PHILIPPINE EDIBLE MUSHROOMS

Stella Marie Mozar-Doyungan *

The Philippines is endowed with a climate favorable for the growth of fungi. Among these fungi that enjoy the warm, moist, humid condition of our country are the mushrooms.

Mushroom season in the Philippines coincides with the rainy season so generally, they start to come out with the first rain of May. Its peak usually is between the months of July-November (Quimio, 1981).

General Morphology of Mushrooms

The parts common to most mushrooms are the cap and the stem. The cap or the pileus is the apical fleshy part which on its lower surface bear gills in Agaricaceae, pores in Polyporaceae and teeth in Hydnaceae. The stem or stipe is present in many genera and is normally central, but it may be abbreviated or wholly absent, in which case it is said to be sessile or recupinate if attached by the back, and the attachment may be excentric (not centrally attached) or lateral. The shape of the cap is described as umbilicate when it has a central depression, infundibuliform when funnel-shaped and umbonate when it has a central elevation. The margin may be involute (rolled in) or revolute (rolled out) or repand (wavy).

*Assistant Professor C, Dept. of Biological Sciences, CSM, MSU-Iligan Institute of Technology, Iligan City, June 1986.

The spores, the microscopic bodies analogous to seeds are developed from the hymenium or spore-bearing tissue which covers the surface of the gills in Agaricaceae, covers the teeth in Hydnaceae and lines the pores in Polyporaceae.

The gills or lamellae are the thin, bladelike radiating structures borne on the lower surface of the cap. Their color is usually determined by the color of the spores. The method of attachment to the stem is various. They are described as adnate when attached squarely to the stem, adnexed when reaching the stem but not attached by the entire width, free when not reaching the stem, sinuate or emarginate when notched or curved at the junction with the stem and decurrent when extending down the stem. The gills are said to be attenuate when their ends are narrowed to a sharp point, acute when they terminate in a sharp angle, obtuse when the ends are rounded, arcuate when arched and ventricore when broadened at the middle.

In the early stages of development, the margin of the cap lies against the stipe. In certain genera, a thin veil is present, uniting the margin of the cap and the stem. This structure known as the veil, consists of fibers growing from the margin of the cap and outer layers of the stem.

The volva or universal veil is the term given to the membranous envelope which in some genera entirely encloses the cap and the stem. In certain species, it ruptures at maturity, leaving a cap-shaped base while often a portion adheres to the pileus in the form of warts and scales (Patterson, 1915).

Outline of Classification of the Philippine Edible Mushrooms (Bessey, 1961; Alexopulus, 1962; and Quimio, 1978)

Class Basidiomycetes
- Subclass Homobasidiomycetidae
  - Order Agaricales
    - Family Agaricaceae
      - *Agaricus bisporus*
      - *A. luzoniensis*
      - *A. perfuscus*
      - *Armillaria mellea*
      - *Psalliota campestris*
      - *P. campestris* var. *edulis*
      - *P. campestris* var. *umbuna*
      - *P. comtula*
      - *P. luzonienzis*
      - *P. perfuscus*
      - *Volvaria esculenta*
      - *V. pruinosa*

Family Boletaceae
Boletus aurantiacus
B. edulis
B. elegans
B. tomentosus
Strobilomyces strobilaceous
Family Cortinaceae
Coprinus comatus
C. confertus
C. plicatilis
Psathyrella disseminata
Family Lepiotaceae
Lepiota americana
Family Plutaceae
Volvariella volvaceae
Family Tricholomataceae
Clitocybe multiceps
Collybia acervata
C. distorta
C. radicata
C. reinneckeana
C. velutipes
Lentinus auracariae
L. elmerianus
L. exilis
L. praegrigidus
L. ramosii
L. sajor-caju
Oudemansiella
Pleurotus canus
P. cornucopiae
P. flabellatus
P. limpidus
P. ostreatus
P. opuntiae
P. porringens
P. pulmonaris
P. ulmaris
Schizophyllum commune
S. alneum
Teritomyces cartilagenous
T. clypeatus
T. eurhizus
T. microcarpus
T. striatus

Tricholoma matsuke
T. panacolum
Marasmius sp.
Order Aphylloporales
Family Polyporaceae
Polyporus sulphureus
Family Hydnaceae
Hydnum erinaceus
Family Clavariaceae
Clavaria crispa
C. stricta
Order Lycoperdales
Family Lycoperdaceae
Bovista pila
Calvatia lilacina
Lycoperdon pyriforme

Guide to Identification of Genera of the Philippine Edible Mushrooms (Bessey, 1961; Alexopulus, 1962; and Quimio, 1978)

Class Basidiomycetes

Subclass Homobasidiomycetidae

The members of this group have large basidiocarps. They have typically club-shaped, non-septate basidium (holobasidium) which bears their basidiospores at the tip of usually four sterigmata.

Order Agaricales

The hymenium is borne free on lamellae.
Basidiocarps are soft and putrescens.

Family Agaricaceae

Gills are found on the undersurface of the cap. They radiate from the stem which are usually central, but sometimes eccentric or lateral. Fleshy. Stipe and pileus cleanly separable.

Agaricus

Ring is present and volva is absent.
Gills are colored and free.

Armillaria

Ring is present and volva is absent.
Gills are adhering or nearly decurrent.

Psalliota

Stem is fibrous. Gills are free.
Ring is present.

Volvaria

Ring is absent but volva is present.
Gills free. Rosy or reddish spores.

Family Boletaceae

Hymenium is composed of pores. The layer of tubes is easily separable from the main portion of the pileus.

Boletus

The stratum of tubes is on the underside of the cap and is easily peeled off.

Strobilomyces

Cap is convex. The thick veil curls up slightly at the lower edge.

Family Cortinaceae

The hymenophore is not readily separable from pileus. Spores with apical germ pore. Black spore prints.

Coprinus

Ring is present, gills are free, broadly attached to the stem or a collar. Cap is cylindrical or egg-shaped.

Psathyrella

Cap is membranous, thin and grooved. Gills free or broadly attached to the stem.

Family Lepiotaceae

The stipe and pileus are readily separable, lamellae are free. Ring is present. Trama regular.

Lepiota

Gills are free or remote from the stem.

Family Plutaceae

Trama is convergent, lamellae are free.

Volvariella

The cap is dark brown, conical, to expanded with fine hairs over the cap surface. Gills are free. Ring is absent and volva is present.

Family Tricholomataceae

The stipe and pileus confluent, trama of various arrangement, the lamellae are rarely free. The stipe is eccentric to lateral to sessile.

Clitocybe

Cap fleshy, plane depressed or funnel-shaped, rolled inward at the margin. Gills decurrent, sometimes broadly attached to the stem. The stem is fibrous, elastic, spongy, stuffed, sometimes hollow, never cartilagenous. Ring is absent.

Collybia

Margin rolled inward in youth. The gills are soft, free, interlaced or with a sudden curve before reaching the stem. Ring and cap are absent.

Lentinus

Cap is fleshy, leathery, flexible or hard and persistent. The stem is soft to hard, central, excentric or lateral. Ring is present in some. Gills are durrent.

Oudemansiella

Cap is flat, expanded and becomes slightly curled aga the cap surface. White gills are senuate and serrate. Bo volva and ring are absent. White stripe is eccentric.

Pleurotus

Cap is large and white. Stem is lateral, eccentric or entir wanting except in some species. Gills are either not eas detached, narrowly attached or decurrent. Veil is abse

Schizophyllum

Gills are split along the edge and generally strongly roll back. The stem is lateral or absent.

Termitomyces

Gills are free and suddistant. Both volva and ring a absent. Stipe is pale ochreous buff in color. Always ass ciated with termite hills.

Tricholoma

Cap is sticky or dry. The stem is continuous with the ca spongy, fleshy to fibrous. Ring and volva are absent. Th partial veil if present is slightly fibrous or cottony. Th gills are notched near the stem.

Marasmius

Cap is dry and flexible, somewhat thin. The gills a simple, pliable, nearly distant with acute, entire edges. Th stem is cartilagenous or horny.

Order Aphyllophorales

The hymenium is borne in various ways. It may be smooth, ridge warty or spiny or it may line inside of tubes or pores or exter surface of the gills.

Family Polyporaceae

Hymenium lines internal of pits or tubes which are deep or if shallow sterile on ridges. The texture is not soft and putrescent.

Polyporus

Have many pores. Annual or perrential. The cap is woody to corky or nearly soft. The stem is central, lateral and absent and may be either single or branched.

Family Hydnaceae

The hymenium covers pendent warts, spines or teeth.

Hydnum

Fruiting bodies are awe-shaped or in the form of spines. It is either simple or with the tips more or less branched. Spines vary in form.

Family Clavariaceae

The basidiocarp is usually pileate. It is generally fleshy and sometimes gelatinous. It is club-or-coral shaped, usually erect.

Clavaria

Hymenium is even and borne on both sides but absent from stem-like portion of the simple club.

Order Lycoperdales

Gleba-is powdery. The hymenium is present in early stages. Spores are mostly light colored and small.

Family Lycoperdaceae

Fruiting bodies are enclosed by two peridial layers which are distinct.

Bovista

Outer covering is thin and fragile, flaking off at maturity.

Calvatia

Outer covering is thick, woven or divided into small spaces. Inner covering is thin and delicate. Base is concave.

Lycoperdon

Small, globose, inversely egg-shaped or top-shaped. Base is filled with a sterile honey-combed tissue. Gleba is composed of minute chambers.

Food Value of Mushrooms

Many workers have presented data to prove that mushrooms have a definite nutritive value. The protein content varies considerably according to different species. Likewise, the growing medium as well as the stage of development of mushroom (whether button stage or mature stage) contribute to some differences reported on the same species (Quimio, 1981). Fresh mushrooms generally contain between 85-92% moisture which is not very high when mushrooms are compared with common vegetables like Chinese cabbage (94.2%). There are considerable variation of moisture content within a species due to the environmental conditions under which they are grown and harvested.

In general, the mushrooms produced from agricultural wastes and industrial discards contain about 30-50% protein on a dry weight basis and about 3-5% on a fresh weight basis (Chang and Miles, 1984). Mushrooms cannot compete with meat in protein content but can do so with most vegetables such as spinach, potatoes and cabbage (Quimio, 1981).

The protein content of mushroom in general is twice that of asparagus and cabbage, four times that of oranges and twelve times that of apples. And also, all mushroom proteins contain all the nine amino acids essential for man. They are generally rich in lysine and leucine which most cereal foods lack. However, they contain low amounts of methionine and cystine, both of which are essential and abundant in meat proteins.

Mushrooms although devoid of Vitamin A, contain vitamins such as thiamine (B_1), riboflavin (B_2), cobalamin (B_{12}), niacin, pantothenic acid (B_5) and vitamins C, D and E (Quimio, 1981 and Chang and Miles, 1984). They are low in calories, carbohydrates and calcium. *Agaricus* is high in Vitamin C and *Lentinus* is high in Vitamin D. Moreover, calorie content of mushrooms is lower than that of apples, bananas, potatoes, pears, rice, pork and beef. Their unsaturated fatty acids range from 74.0-83.5% of the total fatty acids which is more than chicken, pork and beef (Chang and Miles, 1984).

Cultivation of Mushrooms

In view of the growing awareness of the importance of the mushrooms to human diets, interests in research and utilization of the fungi has increased in recent years. In the Philippines, attempts to cultivate edible mushrooms started as early as 1916. And now, with the expansion of research facilities as well as extensive research supports, it will not be long before the Philippines will be sufficient to meet the demands for mushrooms (Quimio, 1981).

So far, about 25 species of more than 2,000 edible fungi are widely accepted for human consumption, but only a few of them are commercially cultivated (Chang and Quimio (eds.) 1982). In the Philippines, three kinds of mushrooms can be cultivated namely: *Agaricus bisporus*, *Volvariella volvaceae* and *Pleurotus*.

Mushrooms can be grown on agricultural and industrial wastes. Because of this, they constitute a source for obtaining food proteins from such wastes. Hence, they can aid in solving many problems of global importance including protein shortages, resource recovery and reuse, and environmental management (Chang and Quimio (eds.), 1982).

The nutrients for mushrooms growth are provided in composts which are prepared differently for different kinds of mushrooms. In composting, complex organic matter is degraded by naturally present microorganisms to simpler components favorable for the mushroom mycelium. The exact nature of the compost determines whether the mushroom grows rapidly and becomes the dominant organism in the compost.

Agaricus sp. in the Philippines is cultivated in Baguio and Cagayan. It is cultivated in rice straw supplemented with either chicken or horse manure as the main material for compost. *Volvariella volvaceae* on the other hand, can be grown on rice straw. Rice straw like other grasses contains a lot of organic substances such as nitrogen, phosphorus and potassium which are released as the straw decays and in turn taken up by the mushrooms (Quimio, 1981). They also contain plentiful carbon, particularly cellulose (10-30%), lignin (5-30%) and some soluble carbohydrates (Chang and Miles, 1984). In addition, *V. volvaceae* can also be grown on other materials such dried banana leaves and water hyacinth.

Pleurotus is a wood inhabiting mushroom. This mushroom can be cultivated in sawdust (80%) and rice bran (20%) and in addition 1% $CaCO_3$ and 2% corn grit (Quimio, 1978).

Spawns are the planting materials in mushroom cultivation. They are actually the mycelium of the mushroom, prepared and growing aseptically on a certain combination of substrate. These substrates are usually agricultural wastes or materials.

For *Volvariella volvaceae*, the following combination of substrate is usually used for spawn preparation: coir dust and dried ipil-ipil leaves (1:1); rice straw and ipil-ipil leaves (1:1); and rice straw and tobacco midrib (1:1). The Pleurotus, the usual substrate is sawdust and rice bran (8:1) (Quimio, 1981).

Preservation of Cultivated Mushrooms

Like all fruits and vegetables, mushrooms are perishable and after harvest, they often change in ways that make them unacceptable for human consumption. The most readily observable of these changes include wilting, ripening, browning, liquefaction, loss of moisture, and loss of texture, aroma and flavor. These changes are usually preceded by an increase in the rate of respiration, which when coupled with other reactions and with the cessation of the nutrient supply will trigger a series of irreversible reactions damaging the mushrooms.

The shelf life of mushrooms can often be extended by pretreatments and/or storage at chilling temperatures (above freezing and below 15°C). Chilling storage however, is not always effective. Depending on the species, the shelf life of mushrooms may vary from one day to two weeks.

For long term storage of mushrooms, canning, pickling and drying are employed. The quality of the finished product often is not comparable to the quality of fresh mushrooms, and furthermore, these processes are not always suitable for all types of mushrooms.

REFERENCES

ALEXOPULUS, C.J. 1962. Introductory Mycology. London: Chapman and Hall.

BESSEY, E.A. 1961. Morphology and Taxonomy of Fungi. Hafner Publishing Co., New York.

CHANG, S.T. and T.C. QUIMIO (eds.) in Chang, S.T. 1982. Mushroom Spawn. In the Tropical Mushrooms. Biological Nature and Cultivation Methods. The Chinese University Press, Hongkong.

CHANG, S.T. and P.G. MILES. 1984. A new look at cultivated mushrooms. Bioscience. 34: 358.

PATTERSON, F.W. 1915. Mushroom and other Common Fungi. USDA. Bulletin. No. 175.

QUIMIO, T.C. 1978. Indoor Cultivation of *Pleurotus* Mushroom. UPLB. Bulletin.

QUIMIO, T.H. 1978. Common Edible Mushroom in the Philippines. Technical Bulletin. Vol. III, No. 2.

QUIMIO, T.H. 1981. Philippine Mushrooms. National Institute of Biotechnology and Applied Microbiology. UPLB.