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Mushrooms as nutritive, Bio-transformer, ultimate Bio-degraders of agro-industrial wastes and a profitable industry

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***Abstract*— Mushroom are eukaryotic, spore bearing ,macrofungi, saprophytic with umbrella like fruiting body ,Both edible as well as poisonous species are well known. Edible fungi like Agaricus compestris, Agaricus bisporus and Pleurotus ostreatus are commercially cultivated all over the world .In India the main centres are at H.P(Solan),Punjab, Haryana and U.P.For mushroom cultivation technical training is a must ,which is freely given at research centres now-a-days. Cultivation requires spawns or seeds which are taken from commercial centres or from labs. in pure culture forms . These are then added to the pre- prepared compost mixture. Temperature as well as moisture plays a very important role as high temperature favors mycelial growth whereas the low temperature favors fruiting bodies (basidiocarp) formation. Mushrooms mainly consist of vitamin C,D, B6, B12 apart from minerals like calcium, iron, potassium, selenium. It is low in carbohydrates and fats with lots of medicinal properties. The bio-active constituents of mushroom show many pharmacological effects. It has antitumours, ,antiviral ,antifungal, antibacterial properties and also show hypocholesterolic and hypoglycemic effects. Mushrooms are good agents of biotransformers and biodegraders since it is seen that they can degrade wastes like straws of crops, stalks , leaves , jute, cotton and sugarcane trash due to their lignin as well as cellulose degrading activity. These are sustainable , technically feasible, environment friendly as well as commercially viable also compared to bacterial and others biodegraders. Protein rich straw left after the mushroom production is fed to cattle and the dung is used for biogas production and vermicomposting. So such integrated system is needed for profitable , sustainable and environment recycling of agro-industrial waste. Cultivation of mushroom is boon for farmers and can be a profitable industry as it provides maximum gains with minimum efforts..**

***Index Terms*—Enter key words or phrases in alphabetical order, separated by commas. For a list of suggested keywords, send a blank e-mail to keywords@ieee.org or visit** http://www.ieee.org/organizations/pubs/ani_prod/keywrd98.txt

I. INTRODUCTION

Mushrooms are macrofungi, with fleshy, subfleshy, leathery or soft, umbrella like fruiting body or sporocarp which bear the fertile spores. There are many types of mushrooms, it could be edible (wild as well as cultivated ones) like those of field mushroom (Agaricus campestris), horse mushroom (Agaricus arvense), parasol mushroom (Lepiota procea), shaggy parasol (Lepiota rhacodes) , sticky bun (Boletus badius) ,shaggy mushroom (Agaricus augustus), oyster mushroom(Pleurotus ostreatus), Boletus, Morchella esculenta, etc whereas many of them are poisonous also eg. Fly agaric (Amanita muscaria), Amanita rubescens and Amanita excels, death cap (Amanita phalloides). Apart from these there are many mushrooms. toadstools, bracket fungi belonging to subdivision basidiomycotina and ascomycotina.

Agaricus (Psalliota) is the most common type of saprophytic mushroom and most of the other mushrooms also grow on dead decaying leaves, wood logs and similar surroundings, mainly in rainy season some are reported growing wildly from snowy mountains to sandy desserts on all types of soils, pastures ,forest land or litters, cropped or fellow land . Of these A.compestris , A.bisporus (European mushroom) , A.brunnescens (cultivated mushroom) and P.ostreatus (oyster mushroom) are common edible mushrooms which are commercially , as they are in demand for their nutritional value.

CULTIVATION

Although mushroom cultivation started as early as 17 th century by French horticulturists , but actual thriving industry came up in Paris in 1850. Till mid of 20th century it was gamble growing mushroom as most of time it failed to produce the sporocarps. This was mainly due lack of sterile conditions to produce the spawns (seeds) or requirement for growth, nutrition and reproduction.

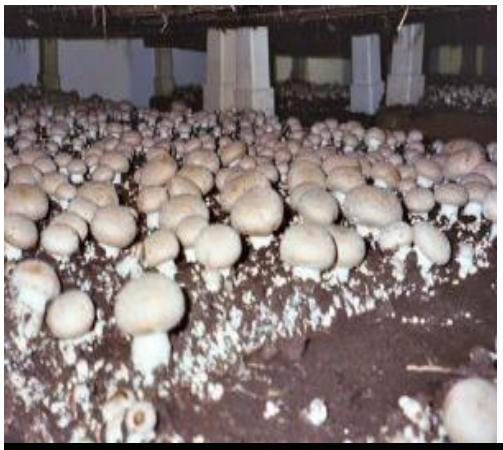
In India, initially it was cultivated on large scale in Solan (HP) agricultural university. But now main mushroom cultivation and research centers are at Punjab university, Ludhiana, CS Azad University, Kanpur and National university, Lucknow. In Haryana, Ch. Charan singh university, Hissar, Mushroom cultivation and research center at Murthal and Sonipat are the main centers. Haryana is second in mushroom cultivation.

For cultivation following steps should be carefully followed with slight variation depending upon the type of mushroom:-

- Production of spawn (starter culture): seeds or spawn should be obtained free from any contamination from commercial centers or laboratories.
- Composting: horse dung, cow dung or manure are mixed with straws of wheat/rice/oat or sugarcane thrash and bagasse, jute and cotton stalk/leaves. Manure to wheat straw are mixed in a ratio 3/1 in case of A. bisporus. Heap of mixture is soaked in water and given

Starter culture

Composite mixture in beds



Young as well as fully mature basidiocarps (fruiting bodies) of *Agaricus compestris*.

3 to 4 turns at weekly intervals. To this, small amount of gypsum is added in 2 or 3 turnings. Time of composting may vary as per the cereal/straw used .

- Growing of fruiting bodies (sporocarps): for the fruiting bodies to come up, controlled temperature, aeration and humidity is required.
- The composite mixtures filled in beds or wooden trees. These are then left for pasteurization by slowly increasing the temperature upto 54 to 60o C and maintained for 24 to 48 hours or higher temperature for less time. This mixture is then ready for introduction to spawn (which is obtained from pure culture). After this the trays are kept at temperature of 23o C at 80 to 90% humidity for about 3 weeks. Cottony mycelial growth will start. Then the surface of the mixture is covered by thin layer of casing soil or vermiculite mixture at 13 to14o C and 80 to 90% humidity. Since high temperature favors mycelia growth whereas low temperature favors fruiting body formation.
- Therefore , because of low temperature, fruiting bodies or basidiocarps begin to appear in 3 weeks time. This will continue then for 5 to 6 weeks. Although in case of A.

bisporus, it can be grown at any time under the above mentioned conditions, but it best grown from October to February.

II. NUTRITIVE VALUE

Mushrooms show surprisingly high nutritive value. It consists of Ascorbic acid (vit C), Vit. D, Pyridoxin (B_6), Cobalamins(B_{12}), Riboflavin(B_2), Niacin(B_3), Pantothenic acid(B_5)(Manjunathan and Kaviyarasan, 2011) and minerals like calcium, iron, potassium, selenium and small amount of sodium, manganese and copper. These are also important source of biologically active compounds with potential additional medicinal value (Cheung 2010). Though, traditionally mushroom was used in China and Japan for medicinal purposes, but now it is common all over the world. Mushroom is considered as rich food because it contains protein, sugar, glycogen, lipids, vitamins, triterpenes etc. *Termitomyces globules* is rich in protein, calcium phosphorus and iron(Jonathan Gbolagade *et .al* 2006*), Pleurotus tuberregium* shows high content of proteins and low in fat(Kuforiji *et. al* 2003), *Volvariella esculenta* is rich source of Cu whereas *Termitomyces microcorpus* is rich in potassium(Fusich. I 1996, Ogundana and Fagade 1982 respectively). The importance of mushroom is as follows:-

- Since they are low in carbohydrates and fats with no starch, therefore these are helpful in lowering bad cholesterol and diabetes. It is good for patients with hypertension and diabetes.
- Low sodium in mushroom also helps to lower cholesterol. In place of cholesterol they posses ergasterol (Chadha and Sharma 1996)
- It is considered as low calorie food hence good for obese.
- Calcium provides free radical protection, which helps the body to absorb iron and assist formation of bones and clotting of blood.
- Bioactive secondary metabolites found in mushroom are phenolic compounds, sterols and triterepenes. These show many pharmacological effects such as antitumor, antioxidants, antiviral, hypocholestrolemic, hypoglycemic effects. These also have antifungal and antiglycemic effects.(Cheug,2010)

III. BIOTRANSFORMATION AND BIO-DEGRADERS OF AGRO-INDUSTRIAL WASTE

Biotransformation or bioconversion means which can convert organic waste into digestable food or energy. Mushrooms are good biological agents which can do this job. Initially it was thought that waste of crops like straws of cereals, stalks and leaves of cotton, jute, sugarcane trash and bagasse, coir waste and other industrial waste of these types require microbial degradation. Although some of these wastes are burned in fields and others are left at the sites of decomposition, causing environmental pollution. Number of systems are available for degradation of these wastes but none of them have reached at the commercial point. As any of such system should be technically feasible, sustainable, environmental friendly as well as commercially viable. For such mushroom cultivation meets almost all the requirements. Most agricultural residues are rich in lignin, cellulosic compounds whose handling and disposal are often problematic due to their chemical structure and their decomposition properties. Some mushrooms have unique oxidative system which together with ligninolytic enzymes is responsible for ligninocellulosic degradation e.g in *Phanerochaete chrysosporium* (Mehdi Dashtban *et .al* 2009). These possess unique and extensive array of degrading activity which can degrade from grasses and straw to timber while other organisms are more potent to cellulolytic activity. Some of the different substrates and there degrading mushrooms are:

- Oyster mushroom grows on unfermented cereals and straws.

Pleurotus spp. Grow very well on the agrowastes and their residues.(Ranathan R. *et .al* ,1996)

- Button mushroom on composted straw.
- Shiitake and black ear mushroom on sawdust and wood log also helps in biodegradation of Oak (*Quercus alba*) wood (Christopher 2003.)

Agropeat (composted coir dust) is used as manure for horticulture crops as well as casein for button mushroom.

In India *A. bisporus* and *Pleurotus spp* .are popular and their production, if integrated with dairy will represent a unique system of ultimate utilization of agro wastes i.e. protein rich straw left after oyster mushroom production is fed to cattle and the dung is used for biogas production. Similarly spent compost left after button mushroom production can be utilized for biogas production and vermicomposting. Such integrated system with mushroom is needed for profitable, sustainable and environment recycling of agro industrial waste.

IV. A PROFITABLE INDUSTRY

Mushroom cultivation has become a profitable business with the product fetching good returns in the market because of their high demand for edible mushrooms particularly oyster mushroom owing to their nutritional benefits. They are in demand both in national and international markets especially from hotel industries.

Oyster business is most exciting as it yields high income, low investment and high profit. It is also a profitable hobby, with

minimal capital investment and requires very less space to work. Sometimes small space as less as a shed, garden or even roof is sufficient enough to cultivate mushroom as small scale industry. Natural calamities such as snow, wind, loo, storm, high temperature etc. have no effect on mushroom cultivation. this is a easy business venture that virtually anyone can start without experience although cultivation of mushroom is not difficult but it requires little bit of technical skill for which basic training should be taken from expert horticultural departments or research centers. Most of the centers give free training to landless farmers, unemployed youth, and housewives etc. who are interested in setting up their own small scale industry. They could also be benefited by seminars, field trainings, door to door visits etc. for compost making, casing, spawn making etc. They are guided for disease and contamination. Last but not the least cultivation of mushroom is boon for all and can be a profitable industry as it provides maximum gains with minimum efforts.

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