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CONTRIBUTIONS OF WILD MUSHROOMS IN LIVELIHOOD MANAGEMENT OF ETHNIC TRIBES IN GURGURIPAL, WEST BENGAL, INDIA

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ABSTRACT: The folk population of Gurguripal has mycophilic inclination, and wild mushrooms play a significant role in sustaining their livelihood. Explorative survey work was undertaken to document the ethnomycological knowledge of wild mushrooms occurring in forest areas of Gurguripal. In the present study, 166 informants from 9 villages were interviewed and information was collected through semi-structured questionnaires and interaction based on local name, edibility, medicinal applicability, preparation, and mythological beliefs among native tribal communities of this region. Santal, Munda, and Sabar are dominating schedule tribes in consuming wild edible mushrooms as food or dietary supplement. A total of 23 predominant mushroom species belonging to 16 families were screened. Among them, 19 species were effectively used against different human ailments by the traditional healers. In particular, *Termitomyces heimii*, *Pleurotus ostreatus*, *Auricularia auricula*, *and Ganoderma lucidum* have shown higher use values and manifold nutraceutical potentials. An Amanitaceous mushroom, namely *Amanita bisporigera* has been reported the first time herein as edible and recently sold in local markets. The present study enlightens the exploration and conservation of traditional knowledge regarding the utilization of wild mushrooms for the welfare of mankind as well as underscores the need for further research to discover new bioactive compounds with potential pharmaceutical applications.

INTRODUCTION: Fungi represent the greatest eukaryotic diversity on earth and have been for a long time the primary decomposers of lignocellulolytic substrates [1] and the main keepers of great carbon storages in soil and dead organic material [2].

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Their edibility, medicinal properties, mycorrhizal, and parasitic associations with the forest trees make them economically and ecologically important for investigation. The biodiversity of woody flora is correlated with an equally diverse mushroom flora. They are one of the most important components of the forest ecosystem and grow generally at the onset of the rainy season.

They are key functional components of forest ecosystems [3]. The high and humid atmosphere during monsoon period provides ideal atmospheric conditions for the growth of mushrooms. FAO promotes the sustainable use of macrofungi for

forest management, biodiversity conservation, and their long term effect on income generation and food security [4]. Mushrooms have a long association with humankind and provide profound biological and economic impact. Mushrooms have beneficial roles in nutrient cycling, agriculture, biofertilizers, antibiotics, food and biotechnological industries [5, 6]. They have been valued throughout the world as an important source of food for thousands of years due to the high content of vitamin, protein and minerals, fibers, trace elements and no or low calories and cholesterol [7, 8]. Mushrooms are enriched by various bioactive substances like antibacterial, antifungal, antiviral, antiparasitic, antioxidant, anti-inflammatory, antiproliferative, anticancer, antitumor, cytotoxic, anti-HIV, hypo-cholesteromic, antidiabetic, anticoagulant, hepato-protective compounds [9, 10, 11].

Wild mushrooms are one of the important natural sources of food and income for many indigenous communities across the world [12, 13, 14]. Traditional or indigenous knowledge systems generally embedded in the cultural practices of regional or local communities based on the accumulation of empirical observations and interactions with the environment. Mycophile was customary in human society from prehistoric times. People belonging to ancient Greece, China, India and Iran used mushrooms in the ritualistic performances [15, 16]. Moreover, there are references to the use of mushrooms as food and medicine in India in the ancient treatise Charaka Samhita (3000 ± 500 BC). Since earliest times, mushrooms have been considered as a special kind of food. The Greeks believed that mushrooms provide strength for soldiers in battle. The Pharaohs preferred mushroom for delicacy, and the Romans considered mushrooms as the "Food of the Gods" and served mushrooms only on festive occasions. Many of the mushrooms have been used in folk medicine for thousands of years. They have been used in medicine since the Neolithic and Paleolithic eras [17].

Studies have indicated that wild edible mushrooms are not only important sources of food but also income-generating livelihood for both developing and developed countries [18]. Purakayastha and Chandra have reported 283 edible species from India, out of which some are cultivated [19].

The production of mushrooms has gained attention all over the world as cultivated mushrooms are available throughout the year and used in enormous quantities to serve with all kinds of table dishes. The diverse climatic conditions of India leads to rich mushroom diversity and form a valuable non-timber forest resource for local folk. A significant number of mushroom species are sold in traditional markets of India and some of them have been commercially exploited as food or medicines [20]. The different types of wild mushrooms consumed by the tribal people as food or medicinal purposes vary with locality and tribe to tribe. India enhouses the largest tribal population (collectively termed as 'Adivasi') in the world [21]. In West Bengal many regional ethnic tribes like Bhumija, Lodha, Kol, Vil, Munda, Sabar, Santals are concentrated in dense forest areas of Gurguripal, Paschim Medinipur. Still a large segment of tribal population depends on hunting and gathering of forest products for subsistence and survival of traditional folklore [22, 23]. Wild edible mushrooms have both spiritual and socio-economic connections with tribal livelihood, and the corresponding knowledge of their utility is a heritage that is extradited from one generation to the other [24]. Previously, ethnomedicinal uses of fungi in different areas of India like Assam [25], Nagaland [20], Madhya Pradesh [26], Northern Odisha [27], Similipal Biosphere Reserve [28], Central India [29] were studied and documented.

Earlier, Singha *et al*., has reported 32 edible and 19 medicinally important mushroom species in Gurguripal eco forest [30,] but so far no extensive ethnomycological study has been conducted on traditional uses of wild mushrooms for the treatment of different human diseases. Considering the ethnomycological knowledge persists among various tribes in India, the present work is a contribution to the documentation of the edible and medicinal mushrooms used by the tribal communities lived around the Gurguripal forest to assess the mushroom diversity as a prelude to their conservation and ecological sustainability.

MATERIALS AND METHODS:

Study Area: Gurguripal is a tribal-based forest-based rural area situated in Paschim Medinipur District of West Bengal, India **Fig. 1**. It is located at 22°25" - 35°8" N latitude and 87°13" - 42°4" E

longitude, having an altitude about 60 mt. Gurguripal forest experiences tropical monsoon weather with distinct wet and dry seasons. The average temperature is in summer remains within 35 °C to 40 °C and in the winter it ranges from 10 °C to 16 °C. The average annual rainfall in this area was reported as 1500 mm and resulted by the south west monsoon. Laterite, the characteristic soil of this region along with the loamy soil of reddish-brown color mostly shields the upper layers of the forest lands. The vegetation represents a dry deciduous and semi-evergreen types of tropical forests, covered up predominantly by Sal (*Shorea robusta* Roth) and scrub jungles. The usual associates of Sal in this region are Mahua (*Madhuca indica* J.F. Gmel.), Palash (*Butea monosperma* (Lam.) Taub.), Kusum (*Schleichera oleosa* Lour.), Kurchi (*Holarrhena antidysenterica* (L.) Wall. ex A. DC.) and Kendu (*Diospyros melanoxylon* Roxb.). Some planted forest segments comprising *Anacardium occidentale* L., *Acacia auriculiformis* A.Cunn. ex Benth. and *Eucalyptus globulus* Labill. are noted also. Hunting and gathering of natural products are the major sources of sustaining tribal livelihood are hunting and gathering of natural products. The study was emphasized in and around tribal villages of deep forest pockets and weekly local markets (called 'hut') of Gurguripal.

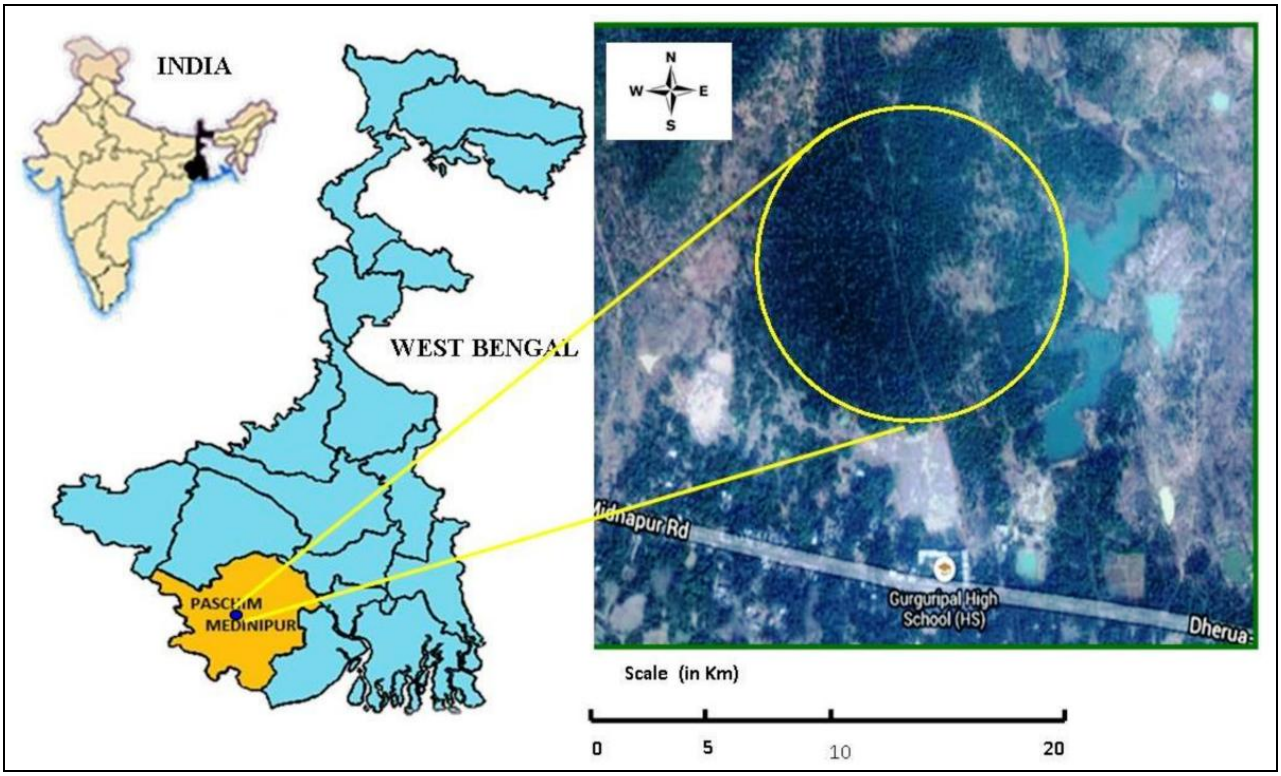

FIG. 1: LOCATION OF STUDY AREA (GURGURIPAL FOREST, WEST BENGAL, INDIA)

Ethnomycological Survey: This explorative ethnomycological survey was conducted in between May 2016 to November 2017 and the information was collected through semi-structured questionnaires and pictorial demonstrations. These communities were selected based on their proximity to ethnomycological knowledge among the different native tribal communities of this region. These communities were selected based on their proximity to ethnomycological knowledge In total 166 peoples of 9 villages belonging to different age groups were interviewed, and the collected information was verified by cross-questioning the informants individually. The traditional healers of different tribal communities were questioned to state the methods of preparation and administration of different medicinal mushrooms for diagnosis and treatment of various diseases. After vivid interpretations with the informants, all collected data have been analyzed and the responses grouped into descriptive tables. The market transaction and business information regarding mushrooms were also noted through interactions with mushroom collectors and sellers.

Finally, the use-value of each mushroom species was calculated by the formula UV= U/N, where, U= the number of citations of each species; N= number of informants [31].

Collection and Identification of Specimens: Collection and identification of mushrooms were done by opportunistic sampling method [32] under the supervision of local traditional healers. Mushroom specimens were collected from different habitats like damp pits, decaying woods, plant litters and termite nests in the forest areas of Gurguripal. The specimens were carefully uprooted to avoid damaging of tissue. Photographs of each specimen were taken in their natural habitat since some characters may be changed after preservation. Collected specimens were studied intensely by macroscopic and microscopic characteristics verified by authentic identification manuals and standard literature [33, 34, 35, 36].

Some of the Mushrooms specimens were preserved in 4% formaldehyde solution as a voucher specimen and deposited to the Department of Microbiology, Vidyasagar University, Midnapore, West Bengal, India.

RESULTS:

Socio-Demographic Profile: Among the total 166 respondents, 134 were men (80.72%) and rest women (19.28%) belonging to 9 native tribal communities (Santal, Munda, Lodha, Kheria, Bhumija, Oraon, Sabar, Bagdi, Kurmi) **Table 1**. Most of them had education up to primary level only (49.39%), while few were graduate (6.02%) and servicemen (3.61%). The traditional healers were interviewed majorly above the age of 50 years. Santals are the dominating tribe in this area and possessed the utmost indigenous knowledge regarding the ethnicity and traditional utilization of mushrooms.

Wild Mushrooms: In this present study a total of 23 different mushroom species belonging to 16 families were collected and identified from the tribal areas of Gurguripal **Table 2**. Among them, 12 mushroom species were found to be edible and 19 were reported to be ethnomedicinally important. The family Russulaceae comprises maximum representatives of 6. According to their ecological habitat, 13 species were found to be saprophytic (growing on dead and decaying substances), 9 species were mycorrhizal (symbiotic association), 1 species was parasitic **Fig. 2**.

The studied tribal communities have their own traditional identification protocols but broadly they used sensory characters such as color, aroma and especially the habitat to identify edible mushrooms. Species like *Amanita bisporigera*, *Volvariella volvacea*, *Termitomyces heimii and Boletus* sp. have larger fruit bodies, while *Astraeus hygrometricus* and *Schizophyllum commune* are comparatively smaller. Some species were occurring abundantly (*Astraeus hygrometricus*, *Auricularia auricula*), some found common throughout the season (*G. lucidum*, *Daldinia concenterica*) and few have seen rare (*Russula cyanoxantha*, *Russula albonigra*) **Fig. 3** in forest areas of Gurguripal.

The members belong to the genus *Russula* exhibited attractive colors. It has been observed that most of the popular edible mushroom species occurred during the either the early or late rainy season. The occurrence frequencies of all 23 mushroom species were not uniform revealed the uneven distribution of species under diverse geo-climatic conditions of the study area.

TABLE 1: DEMOGRAPHIC PROFILE OF INFORMANTS (N = 166)

Criteria	Frequency
Sex	
Men	80.72
Women	19.28
Education	
Illiterate	13.25
Primary education	49.39
Secondary Education	27.71
Graduate	6.02
Servicemen	3.61
Age Group	
10-25 years	22.89
25-50 years	25.3
50-75 years	38.55
Above 75 years	13.25
Religion	
Hindu	83.13
Christian	16.87
Ethnicity	
Santal	20.48
Munda	12.04
Lodha	13.25
Kherai	10.84
Bhumija	9.63
Oraon	8.43
Sabar	10.84
Bagdi	7.22
Kurmi	7.22

TABLE 2: LIST OF WILD MUSHROOMS RECORDED DURING THE SURVEY IN GURGURIPAL

S. no.	Name of the mushroom	Family	Period of Occurrence	Ecological Association	Occurrence Frequency	Edibilty and preparation
1	*Daldinia concentrica* (Bolton) Ces. & De Not.	Xylariaceae	June-September	Saprophytic	Abundant	Not prime edible
2	*Agaricus campestris* L.	Agaricaceae	June-September	Saprophytic	Common	Fruit body is cooked with mustard oil and spices
3	*Lycoperdon perlatum* Pers.	Agaricaceae	June-September	Saprophytic	Abundant	Inedible
4	*Coprinus comatus* (O.F. Müll.) Pers.	Coprinaceae	June-July	Saprophytic	Common	Inedible
5	*Pleurotus ostreatus* (Jacq.) P. Kumm.	Pleurotaceae	June-September	Saprophytic	Common	Fruit body is cooked with mustard oil and spices
6	*Schizophyllum commune* Fries	Schizophyllaceae	May-September	Saprophytic	Abundant	Fruit body is cooked as vegetables with mustard oil and spices
7	*Amanita bisporigera* G.F. Atk	Amanitaceae	June-August	Saprophytic	Abundant	Fruit body is cooked with tamarind and eaten
8	*Volvariella volvacea* (Bull.) Singer	Pluteaceae	May-September	Saprophytic	Abundant	Fruit body is cooked as vegetables with mustard oil and spices
9	*Termitomyces heimii* Natarajan	Lyophyllaceae	June-August	Saprophytic	Abundant	Fruit body is cooked as vegetables with mustard oil & spices
10	*Termitomyces clypeatus* R. Heim.	Lyophyllaceae	September-October	Saprophytic	Abundant	Fruit body is cooked with mustard oil and spices
11	*Boletus* sp.	Boletaceae	June-August	Mycorrhizal	Common	Fruit body is cooked with mustard oil and spices
12	*Astraeus hygrometricus* (Pers.) Morgan	Sclerodermataceae	June-August	Mycorrhizal	Abundant	Fruit body is cooked with mustard oil and spices
13	*Auricularia auricula* (Bull.) J. Schröt.	Auriculariaceae	July-September	Saprophytic	Abundant	Fruit body is cooked with mustard oil and spices
14	*Cantharellus* sp.	Cantharellaceae	July-August	Mycorrhizal	Abundant	Fruit body is cooked with mustard oil and spices
15	*Polyporus badius* (Pers.) Schwein	Polyporaceae	June-August	Saprophytic	Rare	Inedible
16	*Ganoderma lucidum* (Curtis) P. Karst.	Ganodermataceae	June-September	Saprophytic	Common	Grind and mixed with warm water and taken as tonic
17	*Russula albonigra* (Krombh.)Fr.	Russulaceae	June-September	Mycorrhizal	Rare	Not prime edible
18	*Russula cyanoxantha* (Schaeff.)Fr.	Russulaceae	July-September	Mycorrhizal	Rare	Not prime edible
19	*Russula delica* Fr.	Russulaceae	June-August	Mycorrhizal	Abundant	Not prime edible
20	*Russula emetica* (Schaeff.)Pers.	Russulaceae	June-August	Mycorrhizal	Common	Not prime edible
21	*Russula senecis* S.Imai	Russulaceae	June-September	Mycorrhizal	Common	Not prime edible
22	*Lactarius* sp.	Russulaceae	June-August	Mycorrhizal	Common	Inedible
23	*Lentinellus cochleatus* (Pers.) P. Karst.	Auriscalpiaceae	June-August	Parasitic	Common	Not prime edible

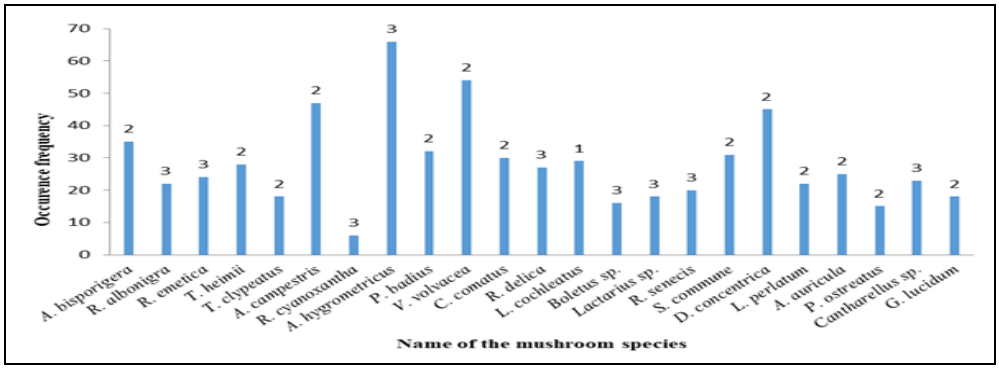

FIG. 2: OCCURRENCE FREQUENCY AND ECOLOGICAL ASSOCIATION OF MUSHROOMS IN GURGURIPAL (1- PARASITIC, 2- SAPROPHYTIC, 3-MYCORRHIZAL)

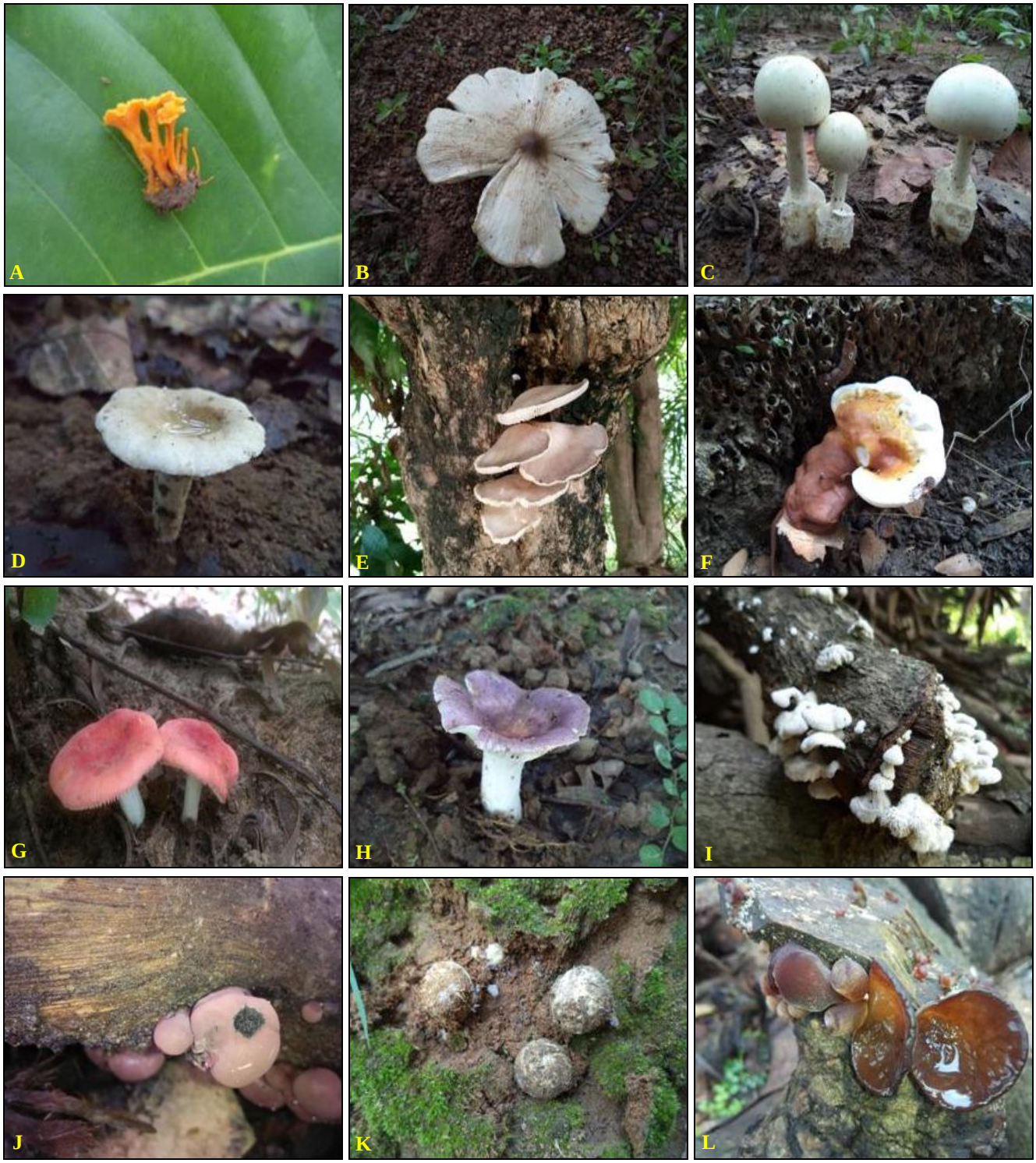

FIG. 3: IMPORTANT WILD MUSHROOM SPECIES IN GURGURIPAL. (A- *CANTHARELLUS* SP., B- *TERMITOMYCES HEIMII*, C- *AMANITA BISPORIGERA*, D- *LACTARIUS* SP., E- *PLEUROTUS OSTREATUS*, F- *GANODERMA LUCIDUM*, G- *RUSSULA EMETICA*, H- *RUSSULA CYANOXANTHA*, I- *SCHIZOPHYLLUM COMMUNE*, J- *DALDINIA CONCENTRICA*, K- *ASTRAEUS HYGROMETRICUS*, L- *AURICULARIA AURICULA*)

Edibility Criteria for Wild Mushrooms: Santal, Munda, and Sabar are the dominating scheduled tribes of Gurguripal consuming wild mushrooms as food or dietary supplement **Fig. 4**. The people of this region have different perceptions by which they judged the edibility of mushroom species. Reasons for the choice and use of selective mushroom species by ethnic tribes in this region are mostly due to their taste, nutritional value, availability, and influence by the neighbors, *etc*. **Fig. 5**. It was revealed that such knowledge of edibility was transmitted from one generation to

next by observing the habitat or substrate on which mushroom grew and whether eaten by insects or other animals [37]. Furthermore, in case of any confusion, the fruit bodies are boiled with metal coins; if the coin turns black, it indicated that the mushroom is not edible.

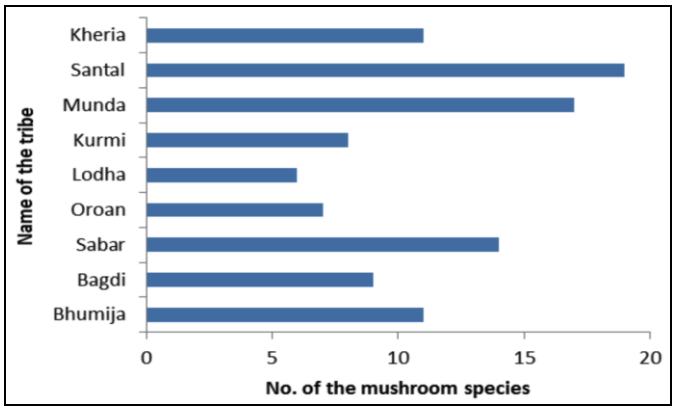

FIG. 4: MUSHROOM SPECIES USED BY THE TRIBAL COMMUNITIES IN GURGURIPAL

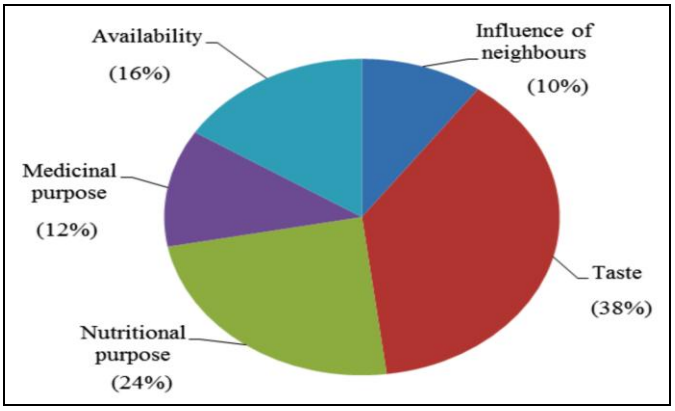

FIG. 5: USABILITY CAUSE OF MUSHROOMS BY ETHNIC TRIBES OF GURGURIPAL

Ethnoeconomical Values of Wild Mushrooms: It was investigated that the ethnic tribes of Gurguripal regularly collected and consumed wild mushrooms of their own during monsoon and the surplus quantity generally sold in the nearby urban market ranging from 100 to 400 INR per kg **Fig. 6**.

FIG. 6: COLLECTION (A, C), CONSUMPTION (B), MARKETING (D, E, F) OF WILD MUSHROOMS IN GURGURIPAL

Genera like *Astraeus*, *Agaricus*, *Pleurotus*, and *Termitomyces* have higher values due to their superior taste and texture. Earlier several reports have revealed that *Termitomyces* species have high economic value due to pleasant taste and greatly contribute to the income of many households in tribal communities [38, 39]. The species like *Ganoderma lucidum*, *Daldinia concentrica*, *Schizophyllum commune*, and *Lycoperdon perlatum* are known to dry and preserved in glass containers by the traditional healers of Gurguripal for health care remedies. Even sometimes those preserved samples are exchanged between healers of different communities, referring to horizontal transfer of traditional knowledge regarding the utilization of wild mushrooms.

Ethnomycological Uses of Wild Mushrooms: The present ethnomycological survey revealed that the ethnic tribes of Gurguripal generally prepare indigenous mushroom dishes with spices and mustard oil. It was also evident that some wildly grown mushrooms of this region are effectively used against different human ailments related to gastrointestinal disorders, dermatological infections, respiratory system diseases, genitourinary infections, cardiovascular diseases, endocrinal disorders and liver problems by the traditional healer's **Table 3**. As per the collected information, 4 mushroom species are popularly used as a remedy of blood pressure-related problems, 4 in curing wound and 5 applied against skin diseases. Among them, *Termitomyces heimii*, *Pleurotus ostreatus*, *Auricularia auricula and Ganoderma lucidum* showed higher use values and manifold nutraceutical potentials. It has been noticed that some mushrooms are inedible and even poisonous when they are consumed but exhibit therapeutic values when used externally as paste, powder or juice, such as extracted juice of *Lactarius* sp. showed antimicrobial activity providing protection against dermatophytes and *Ganoderma lucidum* is effective in curing wounds when used as a paste. Dried powders of *Daldinia concentrica* are useful when applied against burning, itching or inflammations.

So, it is evident that mycophile is a very ancient and traditional concept among the tribal population of this region. Moreover, the present survey revealed that the ethnomedicinal use of a particular mushroom species is not persistent, rather it varies from one sub-tribe to another and even from place to place. *Pleurotus ostreatus* is used by Santals for curing asthma, whereas the same is used by Munda for lowering blood pressure. *Russula delica* is consumed as a nutritional supplement to eradicate malnutrition by Bagdis, while the extract of the same is used as an expectorant by Kurmis.

TABLE 3: ETHNOMEDICINAL USES OF WILD MUSHROOMS IN GURGURIPAL

S. no.	Scientific name	Local name	Tribal groups/ consumers	Ethnomedicinal uses	Use value
1	*Astraeus hygrometricus*	Putka chhatu/ Kurkure chhatu	Kurmi, Bhumija, Bagdi, Sabaar, Oraon	The spore mass is blended with mustard oil and used as a salve against burns	0.084
2	*Auricularia auricula*	Kan chhatu	Santal, Kheria, Munda, Bhumija, Oraon, Lodha, Kurmi	Earache to cure ear infections, cardiovascular diseases, diabetes and hypertension	0.204
3	*Cantharellus* sp.	Kamla chhatu	Santal, Oraon, Sabar, Kurmi, Dule, Munda, Lodha	Treating liver problems	0.132
4	*Coprinus comatus*	Jiban chhatu	Munda, Santal, Sabar, Oraon, Kheria, Kurmi, Bagdi	Fruit body is taken in tea and soups	0.144
5	*Daldinia concentrica*	Kath chhatu	Munda, Oraon, Bhumija, Lodha, Sabar, Kheria, Bagdi, Dule, Santal	Getting relief from burning itching and healing minor skin infections	0.144
6	*Ganoderma lucidum*	Shukna chhatu	Santal, Oraon, Sabar, Kurmi, Dule, Munda, Lodha	Used as an antimicrobial agent curing wound, immune enhancer.	0.192
7	*Lacatarius* sp.	Pitha chhatu/ Atha chhatu	Santal, Sabar, Kharai, Bagdi, Munda	Used to lowering high blood pressure	0.108
8	*Lycoperdon perlatum*	Dhula/ Gua chhatu	Santal, Munda, Bagdi, Sabar, Kheria	Used to cure wound as an antimicrobial agent	0.180
9	*Pleurotus ostreatus*	Jhinuk chhatu	Santal, Munda, Dule, Bhumija, Kheria	Asthma and lowering blood pressure and antitumor agent	0.216
10	*Polyporus badius*	Sonajhuri/ Khop chhatu	Bagdi, Kurmi, Kheria, Sabar, Santal	Powder mixed with coconut oil and applied to skin against poisonous insect bite	0.072

11	*Russula albonigra*	Kalopatra	Santal, Munda, Oraon, Kurmi, Bhumija	Controlling cold and cough	0.060
12	*Russula cyanoxantha*	Jam chhatu	Kharia, Munda, Sabar, Kurmi, Bagdi	Controlling low and high blood pressure	0.096
13	*Russula delica*	Jhor chhatu	Bagdi, Kurmi, Munda, Oraon, Santal	Curing malnutrition, weakness, and nutritional disorders, skin diseases and wound healing	0.072
14	*Russula emetica*	Murgi chhatu	Santal, Munda, Sabar, Bagdi, Kheria	Used in rheumatism and lowering blood pressure	0.144
15	*Russula senecis*	Jhal chhatu	Santal, Munda, Oraon, Kurmi, Bhumija	Treatment of wounds against microbial infection and cuts	0.060
16	*Schizophyllum commune*	Pakha chhatu	Oraon, Sabar, Bhumija, Dule, Santal, Kheria	Used as a tonic for regaining energy	0.168
17	*Termitomyces clypeatus*	Parabana/Ada chhatu	Santal, Munda, Oraon, Sabar, Bhumija	Used to reduce staunch bleeding & reduce swelling	0.168
18	*Termitomyces heimii*	Durga chhatu / Sik chhatu	Lodha, Sabar, Munda, Santal, Kheria, Dule, Bagdi, Bhumija, Kurmi	Fruit body is pasted and applied to the affected area for wound healing	0.228
19	*Volvariella volvacea*	Khor chhatu/ Powal chhatu	Kheria, Santal, Lodha, Sabar	Lowering the blood pressure and blood purifier	0.144

DISCUSSION:

Traditional Knowledge: The present study revealed that the native tribal communities of Gurguripal have rich traditional knowledge regarding the utilization of wild mushrooms. The tribal inhabitants of this region use mushrooms mainly as food and few for medicinal purposes. In monsoon period, local tribals usually hunt for mushrooms along with other non-timber forest products in groups of 5-10 peoples preferably male belonging to the same family or community. It was noticed that traditional knowledge about the ethnomedicinal uses of wild mushrooms was generally confined to elderly aged persons of the villages. The mode of preparation and dose of administration were determined by local traditional healers (vernacularly known as 'Vaidya'). Moreover, it has been noted that all the traditional healers were male as they believe that females cannot take the risk of mushroom hunting in deep forest areas.

All the respondents had stated that they received knowledge about ethnomycological applications of wild mushrooms from their forefathers as a hereditary transfer of their collective traditional knowledge system. Each wild edible mushroom species occurring in this region has different local names assigned by different tribes. These types of folk taxonomy were developed from the traditional knowledge systems that prevailed within native tribal communities. Such positive social inclination of local people towards mushrooms can be scientifically expressed as Mycophilia [40]. It has been also observed that the traditional healers were very sensitive to discuss or exchange their traditional knowledge with any unknown or outsider person not belonging to own community. In this context, the present research work had successfully documented a very important ethnomycological knowledge system that remains hidden so far and might become extinct.

Indigenous Beliefs, Perceptions: The tribals of Guruguripal had some indigenous beliefs on the mushroom collection, consumption, and utilization. Incidence of mushroom poisoning was rare among the studied tribal communities. They have very distinct knowledge about poisonous mushrooms which are very similar in morphological appearance to edible species and may even occur in the same habitat. People think that some mushrooms occur in dirty places, they are unhygienic [13]. As per their myth, when insects or animals feed on mushroom it is edible, and if the mushroom is rubbed on sensitive areas of the human body, it itches then it is poisonous.

The traditional processing and cooking knowledge determine the edibility of some mushroom species [41]. Some of the wild mushrooms not popular as edible species or even poisonous are frequently collected and consumed by local tribes as delicious curry by cooking with salts, spices and mustard oil, which probably reduce their toxicity up to a safer extent. They believed that cooking with sour fruits or vegetables might help in the dilution of mushroom toxins. For example *Amanita bisporigera* (mural chhatu) is cooked with mustard oil and lemon.

In the present scenario still, there are strong ritualistic beliefs among the local tribal communities regarding medicinal uses of wild mushrooms, such as the effects might get enhanced if the preparation is eaten or applied in the empty stomach on the onset of 'Purnima' or 'Amavasya' tithi. Despite traditional home remedies, in case of critical illness, healers send their patients to the hospital after a remedy has failed. Most of the remedies described in this study are administered orally as water-based concoctions, which are in agreement with some of the earlier findings [42-44].

The most remarkable fact emerged in this ethnomycological study was that a large portion of the local ethnic population of this region could not afford animal protein in their regular diet, while wild edible mushrooms are frequently collected, consumed and considered as a substitute of meat by them. So, in this regard wild mushrooms could serve as a vital food supplement especially in solving the protein demand and malnutrition problems of this economically backward region.

Threats and Conservation: Natural calamities like drought and anthropogenic activities such as deforestation for farmlands, expansion of grazing sites, and fire outbreaks by the local communities around the Gurguripal forest were causing great threats to the occurrence and abundance of macrofungi in this forest. The elderly respondents reported that a lot of mushroom species had disappeared in the recent past. They have a belief that intensive collection causes consequent threats to mushroom species. Hence, a traditional method of harvesting also implies the conservation of some fungal fruit bodies, which confirm the production of sporocarps in the next season. But the increasing urbanization is influencing the changes in lifestyles of tribal people, particularly the younger generation are not seriously concerned about ethno-mycological uses of wild mushrooms. Hence this indigenous untapped knowledge must be documented and conserved as soon as possible before they got erased, and the present research work is a footprint to that goal.

Scope of Utilization: Wild edible mushrooms are known to have high nutritional value and are important food supplement for tribal communities that live in and around forest areas, heavily dependent natural resources to solve malnutrition problem [31]. Among the studied mushroom species only *Volvariella volvacea* was domesticated and cultivated in few households of Gurguripal. Other commercially valuable genera like *Pleurotus*, *Termitomyces* can be preserved in air sealed polypackets merely for 2-3 days after harvesting. *Schizophyllum commune* could be preserved for more than a month if dried and kept properly. The growing popularity of mushroom usages, therefore, underscores the need for their domestication and commodification [45].

The local tribes of this region consume an Amanitaceous mushroom (*Amanita bisporigera* G.F.Atk.) as a special recipe with tamarind, while most of the members of Amanitaceae are reported as poisonous [46]. It was assumed that the toxicity of *A. bisporigera* may be encountered by the bioactivity of tamarind (*Tamarindus indica* L.). In this regard, the scientific knowledge about the collection, preservation as well as the poisoning of mushrooms among the local tribes is very much necessary to overcome the risk factors associated with wild mushrooms.

Wild edible species of mushrooms are preferentially more tasteful, palatable, and nutritious than their cultivated counterparts [47]. There are some reports that suggested a positive link between mushroom phytochemical contents and mineral characteristics of their ambient environment [48]. The present study might provide useful information for further research and discovery of new therapeutic agents to combat our growing health problems. Moreover, there is immense scope for the processing of indigenous mushroom juices and soups from wild edible mushrooms as potential dietary supplements for human society.

This ethnomycological study explored the potential utilization of wild mushrooms, including their high economic values as income generation sources for many tribal households, which ultimately can improve the socio-economic status of this locality.

CONCLUSION: Ethnomedicinal knowledge about wild mushrooms is the first and foremost idea of developing modern day medicine like antibiotics and other drug products. The tribal

communities of Gurguripal possess substantial knowledge about the ethnomedicinal utilization of wild mushrooms, which play an important role in their socio-economic livelihood. The folk taxonomy helped in the transfer of this ethno-mycological knowledge from one generation to the next. But such precious knowledge is presently facing the risk of extinction due to proper documentation, while changes in the lifestyle of tribal people are influencing gradual degeneration of sociological myths and spirituality concerned with wild mushrooms.

Hence, there is an immediate need to conserve the indigenous knowledge regarding the ethno-medicinal potentials of wild mushrooms all over the world and the present effort is one of such initiations. Since mushrooms do have not only socio-economic benefits but also play functional roles in maintaining the ecosystem, sustainable government laws and forest policies should be implemented to ensure their conservation.

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