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RESEARCH **P**APER

Survey and collection of some uncommon macrofungi of Gorakhpur district (U.P.)

RAVINDER PAL SINGH, PRATIMA VISHWAKARMA, POOJA SINGH **AND** N. N. TRIPATHI

Department of Botany, Deen Dayal Upadhyay Gorakhpur University, GORAKHPUR (U.P.) INDIA
Email : ravinder.20033@gmail.com

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Mushrooms are important component of human diet throughout the world due to their specific taste, nutritional value and medicinal importance. In present study the survey of different forests of Gorakhpur district between the years 2014 – 2016 were done to collect the macrofungi. The collected macrofungi were identified on the basis of morphological and microscopic characters. In all 20 macrofungi were collected and identified. Out of 20 macrofungi studied *Abortiporus biennis*, *Amanita virosa*, *Bovista plumbea*, *Ganoderma lucidum*, *Lepista inversa* and *Trametes versicolor* were abundant and grow gregariously during rainy season. These macrofungi were well photographed and preserved in dry as well as in wet condition for the further study. This study indicates a great variation in climatic condition of Gorakhpur which made it possible for the abundance and variability of macrofungi in this area.

Key words : Diversity, Mushroom, Nutritional, Medicinal, Macrofungi

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INTRODUCTION

The species diversity of fungi and their natural beauty occupy prime place in the biological world. India has been a support for the diversity of these species. Defining the number of fungi on earth has been a point of discussion and several studies have focused on to compute the world's fungal diversity (Dwivedi *et al.*, 2012). Only a fraction of total fungal wealth has been subjected to scientific scrutiny and mycologists continue to resolve the unexplored and hidden wealth. One third of fungal diversity of the globe exists in India and out of which only 50 per cent are characterized until now (Manoharachary *et al.*, 2005).

Mushrooms are seasonal fungi, which occupy diverse status in nature in the forest ecosystem. They predominantly occur during rainy season and also during spring when the snow melts. Mushrooms are in fact the 'fruit' of the underground fungal mycelium. They are macromycetes forming macroscopic fruiting bodies such as agarics, boletes, jelly fungi, coral fungi, stinkhorns, bracket fungi, puffballs and bird's nest fungi (Pushpa and Purushothama, 2012).

This paper deals with major groups of macrofungi of North Eastern part of Uttar Pradesh with respect to its habit, habitat, edibility and description in brief.

RESEARCH METHODOLOGY

The macrofungi samples collecting sites were located in the North Eastern part of Uttar Pradesh, India, having latitude 27°05' and 27°25' North and longitude 83°20' and 84°10' East at an elevation of about 91m above sea level. The average annual rainfall about 1814 mm; about 87 per cent of annual rainfall is received during warm rainy season and the rest 13 per cent is

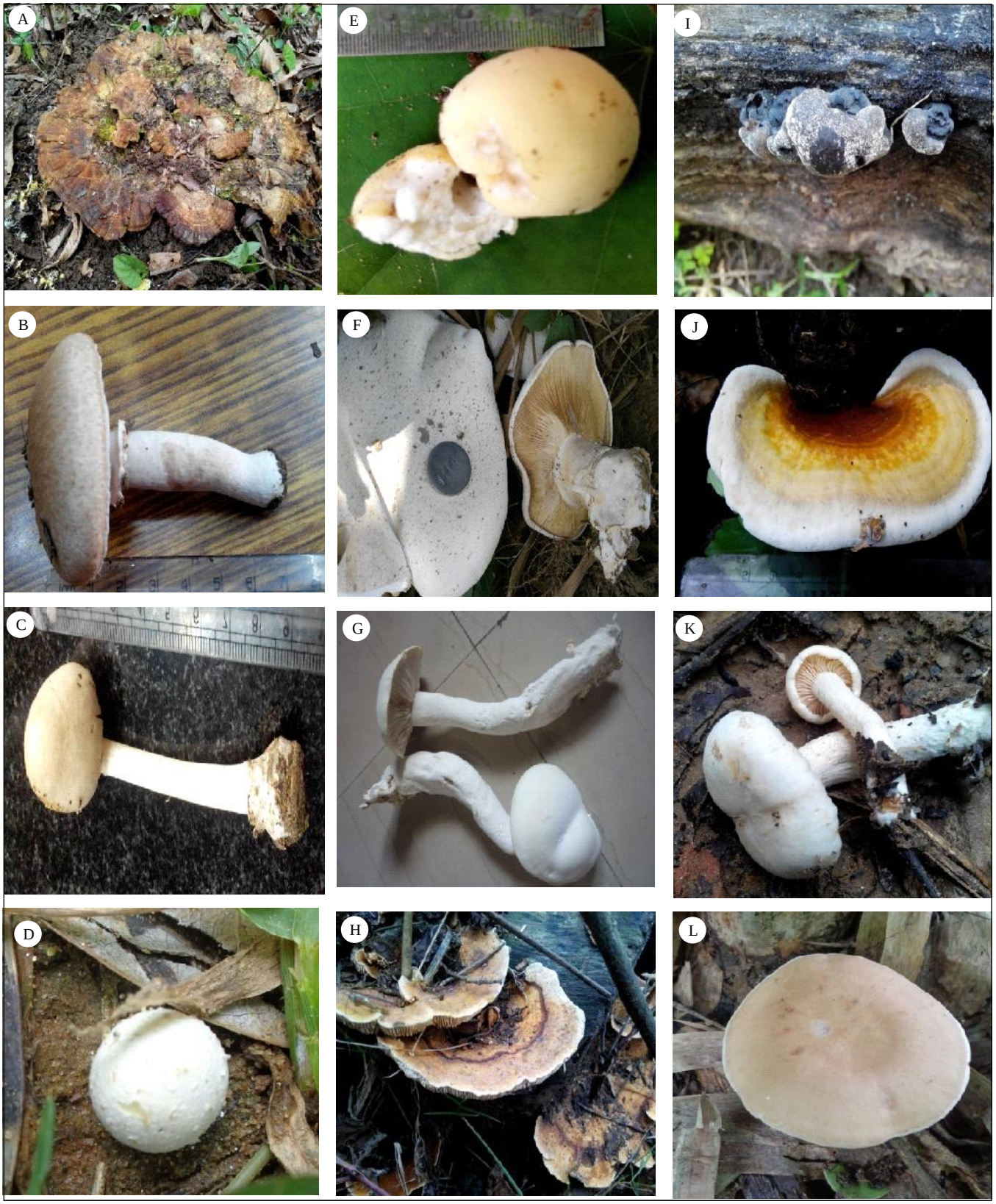

Fig. A : *Contd.....*

Fig. A: **(A)** ***Abortiporus biennis*** **(B)** ***Agaricus silvaticus*** **(C)** ***Amanita virosa*** **(D)** ***Bovista plumbea*** **(E)** ***B. pusilla*** **(F)** ***Calocybe gambosa,*** **(G)** ***C. indica*** **(H)** ***Coriolus hirsutus*** **(I)** ***Daldinia vernicosa*** **(J)** ***Ganoderma lucidum*** **(K)** ***Hygrophorus cossus*** **(L)** ***Lepista inversa*** **(M)** ***Leucocoprinus cepestipes*** **(N)** ***Mutinus caninus*** **(O)** ***Mycena capillaripes*** **(P)** ***Mycena cinerella*** **(Q)** ***Tramella foliacea*** **(R)** ***Trametes versicolor*** **(S)** ***Xylaria hypoxylon*** **(T)** ***Xylaria longipes***

Table A : Average climate values of Gorakhpur district

Data	Year		
	2014	2015	2016
Annual average temperature (°C)	24.6	25.1	25.4
Annual average maximum temperature (°C)	30.9	31.7	31.5
Annual average minimum temperature (°C)	18.6	19.1	19.3
Annual average humidity (%)	73	75	77
Annual average wind speed(Km/h)	2.5	2.1	3.2
Total days with rain (days)	66	58	63
Total days with thunderstorm (days)	44	34	43
Total days with fog (days)	44	37	72

Source: *www.tutiempo.net/en/Climate/Grakhpur/year/423790.html*

distributed in the form of occasional showers from November to May. Relative humidity ranges between 73 to 77 per cent (Table A). The mean maximum temperatures during wet summer, winter and dry summer season are 35.2˚C, 27˚C and 24-39˚C, respectively (Srivastava *et al.*, 2014).

The macrofungi samples were collected from different forests and forest ranges of Gorakhpur division during 2014-2016. The samples were brought to the laboratory and identified with the help of relevant literature and deposited in the Departmental herbarium of DDU, Gorakhpur University, Gorakhpur, India.

Frequent survey of different forests of Gorakhpur was made between March, 2014 to September, 2016. Macrofungi samples were collected from the Kushmi and Campierganj forests of Gorakhpur district. The collected macrofungi samples were well photographed in their natural habitat and preserved in the 4 per cent formaldehyde solution for further study (Fig. A). The surveyed samples were studied for their macroscopic and ecological characteristics like type of substrate, colour, odour of fresh specimens, nature of habit and habitat and noted in the field diary. A particular collection number was given to each specimen. Field samples of macrofungi were collected and brought to laboratory for further studies. Spore prints were prepared and microscopic studies were also done in the laboratory. Macrofungi samples were identified on the basis of macroscopic and microscopic characteristics and confirmed by the relevant literatures (Jordan, 1995).

RESEARCH FINDINGS AND ANALYSIS

In present study a total of 20 macrofungi belonging to 16 genera of 12 families (Fig. 1) were identified, in

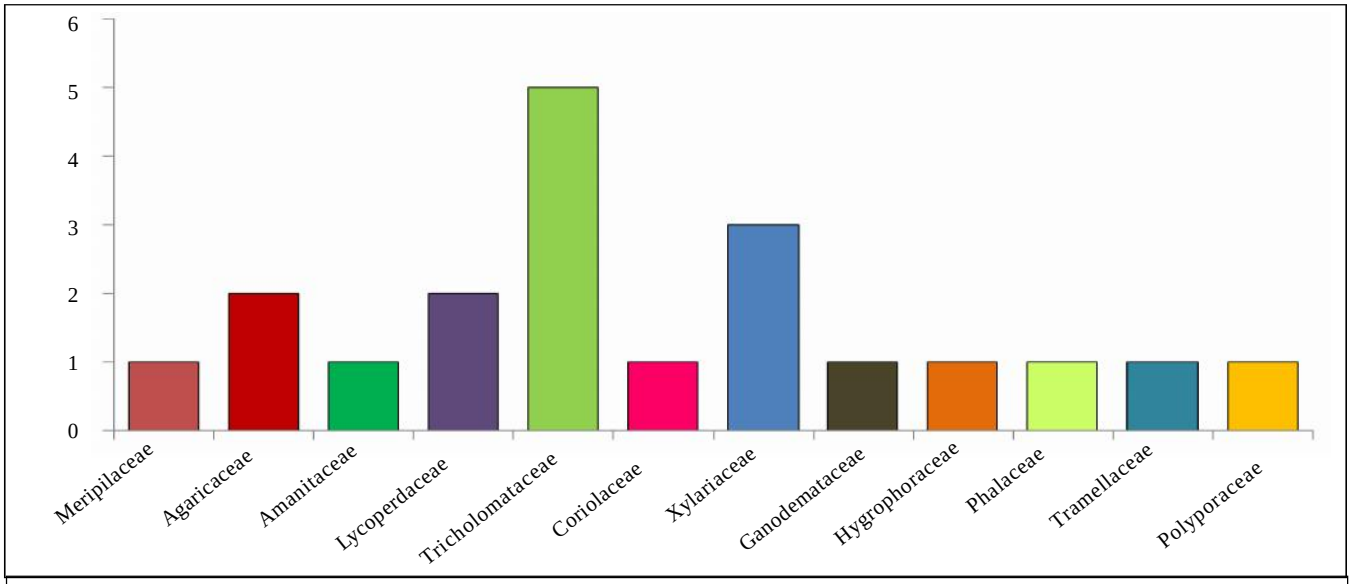

Fig. 1 :Abundance of different families of macrofungi in Gorakhpur

which Tricholomataceae was found to be dominant family consist of 5 species, followed by Xylariaceae having 3 species, Agaricaceae and Lycoperdaceae 2 species each while rest of families *viz.*, Meripilaceae, Phalaceae, Ganodermataceae, Amanitaceae, Coriolaceae, Polyporaceae, Tramellaceae and Hygrophoraceae consist of one species each.

Out of 20 macrofungi identified 7 were found to be edible, 11 inedible, while one medicinal and one poisonous species (Table 1). Out of 7 edible macrofungi, 2 species *viz., Calocybe gambosa* and *C. indica* were excellently edible in tribal areas.

Description of collected macrofungi :

Abortiporus biennis :

Fruit body variable, irregularly top-shaped or rosette-like, 15-20 cm across, 0.5-1.5 cm thick, flattened to concave, whitish soon becoming pinkish. Spores elliptical, ovate to subglobose, 4.7 x 3.5 µm. Long undulating worm-like refractive gloeocystidia present in the hymenium.

Agaricus silvaticus :

White colour fruiting body, Pileus 4-6 cm in diameter, convex, covered in ochre to brown fibrils breaking up into small adpressed scales. Stipe 5-9 cm in height, whitish sometimes with brownish fibrous scales below the dirty brown ring. Flesh white, reddening on cutting when fresh, later turning brownish. Gills pale at first then reddish, later dark brown. Spore print brown. Spores ovoid, 5.6 x 3.3 µm.

Amanita virosa:

Pileus 6-8 cm across, convex-conical at first, then expanded with broad umbo, pure white; smooth, slightly viscid when moist. Gills free, crowded, white. Stipe 8-10 cm in height, usually swelling toward base, white with surface often disrupted into shaggy fibrils, base enclosed in a bag like, white, sheathing volva; Spores globose, amyloid, 9.1 x 8.3 µm.

Bovista plumbea :

Grey puffball, fruit body 2-3 cm in diameter, subglobose without a sterile base but attached to the substrate by a clump of fibres which often break leaving the fruit body free to roll about in the wind, outer wall white at first flaking off in large scales at maturity to

Table 1 : Species, family, edibility, habit and habitat of collected samples

Macrofungi	Family	Habit and habitat	Edibility	Date of collection
Abortiporus biennis (Bull. ex Fr.)	Meripilaceae	Attached with the plant stumps	Inedible	22-08-2014
Agaricus silvaticus Schaeff.	Agaricaceae	Present on litter soil	Edible	15-07-2015
Amanita virosa (Fr.)Bertillon	Amanitaceae	Present on soil in moist area	Poisonous	29-08-2015
Bovista plumbea Pers.	Lycoperdaceae	Present on litter soil in moist	Edible	15-09-2016
B. pusilla (Batsch : Pers)	,,	Present on litter soil in moist area	Inedible	13-07-2014
Calocybe gambosa (Fr.) sing.	Tricholomataceae	Attached with the base of bamboo tree	Edible	23-09-2015
C. indica Purkay. and A. Chandra	,,	Present on straw	Edible	19-09-2016
Coriolus hirsutus (wulf.: Fr.) Quel.	Coriolaceae	Attached with the plant stumps	Inedible	12-09-2014
Daldinia vernicosa (schw.) Ces. and de Not.	Xylariaceae	Attached with the plant stumps	Inedible	29-07-2015
Ganoderma lucidum (Curt.: Fr.) Karst.	Ganodermataceae	Attached with the plant stumps	Medicinal	11-08-2016
Hygrophorus cossus (sow.: Berk.) Fr.	Hygrophoraceae	Present on litter soil	Inedible	15-09-2014
Lepista inversa (Scop.: Fr.) Pat.	Tricholomataceae	Present on litter soil	Edible	27-08-2015
Leucocoprinus cepestipes Fr. Quel.	Agaricaeae	Present on litter soil	Edible	18-08-2015
Mutinus caninus (Hds.: Pers.) Fr.	Phalaceae	Attached with the base of bamboo tree	Inedible	25-08-2015
Mycena capillaripes Peck	Tricholomataceae	Present on litter soil	Inedible	20-08-2015
Mycena cinerella (Karst.) Karst.	,,	Present on litter soil	Inedible	20-08-2016
Tramella foliacea Pers.	Tramellaceae	Attached with decay of stem	Inedible	14-09-2015
Trametes versicolor (L.) Lloyd	Polyporaceae	Attached with the plant stumps	Edible	22-09-2014
Xylaria hypoxylon (L.: Fr.) Grev.	Xylariaceae	Attached with the plant stumps	Inedible	17-09-2015
Xylaria longipes Nke.	,,	Attached with the plant stumps	Inedible	25-08-2015

expose the lead-coloured fragile inner layer enclosing the spore mass and opening by a circular pore. White to olive-brown colour. Spores brown, oval with a long pedicel and finely roughened, 4.6 x 5.5 µm.

B. pusilla:

Fruit body 3-4 cm across, exoperidium whitish, becoming brown, at first smooth, soon coarsely flaky and splitting into distinct patches, falling away in flakes at maturity to reveal grayish-brown papery endoperidium, sub-spherical, opening by a raised, conical, corrugated apical pore, wrinkled below and attached by grey-brown mycelial cords. Spore brown, minutely warty, spherical, 4.1 x 5.3 µm.

Calocybe gambosa:

Pileus 7-14 cm in diameter, subglobose then expanding, often irregularly wavy and sometimes cracking, margin inrolled, white. Stipe 6-8 cm in height, white. Flesh white, soft. Gills narrow, very crowded, whitish. Spores elliptical, 5.6 x 3.4 µm.

C. indica :

Pileus 5-15 cm dia., white, campanulate or convex when young, becoming flattened at maturity, smooth. Stipe 15-25 cm long, 1.5-2 cm thick, cylindrical, more or less equal, smooth. Gills decurrent, narrow, parallel, white, crowded. Spores 3.5 x 6.7 µm, elliptical, hyaline, smooth, non amyloid. Flesh thick, white, leathery.

Coriolus hirsutus:

Fruit body like a bracket, 6-8 cm across, 5-6 cm wide, 0.5-1 cm thick, single or in overlapping groups, upper surface covered with silvery hairs, concentrically zoned and contoured, whitish to yellow-brown or grey when young, greying with age. Flesh tough and leathery, white. Spores whitish, ellipsoid to sub-cylindric, 5.7 x 1.8 µm.

Daldinia vernicosa:

Fruit body 6-8 cm across, hemispherical to subglobose, brown at first soon black and shiny. Flesh concentrically zoned silver-grey and blackish. Spores black elliptical to fusiform, 11.8 x 7.3 µm.

Ganoderma lucidum :

Fruit body usually stalked. Bracket 15-20 cm in diameter, 2-3 cm thick, fan- or kidney-shaped, laterally attached, concentrically grooved and zoned ochraceous to orange brown, later purple-brown to blackish and like the stipe conspicuously glossy as if varnished. Spores rusty, ellipsoid-ovate, 11.1 x 7.6 µm.

Hygrophorus cossus:

Pileus 3-7 cm across, convex becoming more flattened, white flushed buff especially near the centre, slimy. Stipe 6 - 8 cm in height, whitish, slimy. Flesh white. Gills decurrent, whitish. Spores ovoid, 9.6 x 4.9 µm.

Lepista inversa:

Pileus 7-8 cm in diameter, convex with an inrolled margin at first, becoming flat or shallowly vase-shaped, dry, fairly smooth. Stipe 6-7 cm long, more or less equal, dry, finely hairy. Gills running down the stipe, close or crowded, pinkish, developing darker orange or pinkish brown with maturity. Spores 4.5 x 3.4 µm, subglobose to broadly elliptical, finely warty, inamyloid.

Leucocoprinus cepestipes:

Pileus 6-8 cm across, oval becoming broadly bell-shaped to nearly flat with a distinct umbo, white to pale pinkish, more yellowish or darker in age, dry, powdery, becoming warty or scaly in age and margin clearly lined. Gills free, crowded, narrow; white. Stipe 8-9 cm in height, sometimes swollen in places, with an enlarged base, white becoming tinged with flesh-pink, straw yellow, smooth or with a slight bloom. Spores 8.9 x 6.7 µm, broadly ellipsoid, with a germ pore, smooth, weakly dextrinoid.

Mutinus caninus :

Fruit body initially a semi-submerged eggs as in *Phallus impudicus* but much smaller, 1-2 cm across and more cylindrical in shape, whitish-yellow, finally rupturing when the hollow pitted receptacle extends. Stipe 11-12 cm high, pale yellow-buff to bright orange, surmounted by the narrow conical orange-red head covered in dark olive slime which contains the spores. Spores pale yellow, oblong, 4.5 x 1.5 µm.

Mycena capillaripes:

Pileus 1-3 cm in diameter, brown, more pallied brown towards margin, blackish-brown toward centre, at first conical becoming campanulate, translucently striate and sulcate. Stipe 4-5 cm in height, flesh greyish-brown and thin. Spore hyaline, smooth ellipsoid, amyloid with droplets, 9.3 x 5.1 µm.

Mycena cinerella:

Pileus 1-2 cm in diameter, colour ash-grey or with brown tinge, hemispherical then convex, becoming expanded, transparently striate almost to the centre. Stipe 4-5 cm in height, flesh pallid, watery and thin. Gills whitish-grey, adnate , broad, close. Spore hyaline, hyaline, smooth, ellipsoid, amyloid with droplets, 8.1 x 4.3 µm.

Tramella foliacea:

The fruit body is an irregular gelatinous arrangement of lobes and cups fused at the base 4-8 cm wide. The colour is brown to reddish-ochre, lighter when fresh and young. Spores dull cream-yellowish, 9.3 x 8.1 µm nearly spherical.

Trametes versicolor:

Bracket 8-10 cm across, 4-5 cm wide, leathery, usually forming large overlapping tiered groups; upper surface velvety becoming smooth with age, colour variable, concentrically zoned of black-green, grey-blue, grey-brown or ochraceous-rust, with a white to cream margin. Flesh tough and leathery, white. Spores straw-yellow, ellipsoid, 5.5 x´1.5 µm.

Xylaria hypoxylon:

Fruiting body around 5-10 cm long, 2-5 mm thick, tough, erect, branched near the top, cylindrical below, flattened in cross section above, lower portion black, branched portion white, contains asexual spores (conidia). Asexual spores smooth, hyaline, elliptical, black, bean-shaped, 11.4 x 5.6 µm.

Xylaria longipes:

Xylaria longipes similar to *X. polymorpha* but altogether more slender. Fruiting body 1-8 cm long, 5-6 mm thick, cylindrical to irregular, tip pointed, whitish becoming black with maturity, surface smooth. Flesh white, tough. Spores 10.1 x 4.5 µm, smooth, fusiform.

Mushrooms remained as a delicacy in human diet since times immemorial. Many edible wild mushrooms are traditionally used in many Asian countries as food and medicine (Kumari *et al.,* 2012). Macrofungi are present in all type of habitat but most commonly on decaying wood or leaf litter. Moisture is important for its occurrence. Diversity of macrofungi was higher in rainy season compared to others as moisture is one of the major factors influencing the fruiting of macrofungi (Andrew *et al.,* 2013). Lots of work on the diversity of macrofungi has been done in different part of India but North Eastern part of Uttar Pradesh has been less explored.

The ethnomacrofungal study of macrofungi from different forest division of Gorakhpur was done by Srivastava *et al.* (2011). The authors described different species of *Termitomyce*s and their traditional uses by local and tribal peoples. Species composition and diversity of mushroom were examined from different areas of Gorakhpur district. The fruiting bodies of mushrooms were collected between 2011- 2013 during different seasons. As a result of extensive field survey and microscopic studies in laboratory 12 taxa belonging to 8 families were identified (Vishwakarma *et al.,* 2014). The Kushmi forest of Gorakhpur is a natural habitat of a number of macrofungi. Frequent survey of Kushmi forest was made for collection of naturally growing macrofungi. A total of 29 macrofungal species belonging to 12 families were observed, in which Tricholomataceae was predominant. Out of 29 spp. collected 4 were excellently edible, 6 edible, 18 inedible and 1 poisonous (Chandrawati *et al.,* 2014). In present study Tricholomataceae was found to be dominant family calibrating with the previous studies.

All 20 collected macrofungi were grouped in to edible, inedible, medicinal and poisonous category out of which 7 macrofungi *viz., Agaricus silvaticus, Bovista plumbea, Calocybe gambosa, C. indica, Lepista inversa, Leucocoprinus cepestipes, Trametes versicolor* were edible, 11 macrofungi *viz., Abortiporus biennis, Bovista pusilla, Coriolus hirsutus, Daldinia vernicosa, Hygrophorus cossus, Mutinus caninus, Mycena capillaripes, Mycena cinerella, Tramella foliacea, Xylaria hypoxylon* and *Xylaria longipes* were inedible, while *Amanita virosa* was poisonous and *Ganoderma lucidum* was medicinal macrofungi.

Conclusion :

Macrofungi are one of the main ecological key factors which help in bioremediation process. It is rich source of nutrients and also possesses many medicinal values for human welfare. In present study 20 macrofungi have been identified and some are consumed locally as well as on large scale also but still there are lots of macrofungi having high nutrient value and medicinal importance which are not explored till now. So identification and documentation of macrofungi can play a vital role in enriching the socio-economic life of the tribal people. Besides this, it can also provide innovative

way for upbringing new industries.

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