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Wild edible mushrooms of Similipal and their contribution to health, nutrition and economic security of tribals

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ABSTRACT

Similipal Biosphere Reserve, Odishais one of the most diverse ecosystems of the country harbouring rich flora and fauna including mushrooms. The fertile forest floors provide congenial habitat of a wide variety wild mushrooms. A survey was carried out during rainy season (June to October) of 2022 to collect information regarding different wild edible mushrooms occurring in Similipal and their collection by tribals for own consumption, medicine and sale in the nearby markets. The paper reports the occurrence of 12 wild edible mushrooms such as *Russula rosea, R. cyanoxantha, R. brevipes, R. nigricans, Astreatus hygrometicus, Bovista plumbea, Amanita vaginata, A. hemibapha, Termitomyce sheimii, T. eurrhizus, T. clypeatus* and *T. medius* commonly found in Sal forests of Similipal. Some of the mushrooms (*Russula rosea, R. cyanoxantha, R. brevipes, R. nigricans, Amanita vaginata, A. hemibapha*) are locally called 'Patra Chhatu, which are plentily available throughout the rainy season on forest floors rich in leaf litter. Another important group of mushrooms are *Termitomyces* species (*T. heimii, T. eurrhizus, T. clypeatus, T. medius*), which grow in termite nest and also in soft red soils in the Sal forests. These are tastier than that of '*Patra Chhatu'* and are available in bulk quantities in the forest. These mushrooms are also sold at a higher price but grow for a short period of time after rain. The market value of species belonging to genus *Russula* was cheaper in rural areas (Rs.10–30/kg) as compared to urban markets (Rs.60–90/kg) while that of *Termitomyces* species are sold at comparatively higher price in both rural (Rs.200-300/kg) and urban markets (Rs.350–400/kg). These mushrooms are regarded as highly nutritious containing large amounts of proteins, fibers, vitamins and minerals, which support the health of local tribals and boost their economy.

1. Introduction

Forest plays an important role in supporting the livelihood of rural and tribal communities and also in maintaining the ecological balance. Over 53 million tribals and about 60% of the rural communities in India directly rely on forests for their day-to-day requirements.The availability, quantity and pattern of utilization of both timber and non-timber forest products (NTFPs) are crucial to their livelihood sustainability and income generation. The forest dwellers and communities residing close to forests derive their day-to-day needs of food, firewood, shelter, medicine, fiberetc from forests. Some major NTFPs found in the Similipal Forest Division are Mahula flowers and seeds (*Madhuca longifolia* var. *latifolia*), Jhuna resin of *Shorea robusta*), Kurkuti (Red Weaver Ant), wild fruits like Kendu (*Diospyros melanoxylon*), Jamu (*Syzygium cumini*), medicinal plants like Mudika (*Cissampelos pareira*), Patala Garuda (*Rauvolfia serpentina*), Bhuin Nima (*Andrographis paniculata*), wild edible mushrooms etc. Among all NTFPs, though seasonal in habit, the wild growing mushrooms have long been used as a valuable source of food by the tribals.

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Wild edible mushrooms (WEM) are been collected and consumed by people for thousands of years. The edible mushrooms have different forms, some with gills and some with pores, some with stems and some without. Wild edible mushrooms are a valuable non-timber forest resource used by mycophilic societies and their use has been documented in many countries around the world (Chang and Lee, 2004, Roberto & Levesque, 2005). They substantially contribute to the diet and food habit of the local people. The collection, consumption and marketing of wild edible mushrooms is a practice of tribal and poor people in more than 80 countries in the world. The biological diversity of mushrooms is huge and they belong to different use-classes and morphological types.

The number of edible mushroom is only a small fraction of the total mushroom diversity. Of the 14,000 recognized mushroom species (Hawksworth *et al*., 2001; Kirk *et al*., 2008; Schmit *et al*., 2007), the recorded number of wild edible mushrooms is about 1154, which is only 8.24% of the estimated species (Boa *et al*., 2004). Only 15 of the 284 edible species are regularly eaten in Armenia (Boa, 2004). They are sold in traditional markets (Roberto & Levesque, 2005) or commercially exploited as food (Pilz *et al.*, 1999) or medicines (Chamberlain, 1996). The ethnomedicinal aspects of mushrooms have also been studied and documented by few workers in different parts of India and world (Harsh *et al.*, 1993; Didukh, 2001; Adhikary *et al*., 2005). In India, the tribal and rural communities traditionally use and possess ethnomedicinal knowledge on as many as 283 species of wild mushrooms out of approximately 2000 species known globally (Purkayastha and Chandra, 1985). Some of the wild edible mushrooms have also been reported from Manipur and Arunachal Pradesh of North East India (Sing and Sing, 1993; Sing *et al*., 2002). Sometimes edible mushrooms liked by one community may be considered unsuitable for others and often corelated with some health issues or adverse effects. The nutritional value of wild edible mushroom should not be underestimated as many of them are of comparable or nutritionally superior than conventionally consumed vegetables. However, the choice of mushrooms, edibility, pattern of consumption, market value etc. vary considerably among countries and localities.

Fungi are dependent on dead and living material for their growth. They obtain their nutrients in three basic ways: (i) Saprobic - growing on dead organic matter; (ii) Symbiotic - growing in association with other organisms and (iii) Pathogenic or Parasitic - causing harm to another organism. Mushrooms have extended relationship with men and are of profound economic and biological significance. Wild edible mushrooms have been eaten by human beings with delicacy possibly, for their pleasing flavour and taste (Das, 2010). They are rich sources of proteins and other nutrients and minerals including amino acids, sugar, and vitamins with low fat and cholesterol levels. In view of this, the developed countries are increasingly consuming wild edible mushrooms as a part of their daily diet (Barros *et al*., 2008; Kalac, 2009). According to Mattila *et al.* (1994), mushrooms are one of the natural sources of vitamin D, which is necessary for strong bones and teeth. Additionally, they are an excellent source of the B vitamins niacin (B3), pantothenic acid (B5), and riboflavin (B2) (Kalac, 2009; Caglarlrmak *et al.*,2002). Mushrooms are not only sources of nutrients but also have been known as therapeutic foods, useful in preventing diseases such as hypertension, hypercholesterolemia and cancer (Bobek and Galbavy, 1999; Kidd, 2000).

Mushrooms flourish universally under the warm and humid climates. They grow on a wide range of substrates. While most are saprophytic, some are highly habitat specific doing well on termite nest soil, sal leaf litter, decaying woods, rocks etc. Although mushrooms can be found year around, mostly they appear during monsoon rains after relatively dry spells of several weeks (Corner, 1935).

Research on wild edible mushrooms (WEM) is centred around a small number of species that are commercially cultivated. Until recently, WEMs have remained neglected by science, though amateur mycologists often documented species they found in field studies. Their biology and ecology have not been studied at greater detail though wild edible mushroom are used in all parts of the world. Consequently, the wild edible mushroom species used in tropical and developing countries are poorly known, though some information is available on species growing in temperate regions.

2. Materials and methods

Similipal, an important landscape in the entire peninsular India, is situated in Mayurbhanj district of the Odisha, India. This Biosphere Reserve spreads over an area of 5,569 km^2 and one of Odisha's most important watersheds with twelve perennial rivers originating from it.

The study area was located in and around the deep forest pockets of tribal villages situated in the transitional zone of Similipal Biosphere Reserve (SBR). Besides, surveying weekly markets in different areas of Similipal, field studies were undertaken and interviews were conducted among mushroom collectors about their edibility, time of collection, storage time and economic values. The fleshy mushrooms were collected from different habitats such as meadows, decaying woods, rotting plant parts, termite nest soils in the forest areas. Each of the collected sample was

wrapped in wax paper and brought to the laboratory for identification purposes. Local names and information on use values collected from the informants were of immense importance for this study. Sometimes, the local names for edible mushrooms were based on shape, taste and other properties that are distinctive or important to people. Field guides often disagree on which mushrooms are edible, either because they are cautious in recommending species that require pre-cooking or because the authors are unaware of local customs in different parts of the world. The edible mushrooms were morphologically described, identified and assigned a scientific name for use by scientific community. Besides, the scientific names were corroborated with local names to classify them to edible, non-edible and poisonous, medicinal uses etc. based of traditional knowledge of local people. Edible mushrooms occur in two major taxonomic groups: (i) the basidiomycetes containing bracket mushrooms and boletes and (ii) the ascomycetes including truffles and morels. There is no simple test for determining edibility. The scientific literature is the best objective source of advice, but local practices and preferences can also reveal useful information (Boa, 2004).

3. Results and Discussion

The wild edible mushrooms found in forests of Similipal Biosphere Reserve have medicinal, economic, and ecological importance. These mushrooms are high in protein and play an important role in tribal dietary supplements. Additionally, they provide seasonal augmentation of income contributing to the local economy through selling these mushrooms in local market places. A wide range of mushroom species were found to be sold in local markets around Similipal and in nearby cities and towns like Baripada, Karanjia, Jashipur, Thakurmunda etc. contributing to household income generation in lean periods. To encourage the sustainable use of these priceless food resources in the course of the country's economic growth, an effort has been undertaken to describe the economically significant wild edible mushrooms being collected by various communities in Similipal.

Indian tribal people are mostly uneducated and live primarily in forests and mountain ranges in rural areas. They are the poorest social groups having more than 50% of population living below the poverty line (Singh, 1993). The state of Odisha (India) has a multi-cultural and multi-lingual tribal populations. Most of the tribal communities such as Mankirdia, Kharia, Kolha, Santhal prefer wild edible mushrooms as their supplementary food source. Edible mushrooms belonging to genera *Astraeus*, *Russula* and *Termitomyces*, *Amanita*, *Tuber* etc. are consumed as food by many tribes of Mayurbhanj district, Odisha. Beside food, these ethnic groups also use wild mushrooms for ethnomedicinal purposes (Sachan *et al.*, 2013; Panda and Tayung, 2014).

A total of 12 wild edible mushroom species belonging to five families were recorded during the study period from different places of Similipal (Fig. 1; Table 1). Out of 12 wild edible mushroom species,seven species were found in Sal forest soil, two species inforest sandy soil, two species in termite nests and one species in decaying sal mixed soil. The genera with more number of species were *Russula* (four species), *Termitomyces* (four species) and *Amanita* (two species) (Table 2). *Russula* species were found abundantly in forest soils during the peak growing period in monsoon. This is one of the most widespread and commonly eaten group of mushrooms having several edible species. *Amanita* genus has both edible and deadly poisonous species.While *Termitomyces* species were abundant in the sandy forest soil around termite nests, several others were restricted to decomposing leaf litter in Sal forests. Many species of *Termitomyces* are widely eaten, known for their high nutritional value and are widely sold in markets, roadsides and sent to nearby townships. The favourable time for collection of wild edible mushrooms in the study area was just at the onset of rains, the period when the conditions were conducive for the mushroom growth. The wild edible mushroom species started growing in the month of June with the first shower of rains and spread gregariously in larger areas around August and then decreases gradually towards the end of October. Among these mushrooms, *T. heimii* is most popular and delicious, which is sold for more than Rs. 400/- per kg in local markets. Some of these mushrooms are also used as ethnomedicine by the tribals. This study also providedthe information on market values and nutrition properties of the mushroom. *Astreatus hygrometicus* and *Russula nigricans* have wide range of ethnomedicinal uses.

Wild edible mushrooms play an important role in ecosystem processes. Many of the leading species live symbiotically with trees and this mycorrhizal association sustains the growth of native forests and commercial plantations in temperate and tropical zones (Zotti *et al.*, 2013). The saprobic wild edible mushrooms are very crucial in nutrient recycling and also provide economic benefits to rural and tribal people by way of collecting and marketing in the local markets (Boa, 2004; Khulakpam *et al.*, 2018*).* From ancient times, mushrooms have been used as an important dietary supplement with high nutritional and medicinal value (Buyuk *et al.*, 1994). There is a strong emphasis on subsistence uses of wild edible mushrooms and their importance to rural people in developing countries, although this is an area where there are still significant gaps in information. Wild edible mushrooms are among the most

Fig. 1: 1. *Russula brevipes*, 2. *Russula cyanoxantha*, 3. *Termetomyces medius*, 4. *Rusula rosea*, 5. *Rusula nigrica*, 6. *Termitomyces eurrhizus*, 7. *Anamita hemibapha*, 8. *Termitomyces heimii*, 9. *Amanita vaginata (Mayurchatu)*, 10. *Termetomyces clypeatus*, 11. *Astreatus hygrometicus*, 12. *Amanita egregia.*

Table 1

Morphological characteristics of selected wild edible mushrooms.

Sl.No.	Name of the species	Morphological characters
1	*Russula brevipes*	It is laterite soil that is epigeous and dispersed. White, 5- to 7-cm-diameter piles with an inflexible border.The base of the central myceloid stipe is connected by a cylindrical stipe. A somewhat crooked, 3–4 cm long, attached decurrentgill with no volva is present.
2	*Russula cyanoxantha*	Solitary found in deciduous forest. Cap is convex to flat to upside with central depression, Pile is about 5-9cm diameter, dry green to purple green in colour. Gills attached to steam, adnexed, crowed, white to cream colour.Stem is cylindrical, about 3-7cm long, 2-3cm thick white in young towards maturity brownish sport no change in colour while handling, brushing or broken.
3	*Termetomyces medius*	On grassland, scattered. Pileus is attached to centre about 1-3cm diameter. No ring, Gill white, at maturity it turns light brown, crowed and free attached. Stipe is about 2-5cm long, cylindrical
4	*Russula rosea*	Scatter present on hill area, Cap 4-7cm, convex when young and slightly depressed at centre deep pink or red in colour, discolored with age,reflexed margin. Piles surface is fleshy covered by with fibrillose scale. No colour change by handling. No ring or volva. Gills are white in colour, serrate edges and adnexed.
5	*Russula nigrica*	It grows on hill top moist deciduous forest. Cap 5-8cm greyish white, and maturity it turned black, Stipe is 2-4cm long, cylindrical, firm and white. Gills are off white crowed, adnate, it turned black while handling or bushing within 20 mint.
6	*Termitomyces eurrhizus*	Mushroom symbiotic association with termites. Piles 3-10cm diameter, dry, convex, later expanded to flattened, scale present on surface, light brown and dark chocolate at centre, margin is irregular; Stipe is 20-cm long with 2-3cm thick, solid above the ground. No colour change while handling or brushing.
7	*Anamita hemibapha*	Epigeous, orange to yellow. Piles convex, smooth surface, inflexedmargin, fleshy. Stipe is at center cylindrical, ring, 3 cm long and 1-3cm thick. Gills crowed with free attachment
8	*Termitomyces heimii*	It is found in termite infested soil. Cap is about 5-8cm diameter after maturity, have scale fibrous on surface, white in colour. No colour change while handling or brushing. Centrally stipe is 10-20cm long, fibrous surface, annulus. Gills are crowed, free attached, separable white in colour.
9	*Amanita vaginata*	Initially cap is oval then it became convex or flattened, colour grey to light black, gills white and free, stem base is enclosed in loose volva, Ring may be present near the cap.
10	*Termetomyces clypeatus*	Solitary association, grow on grassland in slopes. Pilus is medium 10 cm diameter, Brownish in colour, fibrous scale on surface. White to deep brown centrally attached stipe, fibrous surface, stuffed. No ring no vulva; gills are white, turn brownish on maturity. Densely crowded, freely attachment.
11	*Astreatus hygrometicus*	Sporophores growing on ground scatter, at maturity up to 5cm diameter, globular two layers outer later is cremish white towards maturity is dark brown to black, hygroscopic and inner layer is white to grayish, opening by an ostiole in colour. Capillitium thread attached to the side of the endoperidium.
12	*Amanita hemibapha*	Cap is about 6-18cm, hemispherical to flat, orange red to yellow in colour. Stipe is white to cream yellow, narrow towords narrow, hallow with maturity.

Table 2

List of wild edible mushrooms from Similipal, their seasonality, ecology and selling price

Sl.No.	Scientific name	Local name	Seasonality	Ecology/Habitat	Price/ Kg (Rs.)
1	*Termitomyces heimii*	Parbanachatu, Bhiudachattu	August-October	Termite nest soil	300-400
2	*Termitomyces eurrhizus*	Bali chattu	June-September	Forest sandy soil	100-220
3	*Russula rosea*	NalichattuLali chattu	August-September	Sal forest soil	40-60
4	*Russula cyanoxantha*	Jammu chhatu, Patra chattu	August –September	Sal forest soil	30-50
5	*Termitomyces clypeatus*	Kalimundichhatu	June-Sept	Termite nest soil	80-150
6	*Russula brevipes*	Dhalachhatu, Patra chattu	June-Aug	Sal forest soil	60-100
7	*Amanita vaginata*	Mayur chhatu	June-Sept	Sal forest soil	30-40
8	*Bovista plumbea*	Tumbachhatu	June –September	Sal forest soil	30
9	*Astreatus hygrometicus*	Rutkachhatu, Patakachhattu.	June-August	Sal forest soil	200-250
10	*Russula nigricans*	Kali chatu, Angrachhatu,	June –September	Sal forest soil	50-70
11	*Amanita hemibapha*	Haladi mundi chhatu	June-September	Decaying sal leaf mixed soil	30-40
12	*Termitomyces medis*	Chotobalichhatu	August-September	Forest sandy soil	100-150

valuable (NWFP) with much potential for expansion of trade, but there are also challenges in the integration of their management and sustainable production as part of multiple use forests. There are concerns about the impact of excessive harvesting, which require better data on yields and productivity and a closer examination of collectors and local practices. Closer cooperation between forest managers and those who use wild edible mushrooms is needed.

Wild edible mushroom add flavour to bland staple foods but they are also valuable foods in their own right. Local names for termite mushrooms (*Termitomyces*) reflect local beliefs that they are a fair substitute for meat, a belief that is confirmed by nutritional analyses. Not all wild edible mushrooms have such a high protein content but they are of comparable nutritional value to many vegetables. The mushrooms produced more than 100 medicinal uses and antioxidant, anticancer, antidiabetic, antitumor, anti-inflammatory,antiallergic, immunomodulating, cardiovascular protector, anticholesterolemic, antiviral, antibacterial, antiparasitic, antifungal, detoxification hepatoprotective and other biological activities (Cang *et al.,* 2012; Panda *et al.*, 2014, 2017).

4. Conclusion

Wild useful mushrooms contribute towards diet, income and human health. Many mushrooms also play vital ecological role through the symbiotic relationships known as mycorrhizas that they form with trees. Simlipal is a vast area dominated by Sal forest and the forest floor is abundant with loose soil and leaf litter. When monsoon starts, the leaves start decomposing and mushrooms spores grow being attached to leaves, bark and sometime roots. Some species growing in leaf litter are species of *Russula, Termitomyces, Amanita,* etc. The tribals and other forest dependent people easily identify mushrooms that are edible, non-edible or poisonous. Income from wild edible mushrooms is an important source of revenue earning for rural communities, especially in developing countries.

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