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Oyster Mushroom Cultivation at Sikkim

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SUMMARY

Oyster mushroom cultivation has become more common than any other mushroom cultivation in recent years at Sikkim. It is the most extensively cultivated mushroom due to its easy cultivation technique, low production costs, and adaptability, as well as its high market value. Oyster mushroom can be cultivated by cold and hot method; however, hot method is slightly better than cold method of cultivation. This emerging sector has not only boosted the economy but also provided sustainable livelihood opportunities for especially to the rural youths and farm women and generates an extra income for the farmers.

INTRODUCTION

Sikkim, nestled in the picturesque Himalayan region of India, has been making significant strides in agricultural innovation. The state's unique topography and favourable climatic (tropical to alpine), it has served as a habitat for a large number of mushroom species. Since the dawn of time, Sikkim's indigenous community has been gathering mushrooms from the surrounding forest as food with the onset of monsoon. Numerous wild edible and medicinal mushrooms have been identified and are being sold and consumed by local people.

Climatic Advantages

Sikkim's climate offers an ideal environment for mushroom cultivation. The state experiences a temperate climate with mild summers and cool winters, providing the necessary conditions for successful mushroom production. The average temperature range of 10-25 degrees Celsius throughout the year, coupled with the region's high humidity levels, creates an optimal microclimate for mushroom growth. It has a longer growing season, particularly in Sikkim, where it can be grown for ten months or nearly the entire year. These conditions are particularly favourable for mushroom varieties such as oyster mushrooms, button mushrooms, and shiitake mushrooms.

Production of oyster mushrooms:

Indoor Cultivation: Sikkim's mushroom cultivation primarily takes place indoors, utilizing controlled environments to ensure consistent production. Farmers often employ methods such as mushroom houses, polyhouses, etc to regulate temperature, humidity, and light exposure. These controlled environments help create the necessary conditions for year-round mushroom growth.

Substrate Preparation

Mostly used substrates are organic materials like lingo-cellulosic farm waste on which growth of mycelium takes place to produce mushrooms. Mushroom cultivation in Sikkim relies on locally available organic substrates like paddy straw and maize stalks. These agricultural byproducts serve as the base material for growing mushrooms and are carefully processed through sterilization or pasteurization techniques to eliminate competing organisms. The treated substrate provides the required nutrition for mushroom mycelium growth. Substrate preparation is known to be the most critical stage in the production process to make sure the occurrence of diseases is less with better yield (Jongman *et al.,* 2010). So as to eliminate potential competitors such as *Trichoderma spp.* of *Pleurotus spp*., substrate like grasses, sugarcane bagasse is pasteurized beforehand. Pasteurization can be done by using steam or by using hot water treatment (±70°C) to the substrate for few hours. Soaking the substrates in water treated with

benomyl (0.06g/L) tends to suppress the risk of *Trichoderma spp.* Including commercial production and small-scale production of oyster mushroom, treatments mentioned above can be applied and affordable.

Spawning of Substrate

Spawn, which is used as a seed in propagation for mushroom production is defined as a substrate in which mycelium is impregnated and developed (Woo-Sik Jo *et al.* 2009). Once the substrate is prepared, mushroom spawn is introduced into it. The spawn contains mycelium, the vegetative part of the mushroom fungus. The spawn colonizes the substrate, forming a network of fine white threads called mycelium. The substrate bags are then placed in a controlled environment where the mycelium grows and eventually develops mushroom fruiting bodies. Spawn can be prepared from different carriers of grains such as wheat, sorghum, barley and rice. It is reported that as compare to grains of wheat and barley, grains of sorghum are better mycelium carrier. The yield and biological efficiency can be increased by adoption of the spawn while the spawn running time get reduced.

Incubation and Fruiting

During the incubation period, temperature is optimized to 20-25^0 C in order to get best results and kept in the incubation room without disturbance for 15-25 days also depends on size and conditions of the bags (Saurab Dulal, 2019). At the time of fruiting, the Relative Humidity should be maintained at 70-85% by spraying or sprinkling water to the gunny bags or on the sand spread on the floor. At least 8-12 hours of sunlight is required at the time of fruiting.

Harvesting and Yield

The mushrooms can be harvested by gently twisting the fruiting body before water spray. After first harvesting the bags are kept in growing chamber so that other mycelium can grow and produce more fruiting bodies which can then be again harvested. The harvested mushrooms are then packed in perforated polythene bags for marketing. In a period of one and a half months to two months, from 1 ton of paddy straw around 500-700 kg of fresh mushroom can be harvested.

Post-Harvest Handling

The timing of harvest greatly affects the yield and quality of oyster mushrooms. This section explores the indicators for determining the optimum harvest stage and discusses post-harvest handling practices to maximize shelf life and maintain product quality. It also touches upon value-added products and processing techniques for mushroom utilization

Methods of Mushroom cultivation

Cold water-treatment method of cultivation of Mushroom

Cold water lime pasteurization is a cheap and effective low-tech way to prepare substrates for growing mushrooms. The process is simple. Basically, the straws are soaked for 12-24 hours in a bath of cold water that has been treated with lime @100g/kg and gypsum @ 20g/kg .

These steps are as followed:

- The drums were filled with water mix the lime thoroughly with the water as the ratio mentioned above.
- Submerse the paddy straws (substrate) gradually into the lime water.
- Incubate the treatment for 18-24 hrs.
- After incubation, drain the water and transfer the substrate to a flat surface and allow it to dry.
- It should be noted that the substrate should not be totally dried, a little moisture (60-65%) should be maintained in such a condition that water should not drip when the handful of substrates is squeezed.

Submerse the paddy straws (substrate) gradually into the lime water.

Drying of substrate

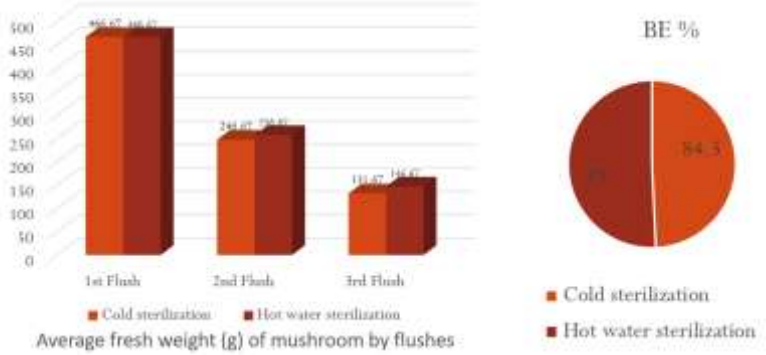
Hot water- treatment method of cultivation of Mushroom

Hot water treatment is a technique used in mushroom cultivation to eliminate or reduce contamination from certain pathogens and competitors that may be present in the substrate.

These steps are followed:

- Pre-soak the substrate for overnight (12-18 hrs)
- Drain the water and put pour hot water or boil the substrate. The temperature should be maintained at 70-80 ℃ for 30-45 mins.
- After the treatment, drain the water and transfer the substrate to a flat surface and allow it to dry.
- It should be noted that the substrate should not be totally dried, a little moisture (60-65%) should be maintained in such a condition that water should not drip when the handful of substrates is squeezed.

Comparison of the two methods



Oyster Mushroom was cultivated duing Februaty to November 2020-2023 at College of Horticulture, Bermiok, Sikkim. With the equation of (Biological efficiency (BE) $=\frac{Yield\ of\ fresh\ mushrooms,\ g}{Total\ weight\ of\ dry\ substrate\ used}$ /X 100), the biological efficiency of the mushroom-based on the cold and hot treatment were estimated. The hot water treatment showed a slight increase in biological efficiency as compared to the cold method which is shown in the graph given above.

Diseases and pest

Green Mould: On occasion, during the spawning season, mushroom beds are seen entirely or in patches clothed in green velvety growth. The fungus *Trichoderma harzianum* impairs mycelial flow, resulting in a drastic decrease in yield. This contamination is the result of improper sterilization of the substrate or contaminated spawn. In Sikkim, it is more problematic during the warmer period.

Management:

• Spray garlic extract prior to spawning;
• Examine the spawn packet for fungal contamination prior to spawning;
• Discard contaminated spawn and remove contaminated beds from the mushroom house.
• Scoop out the green mould patches at the initial stage and spray the area with garlic extract

Ink cap: ***Coprinus sp.,*** often known as the ink cp fungus, is a type of weed mushroom. Due to heavy spore deposition from the fungus, the afflicted bed transforms from black to a deep blue colour. The contamination with this weed is caused by either too much moisture in the straw or straw that has decomposed.

Management:

• Use straw that has been adequately dried and of high quality when preparing beds;
• Avoid using straw that has decomposed or been exposed to rain;
• Take off any ink caps that you find on beds as soon as possible.

Browning: *Pseudomonas sp.* bacteria cause the fruit bodies' and stalks' edges to become yellow to light brown. The accumulation of water on the fruit bodies as a result of watering the beds encourages bacterial growth.

Management:

• Avoid direct watering on the mushrooms
• Shake the beds gently after watering to avoid water droplets deposit on the mushrooms.

Pests:

Sciarid fly, Phorid fly, Staphylinid beetles, Scaphisoma beetles, pleasant beetles

• Adult fly lay eggs on the gills but do not cause damage
• The maggots emerging from eggs feed on soft tissue of fruit bodies
• Adult of the beetles feed on the fruit bodies and also on the mycelium during mycelia run
• The grubs make irregular holes in the gills and stipes where they hide. Infestation of grubs is intense during June-Aug.

Management:

• Remove mature fruit bodies as soon as possible to prevent adults from depositing eggs;
• Bleaching powder repels beetles; apply it in the mushroom house and its surroundings;
• Spray neem-based insecticides three times at a concentration of 3 ml per litre of water. First spray - prior to spawning on the boiled straw; second - after opening of the beds; and third - spray after the first harvest.
• To prevent the entry of flies and beetles, nylon net should be fixed on the ventilations and windows of the mushroom house.
• Smoke the mushroom house daily or every other day to eliminate insect pests.

Economic and Environmental Benefits

The mushroom cultivation practices in Sikkim have generated multiple benefits for the state:

Increased Income: Mushroom cultivation provides farmers with a reliable source of income throughout the year. The quick cultivation cycle, coupled with the high market demand for mushrooms, ensures a continuous revenue stream. Furthermore, mushrooms have a high market value, making them a profitable crop for farmers.

Employment Opportunities: Mushroom cultivation has created numerous employment opportunities, especially for women and rural communities. From substrate preparation to harvesting and packaging, various stages of mushroom cultivation require labour. This has improved livelihoods and contributed to the state's socio-economic development.

Sustainable Agriculture: Mushroom cultivation promotes sustainable agricultural practices. It utilizes agricultural waste and byproducts as substrates, reducing the environmental impact of waste disposal. Additionally, mushrooms are highly nutritious and serve as an alternative protein source, contributing to food security in the region.

Government Initiatives and Support

Recognizing the potential of mushroom cultivation, the government of Sikkim has taken proactive measures to support farmers in this sector. The state's horticulture and agriculture departments provide training, financial assistance, and technical guidance to farmers interested in mushroom cultivation. These initiatives aim to enhance productivity, quality, and market accessibility, further strengthening the mushroom industry.

Market Potential

The demand for mushrooms in Sikkim is growing steadily, driven by increasing awareness of their nutritional value and culinary versatility. Locally grown mushrooms have a competitive edge due to their

freshness and quality. Besides meeting the domestic demand, Sikkim's mushroom cultivators have the potential to tap into national and international markets, presenting an opportunity for export and economic growth.

CONCLUSION

Mushroom cultivation has emerged as a thriving agricultural sector in Sikkim. The favourable climate, suitable growing techniques, and government support have created a conducive environment for farmers to engage in this industry. The cultivation of mushrooms not only ensures year-round income but also offers sustainable agricultural practices, employment opportunities, and economic growth. The two methods of cultivation, i.e, hot method and cold methods may be adopted by the farmers, however hot method proves to be slightly better then cold method of cultivation. With continued support and innovation, Sikkim's mushroom industry is poised to make significant contributions to the state's agricultural landscape and overall development.

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