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The Biology and Method of Cultivation of (*Agaricus*) mushroom

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Abstract

Mushroom are the macro-fungus belongs to Basidiomycotina order Agaricales all species are saprophytic, heterotrophic and achlorophyllous. The most extensively grown mushroom species worldwide is *Agaricus bisporus. A. bisporus* pure spawn is used to inoculate beds of semi-pasteurized composted organic substrate to begin the cultivation process. After that, the *A.bisporus* mycelium colonizes the composted substrate by breaking down the organic matter and releasing nutrients. To encourage the growth of the mushroom crop and preserve the compost environment, a layer of peat, also referred to as "casing soil," is spread on top of the composted substrate. Although the biochemistry and genetics of *A. bisporus* have been extensively studied during the cultivation process, little is now understood about the broader microbial ecology that co-inhabits the casing layers and composted substrate.

Keywords- *Agaricus bisporus*; Biochemistry; Casing; Compost;Saprophytic

Introduction

Agaricus is an edible fungus and is commonly known as" button mushroom" and "dhingri" in Punjab. It is a saprophytic fungus found growing on soil humus, decaying litter on forest floors, in the field .and lawns, wood logs and manure piles. It grows best in moist and shady places and is commonly seen during rainy season. About 17 species of *Agaricus* have been reported from India. *A.campestris , A.bisporus* are common edible mushrooms. Some species of *Agaricus* are poisonous (*A.xanthodermis*) and some species may cause gastrointestinal disturbances like *A.placomyces* and *A.silvaticus. Agaricus* belongs to order Agaricales, commonly called gill fungi contains 270 genera and around 4000 species. These include the mushrooms, toadstools and the boletes. The edible species were called mushrooms and the poisonous ones, toadstools. *Agaricus* is a well- known genus of the family Agaricaceae with about 200 species which are globalized.

Morphology- The family Agaricaceae is characterized by the blackish or brown color of the basidiospores and the presence of pallid or pink colored gills on the pileus. An annulus is typically present on the stipe. The characteristic feature of the genus are the presence of deep purplish-brown free gills, and an annulus but no volva, and stalk that redily separates from the pileus. *A.campestris* is the common or field mushroom and *A.brunnescens* is the cultivated mushroom and grown commercially in many countries. All the species of

Agaricus are edible except a few such as *A.placomyces* and *A.silvaticus* are poisonous which may cause gastrointestinal disturbances in some individuals.It can be studied in two parts: vegetative mycelium and Fruiting body or basidiocarp. Vegetative mycelium is of three types-

Primary mycelium- It originate by the germination of uninucleate basidiocarp carrying either '+' or '-' strain. The cells are uninucleate i.e. monokaryotic. It is short lived and become binucleate by the fusion of two compatible hyphae.

Secondary mycelium- It originates from primary mycelium. After fusion of the hyphae of two opposite strains, the nucleus from one hypha migrates to the other and later forms binucleate secondary mycelium i.e. dikaryotic.

Tertiary mycelium- The secondary mycelium grows extensively under the soil and become organized into special tissue to form the fruiting body or basidiocarp. It is made up of dikaryotic hyphae. These hyphae are called tertiary mycelium. The hyphae are septate and branched. The cells communicate with one another by means of a central pore in the septum. It is a typical dolipore septum.

Agaricus bisporus

Life-cycle

Asexual reproduction- Chlamydospores are produced and on germination, it gives rise to hyphae. It is also known that oidia have a sexual function in diploidization and can arise under specific conditions.

Sexual reproduction- It is mainly somatogamous or pseudogamous. The sex organs are completely absent and the somatic hyphae have taken over their role which are heterothallic. However, a few species of *Agaricus*, like *A.campestris* and *A.bisporus*, are homothallic.

Plasmogamy- The vegetative hyphae with uninucleate haploid cells from mycelia of opposite strain (heterothallic) or from same mycelium (homothallic) come into contact and fuse. Each of this fusion results into a binucleate (dikaryotic) cell and by successive division, give rise to dikaryotic mycelium which produces characteristic fruiting body of the mushroom.

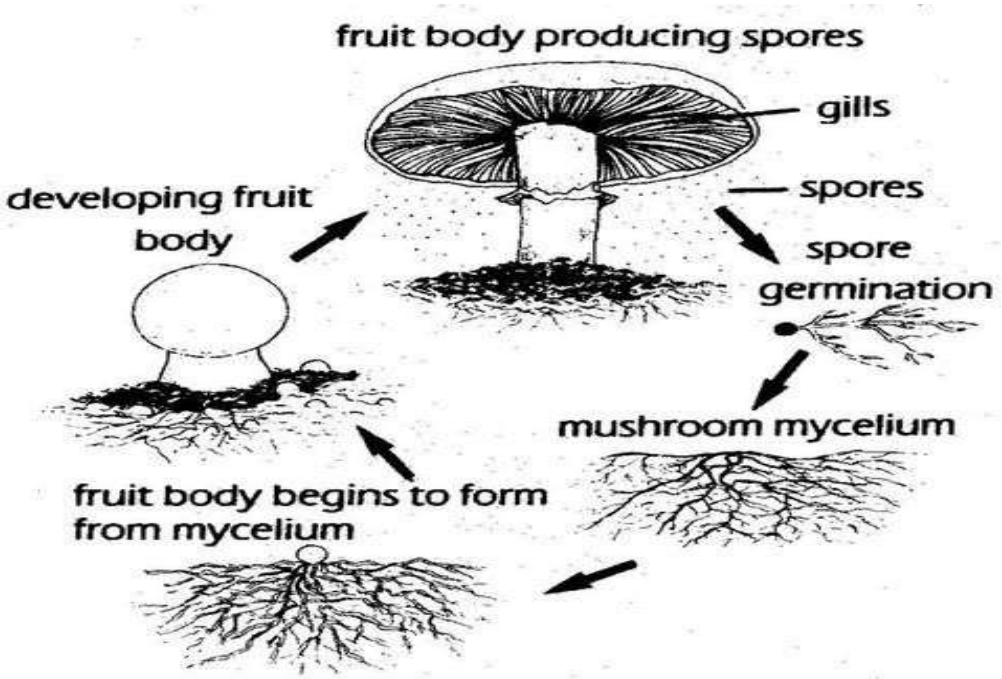
Karyogamy- This step is considerably delayed and takes place in young basidium. In this method, there is a fusion of the two nuclei of dikaryon takes place.

Meiosis- It takes place in basidium prior to the basidiospore formation. The basidiospores formed after meiosis, are haploid.

Development of the Basidiospore- The development of the basidiocarp takes place from mycelial strand known as rhizomorph. After absorbing sufficient food material mycelium produces fruiting bodies, these tiny pinhead structures are the primordia of the basisiocarp. These primordia enlarge into round or ovoid structure represents the 'button stage' of the basidiocarp. Button stage shows that it can be differentiated into a bulbous

basal portion representing the stalk region and an upper hemispherical part which at maturity forms the cap or pileus region. Atkins (1906) described the development of basidiocarp as hemiangiocarpic i.e., the hymenium or gills is at first enclosed but becomes exposed at maturity.

Life cycle of *Agaricus*



Anatomy of basidiocarp- The mature fruiting body can be differentiated into three parts i.e., stipe, pileus and annulus.

Stipe- It is the basal part of the basidiocarp and made up of two kinds of tissue i.e., compactly arranged hyphae known as cortex and loosely arranged hyphae in the central region known as medulla.

Pileus- The mature pileus is 5-12.5 cm in diameter. From the underside of the pileus hang approx. 300-600 strips or plates of tissue known as gills. These gills shows the following three distinct structures-

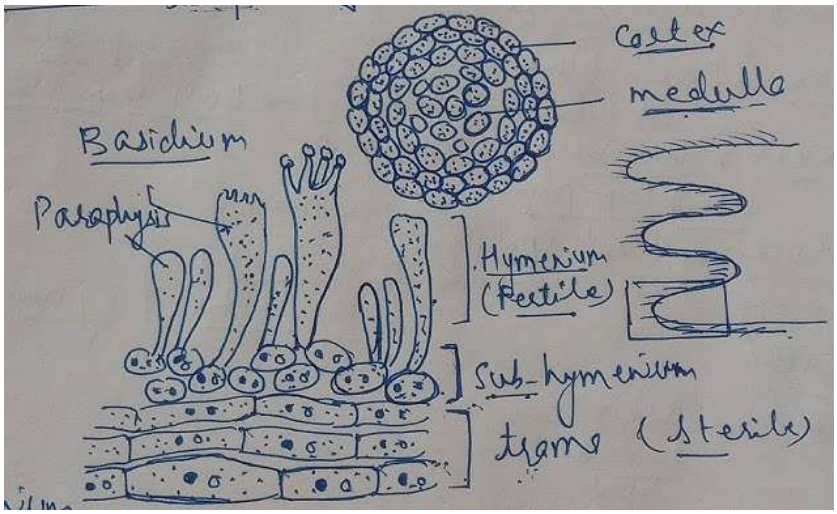
Trama- It is the middle part of the gill. This region is made up of loosely arranged mass of plectenchymatous tissue of long, slender hyphae.

Sub-hymenium- In the trama area, the hyphae curl outward toward each gill surface. The subhymenium is a tight layer made up of tiny diametric cells at the end.

Hymenium- It is the outermost layer and some of it's branches develop a palisade like layer consisting of basidia (fertile) and the paraphyses (sterile). Some of the sterile cells become enlarged and project beyond the basidial layer called as cystidia.

Development of basidium- The basidia are spore producing bodies. As it grows, the two nuclei of the dikaryon fuse to form the synkaryon. The diploid nucleus soon undergoes meiosis to form four haploid nuclei. Simultaneously, four narrow tube-like structures develop at the top of the basidium known as sterigmata. It swell at their tips and form a small, single basidiospore by budding. Thus, four haploid basidiospores are formed in a basidium. Out of the four basidiospores, two are of '+' strain and two are of '-' strain. In *A. bisporus* two basidiospores are produced.

Discharge and dispersal of basidiospores- The mature basidiospores are discharged by "Water drop mechanis" or "water bubble method". A drop of liquid increase in size and attain a size of about one-fifth of the spore known as "Buller's drop".



Internal structure of basidiocarp

Material and methods

Agroclimatic condition- Agaricus requires 25°C for vegetative growth and 16-18°C for reproductive growth. Besides that it requires relative humidity of 80-90% and enough ventilation during cropping. Seasonally, it is grown during the winter months in the north-west plains of India and for 6-9 months in a year on the hills. However, with the advent of modern cultivation technology it is now possible to cultivate this mushroom at any place in India.

Spawn production- Spawn is produced from fruiting culture/stocks of selected strains of mushrooms under sterile conditions.

Mushroom Spawn or Mushroom Seed

Compost preparation- The substrate on which button mushrooms grows is mainly prepared from a mixture of plant wastes (cereal, straw), salts (urea, gypsum), supplements (rice bran/wheat bran) and water. During the first phase of compost preparation, paddy straw is placed in layers and sufficient water is added to the stack along with fertilizers, wheat bran, molasses etc. Completely combined with straw, the mixture is formed into a stack that is nearly five feet high, five feet broad, and can be any length with the use of wooden boards. On the second day, the stack is rotated and watered once again. By adding gypsum and watering, the stack is turned a second time on the fourth day. The compost has its third and last turning on the twelfth day, when it turns dark brown and begins to smell strongly of ammonia. Pasteurization is the second stage. In order to kill unwanted microorganisms and competitors and turn ammonia into microbial protein, the compost made from the microbe-mediated fermentation process must be pasteurized. The entire procedure is conducted in a steam room that maintains an ambient temperature of 600 C for four hours. The final compost should have a granular texture, a pH of 7.5, and 70% moisture content. It should smell nice and unobtrusive, dark brown in color, and free of nematodes, insects, and ammonia. The substrate is cooled to 25°C when the procedure is finished.

Spawning- The process of mixing spawn with compost is called spawning. There are various methods of spawning- spot spawning, surface spawning and layer spawning.

Spawn running- After the spawning process is over the compost is filled in polythene bags. The fungal threads grow out from the spawn and take about two weeks (12-14 days) to colonize the entire compost. The temperature maintained in cropping room is 25°C. Higher temperature is detrimental for growth of the spawn and below this temperature would result in slower spawn run. The relative humidity should be around 90% and a higher than normal CO2 concentration would be beneficial.

Casing- The compost beds after complete spawn run should be covered with a layer of soil(casing) about 3-4cm thick to induce fruiting. The casing material should be high porosity, water holding capacity and pH range between 7-7.5. The casing soil before application should be either pasteurized at 65-68°C for 7-8 hours or treated with formaldehyde 2% and bavistin. The treatment needs to be done at least 10 days before the material is used fir casing. After casing is done the temperature of the room is again maintained at 25°C and relative humidity 85-90% for another 8-10 days.

Fruiting- Fruiting is induced by slowly lowering the temperature to 18°C along with moisture, humidity, proper ventilation and CO2 concentration. The fruit body initials which appear in the form of pinheads start growing and gradually develop into the button stage.

Harvesting and yield- Harvesting is done at button stage, the first crop appears about three weeks after casing. Mushrooms need to be harvested without disturbing the casing soil. Once the harvesting is over, the gaps in the beds should be filled with fresh sterilized casing material and then watered.

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