawn. Based on the results obtained, for production of *Pleurotus djamor* spawn and sporophores yield, glucose would be recommended most effective sugar for spawn and sporophores production use as supplement in wheat grain.

Nutritional properties of oyster mushroom :

Mushroom can not only convert lignocellulosic waste material into human food, but also can produce notable nutraceutical products, which have many health benefits. It is suitable for people with hyper-tension, obesity and diabetes due to its low sodium: potassium

ratio, starch and fat. They are highly nutritious and can be compared with egg, milk and meat. They provide people with an additional vegetable of high quality and enrich the diet with high quality protein, minerals, vitamins which can be of direct benefit to the human health and fitness. It has most of the mineral salts required by the human body. The content of essential amino acids in mushroom is high and close to the need of the human body. Mushroom is also easily digestible and it has no cholesterol content (Oei, 2003). Alkaline ash and high fibre content makes them suitable for consumption for those having hyperacidity and constipation. The chemical composition of the fresh fruiting bodies of oyster mushroom, the spent straw can be re-cycled after growing oyster mushroom. It can be used as cattle feed and also for bio-gas production, the slurry can be used as manure.

Rural entrepreneurship in oyster mushroom cultivation :

Low cost artificial substrate mushroom production and marketing hold some potential to create wealth and reduce poverty among small-scale farmers and improve nutritional status of households' members. Mushroom cultivation can be a labour intensive agro-industrial activity, thus can help generate income and employment, particularly for women and youth in developing countries. Mushrooms are relatively fast growing organisms, thus, mushroom cultivation as a short return agricultural business can be of immediate benefit to the community. Mushroom cultivation requires relatively little space; they can be stacked using shelf-like culture system. It is therefore, hoped that the mushroom farming will become a very important cottage industry in integrated rural development programs. This will lead to the economic betterment of not only small-holder farmers but also of landless labours and other weak sections of communities (Alam and Raja 2001; Sher 2006; Shah *et al.*, 2004; Flores, 2006). The mushroom cultivation technology is very simple technique and requires low investment and can be easily adopted by Women Self Help Group for rural entrepreneurship.

Marketing of mushroom :

Harvested mushroom need to be handled carefully and it should be kept at a place where provision of air circulation, for example in a basket. The mushroom should be protected from sunlight and high temperature. The price of mushroom depends on the quality of mushroom like fresh, healthy and clean mushroom will get better price. Harvested mushroom should be taken to the market without delay to maintain their quality and freshness or they should be stored in a refrigerator or processed.

Processing and storage of oyster mushroom:

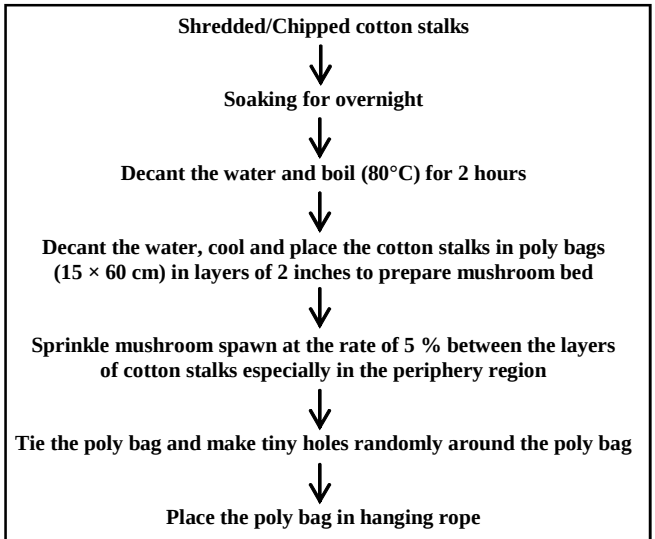
The oyster mushroom is highly perishable commodity and its shelf life is very poor. Normally, the shelf life of oyster mushroom is three days. Spoilage during storage can be caused by bacteria and fungi within the mushrooms. Hence, they are either marketed soon after harvesting or preserved with special care such as stored under controlled environment. The processing is necessary for better shelf life of the mushroom.They should be cooled to storage temperature of 0-2^{0}C within the five hours of harvesting. Under short term storage, mushroom is kept at 8-10^{0}C in packed container wrapped in plastic film.There are many ways to preserve mushroom for longer duration like Drying, pickling and canning. Drying is done to inactivate the microorganisms by removing enough water. Canning is also a common method to preserved mushroom. Canning involves cleaning, blanching, canning, sterilization, cooling, labelling and packaging. Mushroom should be placed in sealed and sterilized cans with 2.5% sodium chloride and 0.24-0.5% citric acid. Mushrooms can also be successfully picked and produce quite favourable products. In this process, the mushrooms are sorted and washed. They can be sliced if desired. Then they are blanched with 3% salt water for three to four minutes in boiling water. After the water drained off, they are placed immediately in cold water to cool. They are then transferred to a jar or bottle, and brine (22% salt) is added with a little vinegar,sugar and other spices such as vitamin C or citric acid to give the mushrooms some fresher color. The jars are thenloosely closed and steamed for one hour. The lids are tightened when cooled and the contents chilled before eating (Mushroom Growers' Handbook 1).

ICAR-CIRCOT technology on oyster mushroom cultivation in cotton stalks :

At Ginning Training Centre, ICAR-CIRCOT, Nagpur, oyster mushroom (*Pleurotus florida* and *Pleurotus ostreatus*) was cultivated on heat treated

cotton stalks of 3-4 cm length. The mushroom was cultivated by hanging bag technique at the mushroom cultivation facility at GTC, Nagpur. The protocol for cultivation of oyster mushroom has been given as flowchart. The experiments were conducted for oyster mushroom cultivation in cotton stalks at GTC, Nagpur during June to September of the year 2016 and 2017. The results showed 300 g of fresh oyster mushroom could harvest from one kg of dry cotton stalks. The cropping period for cultivation of oyster mushroom in cotton stalks was thirty days. Generally, two harvesting takes place per crop. Efforts were taken to diffuse this technology among the farmers of Vidarbha region of Maharashtra. About five hundred farmers including women farmers were given awareness and hands-on-training on oyster mushroom cultivation using cotton stalks.

The average cost of production of one kg of fresh oyster mushroom is Rs. 50/- in which the major cost involved is spawn cost (Rs. 30/-). Two hundred g of spawn was used for the production of one kg of fresh mushroom. The yield of mushroom is mainly depends on the quality of the spawn used. The selling price of fresh oyster mushroom in the market ranges from Rs. 80 to 150/-. The selling price depends on marketing place, quality and other parameters. Thus, a farmer can earn a minimum of Rs. 30/- per kg of oyster mushroom produced. On an average, a famer can generate a minimum additional income of Rs. 6,000/- per acre by cultivation of oyster mushroom in cotton stalks generated from an acre of land. The initial investment required here is thatched house of 20 × 20 feet dimension which costs to Rs. 20,000/-. The payback period is two years within which the initial investment could be recovered (Mageshwaran *et al.*, 2017).



Note: Temperature and Relative humidity required for oyster mushroom cultivation is: 25 – 30° C and 55 – 80 %, respectively. Initially, for first twenty days, the mushroom bed was kept in dark room while for next ten days, poly bag was removed ventilation was given.

Fig. 1 : Flow chart: Protocol for cultivation of oyster mushroom in cotton stalks

Conclusion :

Mushroom cultivation technology is economically viable for conversion of various ligno-cellulosic agro-wastes into food source. This technology is very easy to adopt, requires low investment and can generate employment among the rural masses leading to improve social as well as economic life of rural people.

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