Some medicinal mushrooms of Garhwal Himalaya, Uttarakhand, India

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Article History: Received 15th May 2011, Revised 4th June 2011, Accepted 10th June 2011.

Abstract: Garhwal Himalaya is glorified by the rich diversity of mushrooms. There is vast scope of study on the medicinal mushrooms growing in this region. The wild mushrooms have been used as medicine since time immemorial. They are considered and known to be a rich source of proteins and vitamins. In the present paper details of some medicinally important mushrooms collected from the Garhwal region is being given, whose medicinal uses are recorded from India and elsewhere in the world. Medicinally important mushrooms of the Garhwal Himalaya discussed in the present paper are Ganoderma lucidum, Agaricus campestris, Hydnum repandum, Coprinus comatus, Morchella esculenta and Cantharellus cibarius.

Keywords: Garhwal Himalaya; Medicinal mushroom; Edible; India.

Introduction

Mushrooms are considered to be a good source of digestible proteins with protein content above most vegetables and somewhat less than most meats and milk. Protein content can vary from 10-40% on a dry weight basis. Mushrooms contain all the essential amino acids, but can be limiting in the sulphur containing amino acids, cystine and methionine (Chang 1991; Breene 1990). A large number of mushroom species are not only edible and nutritious but also possess tonic and medicinal qualities. Bahl (1983) reported that mushrooms cure epilepsy, wounds, skin diseases, heart ailments, cholesterol reduction, stress, insomnia, asthma, allergies and diabetes, rheumatoid arthritis, cholera besides intermittent fevers, diarrhoeic, diarrhoea, dysentery, cold, anesthesia, liver disease, gall bladder diseases and used as vermicides. Mushrooms are also known to have effective substances for antifungal, anti inflammatory, antitumor, antiviral, antibacterial, hepatoprotective, antidiabetic, hypolipidemic, antithrombotic and hypotensive activities (Wasser and Weis 1999). The term “mushroom nutriceutical” is used for a new class of new compounds extractable from either the mycelium, or the fruiting body of the mushroom (Chang and Buswell 1996). Nutriceuticals are the functional food enriched/modified and consumed as normal diet to provide health giving benefits. Mushroom nutriceuticals may possess both nutritional and medicinal properties. Several studies have been carried out on the medicinal properties of different species of mushrooms earlier in many parts of the country. Rai (1997) discussed the current status of knowledge on medicinal mushroom, their pharmacologically active principles and mechanism of action. Thekkuttuparambil et al. (2007) studied medicinal mushrooms occurring in South India.

The Garhwal Himalaya represents one of the most fascinating and characteristic vegetation of the Indian sub-continent. Marked variations are noticeable both in the quality and quantity of vegetation with respect to the different latitudinal, altitudinal and habitat conditions. The Garhwal Himalaya consists of widest range of altitudes (ca 350 to 7817 m asl), having contrast climatic conditions viz., warm humid Terai belt on the one hand and on the other cold desert at Tibetan border. Due to these factors, differing magnitudes of habitats give rise to several microclimatic pockets thus high diversity of flora grows and exists in this region. Because of its vast climatic conditions, plant distributions and field features Garhwal Himalaya is very suitable for the growth of mushrooms and many medi-
cinal mushrooms grow in this region. The present paper deals with description and medicinal properties of some of the medicinally important wild mushrooms of the Garhwal Himalaya.

Study area

The Garhwal Himalaya lying between the latitudes 29° 31’9” N and 31° 26’5” N and longitudes 77° 33’5” E and 80° 6’0” E with a total area of 29,089 km² is the most frequented and best known part of the Himalaya, starting from the foothills in the south, it covers all three sections of the Himalaya i.e. outer Shiwalik, the lesser Himalaya comprising linear mountain ranges and the Great Himalaya covering about 40,000 km² of snowfields. Administratively, Garhwal Himalaya comprises seven districts namely, Chamoli, Dehradun, Haridwar, Pauri, Rudraprayag, Tehri and Uttarkashi. The climate is temperate (montane) between 2000 and 3200 m asl. The average precipitation in the region is 1500 mm varying from 600 to 3000 mm. Most of the precipitation as much as 75 % in the region is received during monsoon months (between June and September). The range of climatic conditions in this region is extremely variable because of considerable variation in altitudes. The climatic factors i.e. precipitation, temperature, relative humidity and wind, in association with elevation (valleys or mountain ranges from foot hills to montane zones), proximity of Great Himalaya, slope aspects vegetation etc. causes variations at local or even at microlevels. Variations are also observed in the soil characteristics. The nature, colour and texture of soil vary with the slope, vegetation and topography. The most common features of the soils include coarse and sandy nature, usually less fertile. Generally In densely forested areas, the soil is black with thick layer of humus and litter. The soil cover under the gymnosperms is leached and acidic. Whereas, in the valleys with the xerophytic or shrubby vegetation, the soil cover is very thin.

In the study area, the forests are dominated by Pinus roxburghii (Chir pine) from 1200 to 2200 m asl, Quercus floribunda (Banj oak) from 1400 to 2400 m asl, Abies pindrow (Silver fir) from 2000 to 3000 m asl, Picea morinda (Spruce) from 2000 to 3200 m asl, Cupressus torulosa (Himalayan Cypress) from 2000 to 3000 m asl, Cedrus deodara (Deodar) from 2500 to 3000 m asl, Quercus semecarpifolia (Khursu oak) and Betula utilis (Birch) from 2500 to 3200 m asl. Some mixed hardwoods found on the sheltered valleys, often in scattered areas at the elevation of 2000 to 3000 m asl forming the mixed humid deciduous forests. Some other common tree species of the region are Acer caesium (Kanjula), Acer pictum (Gad papri), Alnus nepalensis (Utees), Buxus wallichiana (Papri), Aesculus indica (Pangar), Corylus jacquemontii (Bhotia badam), Juglans regia (Akhot), Rhus punjabensis (Amlara) and Ulmus wallichiana (Mairu).

Material and methods

The extensive field trips were undertaken between July and September 2010 in different localities of the Garhwal Himalaya to collect the samples of macrofungi. During the field surveys, the macrofungi samples were collected with a great care to avoid damage to the base and other parts of the samples. Macroscopic details such as shape, size, colour, colour change on bruising or ageing, taste, odour, spore deposition of the fresh specimens (Largent 1977a, b) and ecological characteristics of the sample were recorded and samples were photographed in their natural habitats. Samples were kept in separate paper bags to avoid mixing and were taken to the laboratory. Macro and microscopic investigations and micro chemical reactions were carried out on the samples. Collected specimens were dried, preserved in paper or polythene bags and numbered (Atri and Saini 2000). Identification was made on the basis of critical observations of the specimens and perusal of relevant literature. All the identified specimens were deposited in the Garhwal University Herbarium (GUH), Srinagar Garhwal Uttarakhand, India.
Results and Discussion

Some of the medicinally important mushrooms along with their botanical name, family, description, collection place, habitat, collection date and medicinal properties are being discussed hereunder:

1. **Agaricus campestris** L. ex Fr. (Agaricaceae)

**Description:** Pileus 3 6 cm broad, hemispherical to convex becoming plane at maturity, sometimes depressed at centre, pure white when young becoming yellowish at centre with age, surface dry, smooth or silky fibrillose or sometimes with a few greyish to brown fibrils or fibrillose scales over the cap surface; margin entire extending beyond the gills, often hung with veil remnants. Flesh white, thick, firm, reddening on exposure. Taste mild. Odour fungid. Lamellae close, free at maturity, pinkish white in button then bright pink, becoming chocolate brown. Stipe 3 7 cm long and 0.5 1 cm diam., centric, bulbous or attenuated at base, white to whitish, surface smooth above the veil, often with a few fibrils below, silky, stuffed or hollow, context white reddening slightly on exposure. Annulus superior, white, thin, skirt like. Spore print chocolate brown. Spores 5.5 7 x 3.5 5 μm. elliptical.

**Specimen examined:** India, Uttarakhand, Pauri Garhwal, Khirsu forest. Solitary to scattered, associated with grasses, especially with *Cynodon* spp., commonly found along road side and meadows. Specimen collected on 15th July 2010 (Figure 1).

**Medicinal properties:** This fungus is commonly known as field or meadow mushroom. It is found throughout the Garhwal Himalaya and is consumed by the local people. The presence of antihyperglycaemic, insulin releasing and insulin like activity in *A. campestris* were reported. The lectins isolated from *A. campestris* have been recorded to enhance insulin release by isolated rat islets of Langerhans (Ewart et al. 1975, Ahmad et al. 1984a, b). It has been documented as a traditional treatment for diabetes by Gray and Flatt (1998).

2. **Ganoderma lucidum** (Fr.) Karst (Ganodermataceae)

**Description:** Pileus 3 23 cm broad, kidney shaped, elongated, more or less fan shaped at maturity, red to reddish brown when mature, when young often with zones of bright yellow and white toward the margin. Tubes up to 2 cm deep. Pores 0.1 cm, whitish, usually bruising brown. Stipe 3 12 long and 1 2 cm thick, twisted, cylindrical, smooth, dark red to black with a varnished crust, spore print brown.

**Specimen examined:** India, Uttarakhand, Pauri Garhwal, Khirsu forest. Solitary to scattered sometimes gregarious, on living hardwoods (especially oaks), usually near the base of the tree. Specimen collected on 6th September 2010 (Figure 2).

**Medicinal properties:** *Ganoderma lucidum* is the most popular medicinal mushroom of the world. It is also known as Reishi. It has been used for a wide range of health benefits from preventive measures and maintenance of health to the management and treatment of chronic as well as acute human ailments (Rai 1997). Traditionally it has been used widely in the treatment of hepatopathy, chronic hepatitis, nephritis, hypertension, arthritis, insomnia, bronchitis, asthma and gastric ulcer. It is also used by Indian tribals for treating joint pain (Harsh et al. 1993). It is reported to possess very significant medicinal properties viz., anti cancer, anti HIV, anti atherosclerosis, hepato and nephroprotective and very strong immunomodulating effects (Chang 1995). It also has anti tumor, cardiovascular, respiratory and anti hepatotoxic properties (Stamets 2000). Scientific studies have confirmed that the substances extracted from this mushrooms can reduce blood pressure, blood cholesterol and blood sugar level as well as inhibition of platelet aggregation (Thekkuttuparambil et al. 2007). It is used to cure cardiovascular diseases and contains several major constituents which may lower blood pressure as well as decrease LDL cholesterol. These constituents also help reduce blood platelets from sticking together—an important factor in lowering the risk for coronary artery disease. Two controlled clinical trials have investigated its effects on high blood pressure in humans and both found...
that it could lower blood pressure significantly (Kammatsuse et al. 1985; Jin et al. 1996). Kim et al. (1993) and Liu and Chang (1995) have reported anti HIV activity of *G. lucidum*. It is used for treatment of general fatigue, weakness, asthma, insomnia and cough in traditional Chinese medicine (Halpern et al. 2002). It has antioxidant and antitumor activities, and Camptothecin has been found to be responsible for its antioxidant properties (Zhou et al. 2007). It has also been used as an adjuvant in radiotherapy of cancer (Gopakumar et al. 2010).

3. *Hydnum repandum* (L. ex Fr.) Gray, Syn. *Dentinum repandum* (L.) Gray (Hydnaceae)

**Description:** Pileus 3 10 cm in diameter, convex becoming nearly plane, with a central depression, surface dry, smooth to slightly scaly, cream to buff orange, or paler; margin inrolled in the beginning, becoming lobed to undulate at maturity, bruising to orange brown. Flesh white, often discoloring yellowish when exposed or bruised. Odor and taste mild or peppery. Hymenophore decurrent, covered with spines or teeth, 2 6 mm long; pale or dull orange. Stipe 3 8 cm long and 1 2.5 cm thick, equal to enlarged at the base, surface dry, smooth, whitish or colored like the pileus, bruising orange brown. Spore print white. Spores 7 9×5 8 µm, broadly elliptical or almost round.

**Specimen examined:** India, Uttarakhand, Pauri Garhwal, Khirsu forest. Solitary, scattered to gregarious, mycorrhizal with hardwoods or conifers. Specimen collected on 18<sup>th</sup> August 2010 (Figure 3).

**Medicinal properties:** It is commonly known as wood hedgehog or hedgehog mushroom. An extract of the culture mycelia showed 70% inhibition against Sarcoma 180 solid cancer in mice, while extracts from the fruit bodies showed 90% inhibition against both Sarcoma 180 and Ehrlich solid cancer in mice (Ohtsuka et al. 1973). The compound repandiol extracted from it showed potent cytotoxic activity against a variety of tumor cell types, especially colon adenocarcinoma cells (Takahashi et al. 1992). In a study on antimicrobial activity using the disk diffusion method, Yamach and Bilgili (2006) showed that a chloroform extract of this mushroom has mild antibiotic activity against *Enterobacter aerogenes*, *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Bacillus subtilis*, while the ethanol extract has mild activity only against *Bacillus subtilis*.

4. *Coprinus comatus* (Mull. ex Fr.) S.F. Grey (Coprinaceae)

**Description:** Pileus 4 10 cm broad, oval to cylindrical, then elongate bell shaped or conical and soon becoming torn or revolute at margin, surface white becoming pinkish towards the margin then blackish, centre smooth and ochraceous cream, buff or pale fulvous at first with shaggy white to pale brownish scales often darkest at tips; margin decurved, inrolled at maturity. Taste none or slight, pleasant. Odour mild. Lamellae free, crowded, white, becoming gray, then black, and dissolving (deliquescing) with age. Stipe 5 18 cm long and 1 2 cm thick, central, cylindrical, hollow, attenuated upwards from the thickened or bulbous sometimes rooting base, surface white then pinkish, vinaceous or clay buff, smooth and shiny but sometimes becoming brownish fibrillose when handled, base white tomentose. Annulus white, movable, sometimes dropping to the base of the stipe. Spore print fuscous black. Spores 10 12×6 8 µm, ellipsoid amygdaliform.

**Specimen examined:** India, Uttarakhand, Pauri Garhwal, Khirsu forest. Solitary to scattered, sometimes in clusters, lines, or fairy rings on lawns, wood chips, disturbed soil, along roadsides. Specimen collected on 18<sup>th</sup> August 2010 (Figure 4).

**Medicinal properties:** This fungus is commonly known as shaggy ink cap, lawyer’s wig or shaggy mane. It is a very commonly found mushroom in Garhwal Himalaya and is consumed locally by the people. Various bioactive functions of *C. comatus* have been reported in recent years, such as hypoglycemic, consumption of *C. comatus* can help regulate blood glucose concentrations. It has immunomodulation, hypolipidemic, antitumor and antibacterial effects (Bailey et al. 1984; Fan et al. 2006). Antimicrobial activity of *C. comatus* was reported by
Ershova et al. (2001) and antioxidative properties were reported by Wei and Van Griensven (2008). The water extract of C. comatus was recently identified as containing potent antitumor compounds for breast cancer (Gu and Leonard 2006). Antioxidant properties of fruit bodies, mycelia and fermentation filtrate of C. comatus were reported by Tsai et al. (2009) and of cap and stipe were reported by Li et al. (2010).

5. *Morchella esculenta* (Linn.) Pers. (Morchellaceae)

**Description:** Pileus 3.5 cm diameter, 4.8 cm long, subglobose to ovoid, pale brownish cream, pale brown to grayish brown, surface covered with rounded pits, or irregularly interwoven pits of various shapes, framed by irregular ridges following by the pits, the edges rounded, thick, usually whitish or yellowish. Stipe 3.6 cm long and 2.4 cm diam., centric, bulbous or attenuated at base, whitish at first, becoming ochraceous with age, wrinkled, grooved scurfy tufts just beneath the pileus, brittle, hollow. Flesh thin, whitish. Spore print yellow. Spores 11.5–14 × 19.5–23 µm ellipsoid.

**Specimen examined:** India, Uttarakhand, Pauri Garhwal, Nagdev Jhandidhar forest. Solitary to scattered or sometimes gregarious on the ground of mixed open wood, pastures. Specimen collected on 15th July 2010 (Figure 5).

**Medicinal Properties:** *Morchella esculenta* is an edible morel mushroom, locally known as Guchhi. It is a highly prized morel mushroom in Garhwal Himalaya consumed locally by the people. Commercial cultivation of this mushroom has not been successful till now and hence its mycelium is extensively used as a flavouring agent. In the Himalayas, morels are cooked as food and used in medicine and health care systems by the traditional societies and also used clinically. Negi (2006) discussed the nutritional value and medicinal uses of *Morchella* spp. from the Darma valley, district Pithoragarh, Kumaun Himalaya, Uttarakhand. Nitha et al. (2007) reported anti-inflammatory and antitumor activities of ethanolic extract of cultured mycelium of *M. esculenta* from Thrissur, Kerala, India. Nitha et al. (2007) confirmed its antitumor activity against both ascites and solid tumours. Methanolic extracts prepared from the mycelia of *M. esculenta* showed high antioxidant activity and relatively high content of total phenols was suggested to contribute its antioxidant capabilities (Mau et al. 2004).

6. *Cantharellus cibarius* Fr. (Cantharellaceae)

**Description:** Pileus 3–10 cm in diameter, convex at first with inrolled margin often becoming funnel shaped with a wavy margin, pale yellow to egg yolk yellow to almost orange, with a few tiny appressed fibers. Taste mildly peppery. Odour fruity. On the lower surface, underneath the smooth cap, it has Gill like ridges that run almost all the way down its stipe, which tapers down seamlessly from the cap. Stipe 3.5 cm long and 1.2 cm thick in diameter, thin, more or less equal, solid, smooth concolorous the pileus, spore print pale yellow to creamy white. Spores 7.10×4.6 µm smooth, ellipsoid.

**Specimen examined:** India, Uttarakhand, Pauri Garhwal, Khirsu forest. Solitary to scattered sometimes gregarious, in mixed broadleaved forest, mycorrhizal with hardwoods especially oaks. Specimen collected on 20th August 2010 (Figure 6).

**Medicinal properties:** *Cantharellus cibarius* is commonly known as the chanterelle or golden chanterelle. It has good antioxidant activity. Kumari et al. (2011) determined efficiency of antioxidant activity from *Cantharellus* species collected from North Western Himalayan region of India.
Figure 1: *Agaricus campestris*

Figure 2: *Ganoderma lucidum*

Figure 3: *Hydnum repandum*

Figure 4: *Coprinus comatus*

Figure 5: *Morchella esculenta*

Figure 6: *Cantharellus cibarius*
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