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Ethnomycological knowledge of tea tribe and indigenous communities of Upper Assam, India

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A massive survey was done from April to October 2015 in Jorhat and Tinsukia districts of upper Assam for collection and identification of wild edible and medicinal mushrooms used by the rural people and tea tribes. Older adults are experts in the identification of consumable mushrooms found in wild condition by using indigenous knowledge. Mushroom poisoning is common all over the world and the Upper Assam area is also not exceptional. A total of 41 wild edible mushroom species belonging to 24 genera, 17 families, 8 orders and 3 classes were identified. The rural people and tea tribes of the study site mostly consume 12 species out of the 41 species of identified wild edible mushrooms. The tea tribe and other indigenous people living in interior villages are economically very weak and consume the wild edible mushrooms as a substitute of meat, due to taste and easy availability in the spring and summer season. Moreover, 8 wild mushroom species having importance as traditional medicine were identified.

Keywords: Consumable mushroom; Ethnic groups; Hallucinogenic mushrooms, Indigenous knowledge, Traditional medicine

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In India, edible and medicinal practices of mushrooms is quite common, some of which dates back to 1700–1100 BC[1]. Several mycologists have reported ethno-mycological usages of mushroom from India[2-10]. The article[11] "edible wild mushrooms of the Western Ghats: data on the ethnic knowledge" reported 51 edible wild mushrooms species (23 genera) in the Western Ghats region of India. Among the 51 wild mushrooms the most preferred species included *Astraeus hygrometricus*, *Clitocybe infundibuliformis*, *Fistulina hepatica*, *Lentinus sajor-caju*, *Pleurotus* (5 spp.) and *Scleroderma citrinum* and *Termitomyces* (18 spp.). A total of 283 edible fungi have been reported from India[12]. A recent work on ethnomedicinal practices reported 100 spp. of mushrooms belonging to 56 genera which have been diversely used as traditional medicines[13]. On the basis of folk taxonomy and traditional knowledge, tribes use these wild mushrooms in daily life as a source of nutrition and ayurvedic medicine to survive in adverse situation. Recently some authors reported that major therapeutically important mushroom species *i.e.*, *Auricularia auriculata*, *Agaricus bisporus*, *Boletus edulis*, *Ganoderma lucidum*, *Lentinus edodes*, and *L. squarrosulus* have been found in kerala[14]. Ethnomycological study of wild edible and medicinal mushrooms in the Jammu district of J&K, found that local people consumed 14 fleshy wild edible fungi. *Termitomyces* spp. including *Termitomyces heimii*, *Termitomyces clypeatus*, and *Termitomyces striatus* var. *annulatus* were the most important and diversely used medicinal species by the locals[15].

Wild mushrooms are very important natural sources of food and it generated income for many indigenous tribes/communities throughout the globe[16]. Edible mushrooms are rich in proteins, vitamins, minerals, fibre, trace elements and low in calories and cholesterol[17]. A recent study on three edible mushrooms of Manipur *viz.*, *Macrocybe gigantean*, *Lactifluus leptomerus* and *Ramaria thindii* revealed a high protein content of 37.6%, 20.8% and 16.4%, respectively with a high vitamin C and mineral content with low vitamin B1, B2 and folic acid in three major species[18]. One more recent study on nutritional analysis of 5 cultivated mushroom[19] species showed protein, lipid, carbohydrate and dietary fibre content ranged from 15.27 to 38.75%, 0.84 to 3.88%, 39.33 to 69.60%, and 30.22 to 40.48%

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respectively. Most of the mushrooms are important component of folk medicine and considered as nutraceuticals[20-21].

In North East India, a few studies relating to wild edible mushrooms have been carried in different parts of the region[4,6,17,18,22-27], although detailed studies are lacking on indigenous knowledge employed for identification, utilization, and addressing the causes of mushroom poisoning.

Present study reveals ethnomycological knowledge of tea tribe and indigenous communities of upper Assam that would help in documenting, preserving and protecting the traditional knowledge for sustainable livelihood and neutraceutical security of the targeted communities.

Materials and Methods

Study area

The study was carried out in Upper Assam (Fig. 1**)** which consists of nine districts of Brahmaputra valley, Assam namely Golaghat, Jorhat, Sivasagar, Dibrugarh, Tinsukia, Dhemaji, Lakhimpur, Majuli and Charaideo. The Majuli and Charaideo districts are recently separated from Jorhat and Sivasagar districts respectively. The major communities/ethnic groups of Upper Assam are Ahom, Chutia, Moran, Matak, Missing (ST), Sonowal Kacharis (ST), Thengal Kacharis (ST), Deori (ST), and Tea tribes. The Upper Assam has a population of 7.56 million (24% of Assam's population)[28]. A comprehensive reconnaissance survey in nine representative villages (seven villages from Jorhat, two villages from Tinsukia) was carried out. The survey was carried out during pre-monsoon (March to May) and monsoon (June to September) season.

Data collection

Data were collected from 90 (including 30 female) indigenous knowledge holders (IKH) of the selected nine villages, covering all nine major communities of Upper Assam. Prior Informed Consent (PIC) was taken in a written format from the knowledge providers. The wild edible and medicinal mushrooms were photographed in the wild habitat and morphological characters such as colour, size, odour, habitat, and association with other species and termites were recorded. They were collected from different habitats like forest floor, soil, meadow, leaf litter, decaying wood, termite's mound, and rotting plant parts. Specimens/samples of fresh wild mushrooms were brought to the laboratory, Rain Forest Research Institute (RFRI), Jorhat for further macro and micro-morphological study under optical microscope. Identification of each collected sample was done with help of existing standard manuals[12,29-33]. The specimens were deposited in the herbarium center of RFRI, Jorhat.

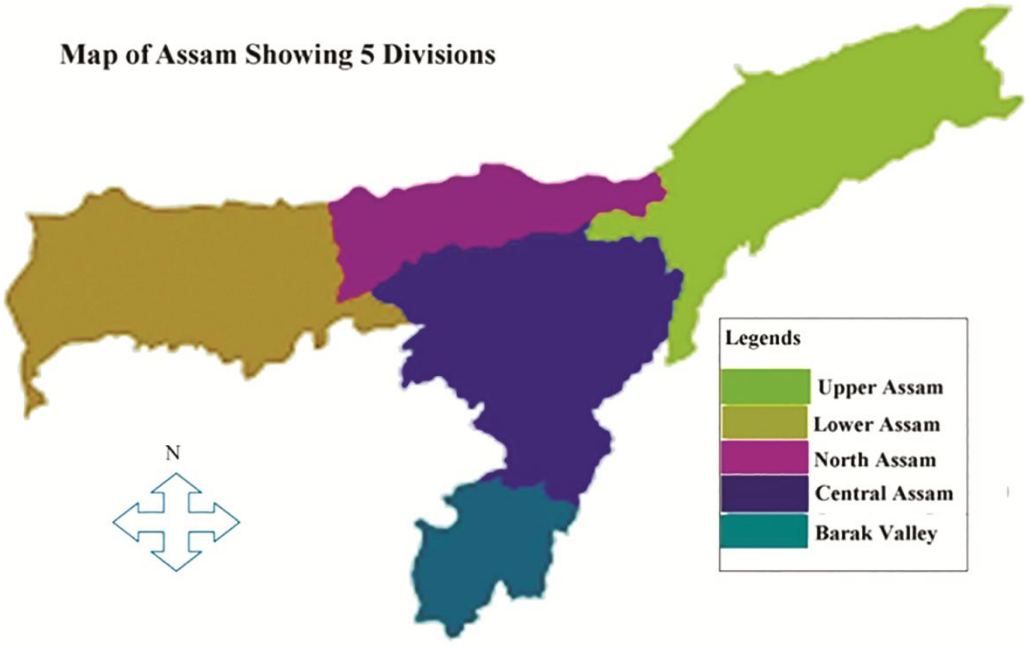


Fig. 1 — Map of Assam showing location of study area (upper Assam)

Results and Discussion

A total of 41 species of wild edible mushroom belonging to 24 genera, 17 families, 8 orders and 3 classes were recorded in the study site covering nine communities (Table 1, Photoplate I, II, III). The genus *Termitomyces* was found dominant with highest number of wild edible mushroom species (5) followed by *Calvatia* (4), *Lentinus* (3), *Phallus* (2), *Bovista* (2), *Agarius* (2), *Cantharellus* (2), *Macrolepiota* (2), *Russula* (2), *Amanita* (1), *Auricularia* (1), *Clavulina* (1), *Dacrymyces* (1), *Dacryopinax* (1), *Gomphus* (1) *Lactarius* (1), *Leucoagaricus* (1) *Leucopaxillus* (1), *Lycoperdon* (1) *Morganella* (1), *Pleurotus* (1), *Pluteus* (1), *Pseudohydnum* (1), *Schizophyllum* (1), *Tremella* (1) and *Volvariella* (1). The Agaricaceae family had maximum species (13) followed by Lyophyllaceae (5), Russulaceae (3), Polyporaceae (3), Phallaceae (2), Cantharellaceae (2) and so on. The maximum number of species of wild edible mushrooms was found under the order Agaricales (27) followed by Cantharellales (3), Russulales (3), Phallales (2) and so on. The class Agaricomycetes (37) was found with highest number of species of wild edible mushrooms followed by Dacrymycetes (2) and Tremellomycetes (2).

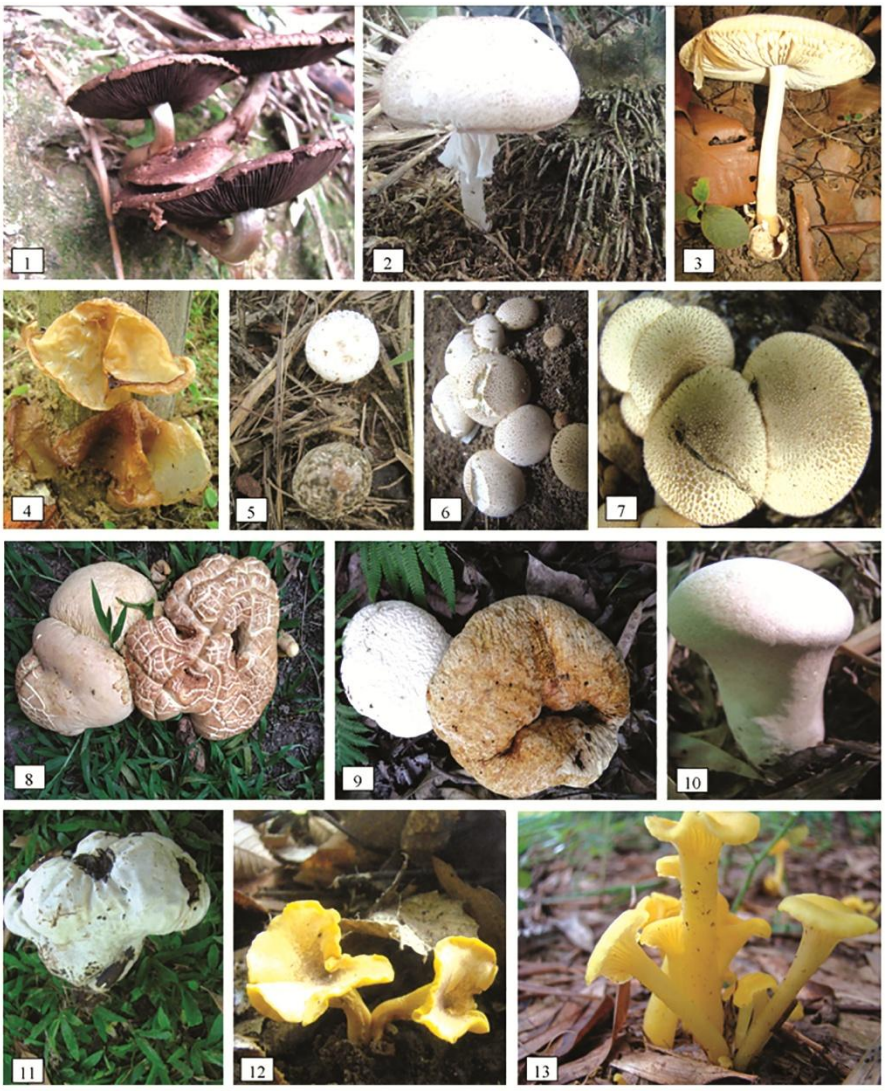
Table 1 — A list of Wild edible Mushrooms of Upper Assam showing their Taxonomic position

SN.	Name of Species	Families	Orders	Classes
1	*Agaricus arvensis* Schaeff.	Agaricaceae	Agaricales	Agaricomycetes
2	*Agaricus sylvaticus* Schaeff.	Agaricaceae	Agaricales	Agaricomycetes
3	*Amanita chepangiana* Tulloss & Bhandary	Amanitaceae	Agaricales	Agaricomycetes
4	*Auricularia auricula-judae* (Bull.) Quél.	Auriculariaceae	Auriculariales	Agaricomycetes
5	*Lycoperdon dermoxanthum* Vittad.	Agaricaceae	Agaricales	Agaricomycetes
6	*Bovista longispora* Kreisel	Agaricaceae	Agaricales	Agaricomycetes
7	*Bovista plumbea* Pers.	Agaricaceae	Agaricales	Agaricomycetes
8	*Calvatia booniana* A.H. Sm.	Agaricaceae	Agaricales	Agaricomycetes
9	*Calvatia craniiformis* (Schwein.) Fr. ex De Toni	Agaricaceae	Agaricales	Agaricomycetes
10	*Calvatia cyathiformis* (Bosc) Morgan	Agaricaceae	Agaricales	Agaricomycetes
11	*Calvatia candida* (Rostk.) Hollós	Agaricaceae	Agaricales	Agaricomycetes
12	*Cantharellus cibarius* Fr.	Cantharellaceae	Cantharellales	Agaricomycetes
13	*Cantharellus flavus* Foltz & T.J. Volk	Cantharellaceae	Cantharellales	Agaricomycetes
14	*Clavulina coralloides* (L.) J. Schrot	Clavulinaceae	Cantharellales	Agaricomycetes
15	*Dacrymyces chrysospermus* Berk & M.A. Curtis	Dacrymycetaceae	Dacrymycetales	Dacrymycetes
16	*Dacryopinax spathularia* (Schwein.) G.W. Martin	Dacrymycetaceae	Dacrymycetales	Dacrymycetes
17	*Gomphus clavatus* (Pers.) Gray	Gomphaceae	Gomphales	Agaricomycetes
18	*Lactarius resimus* (Fr.) Fr.	Russulaceae	Russulales	Agaricomycetes
19	*Lentinus sajor-caju* (Fr.) Fr.	Polyporaceae	Agaricales	Agaricomycetes
20	*Lentinus squamosus* Quél.	Polyporaceae	Agaricales	Agaricomycetes
21	*Lentinus tigrinus* (Bull.) Fr.	Polyporaceae	Agaricales	Agaricomycetes
22	*Leucoagaricus leucothites* (Vittad.) Wasser	Agaricaceae	Agaricales	Agaricomycetes
23	*Leucopaxillus albissimus* (Peck) Singer	Tricholomataceae	Agaricales	Agaricomycetes
24	*Macrolepiota dolichaula* (Berk. & Broome) Pegler & R.W. Rayner	Agaricaceae	Agaricales	Agaricomycetes
25	*Morganella pyriformis* (Schaeff.) Kreisel & D. Kruger	Agaricaceae	Agaricales	Agaricomycetes
26	*Phallus atrovolvatus* Kreisel & Calonge	Phallaceae	Phallales	Agaricomycetes
27	*Phallus indusiatus* Vent.	Phallaceae	Phallales	Agaricomycetes
28	*Pleurotus pulmonarius* (Fr.) Quél.	Pleurotaceae	Agaricales	Agaricomycetes
29	*Pluteus salicinus* (Pers.) P. Kumm.	Pluteaceae	Agaricales	Agaricomycetes
30	*Pseudohydnum gelatinosum* (Scop.) P. Karst.	Exidiaceae	Tremellales	Tremellomycetes
31	*Russula atropurpurea* (Krombh.) Britzelm.	Russulaceae	Russulales	Agaricomycetes
32	*Russula compacta* Frost.	Russulaceae	Russulales	Agaricomycetes
33	*Schizophyllum commune* Fr.	Schizophyllaceae	Agaricales	Agaricomycetes
34	*Macrolepiota albuminosa* (Berk.) Pegler	Lyophyllaceae	Agaricales	Agaricomycetes
35	*Termitomyces clypeatus* R. Heim	Lyophyllaceae	Agaricales	Agaricomycetes
36	*Termitomyces eurrhizus* (Berk.) R. Heim	Lyophyllaceae	Agaricales	Agaricomycetes
37	*Termitomyces heimii* Natarajan	Lyophyllaceae	Agaricales	Agaricomycetes
38	*Termitomyces indicus* Natarajan	Lyophyllaceae	Agaricales	Agaricomycetes
39	*Termitomyces microcarpus* (Berk. & Broome) R. Heim	Lyophyllaceae	Agaricales	Agaricomycetes
40	*Tremella fuciformis* Berk.	Tremellaceae	Tremellales	Tremellomycetes
41	*Volvariella volvacea* (Bull.) Singer	Pluteaceae	Agaricales	Agaricomycetes

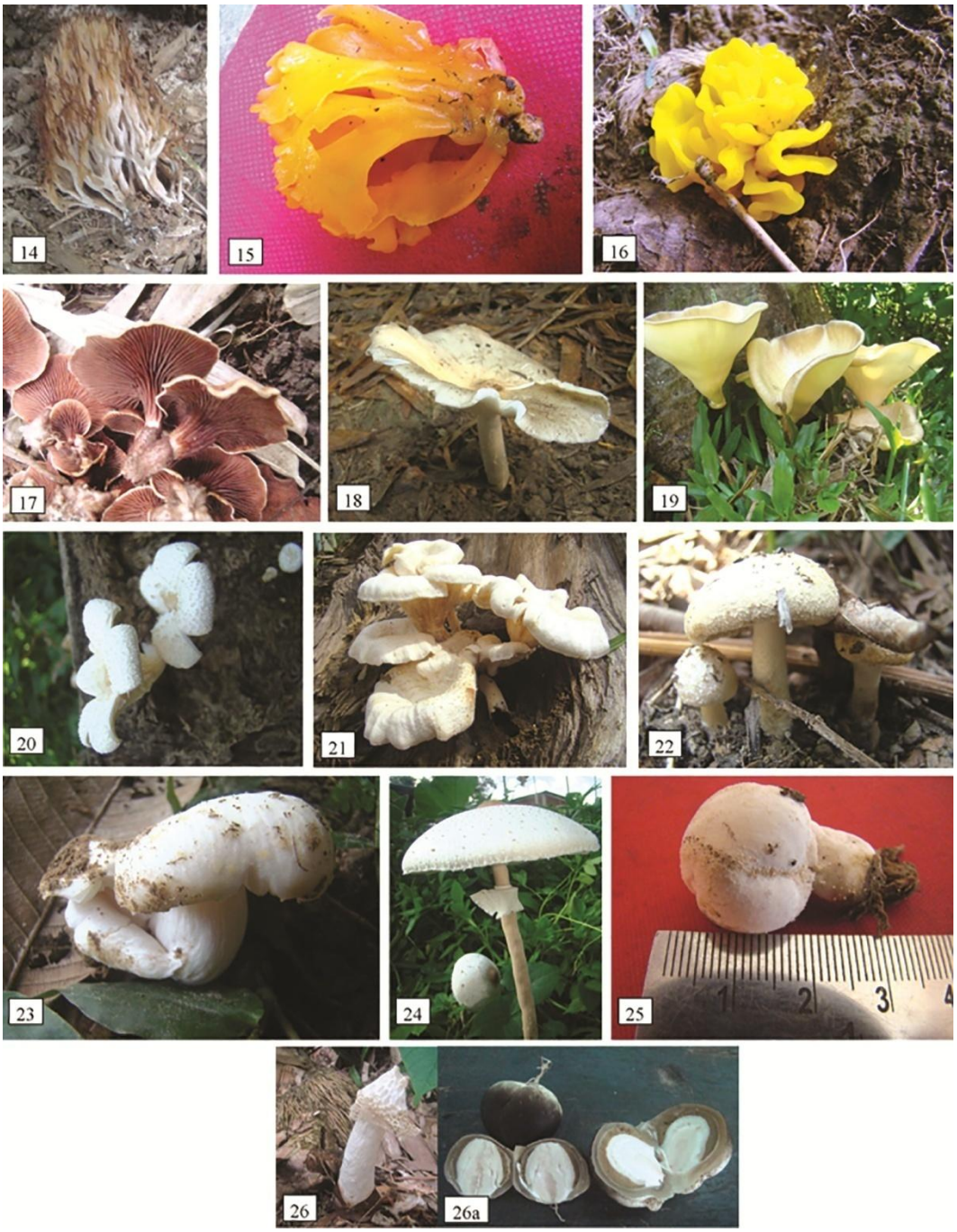
Out of the 41 species of wild edible mushrooms only 12 species (Table 2, Photoplate 19-21, 24, 28,29, 34-39) were preferred as edible mushrooms by the nine major ethnic groups of Upper Assam. Among the 12 species of wild edible mushrooms, 5 species of *Termitomyces*, 3 species of *Lentinus*, 2 species of *Macrolepiota*, 1 species each from *Pleurotus*, and *Pluteus* were found to be consumed by them. Similar type of study was also conducted in Jammu district, J&K where local people of the district, were found having knowledge of 14 mushroom spp. that are specially used for culinary purposes. Agaricaceae and Lyophyllaceae were found to be the most used families and *Termitomyces* (5 species) was the most represented genus in the study area[15].

Table 2 — A list of wild edible Mushrooms used by the nine major ethnic groups of Upper Assam

SN.	Name of species
1	*Macrolepiota dolichaula* (Berk. & Broome) Pegler & Rayne
2	*Macrolepiota albuminosa* (Berk.) Pegler
3	*Termitomyces clypeatus* R. Heim
4	*Termitomyces eurrhizus* (Berk.) R. Heim
5	*Termitomyces heimii* Natarajan
6	*Termitomyces indicus* Natarajan
7	*Termitomyces microcarpus* (Berk. & Broome) R. Heim
8	*Pleurotus pulmonarius* (Fr.) Quél.
9	*Pluteus salicinus* (Pers.) P. Kumm.
10	*Lentinus sajor-caju* (Fr.) Fr.
11	*Lentinus squamosus* Quél.
12	*Lentinus tigrinus* (Bull.) Fr.



Photoplate (I): 1 — *Agaricus arvensis*, 2 — *Agaricus sylvaticus*, 3 — *Amanita chepangiana*, 4 — *Auricularia auricular-judae*, 5 — *Lycoperdon dermoxanthum*, 6 — *Bovista longispora*, 7 — *Bovista plumbea*, 8 — *Calvatia booniana*, 9 — *Calvatia craniiformis*, 10 — *Calvatia cyathiformis*, 11 — *Calvatia candida*, 12 — *Cantharellus cibarius*, 13 — *Cantharellus flavus*



Photoplate (II): 14 — *Clavulina coralloides*, 15 — *Dacrymyces chrysospermus*, 16 — *Dacryopinax spathularia*, 17 — *Gomphus clavatus*, 18 — *Lactarius resimus*, 19 — *Lentinus sajor-caju*, 20 — *Lentinus squamosus*, 21 — *Lentinus tigrinus*, 22 — *Leucoagaricus leucothites*, 23 — *Leucopaxillus albissimus*, 24 — *Macrolepiota dolichaula*, 25 — *Morganella pyriformis*, 26 — *Phallus atrovolvatus*, 26a — Volva of *Phallus atrovolvatus*

The species of *Termitomyces* were always found associated with termites (Photoplate 35-39). A root like structure, called pseudorhiza of the *Termitomyces* species were found attached with termite mound (Photoplate 38a-38b). *Macrolepiota* (Photoplate 24 & 34) was found on land rich in leaf litter or organic matter. The species of *Lentinus* (Photoplate 19-21), *Pleurotus* (Photoplate 28) and *Pluteus* (Photoplate 29) were found on dead wood, stump, branches and twigs.

The aged people of the study area used to identify and collect the wild edible mushrooms in the morning when the mushrooms remained fresh. They didn't

Photoplate (III): 27 — *Phallus indusiatus*, 27a — *Volva of Phallus indusiatus*, 28 — *Pleurotus pulmonarius*, 29 — *Pluteus salicinus*, 30 — *Pseudohydnum gelatinosum*, 31 — *Russula atropurpurea*, 32 — *Russula compacta*, 33 — *Schizophyllum commune*, 34 — *Macrolepiota albuminosa*, 35 — *Termitomyces clypeatus*, 36 — *Termitomyces eurrhizus* 37 — *Termitomyces heimii*, 38 — *Termitomyces indicus*, 38a — Pseudorhiza of *Termitomyces* spp., 38b — Termite mound associated with *Termitomyces* spp., 39 — *Termitomyces microcarpus*, 40 — *Termella fuciformis*, 41 — *Volvariella volvacea*

collect the edible mushrooms in the afternoon or evening because the mushrooms get collapsed and they thought that these collapsed mushrooms get contaminated which become poisonous. Some people used to cook the collected mushrooms along with brinjal, if the mushrooms turn black they didn't consume it. They think that it is a poisonous mushroom which reacts with brinjal and turns it black. The young fruit bodies of *Phallus* spp. called 'Volva or egg' (Photoplate 26a, 27a) are edible.

In spite of this indigenous knowledge, causalities due to consumption of hallucinogenic mushrooms mainly *Amanita phalloides* (Vaill. ex Fr.) Link in many districts of Upper Assam are often reported in the state. After mushroom poisoning the community people don't have any indigenous curative measure

Table 3 — A list of medicinal Mushrooms used by the nine major ethnic groups of Upper Assam

SN.	Name of species	Edibility	Medicinal
1	*Lycoperdon dermoxanthum* Vittad.	Edible in the immature stage	Gleba is used in healing of cuts/wounds in man and animals
2	*Bovista longispora* Kreisel	-Do-	-Do-
3	*Bovista plumbea* Pers.	-Do-	-Do-
4	*Calvatia cyathiformis* (Bosc) Morgan	-Do-	-Do
5	*Calvatia candida* (Rostk.) Hollós	-Do-	-Do-
6	*Calvatia booniana* A.H. Sm.	-Do-	-Do-
7	*Calvatia craniiformis* (Schwein.) Fr. ex De Toni	-Do-	-Do-
8	*Morganella pyriformis* (Schaeff.) Kreisel & D. Kruger	-Do-	-Do-

and they are immediately sent to hospital for recovery. These tragic incidents happen in Upper Assam due to misidentification of wild edible mushrooms and lack of proper indigenous knowledge transfer from generation to generation.

A study revealed that a total of 19 species of wild edible mushrooms were collected by three communities of Dima Hasao district, Assam[27]. Consumptions of wild edible mushrooms by the indigenous people of Assam were also reported by many authors[4,25-27,34-36] mainly from lower Assam and hill districts of Assam.

A total of 8 species of wild edible mushrooms which are also used as medicine by the nine major communities of Upper Assam were only the puffball species (Table 3, Photoplate 5-11,25). The genus *Calvatia* (4), *Bovista* (2), *Lycoperdon* (1) and *Morganella* (1) were the puffballs used by them as a medicine in healing of wounds and cuts. The puffballs are edible only in the immature stage before the formation of puff and when white inside, but precaution must be taken to prevent confusion with young and deadly Amanitas. This can be done by cutting the fruit bodies longitudinally to ensure that they are white throughout, and do not have any internal structures within. Mushrooms are the important component of folk medicine and considered as nutraceuticals[13-15,20-21]. A study in Kamrup district, Assam revealed that the local people used *Ganoderma lucidum*, *Lentinula edodes* and *Bovista plumbea* in medicine[34]. Recently, Gogoi *et al.*[37] reported that wild mushrooms are identified as edible and inedible based only on the rich and unique indigenous knowledge system of local tribes of North-east India. Wild edible mushrooms are consumed due to their appetizing taste and sweet aroma. Tribal women in the Achanakmar-Amarkantak Biosphere Reserve in Chhattisgarh used to collect about 17 species of wild mushrooms from the Biosphere Reserve and they undertake a variety of conservation activities for sustainable management of the forest products[38].

Conclusions

Out of the 41 species of wild edible mushrooms documented only 12 species are preferred by the nine major ethnic groups of Upper Assam for consumption and 8 species are used as medicine for healing of cuts/wounds of men and animals. They don't know about the edibility of the other species of wild mushrooms. There is a great potential in North East India to use the wild mushrooms in a sustainable manner as a source of food and medicine.

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Conflict of Interest

Authors' declare there is no conflict of interest.

Authors' Contributions

GG performed collection and analysis of field data; identification of mushrooms and compilation of manuscript. VP compiled and edited the manuscript.

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