

**Topic: EDIBLE FUNGI**

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## EDIBLE FUNGI

Since ages Fungi were understudied and considered only harmful by causing serious diseases to plants humans and animals. However, studies and researches have proved that they have both bad and good facets. Despite having pathogenic nature and causing diseases of host plants and animals they are also fascinating and useful group of organisms with an incredible biotechnological potential for industrial exploitation.

**Microfungi and Macrofungi:** Usually microorganisms including fungi are microscopic herein, cannot be viewed without aid of microscope. Latin meaning of macrofungi is big fungi, they are distinguished from microfungi in having form structures called fruiting bodies or basidiocarp which can be visualized by naked eye. Well known macroscopic fungi are Mushrooms.

### **Mushrooms –facts:**

- Good example of Macrofungus as food is –Mushrooms. Various kinds of mushrooms are eaten passionately all over the world. They are delicious, nutritious and good sources of proteins for humans.
- They are found usually in Phylum Basidiomycota and class Agaricomycetes and few edible ones like Morels and Truffels are found in Phylum Ascomycota as well.
- Scientifically there is no difference between word **mushroom** and **toadstool**; but literally toadstool are considered to be poisonous mushrooms (*Amanita muscaria*, *Amanita phalloides*, *Boletus satanas*, *Entoloma lividium*, *Russula sp.* etc.). They are fatal and cause death if consumed, therefore popularly called “death caps” or destroying angels. There are about 2000 species of edible ones. Edible mushrooms include many fungal species that are either harvested wild or cultivated.
- They grow saprophytically or sometimes symbiotically upon living and dead plants to obtain organic matter as food.
- Most common edible ones are- Button mushrooms, Oyster, Boletes, Shiitakes, Wood ear, Velvet shank, Cremini, Portobello etc.
- Edible mushrooms include many fungal species that are either harvested wild or cultivated
- They may be epigeneous (above ground) or hypogenous (below ground).
- Some of important edible mushrooms grown in India are :
  - *Agaricus bisporus* ( White button mushroom)
  - *Volvariella volvacea* ( Paddy straw mushroom)
  - *Pleurotus streatus* (Oyster mushroom)
  - *Pleurotus Sajor-caju* (Dhinghi mushroom)
  - *Auricularia polytricha* (Jew’s ear mushroom)
  - *Pholiota nameko* ( Nameko mushroom)

### **Recent Scientific Classification of Mushrooms: (Hibbett et al., 2007)**

Kingdom:	Fungi
Sub-Kingdom:	Dikarya
Division:	Basidiomycota
Subdivisions:	(i) Agaricomycotina (ii) Pucciniomycotina (iii) Ustilaginomycotina

## Classification of Agaricomycotina

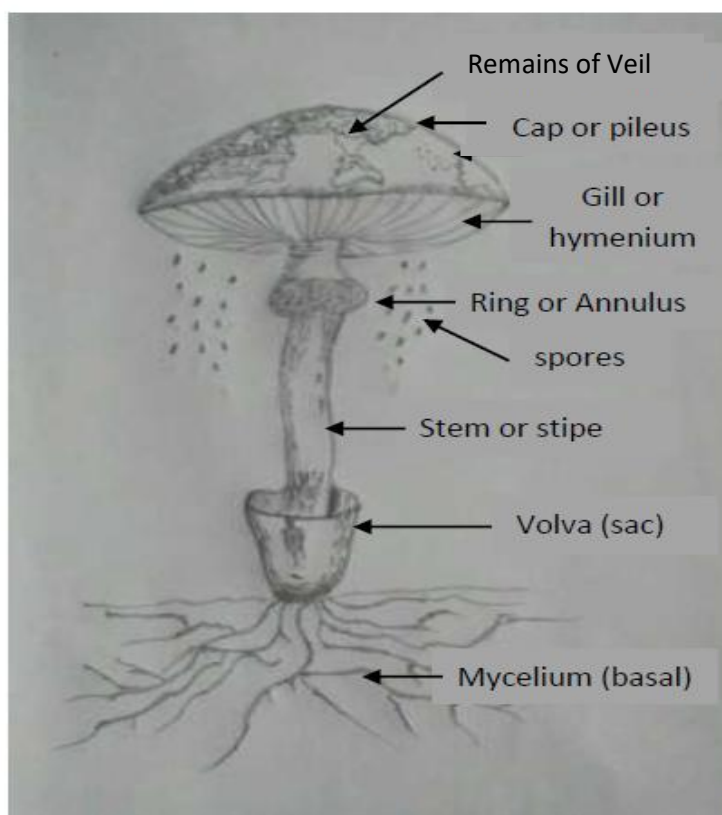
**Class:** Tremellomycetes

**Class:** Dacrymycetes

**Class:** Agaricomycetes

The subdivision Agaricomycotina is one of three taxa of fungal division Basidiomycota. It comprises of three classes: Agaricomycetes, Tremellomycetes and Dacrymycetes. It contains 20,000 species approximately and about 98% of these are in class Agaricomycetes, which comprises of diverse mushrooms types. Other classes like Tremellomycetes and Dacrymycetes and includes Jelly fungi, certain yeasts, Ear fungi etc.

### Macroscopic and microscopic features of Mushrooms:



**Fig. - Part of Mushroom**

Mushrooms come in many shapes, sizes and colors.

#### Macroscopic parts:

**Pileus and Stipe:** The most prominent top part is Pileus /cap borne on Stipe/stem. The caps may be steeply conical, hemispherical, slightly convex, flat with central hump or funnel shaped.

**Gills/Lamellae:** All mushrooms have blade like gills under their cap. These are plate like structures on the underside of pileus. Spore bearing basidia is found on the lamellae.

**Tubes:** Some Mushrooms like *Boletus* have sponge like tube layer with pores instead of gills.

**Veils:** Some mushrooms have membranes termed veils surround and protect the immature stage mushrooms. The membranes protecting immature gills are partial veils, whereas membranes covering entire immature mushrooms are referred as universal veils. Some mushroom feature an annulus, or ring, which is remnant of the partial veil as the mushroom developed. Base of some mushrooms may display remnants of universal veil termed volva.

### **Microscopic Parts:**

**Mycelium:** Their tissue is made up of extensive network of fine threads called hyphae. These anchor the mushroom to substrata and to connects for nutrient supply forms the vegetative part of the fungus.

**Spores:**They have variable features as color, shape, size surface structure/ornamentations and reactions to chemical tests. Spores are borne on short appendages called sterigmata that project out of club shaped basidium/basidia.Usually basidia has four spores but some contain only two spores.

### **Agaricus bisporus (White Button Mushroom)**

Kingdom : Fungi  
Division : Basidiomycota  
Class : Agaricomycetes  
Order : Agaricales  
Family : Agaricaceae  
Genus : Agaricus  
Species : *A.bisporus*

*A.bisporus* commonly known as Button mushroom /white mushroom/crimini/portabella.

**Etymology-** The specific epithet bisporous means having two spores on each basidia, whereas other *Agaricus* species (indeed the majority of the Basidiomycota) have four spored basidia.



Among 2000 known edible mushroom only a handful are commercially cultivated including button and oyster mushrooms having different species and strains. These edible mushrooms are indispensable and cherished food globally owing to their distinctive flavor, esteemed nutrients and therapeutic assets.*Agaricus bisporus* is one of commonly consumed and cultivated in many countries. Native to grasslands in North America and Europe.

**Description** – *A.bisporous* consists of vegetative mycelium (primary,secondary and tertiary) inside substrate and fruiting body (basidiocarp) above substrate which is fleshy and edible. Each basidiocarp is differentiated into :

**Stipe:** Stipe is basal part of pileus ( 2-7 cm. long). It has compactly arranged hyphae in peripheral region known as **cortex** and loosely arranged hyphe in central region called **medulla**.

**Pileus:**Stipe at top supports umbrella shaped /convex pileus.2.5->5 cm.White to brown in color

**Gills:** From underside of pileus hang about 300 to 600 stripes or plates of tissues known as gills or lamellae which are free from stem..The gills are whitish to pinkish in young condition and turn brown to purplish at maturity.

**Basidia with spores:**Basidia two spored,spores ovoid or sub globose, 6-8x5-6 µm long, smooth, thin walled, hyaline in KOH.

**Spore print:** Frequently dark brown.

*A.bisporous* is highly nutritious with generous level of potassium,phosphorus and calcium in addition to nine essential amino acids used in protein synthesis.studies have shown that it suppresses aromatase activity and biosynthesis of esterogen and can be used medicinally to reduce risk of breast cancer in women and numerous other nutritional values.

### **Pearl oyster mushroom (*Pleurotus ostreatus*)**

Kingdom : Fungi  
Division : Basidiomycota  
Class : Agaricomycetes  
Order : Agaricales  
Family : Pleurotaceae  
Genus : *Pleurotus*  
Species : *P.ostreatus*

*Pleoratus spp.* is the second most cultivated edible mushroom worldwide after *A.bisporus*.*Pleoratus* spp. about 70 identified ones among which few are commercially important edible mushrooms and cultivated viz.*P.sajor-caju*, *P.ostreatus*, *P.florida*, *P.eryngii* etc. are successfully cultivated species. Oyster has a short growth time.

*P. ostreatus* is actually wild genera grows on trees in shelf-like clusters. Though,it can be saprobic growing on dead logs. It can be cultivated too.It has a bitter sweet aroma of bezaldehyde(also almonds have this aroma).

**Morphological description:** Species identification within the genus *Pleurotus* is difficult because of the morphological similarities and possible environmental effects.

**Pileus :** of *P.ostreatus* has a broad,expanded biconvex,fan or oyster shaped cap.Ranges from whitish or slightly pale to brown,fading slowly and becomes two toned. Margin somewhat inrolled when young and often lobed and wavy. Flesh is firm.

**Stipe :** Usually absent. When present, it is small, rudimentary, thick and lateral Whitish, hairy, creamish, velvety and tough.



November fruiting of *Pleurotus ostreatus* growing on a log in a stream. Photo © Gary Emberger

**Gills:** Gills run down the stem (pseudostem); close; long-decurrent, crowded; whitish or with grey tinge.

**Chemical reactions:** KOH negative on cap surface.

**Microscopic features:** Spores 7–11 x 3–5  $\mu\text{m}$ , cylindrical smooth and hyaline with vacuoles. Basidia present but cystidia absent.

**Spore print:** whitish to yellowish, or lilac.

### **Cultivation of mushroom (Button and Oyster)**

Mushroom cultivation is biotechnological intervention. Method of cultivation of all mushroom is almost similar, but the ideal growing substrate differs. Button mushroom grows best in composted manure. Oyster grows best in straw or coffee grounds. Different substrates reflect the different nutritional needs of each species. Sawdust and different types of straws are common to almost all.

**Different steps of cultivation technology:** cultivation can be done in large scale and small scale (indoors). Whole process is divided into following steps (although steps are arbitrary).

- |                                 |                          |
|---------------------------------|--------------------------|
| (i) spawn production/purchasing | (ii) compost preparation |
| (iii) spawning                  | (iv) spawn running       |
| (v) casing                      | (vi) fruiting            |
| (vii) picking and packing       |                          |

### **Step 1: Obtaining spawn**

Own spawn can be produced by using sterile culture or can be purchased from reputed sources. Spawn consists of *A bisporus* or *P. ostreatus* or any other species mycelium which eventually produces mushrooms.

### **Step II: preparation of substrate; sterilizing and composting.**

Usually mushroom are primary decomposers ecologically but is a secondary decomposer when cultivated. So the substrate it is to be grown needs to be composted first and then purified of primary decomposers.

Substrates are ideally lignocellulosic and proteinaceous materials like straw and manures. Straw which is ideally used is bought and chopped to 2-3 inches pieces. The substrate on which mushroom grows is mainly prepared from mixtures of agricultural wastes (cereal straw/sugarcane bagasse etc.), salts (urea, gypsum etc.) supplements (rice bran wheat bran) and water. Compost should contain NPK.

The process completes in two phases-

**Phase I**, or microbial fermentation: the moistening of raw materials, mixture and subsequent degradation in controlled environments. The initial mixture becomes homogenous mass rich in nutrients (in large scale production method straw turns brown and emits strong smell of ammonia). Gypsum is also added. It provides calcium and sulfur, which mycelium needs for healthy growth. Gypsum also acts as pH buffer.

**Phase II** or pasteurization stage: the resulting compost from phase I is pasteurized for disinfection of compost to eliminate competitors/ microorganisms. It is heated in boiling water for half an hour then drained and cooled.

**Step III: Spawning and bagging.** Process of mixing Spawn with compost is spawning. Immediately after cool-down at end of phase II the compost is ready for spawning. Spawn is used to 'seed' mushroom compost. Sometimes fungicides are added with spawn to treat green mold infection. Chopped straw are packed into plastic bags (capacity 20-25 kg) and then spawn are tightly sprinkled on the top. This process is repeated till bag is filled fully. Top is closed and holes are poked in the bag. pH is maintained about 7.5.

**Step IV: Spawn running.**

The filled bags are kept in shelves  $23 \pm 2$  C. Higher temperature is detrimental for growth of the spawn and lower temperature below than that specified slower the spawn run. Relative humidity should be 90% and higher than normal CO<sub>2</sub> concentration is beneficial. The fungal bodies grow out of spawn and takes about two weeks to colonize.

**Step V: Casing.**

After complete spawn run the compost should be covered by layer of soil (casing) about 2-3 inches to induce fruiting. Casing encourages the fungus to switch from vegetative to reproductive mode of growth. Casing material preferred is peat moss or any material having high porosity. Casing material has to be pasteurized before application and also treated by formaldehyde (2%) bavistin 75 ppm. Here low CO<sub>2</sub> is favorable for reproductive growth.

**Step VI: Fruiting.**

Under all specified favorable environmental conditions, temperature- initially  $23 \pm 2$  for a week and then  $16 \pm 2$ , moisture 2-3 light sprays for moistening the casing layer, humidity above 85%, CO<sub>2</sub> concentration (0.08-0.15%) and proper ventilation, the fruit body initials start appearing in form of pinheads and gradually develop into mature mushroom of desired type. Mushroom fruits in flushes. These flushes occur three to five times before the crop is replaced with fresh ones.

**Step VII: Picking and packing.** After the last flush of mushroom they are picked. Freshly harvested mushrooms are refrigerated. To prolong the shelf life of mushrooms it is important that mushrooms breathe after harvest. So storage in a non-waxed paper bag is preferred to plastic bag.

With increasing population particularly in India with raised food demand problems mushroom can play an important role to enrich human diet where large sections of people are vegetarians. It can also be an ideal means of recycling agro wastes. The spent compost from mushroom farms is a good organic manure and better substrate for biogas production. It can give gainful employment for unemployed weaker sections of society.