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Mushroom Cultivation: A Sustainable Solution for Nutritional Security and Rural Livelihood

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Abstract

Fungi, like mushrooms, are prized for both their nutritional content and flavour. They have a high natural vitamin D content and are minimal in sugar and sodium. Growing numbers of novice business owners are becoming interested in mushroom growing. On well-prepared compost, they are grown via specially propagated spawns. Because they are delicate by nature, they should be processed quickly if they aren't frozen or preserved. As a result, they go through a number of processing techniques, including freezing, drying, pickling, and canning. In addition to preserving them, these techniques, like pickling, aid in the development of flavour.

1. Introduction-

Agricultural production system has seen a paradigm shift from targeted food security to the nutritional security. Adoption of improved agriculture technologies has been the major factor in achieving the food security. The struggle for achieving nutritional security and sustainability in agricultural production system is still going on. Development and adoption of sustainable agricultural systems which in addition to providing the livelihood security to the agrarians, also able to sustain agro-ecosystem and is climate resilient is critically important in present days scenario. With decreasing arable lands and effects of climate change, secondary agriculture holds a promising place to fill the voids of nutritional food security. It contains more than90% water and less than 1% fat, loaded with Vitamin B,copper and selenium and low in sodium(1).

Mushrooms are one of the most loved foods not only for its exotic taste but also for the benefits with which it comes. It can be consumed in various forms like fresh, pickled, dried, powdered, canned etc. Its farming has picked up a fast pace among contemporary entrepreneurs owing to its nutritional and medicinal benefits and low-cost input with high output. Mushrooms are a fleshy fungus (Basidiomycota, Agaricomycetes) having a stem, cap and gills underneath the cap. They can be edible,

wild and some of them can be toxic too. It contains more than 90% water and less than 1% fat, loaded with Vitamin B, copper and selenium and low in sodium. Usually vegetables, milk and other food products are fortified with Vitamin D by irradiation or direct addition but mushrooms are unique in this sense because they are naturally a rich source of Vitamin D which otherwise is procured from animals or poultry. The reason being that it contains copious amount of plant sterol "Ergosterol". It is a precursor of Vitamin D which when stimulated by sunlight or artificial lightening source converts to Vitamin D. In most cases, vitamin D is added to milk, vegetables, and other food items through irradiation or direct addition; nevertheless, mushrooms are special in this regard since they naturally contain a high concentration of the vitamin, which is typically obtained from animals or fowl(2).

At present, the total mushroom production in India is approximately 0.18 million tons. From 2010-2019, the mushroom industry in India has registered an average growth rate of 4.3% per annum. Out of the total mushroom produced, White button mushroom share is 73% followed by Oyster mushroom (16%), Paddy straw mushroom (7%) and Milky mushrooms (3%). Indian mushroom industry revenue generation for the year 2016-17 was Rs 7282.26 lacs by exporting 1054 quintals of white button mushroom in canned form. It has been estimated that even if 1% of the agro-waste is converted into mushroom production, India can produce about 30 lakh tons of mushroom. Protein conversion efficiency and productivity of mushrooms per unit area and time is far superior to any other plant and animal sources. Haryana is the leader in production of button mushroom which produces this mushroom seasonally in maximum quantity by a large number of seasonal growers. Oyster mushroom production is rapidly expanding throughout the country by different states and by the small farmers or landless migrant laborers.

2. Types of Edible Mushrooms In India-

Some of the major varieties consumed in India are as follows:

2.1. Button Mushroom- Button mushroom (Agaricus bisporus) belongs to Class Basidiomycetes and Family Agaricaceae and is native to Europe and North America. It is of two types white and brown, out of which white button mushrooms commonly grown in India. According to ICAR - Directorate of Mushroom Research, this variety contributes more than 85% to mushroom production. It is the most relished variety used in eateries and households.

2.2. Oyster Mushroom- Oyster Mushrooms (Pleurotus ostreatus) belongs to Pleurotus species. It is known as "Dhingri" in India and has fan or oyster shaped cap. They grow easily on decaying wood or straw.

2.3. Paddy Straw Mushroom- Volvariella volvacea belongs to division Basidiomycota. It is usually grown on Rice straw bed and is used extensively in Asian Cuisines.

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3. Cultivation of Mushrooms-

The basic requirements for mushroom cultivation are manure/compost, spawns, right temperature and humidity. Favorable growing conditions involve 80%- 90% of relative humidity, ample ventilation, a temperature range of 20-28^0 C during spawn run and 12-18^0 C for reproductive growth. Initially for a week temperature must be maintained at 23 ± 20 C and then it can be reduced to 16 ± 2^0 C for subsequent weeks. The CO_2 concentration should be 0.08-0.15 %. If the above stated conditions are maintained appropriately the pin heads start to appear within few days and progressively mature into button stage. Apart from these insecticides, nutritional supplements like nitrogen, vermiculite, water are also required for a healthy harvest. The following steps are to be followed for mushroom cultivation:

Compost Preparation- The compost (synthetic or natural) used for mushroom growth usually comprises of wheat straws, horse manure, poultry manure, rice bran, gypsum etc. Utmost care is taken to protect the raw compost against rain or external moisture, as it might introduce undesirable microbes. The chopped wheat straws or rice bran are mixed with horse dung, sprinkled with water and are heaped in a pile to allow fermentation. The fermentation process along with heat development breaks down the chemical compounds in small components. Frequent turnings and watering is done at a specific interval so as to avoid the drying up of compost. Gypsum is sometimes added to the compost to reduce greasiness and allow more aeration. Within 15 to 20 days the compost gets all set to be used as bed, it is then spread onto wooden trays and sowed with spawns.

Spawning- Spawns refers to the mycelium carefully propagated on agars or grains. Spawning is a process of sowing or mixing spawns in compost. Although mushroom produces spores which acts as a seed for further propagation but are not used generally due to uncertain germination and growth. The spawns are thoroughly mixed with the compost, are covered with newspaper and is watered sufficiently to maintain the moisture. Throughout the cultivation period humidity is kept high to avoid loss of moisture. Gradually they grow into white cottony mycelium growth.

Casing- Casing is a kind of sterilized soil or dressing containing cow manure which is spread onto the spawn mixed compost. It is applied when the mycelium growth commences on the compost surface. After 15 to 20 days of its application mushroom head or pins start becoming visible on the surface. They are allowed to mature for a specific time period and are harvested before opening of the cap. Mushrooms with opened cap (looks like an umbrella after opening of cap) are undesirable and are considered of menial quality.

Harvesting- Harvesting is done by plucking them from soil using hands or the heads are chopped off using knife. The harvested mushrooms are then subjected to primary processing.

4. Processing of mushrooms after harvesting-

Mushroom is very fragile and has a short shelf life, unless consumed fresh. At ambient

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temperature they lose their freshness within a day and deteriorate rapidly if not processed or refrigerated. They also tend to brown due to presence of compound Tyrosinase. It converts monophenols to diphenols which in turn are oxidized to quinones resulting in the formation of insoluble brown pigment called Melanin. Initial processing involves washing mushrooms to remove adhering soil or compost and blanching them for few minutes to inactivate the enzymes. In order to prevent discoloration, they are treated with brine, salt or citric acid prior to canning or packaging.

As the fresh mushrooms have more than 90% moisture content, they have very short shelf life. The high-water content of mushrooms also becomes conducive for multiplication of various microbes which cause rot of the harvested fresh mushrooms. Metabolic activities continue even after harvest and fruit bodies get wither due to the loss of water content. Therefore, harvested mushrooms cannot be kept fresh for longer periods. However, it can be stored for certain time period by adopting some preservation procedures. The methods of preservation developed for mushrooms can be grouped in to two types, they are:

1. Short term preservation (can be stored for maximum period of 10-15 days)

i. Room temperature: Keeping in room temperature of around 30-33° C, the mushrooms remain fresh for 8-12 hours only whereas it is possible for 24-36 hours during winter at lower temperatures.

ii. Refrigeration: Fresh mushrooms can be stored for 7-15 days in a refrigerator depending on the type of package and storage temperature.

iii. Brine solution preservation: In a solution of common salt (in water) in high concentration (10-15%), fresh mushrooms can be kept safe for 6-7 days.

iv. Other methods: Lactic acid fermentation and gamma irradiation. These are tedious, costly and sometimes risky also.

2. Long term preservation

i) Sun drying: Fresh mushrooms after sorting and selection (trim off the hard stalk portions), are thinly spread on a sieve and sun dried for 3-5 days. To avoid browning of the fruit bodies, a shade may be provided to the mushrooms by spreading a black cloth at about 1 foot above the sieve. This type of dry mushrooms can be kept in air tight containers up to 5-6 months.

ii) Machine drying: In machine drying method, fresh mushrooms are dried in electrically operated drier within 6-8 hours. It is a costly method.

iii) Blanching: Sorted out mushrooms are steeped in warm water of 80-85° C for 1-2 min. only and then sun dried. Sometimes sodium chloride @ 400 ppm and citric acid @ 0.1- 0.2% may be added to the water before boiling to retain or improve the natural colour.

iv) Other methods: Freeze drying, canning, pickling etc. Fresh mushrooms can also be processed and value added products like various mushroom culinary, soup powder etc. can be prepared.

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Mushrooms can also be canned to meet the demand in the off season.

5. Management of Spent Mushroom

Substrate Once the mushroom crop is harvested, the mushroom beds become exhausted and the substrates are considered 'spent' or 'used mushroom substrate'. If not handled properly, the 'spent mushroom substrate' creates various environmental problems including ground water contamination and nuisance by being the safe home for pathogens. The diversified uses of 'spent mushroom substrate' in managing agriculture, environment and recycling energy have come to light recently.

1. The used mushroom beds can be broken into pieces and applied in vegetable or flower garden as organic manure.
2. Spent mushroom substrate is a better substrate for vermicompost. Usually 100 kg of spent mushroom substrates yield 50 kg vermi-compost. The nutrients contents of the vermicompost prepared from spent mushroom substrates are Nitrogen (1.85%), Phosphorus (0.90%) and Potash (1.12%).
3. The spent oyster mushroom substrates serve as good livestock feed especially for goats, cattle and pig because the oyster mushrooms have the capability of reducing the organic carbon and increasing the nitrogen content of plant residues. Cattle prefer these when the spent bed is broken in to pieces, boiled with other feed and salt.

6. Conclusion

In this context of increasing population, decreasing arable land and issues related to nutritional security, mushroom cultivation is gaining popularity worldwide. In addition to provide economic benefits, it can help combating the protein deficiency, thus providing nutritional security. With the cultivation technology available for a number of mushroom species which can be cultivated under wide range of agro-ecological situations, it is now possible to undertake mushroom cultivation throughout the year. Mushroom production is a profitable venture, which does not require any significant capital investment or arable land and can be grown on agricultural waste substrate. As a livelihood diversification option, mushroom cultivation has enormous potential to improve food security and income generation being fast yielding and nutritious food with great medicinal value. Spawn production and mushroom cultivation can be taken up with low inputs, on a part time basis, requires little maintenance and is a viable and attractive activity for rural women, unemployed youth and other farmers. Small, medium or large size entrepreneurships of spawn and mushroom production can be undertaken in rural or semiurban areas of North East India which can provide a gainful employment to the rural youths, farm women and rural farmers. In future, for making this enterprise more economic and beneficial; establishment of spawn production units in public and private sector and their monitoring to provide the quality spawn, involvement of cooperative and other marketing organizations for providing inputs and suitable marketing system, availability of technical guidance

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and financial support to the small scale and export oriented mushroom industries will be required.

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