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A Comprehensive Study on *Agaricus* Species of North Cyprus

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Abstract: A survey was conducted in 2008 by collecting wild mushrooms from different places in North Cyprus included forests, fields and coastal plains. Eight *Agaricus* species were found in this study in addition to *A. macrosporus* which was brought from a supermarket from the Greek side of Cyprus. *Agaricus placomyces* was suspect poisonous and better to be avoided, while edibility of *A. bresadolianus* was not known. The other seven *Agaricus* species found in this study were edible. The main characteristics of this genus are free gills, chocolate brown spores, the presence of a veil, medium to large size and a central stalk that separates easily from the cap. The information from this study will help mushroom collectors to differentiate between edible, non-edible and toxic mushrooms.

Key words: *Agaricus* % *Psalliota* % Mushrooms % Large fungi % Agaricaceae

INTRODUCTION

Mushroom have become attractive as a functional food and as a source for the development of drugs. *Agaricus brasiliensis* contained antitumor polysaccharide and exo-polysaccharides [1]. Mushrooms are considerd to be good sources of digestible proteins, carbohydrates, dietary fibre and all essential amino acids [2, 3]. Chanterelles and king bolete (*Boletus edulis*) collected from Uppland forests in Sweden were found to be good sources of vitamin D_2 compared with cultivated mushroom that had a low content [4]. Mushrooms are not only sources of nutrients but also useful in preventing diseases such as hypertension, hypercholesterolemia and cancer [5]. Mushrooms are fruiting structures of large fungi. The function of fruiting body is to produce spores for recontinuation of mushroom production. *Agaricus* is a large Genus and found in forty species in Britain [6, 7] and up to 90 species in Europe [8]. This genus contains both marketable and non edible mushrooms. Estimates of numbers of *Agaricus* species worldwide vary, but seem likely to exceed 300 [9]. Most species are non toxic [10]. *Agaricus bisporus* and *Agaricus campesrtris* are the most market and cultivated mushrooms under controlled conditions. This fungus produces their spores in gills and called gill fungi. The purpose of this study was to identify *Agaricus* species of Cyprus in addition to study their ecology, distribution and toxicity. The information from this survey will help mushroom collectors to differentiate between edible, non-edible and toxic mushrooms. It will be helpful for people interested in biological and environmental sciences.

MATERIALS AND METHODS

A survey was conducted in 2008 by collecting wild mushrooms from different places in North Cyprus included forests, fields and coastal plains. The purpose of this survey was to identify wild mushrooms, their ecology, distribution, classification and their toxicity. Several field trips were done during Winter and Spring 2008 to collect mushrooms. Each sample was studied in the field by taking measurements on the morphological structures of the cap, stem and recording gills color, shape and dimensions. Also smell and taste for each fruiting structure were taken in consideration. The host on which the fungus was growing was recorded whether it grows on soil surface or attached to a certain wood host. Samples were photographed and then kept in small polyesterene boxes inside ice box and brought to the laboratory for further tests. Spore print for each sample was taken and the ornamentation of the gill type was also defined. Spores were microscopically tested by recording the shape, colour and size of more than twenty arbitrary choosen spores. Mushroom samples were classified according to Phillips [6] and Benjamin [11].

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RESULTS

This genus belongs to Phylum Basidiomycota, Class – Hymenomycetes (newly described Class Agaricomycetes), Order: Agaricales, Family: *Agaricaceae*. *Agaricus* species were found growing on pastures among grass and in mixed forests on calcareous soils. It was found in Alevkaya forests during autumn, winter and spring. Eight species were found in this study in addition to *A. macrosporus* which was brought from a supermarket from the Greek side of Cyprus. *Agaricus placomyces* was suspect poisonous and better to be avoided, while edibility of *A. bresadolianus* was not known. The other seven *Agaricus* species found in this study were edible.

1- *Agaricus bernardii* (Quel.) Sacc: Cap hemispherical or convex first later flattened and centrally depressed, white to creamy colored, surface disrupting into coarse brownish scales and 10.5 cm across. Gills free, pale-grey then becoming dark brown colored. Stem white to cream, narrowing slightly at the grayish-brown base, ring sheathing, whitish and narrow, 25×35 mm. Flesh cream and fibrous becoming reddish in cutted slices. Smell fishy and taste unpleasant. Spore print dark brown, globose to oval or kidney shaped, spores with distinctive pore in a form of a nipple, 6-7×5-6 µ (Fig. 1).

Synonym: *Agaricus campestris subsp. bernardii* (Quel.) Konrak and Maubl.

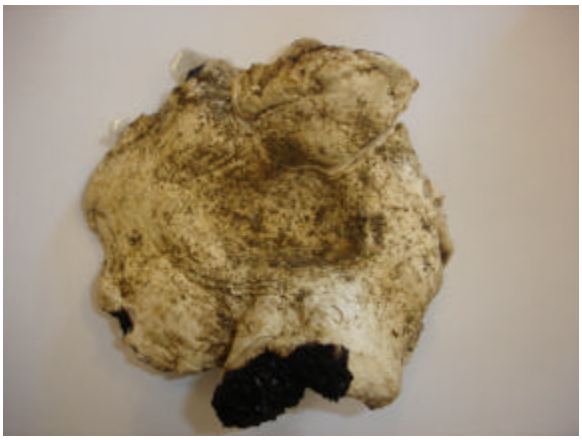

Fig.1: *Agaricus bernardii*

2- *Agaricus bresadolianus* Bohus: Cap 3-7 cm across, flat and slightly depressed at the centre in old specimens, margin finally wavy, dark brown. Cap edges curled slightly downward. Gills light brown, crowded. Cap attached to the stem centrally. Light brown stem, 30-50×4-15 mm, with a basal bulb at the rooting base, ring white and narrow and short-lived leaving an indistinct ring zone in older specimens. Flesh brown beneath the cap cuticle. Smell and taste pleasant and slight, respectively. Spore print: Brown, elliptical to ovate, 7-8×4-5 µ (Fig. 2).

Synonym: *Agaricus campestris var. radicatus.* Vitt.

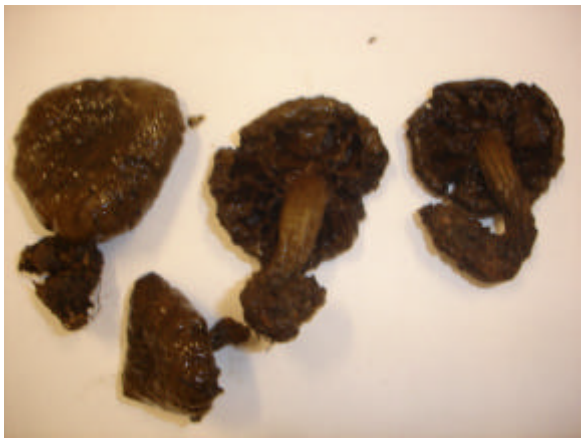

Fig. 2: *Agaricus bresadolianus*

3- *Agaricus campestris* L. Ex. Fr. (Field Mushroom): Cap concave then flattened, white creamy, smooth, fibrous, cap margin incurved downward, 5.5 cm across. Gills in young specimens long and deep pink, with age darkening to chocolate brown. Stem white, ring thin and white, short lived, woolly mycelial mass at the base, 42×6 mm. Flesh white-creamy. Smell and taste mushroomy and pleasant. Spore print purplish-brown, oval, with distinctive germ pore, 6.5-8×4.5-5.5 µ (Fig. 3).

Synonym: *Psalliota campestris* (L.ex. Fr.) Quel:

Fig. 3: *Agaricus campestris*

4- *Agaricus macrosporus* (Moller and Schaeff.) Pilat: Cap convex, whitish splitting into large ochraceous scales, the margin becoming toothed with age, 10-15 cm across. Gills free, grey in young specimens later dark brown. Stem cream to mousy grey, with a fusiform rooting base, covered in floccules, ring very thick and scaly on the upper 2-3 cm of the stem, 50-100×20-35 mm. Flesh white and firm, reddening in the cutted stem sections. Smell and taste pleasant of aniseed. Spore print brown, lemon-oval shaped, 7-11×5-7 µ (Fig. 4).

Fig. 4: *Agaricus macrosporus*

5- *Agaricus placomyces* Peck: Cap concave later flattened with an involute marginal zone, covered with grey-cinamon scales especially at the centre on a whitish ground, 3-4-3.6 cm across. On rubbing, the surface finally turns brownish. Gills free, with intercalated lamellulae, crowded, 8 mm abroad, at first white, finally reddish chocolate colored to dark brown. Stem slender, cylindrical, at the base usually somewhat curved, slightly marginate bulbous. With a thin annulus that is removable in an upwards direction, at first white, turning yellowish to brownish, 23-27×5-6 mm. Flesh white in fresh cut surfaces later becoming brown. Smell of young fruits and taste mild sweetish. Spore print purplish brown, elliptic with distinctive germ pore, 6-7×3-5 µ. With potassium hydroxide flesh rapidly becoming intense chrome-yellow (Fig. 5).

Synonym: *Psalliota arvensis Subsp. Macrospora* Moller and Schaeff:
Synonym: *Psalliota meleagris* Schaef.

6- *Agaricus porphyrocephalus* Moller: Cap hemispherical then flattened, cream later brown with darker radiating fibrils, cap margin incurved downward, 5 cm across. Gills free, pink at first and later chocolate brown, many short gills. Stem white, swollen towards the base and slightly bulbous, ring thin and white, 38×11 mm. Flesh white to pale cream. Smell and taste mushroomy. Spore print purplish-brown, kidney to bean shaped, with distinctive germ pore, 6-7×4-5 µ (Fig. 6).

Fig. 5: *Agaricus placomyces*

Synonym: *Psalliota porphyrea* Moller.

Fig. 6: *Agaricus porphyrocephalus*

7- *Agaricus silvaticus* Schaeff. Ex. Secr: Cap convex later expanded flat, ochraceous to dark brown and darker in the centre, covered in fibrils, 4-6 cm across. Cap attached to stem centrally. Gills pale at first, later dark black, crowded, free. Stem whitish sometimes with brownish fibrous scales below the brown ring, hollow. Flesh white, in cut surfaces quickly red blood changed, later brown-black. Smell and Taste: Not distinctive. Spore print dark brown, spores ovoid-bean shaped, with distinctive pore, 5-7 × 3-4µ (Fig. 7).

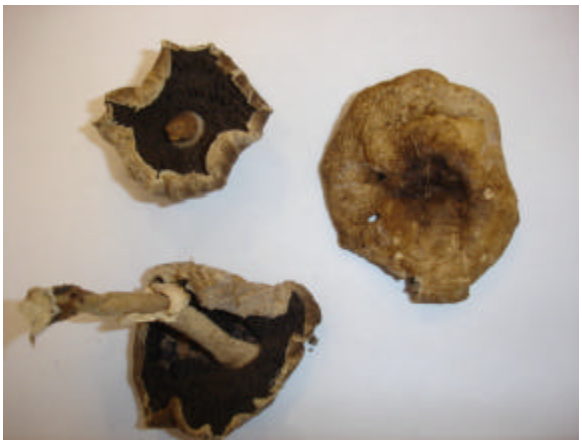

Fig. 7: *Agaricus silvaticus*

8- *Agaricus silvicola* (Vitt.) Peck. (Wood Mushroom): Cap convex later expanded with cap margin highly curled inward for 1.5 cm, cream mousy-light brown colored, smooth, 5-6 cm across. Gills free, dark black-dark brown. Stem light black to dark brown, bulbous base, upper stem part white colored, lower darker, large ring and pendulous, 40-70×8-12 mm. Flesh cream, thin and has large cells. Taste mushroomy and smell of aniseed. Spore print purple-brown, globose to oval, 5-7×4-5µ (Fig. 8).

Fig. 8: *Agaricus silvicola*

9- *Agaricus vaporarius* (Vitt.) Mos: Cap subglobose in young specimens later flattened with umbo in the centre, margin incurved downward, pale brown to grey brown colored, 9.2-10 cm across. Gills pale pink in young specimen later chocolate brown, free, crowded. Stem grey-brown colored with fibrous scales, tapering and occasionally fuse together with near specimen at base, deeply buried in the soil, ring thick and white, pendulous, 90×50 mm. Flesh white and later in old specimen creamy to light grey, fibrous. Smell mushroomy and taste nutty. Spore print purplish-brown, oval to kidney shaped, some spores were globose, 6-8×5-6 µ (Fig. 9).

Synonym: *Psalliota vaporaria* (Vitt.) Moller and Schaeff.

Fig. 9: *Agaricus vaporarius*

The main characteristics of this genus are free gills, chocolate brown spores, the presence of a veil, medium to large size and a central stalk that separates easily from the cap. Any *Agaricus* smell like chemicals as phenol should be avoided. Adviced not eat *Agaricus* that stain yellow or amber at the base of the stalk when it is cut vertically.

DISCUSSION

Agaricus is a large and important genus of mushroom containing both edible and poisonous species, with possibly over 300 members worldwide [9, 8]. The genus includes the most dominant cultivated mushrooms (*A. bisporus and A. campestris*). Members of *Agaricus* are characterized by having a fleshy cap, from the underside of which grow a number of radiating gills on which the naked spores are produced. *Agaricus* species are distinguished from other members of their family (*Agaricaceae*) by their chocolate-brown spores. Some members have a stem, which elevates the cap above the substrate on which mushroom grows and a partial veil, which promotes the developing gills and later forms a ring on the stem. For many years members of the genus *Agaricus* were given the generic name *Psalliota* and this can still be seen in older mushroom books. This name was derived from the Greek psalion (ring). *A. campestris* was excluded from *Agaricus* by Karsten and was apparently in *Lepiota* at the time Donk wrote his report [12]. The most

notable inedible species is the yellow-staining mushroom (*A. xanthodermus*). *A. aurantioviolaceus* was reported from Africa as deadly poisonous. In a previous study done in North Cyprus by Viney [13] another picture of *Agaricus* distribution was found. An excellent edible mushroom, *Agaricus campestris* can be found on pastures on the islands of Maui and Hawaii. It is distinguished from other *Agaricus* species by its white, glabrous pileus, small and band like annulus and pleasant odor [14]. *Agaricus campestris* is a short stalked mushroom with an evanescent veil and bright pink gills when young. The odor is fungal and does not stain [11]. Five *Agaricus* sp. proved to have antioxidant activity and mushroom extracts revealed similar electrochemical responses, suggesting similar electroactive chemical composition and oxidation potentials more positive than those of the standards (ascorbic and gallic acids). *Agaricus silvaticus* was the most efficient species presenting the lowest EC_{50} values in the chemical and biochemical assays and the highest antioxidant power in the electrochemical assays [15]. Some mushrooms may acquire different levels of trace metals from the growing substrate. Mushrooms species in the highest levels of trace elements were found *Entoloma sinuatum* for Cu and Zn, *Leucoagaricus leucothites* for Mn, *Amanita pantherina* for Fe and Se, *Agaricus arvensis* for Cd [16]. The Genus *Agaricus* includes both heterothallic and homothallic species, RAPD markers were utilized to assess genetic variation in single spore progeny from different *Agaricus* species and to confirm heterokaryon formation in mating. Single spore progeny from heterothallic species should be more heterogeneous than those from homothallics [10]. *Agaricus macrosporus* has a great commercial potential as an edible mushroom [17].

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REFERENCES

1. Fan, L., A. Soccol, A. Pandey and C. Soccol, 2007. Effect of nutritional and environmental conditions on the production of exo-polysaccharide of *Agaricus brasiliensis* by submerged fermentation and its antitumor activity. Food Sci. Technol., 40, 30-35.
2. Barros, L., P. Baptista, D. Correia, S. Casal, B. Oliveira and I. Ferreira, 2007. Fatty acid and sugar compositions and nutritional value of five wild edible mushrooms from Northeast Portugal. Food Chem., 105: 140-145.
3. Manzi, P., A. Aguzzi and Pizzoferrato, 2001. Nutritional value of mushrooms widely consumed in Italy. Food Chem., 73:321-325.
4. Teichmann, A., P. Dutta, A. Staffas and M. Jägerstad, 2007. Sterol and Vitamin D_2 concentrations in cultivated and wild grown mushrooms: Effects of UV irradiation. Food Sci. Technol., 40: 815-822.
5. Bobek, P. and S. Galbavy, 1999. Hypocholesterolemic and antiatherogenic effect of oyster mushroom (*Pleurotus ostreatus)* in rabbit. Nahrung, 43(5): 339-342.
6. Phillips, R., 1985. Mushrooms and other fungi of Great Britain and Europe. PAN Books. London, pp: 288.
7. Dennis, R., P. Orton and F. Hora, 1960. New check list of British agarics and boletes. Transactions of the British Mycological Soc., 43: 1-225.
8. Capelli, A., 1984. *Agaricus*. L. Fr. (*Psalliota* Fr.). Libreria editrice Bella Giovanna, Saronno, Italy.
9. Bas, C., 1991. A short introduction to the ecology, taxonomy and nomenclature of the genus *Agaricus*. In Genetics and breeding of *Agaricus*. (L. Van Griensven ed.): 21-24. Pudoc, Wageningen, The Netherlands.
10. Calvo-Bado, L., M. Challen, C. Thurston and T. Elliott, 2001. RAPD, characterization of heterogeneity in spore progenies and sexuality in the genus *Agaricus*. Mycol. Res., 105 (3): 370-376.
11. Benjamin, D., 1995. Mushrooms: Poisons and Panaceas- a Handbook for Naturalists, Mycologists and Physicians. New York. WH Freeman and Company.
12. Donk, M., 1962. The generic names proposed for Agaricaceae. Beiheifyte zur Nova Hedwigia, 5: 1-320.
13. Viney, D., 2005. An illustrated introduction to the larger fungi of North Cyprus. Kevin Viney Publishing company. Buvks. Great Britain, pp: 302.
14. Zeitlmayr, L., 1976. Wild Mushrooms: An illustrated handbook. Garden City Press. Hertfordshire.
15. Barros, L., S. Falcao, P. Baptista, C. Freire, M. Vilas-Boas and I. Ferreira, 2008. Antioxidant activity of *Agaricus* sp. mushrooms by chemical, biochemical and electrochemical assays. Food Chem., 111: 61-66.

16. Tuzen, M., E. Sesli and M. Soylak, 2007. Trace element levels of mushroom species from East Black Sea region of Turkey. Food Control, 18: 806-810.

17. Fermor, T., 1982. *Agaricus macrosporus*: an edible fungus with commercial potential. Scientia Horticulturae, 16: 273-282.