

Wild edible macrofungal species consumed by the Khasi tribe of Meghalaya, India

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Wild edible macrofungi collected from the forests by the ethnic tribes and sold in the local markets of the Khasi hills of Meghalaya, India have been documented for their traditional knowledge and ethnic relevance. The ethnic tribal population have extensive ethnomycological knowledge based on which they discretely collect and sell the edible macrofungi. We observed considerable diversity among the edible macro-fungal species sold in the local markets. During the study period a total of 11 different species were identified based on their morphology that belonged to 9 genera and 8 families. *Clavulina* spp. was the most abundantly available species whereas *Albatrellus* spp. was rarely available in the local markets.

Keywords: Wild edible, Macrofungi, Ethnic tribes, *Clavulina* spp., Mushrooms.

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Introduction

Macrofungi such as mushrooms serve as important dietary food in many countries¹. Throughout history many cultures have built-up a practical knowledge of which mushrooms are suitable to eat and those that are poisonous². Wild edible fungi (WEF) are a natural resource with a high nutritional and economic value. Studies confirm that they are an important source of food and income in both developing and developed countries³⁻⁵. They are sold in local markets^{6,7} or commercially exploited as food^{8,9} or medicines¹⁰⁻¹². Some workers have dealt with the ethnomycological aspects in different parts of India and the world¹³⁻¹⁶. In North-East India, wild mushrooms are sold in the local markets and are known to provide sustenance to the local people and forest dwellers during the lean period (rainy season) when other non-wood forest products are unavailable in the forests¹⁷. Such wild edible mushrooms from Assam, Arunachal Pradesh and Manipur have already been reported¹⁸⁻²¹. There are a few reports on wild edible mushrooms of Meghalaya and their nutritional value^{22,23} but the ethnic knowledge documentation on their food value, collection criteria and market cost is completely lacking.

The tribal people of Meghalaya are very close to nature and have acquired enormous knowledge about

plant wealth and the utilization of different forest products^{24,25}. Meghalaya has a mycophilic society comprising of ethnic groups that have extensive traditional mycological knowledge. The varieties of mushrooms consumed by the local tribes have always been harvested from wild habitats and no efforts have been made to cultivate these varieties on a commercial scale. The discrimination on the poisonous nature of the collected mushrooms is based on the traditional knowledge of the tribes. With growing urbanisation, and changes in the food habits accruing due to it, the ancient tradition of gathering and consuming wild mushrooms by the local tribes is slowly on the decline²³. The present study was, therefore, aimed at documenting the most widely collected wild edible macro-fungal resources consumed by the Khasi tribe and their availability in the local markets of the east Khasi hills of Meghalaya, India, with a view to document the ethnic knowledge and explore for their bioprospection and value addition.

Materials and Methods

Study area

The east Khasi hills is the most populated district among the seven districts of the State of Meghalaya²⁶ (Plate 1). The district occupies an area of 2748 Sq Km and lies between 25°07" & 25°41" N and 91°21" & 92°09" E comprising mainly of the Khasi and the Jaintia tribes. Forests occupy 35.34% of the land

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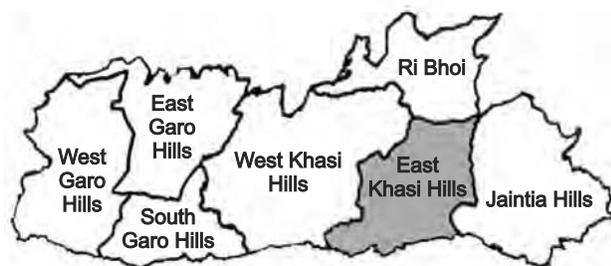


Plate 1—Map of Meghalaya showing different districts of the state including the study area (East Khasi hills district) (Map not to Scale)

area and have been exploited over the years for natural resources such as timber, medicinal plants, fodder, fuelwood and food resources like mushrooms²⁶.

Collection and survey of edible mushrooms in local markets

The survey on the type of mushrooms available was initially done in the forests of mawsmat, jingkiengmawkdok, shillong peak and mawphlang and the local markets were visited for their availability during April to October, 2011. The edible mushrooms sold in the traditional markets (Table 1) of the east Khasi hills district of Meghalaya were collected for their documentation and study. Information about the wild habitats of the edible mushrooms, market price, availability, local names and local culinary uses was gathered by carrying out unstructured and semi-structured interviews designed for the sellers. Prior informed consent of the knowledge providers were taken during the information gathering process. The samples were wrapped in aluminium foil and stored in sterile containers prior to their transport to the laboratory for preservation and identification. Care was taken to avoid distortion of the fleshy fungi.

Preservation and storage of the edible mushrooms

Each of the collected specimens was assigned a unique identifier accession number (Table 2) and stored in the in-house culture collection of the Department of Biotechnology and Bioinformatics, North-Eastern Hill University, Shillong in 4% formaldehyde as per standard procedures²⁷. Alternatively, the specimens were also oven dried at 80°C for 5 days, wrapped in aluminium foil and placed in labelled containers for further analysis. The containers were then stored at -20°C.

Identification of the edible mushroom specimens

The edible mushrooms were identified based on the morphological characters of the fruiting bodies after comparing them with standard manuals for mushroom identification^{28,29} and mycokeys available at www.mushroomexpert.com and www.mycology.com^{30,31}.

Results and Discussion

The mushroom collectors gathered the resource mostly from forests and meadows (Plate 2) and transported it to the sellers by wrapping them in banana (*Musa* spp.) and *Pyrrhium pubinerve* Bl. leaves (Plate 3). The gatherers who have good knowledge about the morphological structures of each mushroom picked are able to differentiate the edible mushrooms from the poisonous ones such as *Russula emetica*, *Amanita* spp., etc. The poisonous mushrooms are called 'tit buit', 'buit' in the Khasi dialect meaning poisonous. The information on edible mushrooms collected from the wild was based on the knowledge provided by the local consumers (Table 3). This knowledge was, however, not found to be documented by the tribes but was found through the word of mouth. The tribes were found to use a traditional technique called 'narsuh' while cooking these mushrooms. A small iron rod was taken with a wooden handle and the tip was heated till it became red hot. The rod was then immediately placed in the middle of the bowl containing the cooked mushrooms. The heat from the rod was believed to absorb or destroy the harmful substances (if they are present) from the mushrooms.

Throughout the period from April to October, 2011, the traditional markets had a wide diversity of wild edible fleshy fungi which were freshly collected from the forests and sold by the ethnic tribes. A total of 11 different edible macrofungal species belonging to nine genera and eight different families were documented during the study period (Table 2). The macrofungal species had different morphological characteristics and colours (Plate 4). From mid October onwards, the number of stalls selling edible mushrooms started reducing and totally vanished with the onset of the cold winter during November. It was interesting to note that *Gomphus floccosus* (Schw.) Singer which has been described by some authors as an inedible mushroom was quite prevalent in the local markets as an edible fungus³². *G. floccosus* and *Tricholoma* spp. were available throughout the study period.

Table 1—Local markets visited during the study period and the number of informants

S. No.	Name of local market	Location	No. of Informants		Age (range in years)
			Male	Female	
1.	Barabazar/Iewduh	Shillong, East Khasi hills	2	25	25-50
2.	Polo Bazar	Shillong, East Khasi hills	-	6	40-50
3.	Mawphlang Bazar	Mawphlang, East Khasi hills	-	20	40-50
4.	Laban Bazar	Shillong, East Khasi hills	-	6	30-45
5.	Mawdatbaki Bazar	Shillong, East Khasi hills	-	3	35-50
6.	Sohra Bazar	Cherrapunjee, East Khasi hills	1	12	20-45

Table 2—Information collected from informants based on the criteria used by the ethnic Khasi tribe to distinguish edible mushrooms from poisonous ones.

Edible mushrooms	Poisonous Mushrooms
Possess a flat, rounded or depressed cap	Possess a pointed cap
Presence of worms or insects	Absence of worms or insects
Dull coloured	Brightly coloured
Absence of warts or scales on the surface of the cap	Presence of warts or scales on the surface of the cap
Pleasant odour	Unpleasant odour
The colour of the fruiting body does not turn dark on breakage	The colour of the fruiting body turns dark on breakage (black or purple)

Plate 2—Edible macrofungi growing in the wild (a) *Gomphus floccosus* (Schw.) Singer; b. *Lactarius volemus* (Fr.) Fr.; c. *Cantharellus cibarius* Fr.

The other species had periodic availability (Table 3). Among the edible mushrooms, *Albatrellus* spp. was the rarest and collected only from Iewduh (Bara Bazar) during September 2011. About 96% of the sellers were local tribal women (Plate 5) (addressed as ‘Kong’ by the local people) and 90% of the informants were above the age of 25 who shared the traditional mycological knowledge of the tribes with the authors.

The average market prices of the wild edible mushroom species ranged from Rs 200-350/kg with *Clavulina* spp. being the costliest variety sold at the price of Rs 300-350/kg throughout the selling period

(Table 4). It was being sold in all the local markets and was available in both dried and fresh forms.

Use of mushrooms in local cuisines

‘*Syrwa tit*’ (*Mushroom soup*): The mushrooms are thoroughly washed and cut into small pieces and water is removed by applying pressure. The mushrooms are then fried with butter and salt, black pepper, chilli and little garlic paste is added to it. When it is half cooked, hot water is added and boiled for a few minutes till the mixture becomes thick. Some times mustard greens [*Brassica juncea* (L.) Czern.] locally called as ‘*lai patta*’ or ‘*tyrso*’ are also added to the soup.



Plate 3—Mushrooms brought to the market wrapped in leaves of *Pyrnium pubinerve* Bl.



Plate 4—Wild Edible macrofungi collected from the local markets of the East Khasi district of Meghalaya [a. *Gomphus floccosus*; b. *Tricholoma viridiolivaceum*; c. *Craterellus odoratus*; d. *Lactarius volemus*; e. *Cantharellus cibarius*; f. *Tricholoma saponaceum*; g. *Tricholoma* sp.; h. *Laccaria lateritia*; i. *Albatrellus* sp.; j. *Ramaria* sp.; k. *Clavulina* sp.

Table 3—Wild edible macrofungi available in the local markets of east Khasi hills of Meghalaya and their ethnic usage

Specimen Number	Accession Number	Identity*	Vernacular Name (Khasi)	Usage by ethnic tribes
1.	PKSR1	<i>Gomphus floccosus</i> (Schw.) Singer (Order : Phallales;Family: Gomphaceae)	<i>Tit дума/Tit thlong/ Tit tyndong</i>	Food
2.	PKSR2	<i>Tricholoma viridiolivaceum</i> Stev. (Order: Agaricales;Family: Tricholomataceae)	<i>Tit kseh/Tit kdait</i>	Food
3.	PKSR4	<i>Craterellus odoratus</i> (Schwein.) Fr. (Order: Cantharellales;Family: Cantharellaceae)	<i>Tit stem</i>	Food
4.	PKSR5	<i>Lactarius volemus</i> (Fr.) Fr. (Order: Russulales;Family: Russulaceae)	<i>Tit doh/Tit tung</i>	Food
5.	PKSR7	<i>Cantharellus cibarius</i> Fr.(Order : Cantharellales; Family: Cantharellaceae)	<i>Tit khangai pylleng</i>	Food
6.	PKSR8	<i>Tricholoma saponaceum</i> (Fr.) P. Kumm. (Order: Agaricales;Family: Tricholomataceae)	NA	Food
7.	PKSR9	<i>Tricholoma</i> sp. (Order : Agaricales;Family: Tricholomataceae)	NA	Food
8.	PKSR11	<i>Laccaria lateritia</i> Malençon (Order: Agaricales;Family: Hydnangiaceae)	<i>Tit tyngab/Tit iong</i>	Food
9.	PKSR12	<i>Albatrellus</i> sp. (Order : Polyporales;Family: Albatrellaceae)	NA	Food
10.	PKSR13	<i>Ramaria</i> sp. (Order : Gomphales;Family: Gomphaceae)	<i>Tit lbong hati</i>	Food
11.	PKSR1CF	<i>Clavulina</i> sp. (Order : Gomphales;Family: Clavulinaceae)	<i>Tit thnat syiar</i>	Food

* Morphological identity; NA-Not Available

Table 4—Average cost of the edible macrofungi in the local markets

Name	~Price/kg in INR
<i>Gomphus floccosus</i> (Schw.) Singer	200
<i>Tricholoma viridiolivaceum</i> Stev.	200
<i>Tricholoma saponaceum</i> (Fr.) P. Kumm.	200
<i>Tricholoma</i> sp.	200
<i>Laccaria lateritia</i> Malençon	280-300
<i>Clavulina</i> sp.	300-350
<i>Ramaria</i> sp.	250-300
<i>Craterellus odoratus</i> (Schwein.) Fr.	280
<i>Cantharellus cibarius</i> Fr.	280
<i>Lactarius volemus</i> (Fr.) Fr.	200
<i>Albatrellus</i> sp.	200

‘Tit tung bad doh sniang’ (Mushroom with pork): *Lactarius volemus* (Fr.) Fr. or *Tit tung* is cooked with black sesame seeds and pork, and is one of the favourite dishes of the Khasi tribe. The pork is boiled separately with garlic. In hot oil chopped onion, garlic and ginger with hot chilli *Capsicum frutescens* L. and sesame seeds is fried. Diced tomato and pieces of mushroom are then added. Salt, turmeric, pepper and a bit of sugar are added according to taste. When the mushrooms are half cooked the pork with the stock are added and boiled till the dish is cooked fully.

‘Tit tyngab bad tungtap’ (Mushroom with fermented fish): *Laccaria lateritia* Malençon is cooked with ‘*tungtap*’, a traditionally fermented fish product of Meghalaya³³. The mushrooms and the ‘*tungtap*’ are boiled together with sliced potato, garlic, ginger and salt. Chopped chilli and coriander are added for garnishing. It is served with rice.

‘Tit tyngab bad Jadoh’ (Traditionally prepared rice based dish with mushroom): To hot oil in a flat bottomed pan bay leaves, chopped onions, ginger paste, turmeric and black pepper are sautéed and fried. Pieces of pork and mushroom are added after two minutes and fried till the colour turns golden brown. The pre-washed rice is then added and fried for a few minutes. Salt is added according to taste. Water is added as per the quantity of rice and simmered till it is cooked.

Among the different varieties of mushrooms available in the market, *Clavulina* sp. is a commonly consumed mushroom which is called as ‘chicken mushroom’ by the local people and prepared with garlic, ginger and other condiments. The mushrooms are sometimes chopped into small pieces and used to make dumplings or added to other local dishes to enhance their flavour. Some tribal people also cook mushrooms with bamboo shoot (*Bambusa* spp.) or

'lung siej' and red hot chilli (*Capsicum frutescens* L.) or 'sohmynten byrwa' or 'sohmynten rakot'.

Taxonomic description of the characterized macrofungi:

***Gomphus floccosus* (Schw.) Singer**

Cap, 5-8 cm wide; vase or funnel shaped, at first conical or almost cylindrical with a flat top, shallow funnel shaped, yellow to pale orange, margin curved downward or rolled inward. Gills, 8-12 cm, 1-2 mm wide, 1 mm thick. Stem 3-6 cm long, 1-2 cm thick, uniform in diameter, solid, pale yellow. Flesh, white, ridge like, long decurrent but ending rather abruptly on the stem, frequently forked and joined, yellow to reddish yellow. Spore print, light brown.

***Ramaria* sp.**

Colour, tips light yellow; branches light orangish-yellow; base orangish-white; base and lower branches staining dark reddish-brown when bruised and specimens dry into a paler colour. Flesh, colored much like surface, texture softly stringy. Form, medium, 10 cm height X 6 cm width; base single, tapering, 2-4 cm height X 1.5-2 cm width; branching pattern, lower branches up to 2.5 cm in diam, upper branches mostly 2-6 mm in diam, polydigitate or polynodulose near apices, apices rounded. Spore print, grayish orange.

***Clavulina* sp.**

Form, coralloid, erect, 3-7 cm tall, 2-4 cm broad, branched 3-4 times, tips with short, tooth-like projections; base 2.0 cm tall, consisting of fused branches; surface smooth to slightly wrinkled, white, becoming cream, sometimes tinged yellowish in age. Flesh, white to marbled. Spore print, white.

***Lactarius volemus* (Fr.) Fr.**

Cap, 3-13 cm wide; at first convex with an in-rolled margin, becoming flat, with a central depression, shallowly vase-shaped, or (rarely) with a slight bump over the disc, even margin, smooth or slightly wrinkled but usually finely velvety to the touch, at least when young, orangish brown, or sometimes lighter or darker (approaching deep brownish red); without concentric zones of colour, but often darker towards the centre. Gills, 8-12 cm, 1-2 mm wide, 1 mm thick attached to the stem or running slightly down it, creamy white; discolouring brown where injured, often forking near the margin. Stem 5-10 cm long, 0.5-2.5 cm thick, coloured like the cap or paler, equal or tapering to base, smooth, solid or becoming hollowing. Flesh, firm, compact, exudes

white or watery latex (milk) when cut and discolours when cut, bruised or damaged. Spore print, white.

***Cantharellus cibarius* Fr.**

Cap, 3.5-7 cm broad, vase-shaped, the disc frequently depressed but not funnel form, margin incurved, wavy, in age decurved, plane to upturned, surface smooth, dry. Gills, reduced to ridges, decurrent, forking, often cross-veined or anastomosing, colored like the cap or lighter. Stem, stipe 2-7 cm long, 0.5-2.5 cm thick, tapering to a narrowed base, surface dry, smooth, concolorous or lighter than the cap. Flesh, yellow, thin. Spore print, light yellow.

***Craterellus odoratus* (Schwein.) Fr.**

Cap, cone-shaped, crimped, lobed ends, convex, thin often several near each other, 7-15 cm wide, bright yellow. Gills, absent; stem, one stalk for several convex cones, hollow, short, not easily notable from outer structure. Flesh, yellow, thin, smooth. Spore print, pale yellow.

***Laccaria lateritia* Malençon**

Cap, 3-3.5 cm broad, flat, broadens with age, striated margin, pale brick coloured. Gills, adnate to subdecurrent, moderately broad with alternating lamellulae, intervenose, pinkish to flesh-colored.

Stem, stipe 1.5-5 cm tall, 2-5 mm thick, fragile, hollow, round. Flesh, thin, coloured like the moist cap. Spore print, white.

***Tricholoma saponaceum* (Fr.) P. Kumm.**

Cap, 8-12 cm in diam. usually greyish or dark grey in the centre but with a paler, often almost white edge, initially convex, the caps flatten, sometimes with a slight umbo. Gills, sinuate and well spaced apart, the gills are white. Stem, 1 cm in diam. the stem is white and covered with small light-grey fibres. Spore print, white.

***Tricholoma viridiolivaceum* Stev.**

Cap, 3-8 cm diam., olive green overlain with sparse brown fibrils at centre, convex with down-rolled margin at first, becoming irregularly plane, moist and smooth. Gills, sinuate, moderately distant, long and short intercalated, often forked, creamy white. Stem, 3-8 × 3-5 cm, often swollen. Flesh, dull whitish, somewhat water-soaked. Spore print, white.

***Tricholoma* sp.**

Cap, 3-4 cm diam. dark grey, convex with down-rolled. Gills, moderately distant, long and short intercalated, forked, creamy white. Stem, 2 × 5 cm, slightly swollen. Flesh, pale white or creamy. Spore print, white.

***Albatrellus* sp.**

Cap, 8-15 cm across, convex becoming flatter, circular, lobed or depressed; margin often wavy and inrolled at first, yellowish green; dry, hairy, velvety and then matted forming coarse scales. Pores on hymenium, 0.5-1 mm in diam. off white, circular to angular. Stem, 30-120 × 20-60 mm, off-centre or lateral, solid, greenish yellow or similar to cap; tough, minutely hairy. Flesh: Thick, firm, white. Spore print, white.

Conclusion

The wild macrofungal species consumed by the tribes of Meghalaya are harvested completely on the basis of ethnomycological knowledge of the local people. In spite of the absence of scientific experimental based knowledge on the distinction of poisonous and non-poisonous mushrooms among the tribes, the ethnic tribals collected the edible forms as evident from the absence of reports on mushroom poisoning caused by their consumption. None of these resources have been commercialized yet, although they are sold by the local consumers on the basis of seasonal availability. Proper documentation of the traditional knowledge of the ethnic population for using these species as part of their cuisine and traditional medicine systems needs to be undertaken. Coupled with these, there is also a need to document, preserve and characterize these wild mushrooms owing to the rampant destruction of their wild habitats in the wake of urbanization and industrialization. The economic potential of the trade of these wild edible macrofungi which are not only rich in protein sources but also have medicinal value can go a long way in the economic upliftment of the hill people, if proper technology for their commercialization and off season cultivation is developed in the near future.

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