Sal Forest: A Source of Wild Edible Mushrooms for Livelihood Support to Tribal People of Dindori District, Madhya Pradesh, India


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Abstract

Information on wild edible mushrooms was collected from sal forests of Dindori district, Madhya Pradesh by visiting different sites in forest areas. Rural folk/tribal people were contacted and information was recorded by personal interviewing. Commonly collected mushrooms from sal were: Astraeus hygrometricus, Russula congoana, Termitomycetes clypeatus, T. eurhizus, T. microcarpus and Termitomycetes sp.

Keywords

Central India, Edible mushrooms, Mushroom hunting, Termite mounds

Introduction

Edible mushrooms belong to genera Astraeus, Russula and Termitomyces are used in food by Baiga and Gond tribes of Dindori district, Madhya Pradesh. The gasteroid fungus Astraeus hygrometricus was reported as early as in 18th century as Geastrum (Persoon, 1801). Till date 10 species are known which include: Astraeus asiaticus, A. koreanus, A. morganii, A. odoratus, A. pteridis, A. sirindhorniae, A. smithii, A. telleriae and A. thailandicus. The genus has worldwide distribution especially in the sandy soils forests of Africa, Asia, Australia, Europe, Mexico, North America and South America (Pavithra et al., 2015). A. hygrometricus is distributed in 11 Indian states of India including, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Odisha, Punjab, Uttarakhand, Uttar Pradesh and West Bengal (Verma et al., 2017a). Eight species of gilled mushroom, Russula, namely R. congoana, R. crustosa, R. lepida, R. lutea, R. olivacea, R. parvovirens, R. senecis and R. virescens were reported to be edible (Verma et al., 2018). Edible mushrooms, A. hygrometricus, R. lepida, T. eurhizus, T. heimii, T. microcarpus were reported to be collected from sal (Shorea robusta) forests by local
people and Tibetan residents in Dehradun, Uttarakhand (Semwal et al., 2014). Twelve species of Russula including some edible species (R. congoana) were reported from Kerala (Mohanan, 2014). Genus Termitomyces was established in 1942 (Heim, 1942) and its various species are reported to be edible for most people. These mushrooms grow on 'combs' which are formed from the termites' excreta, dominated by tough woody fragments (Makonde et al., 2013).

Edible species of Termitomyces include: T. albuminosus, T. clypeatus, T. globules, T. heimii, T. microcarpus, T. sagittiformis, T. striatus, etc. Termitomyces eurrhizus is a wild edible mushroom used by ethnic tribes of Nagaland (Bhaben et al., 2011) and it was also reported from a market of Midnapur, West Bengal (Purkayastha and Chandra, 1975). Eighteen edible Termitomyces species were reported from Western Ghats (Karun and Sridhar, 2017). Role of wild edible mushrooms collected from Shorea robusta forest ecosystem by the Santal in lateritic region of West Bengal was studied and inventoried (Pradhan et al., 2010; 2013a, b).

Information on collection and utilization of this mushroom were also available from Nepal and Japan (Christensen et al., 2008, Fangfuk et al., 2010).

Studies were conducted in dry deciduous forests of lateritic eastern parts of India on economic contribution of wild edible mushrooms of a forest fringe ethnic community (Manna and Roy, 2014) and its tribal relation to spatio-temporal variation were reported (Manna et al., 2014).

In the present study an estimate of edible mushrooms (Astraeus, Russula and Termitomyces) collected by local and tribal people from sal forest of Dindori district, Madhya Pradesh and their role in economy of rural folk is given.

Materials and Methods

Study sites

Dindori is a district of Madhya Pradesh state of central India it is situated on the eastern part of the state. The district is surrounded by Shahdol in the East, Mandla in the West, Umaria in the North and Bilaspur and Kawardha (Chhattisgarh) in the South. It is located at 22.95°N 81.08°E and an average elevation of 640 metres (2,099 feet). The total area of the district is 7,470 sq. kms and is surrounded by herbal rich Maikal mountain ranges. It is divided into seven blocks namely Dindori, Shahpura, Mehandwani, Amarpur, Bajag, Karanjiya and Samnapur (http://www.dindori.mp.gov.in). About 64% of the population belongs to tribal communities like Koel, Gond, Korwa, Baiga, and others. The timber trees of district are: sal, saj, amla, teak, tendu and tinsa. In addition of this, dhawda, bija, lencha, hardu and koha are common trees found throughout the district. Bamboo is also rarely available in the district. The sal trees are grown most luxuriantly in sandy soil, especially in Dindori and its neighboring districts. Specimens of edible mushrooms were collected from different places sal forests of Dindori district for microscopic study. Information on sale of mushrooms were collected from Bajag, Bhilania, Chada, Chandnalalpur, Chada road (near forest range office), Tarach, Chakrar, Gadasarai, Gorakhpur, Jhigri, Labeda, Karonjia, Nevsa (Amarkantak road) and Rusa of Dindori district in Madhya Pradesh (Fig. 1).

Collection of mushroom

Edible mushrooms were collected by local people during rainy seasons mainly from sal forests and its associate tree species during rainy season (July-Sep). The immature fruit bodies of Astraeus hygrometricus were collected from sal forests during early (June)
to late monsoon (August) (Fig. 2). Mature open fruit bodies with wings are not edible (Fig. 3). Under sal trees careful observation were made to locate cracks on soil surface and with white matrix. The scratching of soil surface was done below the crack surface to locate the immature fruit bodies with the help of iron or wooden tools. The immature basidiomata were solitary or in cluster of 4-10, fully or partially buried (0.5-1cm deep) in soil and/ or sometimes visible along with pebbles of laterite soil as bone-white mycelial mass (Verma et al., 2017a). Termitomyces species are deeply rooted and arises from termite mounds. For collection of these mushrooms soil is deeply dug with the help of pointed wooden (preferably bamboo) or iron ram (Fig. 4, 5). The dug out mushroom along with long stipes were collected, wrap in mahul patta (Bauhinia vahlii) or bound in bundles for sale. Fruit bodies of Russula species are easy to collect, the fruit bodies are plucked from the soil surface by hand.

Collection of information on mushrooms

Local markets were visited for collection of information on sale of mushrooms. Local village markets and road sides were also observed for sale of mushrooms. Information was collected from mushrooms sellers/collectors. 10 local mushroom collectors/sellers were contacted and information on collection of wild mushroom was collected (Table 4).

Processing of specimens and microscopic study

Some parts of collected samples were preserved in 70% alcohol just after collection for microscopic study. The fruit bodies of fungi were dried under the sun or in the wooden box lighted with 100W electric bulb. Microscopic slides were prepared by using stain, mountant, clearing and softening chemicals. Slides were observed under advanced research microscope (Leica, Germany) using 5x, 10x, 20x, 40x objectives and 10x and 15x eyepieces. Observations under phase contrast and dark field were also made whenever required. Photomicrography was done with the help of a digital camera (make, Leica) attached to the advanced microscope.

Identification of mushrooms

Identification of fungi has been done with the help of published literature, monographs, books, keys, etc. (Ahmad, 1950; Christensen et al., 2008; Dring, 1964; Fangfuk et al., 2010; Hembrom et al., 2014; Karun and Sridhar, 2014; Mohanan, 2011; Pavithra et al., 2015; Phillips, 2006; Pradhan et al., 2013a, b; Pyasi et al., 2011; Semwal et al., 2014; Surcek, 1998).

Results and Discussion

Information on wild edible mushrooms occurring in sal forests of Dindori district, Madhya Pradesh were conducted and mushroom collected by local people for their self use and for sale in local markets were collected. Mushroom is being frequently collected from sal forest belongs to 3 genera namely; Astraeus (Fig. 2), Russula (6) and Termitomyces (Figs. 7-10), these mushrooms were collected on large scale (Table 1). Besides these few species of Amanita and Pleurotus were also collected on small scale. Information on sale of these mushrooms in local markets and road side were also collected from different areas including, Bajag, Chada, Chakrar, Chandnalalpur, Jhigri, Karanjia, Labeda, Nevsasal and Rusa villages (Table 2, 3). These places were personally visited and information was collected. 10 persons were interviewed and data on collection and marketing of mushroom was collected.
The local people collect immature fruit bodies of *A. hygrometricus* (also known as ‘Sehula’ in Uttar Pradesh meaning mushroom from sal forest and ‘Puttu’ in Madhya Pradesh) during June-September and the highest yield obtained during July-August. Local people identify troops of *A. hygrometricus* by scratching the surface of soil and looking for white matrix. Wherever white matrix seen on the surface or subsurface, it is a perfect indication that troops of immature fruit bodies prevail in its surroundings. Local family members harvest tender *A. hygrometricus* during rainy season and female members were likely to sell in local markets (Fig. 12-13). Probability of finding mushrooms is likely to be more in open and buffer zones as compared to typical forest locations. *Termitomyces* species were collected by all family including children (especially female members) (Fig. 14). Harvested mushrooms are collected in bamboo baskets (Figs. 15-16). The harvested mushroom is cleaned with water to remove debris and hairy structures on the surface. The mushrooms are wrapped in mahul patta or make bundles (Fig. 17-18) and sold on the road side, if buyers are available (Fig. 19). Collected tender mushroom reaches to the local markets or road sides on the same day (Figs. 20-23). Sale of *Termitomyces* mushroom was also noticed along with vegetable of tree origin (Menhar) at Bajag in Dindori (Fig. 22). Usually cleaned mushrooms will be cooked and consumed on the same or subsequent day. In the present study data on

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Botanical name</th>
<th>Local name of mushroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Astraeus hygrometricus</em></td>
<td>Puttu, Rugra</td>
</tr>
<tr>
<td>2.</td>
<td><em>Russula congoana</em></td>
<td>Sarai Pihari</td>
</tr>
<tr>
<td>3.</td>
<td><em>Termitomyces clypeatus</em></td>
<td>Chirko Pihari</td>
</tr>
<tr>
<td>4.</td>
<td><em>Termitomyces eurhizus</em></td>
<td>Bhondo Pihari</td>
</tr>
<tr>
<td>5.</td>
<td><em>Termitomyces</em> sp.</td>
<td>Raj Bhondo Pihari (big size)</td>
</tr>
<tr>
<td>6.</td>
<td><em>Termitomyces microcarpus</em></td>
<td>Bhat Pihari</td>
</tr>
</tbody>
</table>
Table 2: Market survey and collection of information on edible mushrooms collected from sal forests of Dindori district, Madhaya Pradesh

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Name of mushroom</th>
<th>Place of collection</th>
<th>Period of collection</th>
<th>Family member involved in collection of mushroom</th>
<th>Estimated quantity of mushroom collected/day/family (kg)</th>
<th>Market price per kg (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Termitomyces</em></td>
<td>Bajag road, Lalpur</td>
<td>July- Aug.</td>
<td>2-3</td>
<td>4-6</td>
<td>250-350/-</td>
</tr>
<tr>
<td>2.</td>
<td><em>Russula</em></td>
<td>Tarach, Bajag</td>
<td>July- Aug.</td>
<td>1-2</td>
<td>3-5</td>
<td>60-150/-</td>
</tr>
<tr>
<td>3.</td>
<td><em>Termitomyces</em></td>
<td>Tarach, Bajag</td>
<td>July- Aug.</td>
<td>3-4</td>
<td>2-5</td>
<td>250-350/-</td>
</tr>
</tbody>
</table>
| 4.   | *Astraeus hygrometricus* | Chada | June-Aug. | 4-5 | 10-12 | 60-100/-
| 5.   | *Russula*        | Chada               | July-Aug             | 3-4                                             | 6-8                                                 | 60-150/-                 |
| 6.   | *Astraeus hygrometricus* | Gadasarai | June-Aug. | 3-4 | 10-15 | 60-100/-
| 7.   | *Termitomyces*   | Gadasarai           | July-Aug             | 2-3                                             | 5-6                                                 | 200-350/-                |
| 8.   | *Astraeus hygrometricus* | Nevsa, Purani Dindori | June-July          | 4-5                                             | 6-7                                                 | 60-100/-                 |
| 9.   | *Astraeus hygrometricus* | Chada road, near Bajag | June-Aug | 2-3 | 5-6 | 60-100/-
| 10.  | *Termitomyces* sp. | Bhilania, Bajag     | July-Aug             | 3-4                                             | 0.80-1.0                                             | 320/-                    |
| 11.  | *Termitomyces* sp. | Chada road Bajag    | July-Aug             | 4-5                                             | 1.5- 2.0                                             | 250-350/-                |
| 12.  | *Termitomyces* sp. | Ladbena, Chada Road | July-Aug             | 3-4                                             | 2-3                                                 | 200/-                    |
| 13.  | *Termitomyces* sp. | Chada Road, in sal forest | July-Aug | 3-5 | 2-3 | 200-300/-
| 14.  | *Termitomyces* sp. | Amarkantak Road, Rusa, Karanjia | July-Aug | 2-3 | 2-3 | 200-350/-
| 15.  | *Astraeus hygrometricus* | Amarkantak Road, Gorakhpur, Karanjia | June-Aug | 2-4 | 8-10 | 80-100/-
| 16.  | *Termitomyces heimii* | Amarkantak Road, Gadasarai | July-Aug | 1-2 | 2-2.5 | 280-300/-

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Table.3 Name of persons who provide information on mushroom along with address

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Name of person</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Arjun Singh Saler</td>
<td>Chada road, near Forest range Office, Bajag,</td>
</tr>
<tr>
<td>2.</td>
<td>Budhvaria Bai.</td>
<td>Gram – Chada, Bajag, Dindori, Madhya Pradesh</td>
</tr>
<tr>
<td>3.</td>
<td>Dhansingh Maravi</td>
<td>Gram – Chakrar, Karanjia block, Dindori, Madhya Pradesh</td>
</tr>
<tr>
<td>4.</td>
<td>Govindsingh Dhurve</td>
<td>Gram – Chada, Bajag, Dindori, Madhya Pradesh</td>
</tr>
<tr>
<td>5.</td>
<td>Indravati</td>
<td>Gram – Chada, Bajag, Dindori, Madhya Pradesh</td>
</tr>
<tr>
<td>6.</td>
<td>Laliyabai and Kalavati</td>
<td>Gram - Chandnalalpur, Jhigri, Rusa, Dindori, Madhya Pradesh</td>
</tr>
<tr>
<td>7.</td>
<td>Raisingh</td>
<td>Gram – Chada, Bajag, Dindori, Madhya Pradesh</td>
</tr>
<tr>
<td>8.</td>
<td>Raju Rathour Saler</td>
<td>Nevs, Amarkantak Road, Purani Dindori, Madhya Pradesh</td>
</tr>
<tr>
<td>9.</td>
<td>Ramkalibai and Premvati Paraste</td>
<td>Gram – Jhigri, Rusa, Dindori, Madhya Pradesh</td>
</tr>
<tr>
<td>10.</td>
<td>Shobhit Singh Aarmo</td>
<td>Gram - Labeda, Bajag, Dindori, Madhya Pradesh</td>
</tr>
</tbody>
</table>

Fig.1 Study area (study spots shown with black dots)

Fig.2&3 *Astraeus hygrometricus*: 2. Hypogenous and edible fruit bodies, 3. epigeous and open fruit bodies in their natural area (not edible)
**Fig.4&5** Termitomyces: collection of mushroom by digging soil in sal forest

**Fig.6** *Russula congoana*, fruit body growing in sal forest

**Fig.7,8&9** Termitomyces: Young fruit body from termite mount

Figures 6: Mushrooms collected from sal forest by local and tribal people for their consumption and sale in local market
**Fig.10&11** *Astraeus hygrometricus:* collected from sal forest and sale in local market along with other vegetables at Dindori, Madhya Pradesh

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**Fig.12&13** *Astraeus hygrometricus:* 11 a Tribal family with collected mushroom, man showing edibility of mushroom by eating it raw and 12 selling of mushrooms (*Astraeus hygrometricus* and *Termitomyces*) in local market collected from sal forest of Dindori, Madhya Pradesh by local women

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**Fig.14** *Termitomyces:* tribal family members including children on trip of mushroom hunting from sal forest, Dindori, Madhya Pradesh

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Fig.15 & 16 Termitomyces: 14, a tribal lady along with collected mushroom from sal forest, Dindori, Madhya Pradesh, 15, mushroom kept in bamboo basket for carriage

Fig.17, 18 & 19 Termitomyces: selling of mushroom at road side at Dindori–Chada road, Madhya Pradesh

Fig.20 & 21 Termitomyces: sale of mushroom at local market in Dindori, Madhya Pradesh
Fig. 22&23 Termitomyces: 22 sale of mushroom along with vegetable of tree origin (menhar) and 23 sale of mushroom at Bajag, Dindori, Madhya Pradesh

Some Amanita mushrooms were also collected from sal forest. Vrinda et al. (2005) also reported collection of edible Amanita from Western Ghats of Kerala. Recently seven edible species of Russula including: Russula crustosa, R. lutea, R. lepida, R. olivacea, R. parvovirosescens, R. senecis and Russula virescens were listed from different parts of India (Verma et al., 2018b). R. senecis is the mushroom frequently collected by tribes in West Bengal. This mushroom was originally reported from Japan and also frequently reported growing in association with Vateria indica in dipterocarp forests of Western Ghats and mixed forests of Sikkim, Himalayas (Khatua et al., 2015).

When bulk quantity of mushrooms was collected, it can be preserved under soil up to 3-4 days and desired quantity will be fetched for daily use. This indigenous method of preservation is also in practice in Eastern lateritic parts of India and the highest yield was during July (Manna et al., 2014; Manna and Roy 2014). Astraeus hygrometricus is generally collected from sal forest of central India in bulk and sold in local markets (Figs. 10-13). Another species of this genus, Astraeus odoratus mushroom which formed ecto-mycorrhiza with trees was also collected mainly from the fire affected scrub jungle of lateritic soils in Konaje, Karnataka, (Pavithra et al., 2015).

This mushroom was also associated with tree species like Shorea robusta in Rajmahal Hills and Dalabari region of Jharkhand (Hembrom et al., 2014). Burning reduces the diversity of saprophytic macro-fungi, but ectomycorrhizal mushrooms survive in subsoil along with roots it support the growth of selected macro-fungi like, A. hygrometricus in northern Thailand (Sysouphanthong et al., 2010). This is one of the highly prized mushrooms costing Rupees 300–500 per kg. In Northern Thailand, yield of A. odoratus was significantly increased in burnt floors of dipterocarp-oak forests and serve as an important culinary delicacy as well as household income (Kennedy et al. 2012).

In conclusion, mushrooms belonging genera, Astraeus, Russula and Termitomyces were collected by local and tribal people from sal forest of Dindori district and sold in local markets. Thus the sal forests provide a source of income to local inhabitants in the form of wild edible mushrooms.
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