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Prevalence of tribal mushrooms in sal forests of Chhattisgarh

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Chhattisgarh state is well known for the largest forest area and tribal population in India. The tribal have a very close linkage with their forest habitat and familiar with a number of biological species. Among the tribal groups the Baiga is one of the most alien group, mostly confined in and around the Achankamar-Amarkantak Biosphere Reserve (ABR). These aborigine people have developed pharmacopoeia using flora and fauna and recognized a variety of mushroom as a food and medicine. The forest of ABR creates a most congenial atmosphere for occurrence several micro, macro flora and fauna, having a numbers of edible and medicinal mushrooms which have parental of providing alternatives for food and medicine. Since ABR is rich in vascular plants particularly tree species, therefore mushroom has become major component of the forest ecosystem and have important contributions to ecosystem functioning. During our systematic approach, to catalogue the indigenous tribal mushrooms diversity in ABR, numbers of tribal edible and medicinal mushroom species have been recorded, which are more nutritious, with better taste and safer i.e. without pesticide residues.

Key words: Chhattisgarh, biosphere, mushroom, sal forest, tribals

INTRODUCTION

Chhattisgarh is one of the important states of India which occupies the south eastern part of country. Geographically it is situated between 17°46 N and 24°5 North Latitude and 80°15 E and 80°20 East Longitude. It is an important state of India covering the unique tropical sal forests in its largest percentage 44% of total geographical area. The states sal forests representing primary forest in its primordial in origin and evolution, whereas *Eucalyptus, Pinus, Tectona grandis* (teak) and some other exotic species representing secondary vegetation of current period. The tropical ecosystem of Sal forest of state abound a large number of tree species along with mycological wealth.

In the world for tribal population, India has been placed second only after African subcontinent. In this context Chhattisgarh state is well known for the largest population of primitive tribal (Tiwari, 1994) population in the country, where more than 33% of its own population belongs to the schedule tribe. Most of the tribal refer to live around the forest area. They live in the forest in a symbiotic manner and are well acquainted with the biology of the forest, not in any structured form but through experience and compulsions (Rajak *et al.*, 2002). Tribal greatly depend on non-traditional food like tubers, fruits and mushrooms, because they avoid agricultural practice (Harsh *et al.*, 1990) and are not traditionally agriculturist.

It is probable that from its earliest beginning man has utilized mushrooms as a food (Rahi *et al.*, 2004). Due to the increasing realization of nutritive significance, mushrooms have been recommended by the "FAO" in solving the use the protein deficiency specially, in developing countries (Chang, 1995). Mushrooms have good flavour and texture and some are important in medicine (Buswell and Chang, 1993). They have high nutritional value

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proteins (35% dry weight) with all essential amino acid including lysine and methionine, which are commonly deficient in plant. Mushrooms also have a high proportion of unsaturated fatty acids and are a good source of several vitamins, fibers and minerals and are low in calories, sodium and cholesterol. The scientific studies have revealed that mushrooms are biochemically endowed with the ability to secrete a variety of hydrolyzing and oxidizing enzymes (Rajarathnam and Bano, 1993).

Many mushrooms have also been used in medicine for centuries especially in Asian countries where lot of work has been done on medicinal aspects of several edible mushrooms (Helpern and Miller, 2002). They are a typical source of physiologically active compounds that have been studied for the development of some natural medicines. The active constituents found in mushrooms are polysaccharides, dietary fibers, oligosaccharides, triterpenoids, peptides and proteins, alcohols and phenols, and mineral elements. Regular intake of mushroom nutraceuticals may enhance the immune response of the human body, thereby, increasing resistance to diseases (Lakhanpal and Rana, 2005).

Presently, mushroom-based nutriceuticals and dietary supplements products either of mycelia or fruiting bodies of mushrooms, are consumed in the form of capsules, tablets or extracts, due to their potential therapeutic effects. Tribal mushrooms from ABR have considerable potential as dietary supplements and for use in the prevention and treatment of various human disease without the troublesome side effects. Since the tribal has their intimate association with forests, therefore they have maximum knowledge of mushroom species of human value (Kaul 1993, Harsh *et al.*, 1993b and Kumar and Shukla, 1995). In Chhattisgarh, the hunting of mushrooms is an occupation of tribals particularly in rainy season. *Volvariella volvacea* (straw mushroom) is more common among the tribal community. The village people practiced its cultivation by their own ways using paddy straw as a substrate and bring it to local market where it fetches for good prices (Thakur *et al.*, 2003).

Potential and relevance of wild mushrooms

The diversity of climatic conditions prevalent in India made this country a natural habitat of a number of mushrooms (Sarbhoy, 1997). In India, numbers of species of mushroom have been listed by various workers (Manjula, 1983; Bhavani Devi and Nair, 1987; Saini and Atri, 1993; Verma *et al.*, 1995; Natrajan, 1995; Atri *et al.*, 1995; Lakhanpal, 1995, Doshi and Sharma, 1997). Most of these additions came from southern and northern part of India but no concerted efforts have been made for any detailed study on natural agaric flora available in Chhattisgarh Central India. Previously, Dadwal *et al.* (1989), Kumar *et al.* (1991) and Harsh *et al.* (1993a) have attempted for selective study relating collection and marketing of mushrooms of Chhattisgarh.

Chhattisgarh state occupies many eco-climatic zones on account of unique vegetational composition and associated ecological aspects such as temperature, humidity, rainfall, soil, pH and mycorrhizal association. Due to varied climatic conditions, a large number of fleshy fungi including edible mushrooms are found growing in these forests. A vast area of primary forest (sal) and secondary forest (bamboo and teak) of the state has been virtually unexplored. As regard to macromycetes it is in fact unrepresented in most of the surveys. The documentation and characterization of wild mushrooms (gilled fungi and truffles) which are found in soil, dung, plant derbies, independently or in association with particular plant species have never been conducted. Therefore, study on occurence and distribution of gilled fungi found above the ground has been made with the help of Baiga tribes who are well acquainted with the habitat and period of occurrence of these mushrooms. The study on most of the truffles is still difficult as these are found hidden below the ground surface.

MATERIALS AND METHODS

In Bilaspur district of Chhattisgarh, the study site Achanakmar-Amarkantak Biosphere Reserve (ABR) is the newly formed Biosphere reserve of the country, covering an area of 552 sq. km. lies 20°24′ 20°35′ N latitude and 81°34′ 81°85′ E longitude. It endorsed with the floristic diversity on account of its unique topography and falls under bio-geographic zone Decan Peninsula, central highlands of the country. In ABR three study sites were selected for the collection of tribal mushroom. Since the ecological conditions of the state is deteriorating at

a rate faster than anticipated, thereby, endangering depletion of a rich pool of forest areas of Achanakmar-Amarkantak Biosphere Reserve (ABR) of Chhattisgarh were made to collect and identify those mushrooms, which are found growing on the forest floor during rainy season. In present investigation an area of 500 × 5 meters was selected in each site (site - I, site - II and site - III) for the collection of mushrooms.

Site - I

This is a primary dense forest site of Diyabar road in Lamni range situated at an elevation of 450 meters. Beside the dominance of *S. robusta* (Sal) a considerable percentage of tree species *A. latifolia, B. lanzan, Diospyros melanoxylon* (tendu), *Eugenia janbolana* and *T. tomentosa* were observed. The site showed more tree species and more diverse than the site - II and site - III. In some part of the site there were true sal forest where, sal tree dominated over other tree species such as *A. latifolia, D. melanoxylon, E. jambolana* and *L. parviflora* due to plane surface area of the ABR. The prime sal forest had dense canopy, protecting from excessive radiation and temperature to the forest floor. The site had understory that is dominated by Dipterocarpaceae. The diversity of the vegetation in mixed deciduous forest was evident that a combination of soil pH, light, slope, degree of water logging and human disturbance were important in determining the level of species in general found associated with sal and other tree species for their shelter, food and forage.

Site - II

The study site is *Tectona grandis* (teak) dominated forest area of ABR in between Chhaparawa to Lamni area. This site was near Chhaparawa village and was disturbed by local people and cattle's. The area was occupied by secondary vegetation cover of *Tectona grandis* since more than 40 years age. Besides some scattered sapling of bamboo no other full-grown tree species was obtained. However, some of the seedlings and saplings of *D. melanoxylon, S. robusta* and *Cassia fistula* etc. had been recorded in this site. The site was poor in organic contents because of the lack of litter falls.

Site - III

This is site of secondary vegetation of *Dendrocalamus strictus* (bamboo) near to site of Talaidabra in Lamni range. This was one of the most disturbed sites of human interference. Bamboo had infinite uses to give a catalogue of practically every human need, even food in the form of fresh or preserved young shoots. The enormous litter fall of bamboo maintained the organic content for mushroom growth.

The collections were made periodically from the tribal inhabiting sites of ABR during the monsoon season of 2005-2008. During collection, important field notes on ecological features, macroscopic characters were recorded. Information on edibility and other uses of mushroom species was also obtained by contacting head of villages, local inhabitants of the area from where the species were collected and also from the tribal and urban markets where mushrooms were kept for sale. Macroscopic studies of fresh collection of mushrooms were performed and distinguishing characters of the pileus, gills, stipe, veil, annulus, volva along with odour and taste had been noted. Since spore print and its colour were also important criterion in the taxonomy of mushroom, spore print of freshly collected mushroom was obtained on half black and half white paper. All the collected mushrooms had been preserved wet in Alcohol formalin solution and dry. The specimens were dried the some day in a hot air drier. The completely dried specimens were packed in 6" × 4" sized polythene packet along with naphthalene balls to avoid insect pest attack. These polythene packets were labeled and stored in a cool dry place. The specimens were studied in detail for their microscopic character which included basidiospores, hymenium and cuticle/context of pileus and stipe. Identification of the agarics was based on macroscopic and microscopic characters with the help of available literature.

RESULTS AND DISCUSSION

In present investigation sixteen numbers of edible mushrooms were identified from different sites of ABR (Fig. 1). Numbers of mushrooms in association with sal forest were ruthlessly harvested for their marketing. Site - I, with native tree species of *Shorea robusta, Anageissus latifolia, Diospyrous melanoxylon, Eugenia. jambolan, Legerestonia parviflora, Terminalia tomentosa, T. chebula, T. belerica, Butea monosperma and B. superbaa* had been attributed for maximum bushroom diversity.

Table 1. Most prevalent edible tribal mushroom species of Chhattisgarh

Mushroom species	Local Name
Agaricus sp.	Dharti Phool
Agaricus sp.	Dharti Phool
Calvatia sp.	–
Cantharellus sp.	Bans Pihari
Lentinus sp.	Lakri Pihari
Lycoperdon sp.	–
Amanita vaginata	Sua Munda
Russula delica.	Sarai Pihari
Russula pseudodelica	Sarai Pihari
Pleurotus florida	
Termitomyces microcarpus	Kanki Pihari
Termitomyces striatus	Dilwa Pihari
Termitomyces heimii	Dilwa Pihari
Volvariella volvacea	Para Pihari
Sinotermitomyces sp.	Putu
Rhizopogon sp	Gol putu

Table 2. Potential utilization of tribal mushrooms of Chhattisgarh by tribals

Mushroom sp.	Local Name	Potential utilization
Agaricus sp.	Gobari Pihari	For treatment of goiters edible purpose
Cantharellus sp.	Baans Pihari	Tonic for easy delivery for women / eating purpose
Russula sp.	Sarai Pihari	Healing wounds/eating purpose
Termitomyces microcarpus	Kanki Pihari	Tonic for weakness/ eating purpose
Termitomyces sp.	Raj Bhoru	Tonic for easy delivery for women / eating purpose
Calvatia cyathiformis	Dharti Phool	Used for healing wounds
Lycoperdon sp.	–	Used for coagulation of blood

Table 3. Occurrence of tribal mushroom in different sites

Mushroom sp.	Site 1	Site 2	Site 3
Agaricus sp.	+	–	–
Agaricus sp.	+	–	–
Calvatia sp.	+	–	+
Cantharellus sp.	+	–	+
Lentinus sp.	+	–	+
Lycoperdon sp.	+	–	–
Amanita vaginata	+	+	+
Russula delica.	+	+	+
Russula pseudodelica	+	+	+
Pleurotus florida	+	–	+
Termitomyces microcarpus	+	+	+
Termitomyces striatus	+	+	–
Termitomyces heimii	+	+	–
Sinotermitomyces sp.	+	+	+
Volvariella volvacea	+	–	–
Volvariella sp.	+	–	–
Schizophyllum communae	+	+	+
Rhizopogon sp.	+	–	–
Boletus sp.	+	–	+

Amanita vaginata, Lycoperdon sp., *Rhizopogon* sp., *Russula delica, R. pseudodelica, Cantharellus* sp and *Boletus* sp., species were ectomycorrhizal mushrooms, which had permanent association with particular tree species for their annual recurrence. The site-II of secondary forest of *Tectona grandis* (teak) recorded for lesser number of mushrooms. No ectomycorrizal association of mushroom species had been recorded in association with teak tree species. The site - III secondary forest of *Dendrcalamus stricta* (bamboo) was some what better habitat rather than site - II of teak forest (Table 3).

The change in population structure particularly in secondary vegetation of teak is attributed to the variation in microclimatic conditions such as temperature, humidity and light intensity. The steep terrain, structural diversity and the fire practice reflect not only the absence of mushroom species but also other ground flora and fauna in the site - II. The removal of primary forests has caused to changes in the amount of heat, light, and moisture available to the mushrooms reducing the inoculums source for future mycorrhizal associations. Therefore, selected saprophyte mushroom species were obtained in association with teak and bamboo sites.

The site - I, ensured the retention or development of large old trees as an integral part of sal forest. These trees were needed to act as host trees for fungal groups that required large old trees. They provided large woody ground debris to host the saprophytic fungi. Therefore, without knowing the biological relationship one should not go for removing all tree species from primary forests and mass afforestation program as teak plantation had been taken over in ABR. In ABR the soil was acidic in nature which in general caused a wider range of stress symptoms particularly to teak which is of alkaline soils. The soil of ABR was generally deficient in calcium, magnesium and potassium. The concentration of nitrogen is also low as bacteria involved in fixing this nutrient required calcium in order to function. Thus in acidic soil conditions, the increased solubility of iron, aluminum, manganese and some metal compounds leading toxicity symptoms to timber tree teak which couldn't gain its full girth after a long period of 40-50 years. And economic benefits that the sal

Fig. 1. – Tribal mushrooms.

1. *Amanita vaginata*, 2. *Amanita pantherina*, 3. *Amanita emilii*, 4. *Amanita* sp., 5. *Amanita* sp., 6. *Russula* sp., 7. *Russula* sp., 8. *Russula* sp., 9. *Russula* sp., 10. *Russula* sp., 11. *Lactarius* sp., 12. *Inocybe* sp., 13. *Cantharellus* sp., 14. *Rhizopogon* sp., 15. *Scleroderma* sp.

forests provide couldn't be gained from secondary teak forests.

In ABR there are *Amanita vaginata, Agaricus* sp., *Cantharellus* sp., *Clitocybe* sp. *Ganoderma lucidum, Lactrius* sp., *Lentinus edodes, Lycoperdon* sp., *Pleurotus florida, Russula delica, Scleroderma* sp., *Termitomyces striatus., Termitomyces heimii, Sinotermitomyces* sp., *Volvariella volvacea* had a better market in metropolitan cities and even abroad. Presently, over harvesting of wild mushrooms in successive years had created a great loss to the tribals, who used mushrooms as food, medicine and for the marketing. The loss of mushrooms (ectomycorrhiza) seed-bank had also disrupted the symbiotic relationship of forest trees. The understanding of below ground diversity of this group of mushroom can be strongly related to the nutrient input the broad leaf forest tree species (sal, saja, bija, bahera, harra etc). Quite obviously, site - 1 horizon indicating nutrient leaching where both mycorrhizae and mushroom development occurred in the soil horizon. The fungal mats of white and gray mycelium present at the forest floor helped in the process of mineralization. This was a degree of specificity between native broad leaf tree species and mycorrhizal mushrooms. The sal tree seems to be most dependent on a suit of mycorrhizal mushrooms and other fungi for its growth. In this regard the *ex-situ* conservation of mushrooms under artificial conditions would be a viable alternative for maintaining mushroom deversity in state's forests.

Mushrooms diversity also gives a great value to the forests economics which can be seen in litter degradation, supply of nutrients to ground flora (herbaceous medicinal plants), but there are just as many economists who does not look positive the economic impact of mushrooms on local communities. The poor tribals also rely on the non-taxed income generated by the wild mushrooms. This social disparity explains the fact that in mushrooms over-harvesting the social of baiga tribe population over exploited by the traders for commercial benefit. Keeping in mind the demand and lucrative prices the traders rush even in to inaccessible sites of tribals. This has led to conflicts between traders and foresters who follow the mushroom harvest through tribals. However, in over exploitation practice it seems difficult to protect hidden treasure of tribals and to get rid of trader pressure in ABR.

Presently, mushroom has potential nutritional and medical interest, as their metabolites release substances (enzymes) active upon a given function of the body or efficient for inhibiting development of the parasites and they may improve human health by supplying trace elements and vitamins. Thus particular products of numbers of mushrooms have developed a good market. Therefore, state forests along with tribal population could be utilized for higher production volumes of edible and medicinal mushrooms. This would be a new challenging opportunity employment to the poorest tribals.

In ABR forest, a variety of mushrooms grow abundantly as a food and medicine. And many of which are still not known out side the state, which may have potential of providing alternatives for food and medicines. In this regard scientific information of indigenous mushrooms is essential to reach at the grass roots level in general populace of the state. In this direction, it is not enough to introduce legislation to protect gene pools by prohibiting destruction of forests and banning the export of genetic material. More crucial is to know the types and value of organisms such as mushrooms, which sustain soil environment for high productivity.

In present study many edible mushroom are recorded as medicine which is used by tribals. *Cantharellus* sp. is very popular mushroom among them and is used as tonic for easy delivery. *Russula* sp. is commonly found and used for healing wounds, *Termitomyces microcarpus* is found in bulk during rainy season and used as a tonic for weakness beside their eating purpose. *Termitomyces* sp. is used as tonic for easy delivery, whereas *Lycopedon* is to be used in blood coagulation.

Conclusively, tribal mushroom harvesting sites of primary sal forests are being lost due to felling down native tree species. Therefore, unless the sal and its wild relative tree species are not protected and managed in a sustainable way along with tribals, the non-native traders and others will lose these tribal mushrooms of nutritional and pharmaceutical importance.

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