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Mushroom diversity conservation through tribal women in Achanakmar-Amarkantak Biosphere Reserve

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Achanakmar-Amarkantak biosphere reserve has a very high concentration of tribal population. Some of the major tribal communities found in the region are Gonds and their sub-tribes like Madia, Mudia, Gurva, Agariya, Rajgond, Baigas, Kol, Kanwar, and Pradhans. The aim of the study is to analyse collection pattern and conservation of edible wild mushrooms by tribal women which focuses on the equitable allocation of forest benefits, fair decision-making processes, and sustainable utilization of the forests. The tribal women communities largely collected wild species like *Agaricus trisulphuratus* (Berk.), *Astraeus hygrometricus* (Pers.) Morgan, *Amanita muscaria* (L: Fr.) (Hook.), *Geastrum quadrifidum* (Pers.), *Calvatia craniiformis* (Schwein.) Fr., *Clitocybe* robusta (Fr.) Staude, *Clitocybe geotropa* (Lucien Quélet.), Coprinus *comatus* (O. F. Müll.) Pers., *Geastrum spp* (Pers.), Macrolepiota *dolichaula* (Berk. and Fr.), *Pulveroboletus shoreae* (Singh and Singh), *Podabrella microcarpa* (Sathe & J. T. Daniel), *Russula apida* (Pers.), *Russula crescens* (Pers.), *Termitomyces robustus* (Beeli) R. Heim, *Lactarius picinus* (A. H. Sm. & Hesler), *Volvariella volvacea* (Bul.) Singer. A study was carried out on different ranges of Achanakmar-Amarkantak Biosphere Reserve. The occurrence of these wild fungi varies with habitat and climatic conditions. These naturally occurring edible wild mushrooms can be collected and may be used as a staple food for human consumption or even marketed like other minor forest products, and have excellent potential to add to the tribal economy. The findings indicated the edible wild mushroom diversity is very rich in Chhattisgarh. In monsoon, the other NTFP are difficult to access from the forest, so mushrooms can give good alternate for their income. The tribal women actively participate in most of the collection, marketing, and conservation processes.

Keywords: Achanakmar-Amarkantak Biosphere Reserve, Collections, Edible mushrooms, Rural livelihood, Sporophores

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With 59700 square km of its 1.35 lakh square km of land covered by forest, Chhattisgarh is one of the Indias's main forest states. There are 20379 villages in the state with 11187 of thes situated only 5 km from the fringe of a forest. More than 80% of the village inhabitants are tribals, and the forest provides a significant portion of their income.

The societal construction of gender roles has given Chhattisgarh's women a special place in the nation's economy. According to data from the 2001 census, the population's sex ratio is 990 women for every 1000 men.

The usage of biological products from the wild is widespread, affecting millions of people worldwide[1,2], These goods also known as non-timber forest products (NTFPs), are gathered for both commercial and domestic usage, either on a regular basis or as a last resort in times of emergency. They improve peoples' livelihood security, particularly for rural residents and indigenous women. NTFPs may also be of significant cultural importance and value[3,4]. We define NTFP broadly to cover any biological resource that rural people acquire for small-scale direct consumption or revenue production from the wild. Edible wild mushrooms are traditionally used in many countries as food and medicine.

Gonds (Maria, Mudia, Gurva, Agariya, and Rajgond sub-tribes) and Baiga, Kol, Kawar, and Pradhans are tribal women who have a thorough understanding of the area's wild resources, particularly its wild mushrooms. The fleshy and palatable fruit bodies of some species of macrofungi are known as edible mushrooms. Humans eat edible mushrooms because of their nutritional value. Some

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fungus can be consumed for medicinal purposes. Because edible mushrooms have a greater mineral content than meat, fish, and the majority of vegetables, they are regarded as nutritious meals[5] (In addition, fresh mushrooms provide roughly twice the amount of protein as vegetables[5], as do wood logs, bamboo tree trunks, and leaf litter. Mushrooms in particular have been recognised as items of sustenance dating back to prehistoric times. In addition to being thought of as a possible source of proteins, amino acids, vitamins, and minerals, mushrooms offer exquisite tastes. Several fleshy mushrooms arise in grassland, deserted places, and woods on decomposing organic materials during the rainy season. Tribes collect the naturally occurring fleshy mushrooms, use them for food, and sell them in the neighbourhood market[6]. In this study, we studied the sale and conservation of edible wild mushrooms by tribal women of the Achanakmar-Amarkantak Biosphere Reserve.

Methodology

Study area

The Achanakmar-Amarkantak Biosphere Reserve is one of India's premier biospehere reserves. The reserve is spread in 3835.5189 square kilometres area and is located in almost the northern region of the Biogeography zone 6 and Province 6a (Deccan peninsula, Central highlands). The Achanakmar-Amarkantak Biosphere Reserve is located between latitudes 22'15' and 22'58' N and longitudes 81'25' to 82'5' E. About 68.10% of the total area of these reserves is located in Chhattisgarh's Mungeli district. The reserve has a tropical climate, and the year is clearly divided between the dry, wet, and winter seasons. Within the yearly cycle, the mean monthly minimum temperature ranges from 10.9°C to 25.6°C and the mean monthly maximum temperature from 24.1°C to 42°C. With a mean monthly range of 6.63 mm to 359.88 mm, the average annual rainfall is 1322 mm, with around 85% of that falling between mid-June and September. One of the important watersheds in peninsular India is the region of the Achanakmar-Amarkantak Biosphere Reserve. It divides the rivers that go into the Bay of Bengal and the Arabian Sea. The reserve is quite distinct as it serves as the river origin of several significant rivers, including the Narmada, Johilla, and Sone of the Ganga basin.

The entire area of Biosphere Reserve has been divided into eleven ranges: Lamni Range, Achanakmar Range, Game Range, Lormi Range, Kota Range, Khudia Range, Belgehana Range, Khodri Range, Marwahi Range, Gorela Range and Lamni Range.

The biosphere reserve region has a population density of 177 people per square kilometre. The Area's gender distribution is much higher than the 976/1000 male national average. Less than 25% of people are literate (Male-37 & Female-13). The geographical area is 3835.51 sq km and is divided into 7 development blocks in 3 civil districts. It is largely comprised of agricultural rural settings with a prevalence of woods suggestive of its inter-land condition.

According to the 1991 Census, the area's total population was 3,38,738, of which 54.11% and 6.90% were members of Scheduled Tribes (ST) and Scheduled Castes, respectively. Tribal people predominate in the area as a result. Agriculture, albeit still in its infancy, is the primary activity of the vast majority of people. Due to the lack of irrigation facilities in the area, rain-fed farming is the predominant method used.

In the area, flow irrigation is inadequate. According to the region's occupational distribution, over 88% of the population is directly or indirectly reliant on agriculture, which is further broken down into cultivators (69.25%) and agricultural labourers (27.3%). Only 4.0% and 8.2% of the population, respectively, are supported by the secondary and tertiary sectors, which urgently need improvement.

Land use pattern

According to statistics on land use and forest cover, 61.1% of the biosphere reserve's total geographic area is located in the districts of Bilaspur (16.2%), Anuppur (16.2%), and Dindori (15.7%). According to the land use research, woods make up 66.31% of the total area (2423.54 sq km), agricultural areas make up 34.03% (1305 sq km), and wastelands make up the remaining 1.36%, or 52.22 sq km alone (Fig. 1). With reference to the forest type, closed forests represent the largest area (55.35%), followed by open forests (4.53%), degraded forests (2.45%), and forest blanks (0.85%), in that order[7]. Since every type of land use outside industrial states is possible, there is a huge possibility to apply sustainable, environmentally friendly technology to a variety of land uses under the Biosphere Reserve Programme.

Interviews

The interviews were semi-structured having a set of questions that were put to the selected tribal

Communities to ascertain their views on historical background, harvesting technique, traditional usage, edibility status, methods of drying, preservation, and marketing of fleshy fungi. An effort was made to reach the key informants, people who were known to collect and sell edible mushrooms as natural resource wealth in a sustainable way. Repeated interviews were conducted to substantiate and authenticate the information.

11 ranges of Achanakmar Amarkantak Biosphere Reserve 33 village were selected for the study. In all ranges 200 or more households were by interviews with key informants and group participatory rural appraisal exercises. Villages surrounded by the forest were selected based on the purposive sampling method using the criteria of rural families engaged in the mushroom collection. In most of the studies reviewed in the local market survey and calculated the quantity per day. Sometimes personnel interviews in the collection site were also visited for studying the method of collection.

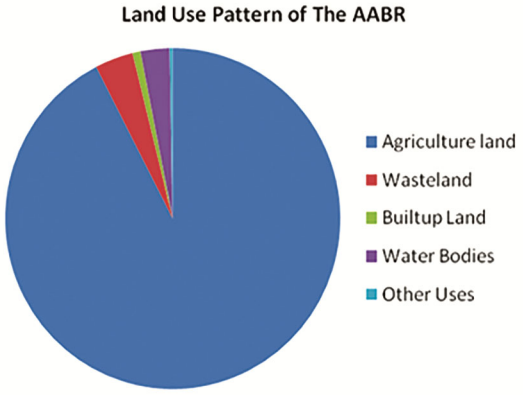

Fig. 1 — Land Use Pattern in the Achanakmar-Amarkantak Biosphere Reserve

Results and Discussion

In the present study, surveys were made for the identification, collection, harvesting technique, and marketing of fleshy mushrooms in different localities of the woman in Achanakmar-Amarkantak Biosphere Reserve. Edible wild mushrooms sporophores were described by following the standard procedure. In all cases, a pictorial atlas of soil and fungi (Tsuneo Watanabe) was followed. Some mushrooms collectedd by tribal women like Gonds, Baiga, Kol, Kawar, and Pradhans are summarized in Table 1 and are briefly described. There is a high diversity of mushrooms in the Achanakmar-Amarkantak Biosphere Reserve forest like *Agaricus trisulphuratus* (Berk.), *Astraeus hygrometricus* (Pers.) Morgan, *Amanita muscaria* (L: Fr.) (Hook.), *Geastrum quadrifidum* (Pers.), *Calvatia craniiformis* (Schwein.) Fr., *Clitocybe* robusta (Fr.) Staude, *Clitocybe geotropa* (Lucien Quélet)., Coprinus *comatu* (O. F. Müll.) Pers., *Geastrum pp* (Pers.), *Macrolepiota dolichaula* (Berk. and Fr.), *Pulveroboletus shoreae* (Singh and Singh), *Podabrella microcarpa* (Sathe & J. T. Daniel), *Russula apida* (Pers.), *Russula crescens* (Pers.), *Termitomyces robustus* (Beeli) R. Heim, *Lactarius picinus* (A. H. Sm. & Hesler), *Volvariella*

Table 1 — List of edible fungi in Achanakmar-Amarkantak Biosphere Reserve

Scientific Name	Local name	Distribution	Storage
Agaricus trisulphuratus (Berk.) (1885)	Sughare Pihari	Frequent	can't be kept in storage for a long period.
Astraeus hygrometricus (Pers.) Morgan (1889)	Bodo, Puttu	Rare	can't be kept in storage for a long period.
Amanita muscaria (L:Fr.) (Hook. 1821)	Sua Pihari	Rare	can't be kept in storage for a long period.
Geastrum quadrifidum (Pers.) (1794)	Boda, Rakhri	Rare	Dried fruiting bodies can be stored.
Calvatia craniiformis (Schwein.) Fr. (1849)	Dalha Pihari,	Rare	can't be kept in storage for a long period.
Clitocybe robusta (Fr.) Staude (1857)	Sona Pihari	Rare	Sun-dried can be used for a long time
Clitocybe geotropa (Lucien Quélet) (1872)	-------	Frequent	can't be kept in storage for a long period.
Coprinus *comatus* (O. F. Müll.) Pers. (1797)	-------	-----	Sun-dried can be used for a long time
Geastrum, Spp (Pers.) (1794)	Boda, Rakhri	Rare	Sun-dried can be used for a long time
Macrolepiota *dolichaula* (Berk. and Fr.) (1969)	Tithari Pihari	Rare	can't be kept in storage for a long period.
Pulveroboletus shoreae (Singh and Singh) (1971)	--------	Frequent	can't be kept in storage for a long period.
Podabrella microcarpa (Sathe & J.T. Daniel) (1981)	Kanki Pihari	Rare	can't be kept in storage for a long period.
Russula apida (Pers.) (1796)	Murga Chandra	Frequent	can't be kept in storage for a long period.
Russula crescens (Pers.) (1796)	----------	Frequent	can't be kept in storage for a long period.
Termitomyces robustus (Beeli) R. Heim (1951)		Rare	can't be kept in storage for a long period.
Lactarius picinus (A. H. Sm. & Hesler) (1962)		Rare	can't be kept in storage for a long period.
Volvariella volvacea (Bul.) Singer (1951)		Rare	can't be kept in storage for a long period.

volvacea (Bul.) Singer. A large number of edible mushrooms are found in the Achanakmar-Amarkantak Biosphere Reserve indicating a suitable environment for the growth and occurrence of a variety of mushrooms.

Some attempts have been made in past to collect and identify the ectomycorrhizal fungal species in various regions[8-13]. But only a few references can be made about the information on edible fungi of Madhya Pradesh[14-16]. It is with this intention that the survey of Achanakmar-Amarkantak Biosphere Reserve was undertaken to explore the hidden wealth of these fungi occurring naturally here.

The edible mushroom described above is of frequent occurrence after the onset of monsoons up to September. The occurrence of these fungi varies with habitat and climatic conditions. These naturally occurring edible wild mushrooms can be collected and may be used as a staple food for human consumption or even marketed like other minor forest products, have excellent potential to add to the tribal economy. It was found that the collection of wild mushrooms was undertaken early in the morning. Mushroom sellers were mainly women and a considerable amount was indigenous. The tribal communities are largely dependent on the forest produces for their sustenance. The Food and Agriculture Organisation (FAO) has been actively promoting mushroom cultivation for rural development and food security in developing countries[17].

The average quantity of mushrooms collected by the number of women in the selected 11 ranges along with the average quantity (kg) from Achanakmar-Amarkantak Biosphere Reserve is summarized in Table 2. This study was carried out for all locally occurring wild edible mushrooms of the biosphere reserve which revealed that 57034.79 kg mushrooms were collected in one season. The economic gain from the marketing of the mushrooms is not evaluated due to variation of prizes in different haat (market) of all ranges. Usually, the mushrooms are sold in local *haat* and the method of selling is primitive which is shown in Plates -1 and 2. In forest many edible mushrooms species are found and women collected more species and keep it in a leaf plate separately. It was also observed they know the fragile nature of the fruiting bodies of mushrooms so, that they sell all in low prizes also.

Besides these, during the study 11 ranges were selected from the forest. Each range had approximately 200 families. A study of 2200 homes has been conducted to determine how many women are involved in the gathering of mushrooms to boost local economies. The amount of money made from the sale of various types of mushrooms and their contribution to overall earnings could not been calculated. The most likely causes include lack of suitable markets, inadequate transportation options, insufficiently high sale prices, and middlemen's

Table 2 — Production of mushroom in Achanakmar-Amarkantak Biosphere Reserve

S. no.	Name of Ranges	No. of women collected Mushrooms	Collection of Mushrooms (kg.)
1.	Lamni Range	96	2945.35
2.	Achanakmar Range	130	7790.77
3.	Lormi Range	93	3236.40
4.	Kota Range	87	5322.90
5.	Khudia Range	112	6312.71
6.	Belgehana Range	99	5895.36
7.	Khodri Range	86	5475.52
8.	Marwahi Range	75	4928.50
9.	Gorela Range	69	5377.60
10.	Lamni Range	60	4700.48
11.	Game Range	63	5049.20
			Total: 57034.79 Kg.

Plate 1 — Collected fresh *Agaricus trisulphuratus* species in the forest

Plate 2 — Tribal women selling mushrooms in Achanakmar Village haat

exploitation. Table 2 shows that the majority of the mushroom producing operations are actively carried out by women. Every year, wild mushrooms are taken from the Chhattisgarh Achanakmar-Amarkantak Biosphere Reserve for use in food and medicine.

The data indicated that the highest collection of wild edible mushrooms obtained in the Achanakmar Range was 7790.77 kg by tribal women's followed by Khudia Range (6312.71 kg) and Belgehana Range **(**5895.36 kg). Women tribes are gently plough the mature mushroom fruiting bodied. They Understand the fact the immure and mature fruiting bodied are sources to regenerate the mushroom again. So unknowingly they conserve and harvest the mushrooms in sustainable manner. Tribal women consider that mature mushrooms release spores into the air that are essentially mushroom seeds, thus maintaining the diversity. A very peculiar phenomenon was observed that while collecting mushrooms in bamboo baskets or open containers, sometimes they might drop on the way, thereby increasing its distribution.

Women's involvement in mushroom cultivation in Chhattisgarh, India, was evaluated by Khare *et al.*[16] in their study. The results showed that the majority of the activities involved in mushroom production are actively undertaken by women.

Conclusion

Wild edible mushrooms are a source of sustenance for a sizable portion of tribal women. This has significant socioeconomic implications for employment and revenue production particularly for the weaker segments of society like tribal members. Tribal women in the Achanakmar-Amarkantak Biosphere Reserve in Chhattisgarh undertake a variety of conservation activities because they recognize the importance of plants in their daily lives. They are also aware of how crucial forest flora is to their way of life and safety in terms of their health. Tribal women have learnt how to manage their forest resources sustainably because they are well aware of how much their way of life depends on the forest and the products it produces. Tribal groups have been observed to use different plant species in their celebrations in order to encourage conservation. Instead of collecting the entire plant, tribal's collect plant parts and also leave a part of a plant in soil for regeneration.

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Conflicts of Interest

Authors declare that there are no conflicts of interest.

Authors' Contributions

B D and R E conceived the ideas and designed methodology; B D collected the data and R E analyzed the data; B D led the writing of the manuscript. Both authors contributed critically to the drafts and gave final approval for publication.

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