 doi:10.20944/preprints202105.0553.v1

Research Article

New Reports of Wild Mushroom Diversity from Foothill region of Uttarakhand

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Abstract: A The present investigation was undertaken in foothill regions of Uttarakhand from July-2016 up to December-2018. A total of thirty four different sites ranging from the roadside areas, grasslands to forests were studied and Mushroom fruiting bodies were collected. A total of One Hundred sixty six fruiting counts were obtained and 68 mushroom genera belonging to 15 orders and 43 families were identified. During collection visits mushroom were apparent from organic debris of diversified habitats ranging from humid soil; grassland; leaf litter; living tree trunk; dead wood log of forest zone. Maximum fruiting bodies (75%) were obtained between July to September and minimum i.e. 6% between November – February. Among the collected mushroom *Stereum rugosum, Crepidotus variabilis, Laccaria laccata, Schizophyllum commune, Ganoderma applantum, Cantharellus cibarius* were more prevalent. Out of all collected mushroom sample the frequency of Mushroom belonging to order Agaricales was 45.18% followed by Polyporales *i.e.,* 27.7%. The collected mushroom were cultured on PDA medium and their mycelial forms were preserved for further studies.

Keywords: ***Mushroom, organic-debris, fruiting bodies, diversity, frequency.***

1. Introduction

The Macro-fungi having fleshy, sub-fleshy, leathery, and umbrella like fructifications, bearing their spore producing surface either on lamellae (gills) or lining the tubes, opening out by means of pores designated as Mushroom [1]. These fruiting bodies falls under the category of gilled mushroom, bracket mushroom, puffballs, coral mushroom, jelly mushroom, stinkhorns, earthstars, birds nest mushroom on the testimony of their sporocarps [2]. From the taxonomic point of view, mainly Basidiomycetes are known as mushroom but also some species of Ascomycetes have been known to produce mushroom like fruiting bodies [3]. Mushroom are inseparable parts of ecosystem being soil replenisher due to their strong property of degrading cellulose and other organic polymers. The fact marks presence or absence of mushroom are useful trafficator to assess the damage or the maturity of an ecosystem [4]. Mushroom in the 21st century has been explored as crucial component for food safety and security. They have rich nutritional value with high content of proteins, vitamins, minerals, fibers, trace elements, limited calories and cholesterol [5]. Besides, they also contain good amount of secondary metabolites and were reported to possessed antioxidant, anticancer, anti-mutagenic, antimicrobial and antiradical properties [6]. The rate of consumption of fleshy fungi in many countries has increased in recent years and hence it becomes imperative to explore the treasure of wild mushrooms. The day by day increasing population and its developmental activities are detrimental to ecological diversity. India is rich in diversity of its fauna and flora consequently may possess virtuous heterogeneity of Mushroom. The first scientific study on Indian mushroom was handled by Linnaeus in 18th century with the identification and description of *Podaxis pistillaris* [7]. Several mycologists have reported

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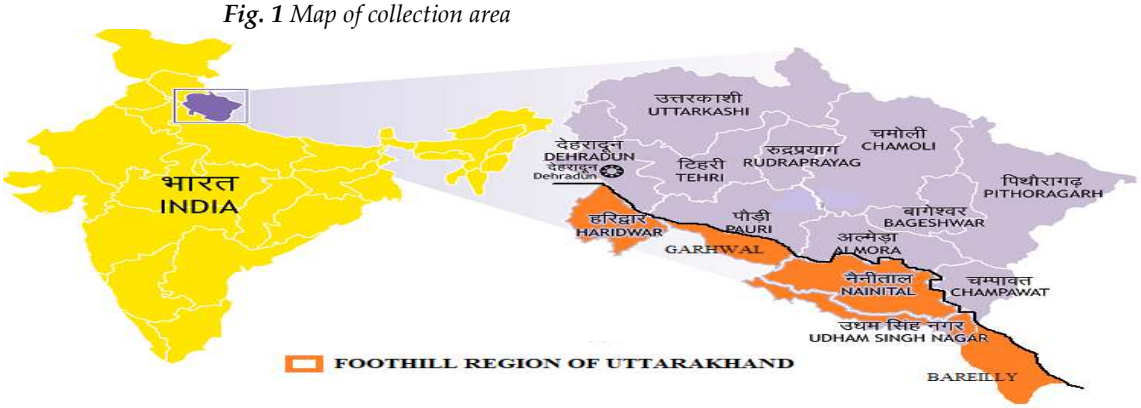
ethno-mycological usage and additional lists appeared in between 18th to 21st century culminating with this natural resource wealth of India. The studies on mushrooms are mainly aimed at describing only common cultivating varieties and validating its status but, there are relatively a few studies that have been undertaken on wild mushroom mainly due to their short life span of their fruiting bodies. Ecological value, diversity and economic importance of mushroom are three key aspects in the world of biology [8]. However, indigenous knowledge about edible and medicinal mushrooms has not been given significant attention in Foothill region of Uttarakhand. The cities of Uttarakhand have an upscale repository of the unexplored macro-fungal wealth due to its varied climatic and topographic conditions. Therefore, present study has been undertaken to explore the biodiversity of mushroom from Foothill region of Uttarakhand especially of Kumaon region.

2. Materials and Methods

Regular collection visits were conducted in different months during July-2016 up to December-2018 from Bareilly to Uttarakhand. Prior and during the collection from selected sites a standard protocol had been followed [9]. The study area was located between 28° 43' – 31° 27' N latitudes and 77° 34' – 81° 02' E longitudes, 64% of which is covered with alpine rain forest. The Foothills of Uttarakhand in the south is delimited by Bareilly region of Uttar Pradesh. It has a subtropical climate and the weather is cool to pleasant. The temperature ranges between 32°C - 4°C. The study area has been divided into four sub areas *i.e.,* 1.Nainital; 2.Udham Singh Nagar; 3.Haridwar;4.Garhwal in conjunction with foothill bordering geographical region *i.e., 5.*Bareilly *(fig1.)* A total of thirty four sites were selected from above mentioned sub areas for the collection of fruiting bodies in different environmental conditions. The full bloomed and complete fruiting bodies of fresh samples were photographed with the aid of Nikon D3400 camera and collected from their natural habitats. All of the physicochemical parameters of collection sites were recorded with the help of a multimeter of Cutezy and a digital thermometer. The entire collected Mushroom were brought to Microbiology Laboratory under aseptic conditions in cooling thermocol containers for Microscopic examination under microscope (cell image centre Llyod) and further evaluation. Identification had been undertaken as per mentioned procedure at the sites www.rogersmushrooms.com, www.mushroomexpert.com and comparing the external morphology, pictures and microscopic slides preparations with standard manual and field guide [10,11,12] Isolation of pure culture of fruiting body had been obtained on PDA media and pure forms were stored at 4°C for further biochemical and physicochemical analysis. The Frequency of the collected mushroom was calculated by the following formula:

$$\textbf{Frequency of mushroom species} = \frac{\textbf{Number of sites in which the species occured}}{\textbf{Total no of sites}} \times 100$$

Fig. 1 *Map of collection area*



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3. Results and Discussion

This research paper represents the new report made on wild mushroom from Foothill region of Uttarakhand, India. A total of 166 Mushroom samples were collected and identified. The collected mushroom were found to grew naturally in different habitats like grasslands, living tree trunk, under soil, dead wood log, leaf litter etc. in different environmental conditions. Most of the collected mushrooms were found to prevail from July to November due to the favorable temperature and humidity of that time span for fruiting bodies to bloom (table 1). Generally good amount of Rainfall occurs during the month of August, thus decreasing the emergence of fruiting bodies followed by the highest collection percentage in September (30%) with average day temperatures of 18°C dropping at night to 4°C. The occurrence and collection per cent of mushroom has been recorded predominantly where pH was ranging from 7.1-7.5 (*table 1.*). Agaricales and Polyporales emerged out to be the dominant mushroom orders (*fig. 2.*) in the studied region with their per cent frequencies 45.18 and 27.7 alternatively. Out of total 166 identified samples; 102 different species of 15 orders and 43 families were identified. Among identified mushroom *Crepidotus variabilis, Stereum rugosum, Ganoderma applantum, Schizophyllum commune* were more prevalent followed by gilled mushroom *i.e. Laccaria laccta, Cantherallus cibarius and Chlorophyllum molybdites* whereas jelly fungi were rarely found *viz. Dacrymyces palmatus, Auricularia mesentrica (table2.).*

Table 1: *Average Physicochemical Parameters of Sites*

Site	Code	Temperature (°C)	pH	Light (lux)	Moisture
Lalkuan	*S1*	29	7.2	1200	6
Haldwani	*S2*	33	6.2	1000	3
Kathgodam	*S3*	25	7.5	800	4
Gola Beraj	*S4*	26	8	600	8
Dolmar	*S5*	23	7.8	300	10
Jeolikot	*S6*	22	7.2	200	9
Amdanda	*S7*	21	7.2	200	8
Garjiya	*S8*	31	5.9	500	3
Kaladhungi	*S9*	25	7.1	400	5
Ramnagar	*S10*	22	7.3	500	3
Pantnagar	*S11*	31	7.5	800	4
Haldi	*S12*	29	7.3	700	3
Pattarcahata	*S13*	29	7.2	600	3
Mundeli	*S14*	27	7.6	900	2
Pari	*S15*	26	7.5	700	2
Khatima city	*S16*	30	7.8	1000	3
Nanakmatta	*S17*	31	7.8	1200	3
Sitarganj	*S18*	32	7.9	1000	4
Jaspur	*S19*	31	7.6	900	5
Gadarpur	*S20*	31	7.5	800	3
Rudrapur	*S21*	30	7.6	600	3
Chidiyapur	S22	25	6.9	500	8
Laksar	S23	30	7.8	700	3
Jwalapur	S24	29	7.7	600	6
Raiwala	S25	26	7.8	300	4
Chiddarwala	S26	25	6.9	200	7
Asafpur	S27	31	7.6	800	3
Landsowne	S28	23	7.5	400	7
Dogadda	S29	22	7.7	300	5
Kotdwar	S30	26	7.1	600	7
University	S31	30	6.8	500	7
Kargaina	S32	29	7.2	900	2
Subhash Nagar	S33	32	7.3	1000	3
C.B. Ganj	S34	28	7.5	700	8

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Table 2. Mushroom Diversity of Foothill region of Uttarakhand

SITE	SAMPLE	IDENTIFIED SPECIES	OCCURRENCE	ORDER	% FREQUENCY
S1	M1	*Mycena polygramma*	Grassland	Agaricales	8.82
	M2	*Pycnoporus sanguineus*	Leaf litter	Polyporales	8.82
	M3	*Coprinus plicatilis*	Leaf litter	Agaricales	5.88
	M4	*Hygrocybe pratensis*	Base of Stem	Agaricales	5.88
	M5	*Dacrymyces palmatus*	Base of Stem	Dacrymycetales	2.94
	M6	*Chlorophyllum molybdites*	Leaf litter	Agaricales	11.76
	M7	*Trametes versicolor*	Dead woodlog	Polyporales	8.82
	M8	*Stereum rugosum*	Leaf litter	Rusullales	14.71
	M9	*Daedalea quercina*	Deadwoodlog	Polyporales	5.88
	M10	*Crepidotus variabilis*	Base of Stem	Agaricales	14.71
S2	M11	*Pleurocybella porrnigens*	Base of Stem	Agaricales	5.88
	M12	*Laccaria laccata*	Base of Stem	Agaricales	11.76
	M13	*Coltricia perennis*	Grassland	Hymenochaetales	5.88
	M14	*Mycena polygramma*	Grassland	Agaricales	8.82
S3	M15	*Volvopleutus gloiocephalus*	Base of Stem	Agaricales	5.88
	M16	*Hygrocybe pratensis*	Base of Stem	Agaricales	5.88
	M17	*Auricularia auricula judae*	Dead woodlog	Auriculariales	8.82
	M18	*Chlorociboria aeruginascens*	Leaf litter	Helotiales	2.94
	M19	*Pleurotus ostreatus*	Leaf litter	Agaricales	5.88
	M20	*Pycnoporus cinnabarinus*	Leaf litter	Polyporales	2.94
	M21	*Marasmius alliaceus*	Base of Stem	Agaricales	5.88
S4	M22	*Pycnoporus sanguineus*	Dead woodlog	Polyporales	8.82
	M23	*Coprinopsis atramentaria*	Leaf litter	Agaricales	2.94
	M24	*Coltricia perennis*	Grassland	Hymenochaetales	5.88
	M25	*Volvopleutus gloiocephalus*	Base of Stem	Agaricales	5.88
	M26	*Ganoderma curtissi*	Wood log	Polyporales	2.94
S5	M27	*Macrolepiota procera*	Grassland	Agaricales	8.82
	M28	*Lycoperdon pyriforme*	Grassland	Agaricales	5.88
	M29	*Hexagonia spp.*	Leaf litter	Polyporales	2.94
	M30	*Pleurocybella porrnigens*	Base of Stem	Agaricales	5.88
	M31	*Tricholoma sulphurium*	Grassland	Agaricales	5.88
S6	M32	*Coprinus domesticus*	Leaf litter	Agaricales	5.88
	M33	*Stereum rugosum*	dead woodlog	Rusullales	14.71
	M34	*Leptoporus adustus*	Deadwoodlog	Polyporales	2.94
	M35	*Coprinus plicatilis*	Leaf litter	Agaricales	5.88
	M36	*Ganoderma adspersum*	Wood log	Polyporales	2.94
	M37	*Climacodon septentrionalis*	Base of stem	Polyporales	2.94
S7	M38	*Calvatia craniiformis*	Leaf litter	Agaricales	5.88
	M39	*Laccaria bicolor*	Leaf litter	Agaricales	5.88
	M40	*Cantharellus minor*	Grassland	Cantharellales	5.88
	M41	*Laccaria laccata*	Grassland	Agaricales	11.76
	M42	*Daedalea quercina*	Woodlog	Polyporales	5.88
	M43	*Trametes versicolor*	Dead woodlog	Polyporales	8.82
	M44	*Mycena marginata*	Dead woodlog	Agaricales	8.82
	M45	*Crepidotus variabilis*	Base of stem	Agaricales	14.71
	M46	*Schizophyllum commune*	Living tree base	Agaricales	14.71
	M47	*Mycena polygramma*	Base of stem	Agaricales	8.82
S8	M48	*Lycoperdon pyriforme*	Grassland	Agaricales	5.88
	M49	*Chlorophyllum molybdites*	Leaf litter	Agaricales	11.76
	M50	*Crepidotus variabilis*	Grassland	Agaricales	14.71
	M51	*Xylaria polymorpha*	Woodlog	Xylariales	2.94

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S9	M52	*Meripilus giganteus*	Leaf litter	Polyporales	2.94
	M53	*Cantharellus minor*	Base of stem	Cantharellales	5.88
	M54	*Schizophyllum commune*	Saprophtic	Agaricales	14.71
	M55	*Ganoderma applantum*	Base of stem	Polyporales	14.71
	M56	*Crepidotus variabilis*	Leaf litter	Agaricales	14.71
	M57	*Laccaria bicolor*	Leaf litter	Agaricales	5.88
	M58	*Pleurotus ostreatus*	Woodlog	Agaricales	5.88
	M59	*Trametes gibbosa*	Woodlog	Polyporales	2.94
	M60	*Polyporus alveolaris*	Base of stem	Polyporales	2.94
	M61	*Coprinus comatus*	Dead woodlog	Agaricales	2.94
	M62	*Tricholoma sulphurium*	Grassland	Agaricales	5.88
S10	M63	*Amanita virosa*	Woodlog	Agaricales	2.94
	M64	*Schizophyllum commune*	Tree trunk	Agaricales	14.71
	M65	*Lentinus tigrinus*	Woodlog	Polyporales	2.94
	M66	*Psathyrella conopilus*	Grassland	Agaricales	2.94
	M67	*Collybia dryophila*	Dead wood	Agaricales	2.94
	M68	*Lactarius deliciosus*	Living treebase	Russulales	5.88
S11	M69	*Entoloma conferendum*	Mycorrhizal	Agaricales	2.94
	M70	*Schizophyllum commune*	Mycorrhizal	Agaricales	14.71
	M71	*Clitocybe gibba*	Grassland	Agaricales	5.88
S12	M72	*Mycena marginata*	Leaf litter	Agaricales	8.82
	M73	*Hygrocybe calyptiformis*	Grassland	Agaricales	2.94
	M74	*Agaricus sylvaticus*	Leaf litter	Agaricales	2.94
S13	M75	*Cantharellus cibarius*	Debris	Cantharellales	11.76
	M76	*Cliptopilus prunulus*	Debris	Agaricales	2.94
S14	M77	*Auricularia auricula judae*	Deadwood log	Auriculariales	8.82
	M78	*Cantherellus cibarius*	Grassland	Cantharellales	2.94
S15	M79	*Condrostereum pupureum*	Leaf litter	Agaricales	2.94
	M80	*Sparassis crispa*	Woodlog	Polyporales	8.82
S16	M81	*Tyromyces chioneus*	Deadwood log	Polyporales	2.94
	M82	*Auricularia mesenrtica*	Living tree trunk	Auriculariales	5.88
	M83	*Polyporus brumalis*	Deadwood log	Polyporales	2.94
	M84	*Cortinarius spp.*	Debris	Agaricales	2.94
	M85	*Xylaria hypoxylon*	Deadwood log	Xylariales	8.82
S17	M86	*Coriolus versicolor*	Living Tree trunk	Polyporales	5.88
	M87	*Cantherallus subalbidus*	Leaf litter	Cantharellales	2.94
	M88	*Daedaleopsis confragosa*	Living tree trunk	Polyporales	5.88
	M89	*Gymnophus dryophilus*	Deadwood log	Agaricales	2.94
	M90	*Trametes hirsuta*	Deadwood log	Polyporales	2.94
S18	M91	*Ganoderma applantum*	Living tree trunk	Polyporales	14.71
	M92	*Ganoderma resinaceum*	Deadwood log	Polyporales	8.82
	M93	*Macrolepiota procera*	Grassland	Agaricales	8.82
	M94	*Auricularia auricula judae*	Deadwood log	Auriculariales	8.82
	M95	*Gleophyllum odoratum*	Deadwood log	Gleophyllales	2.94
	M96	*Ganoderma applantum*	Living tree trunk	Polyporales	14.71
S19	M97	*Pseudohydnum gelatinosum*	Deadwood log	Auriculariales	2.94
	M98	*Mycena marginata*	Debris	Agaricales	8.82
S20	M99	*Disciotis venosa*	Deadwood log	Pezizales	2.94
	M100	*Podoscypha petalodes*	Deadwood log	Polyporales	2.94
S21	M101	*Hymenochaete rubiginosa*	Deadwood log	Hymenochaetales	2.94
S22	M102	*Lenzites betulina*	Deadwood log	Polyporales	2.94
	M103	*Phlebia tremellosa*	Livilg tree trunk	Polyporales	2.94
	M104	*Polyporus umbellatus*	Leaflitter	Polyporales	2.94
	M105	*Stereum rugosum*	Deadwood log	Rusullales	14.71
	M106	*Xylaria hypoxylon*	Leaflitter	Xylariales	8.82
	M107	*Ganoderma resinaceum*	Deadwood log	Polyporales	8.82
S23	M108	*Cymatoderma spp.*	Living tree trunk	Agaricales	2.94
	M109	*Heterobasidium annosum*	Deadwood log	Rusullales	2.94

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S24	M110	*Crepidotus porringens*	Living tree trunk	Agaricales	5.88
	M111	*Gloeophyllum sepiarium*	Deadwood log	Gleophyllales	5.88
	M112	*Cantharellus cibarius*	Leaflitter	Cantharellales	11.76
S25	M113	*Sparassis crispa*	Deadwood log	Polyporales	8.82
	M114	*Clitocybe nuda*	Grassland	Agaricales	2.94
	M115	*Polyporus squamosus*	Deadwood log	Polyporales	2.94
	M116	*Hygrophoris aurantiaca*	Grassland	Boletales	2.94
	M117	*Ramaria stricta*	Leaflitter	Dacrymycetales	2.94
	M118	*Phellinus spp.*	Living tree trunk	Hymenochaetales	2.94
	M119	*Lactarius deliciosus*	Living tree trunk	Russulales	5.88
	M120	*Fomes fomantarius*	Woodlog	Polyporales	2.94
S26	M121	*Crepidotus porringens*	Living tree trunk	Agaricales	5.88
	M122	*Clitocybe gibba*	Grassland	Agaricales	5.88
	M123	*Mycena pelianthena*	Leaflitter	Agaricales	2.94
	M124	*Lenzites tigrinus*	Leaflitter	Polyporales	2.94
	M125	*Thelophora terrstris*	Leaflitter	Thelophorales	2.94
	M126	*Flemmulinas velutipes*	Leaflitter	Agaricales	2.94
	M127	*Lactarius trivialis*	Grassland	Rusullales	2.94
	M128	*Pleurotus sajor caju*	Living tree trunk	Agaricales	2.94
	M129	*Ganoderma applantum*	Deadwood log	Polyporales	14.71
	M130	*Trichaptum abietum*	Leaflitter	Polyporales	2.94
S27	M131	*Clitopilus prunulus*	Deadwood log	Agaricales	2.94
	M132	*Pycnoporus sanguineus*	Deadwood log	Polyporales	8.82
S28	M133	*Daedaleopsis confragosa*	Deadwood log	Polyporales	5.88
	M134	*Gloeophyllum sepiarium*	Living tree trunk	Gloeophyllales	5.88
	M135	*Laetiporus sulphurius*	Living tree trunk	Polyporales	2.94
	M136	*Scleroderma verucosum*	Grassland	Boletales	2.94
	M137	*Bondarzawia berkeleyi*	Dead woodlog	Russullales	2.94
	M138	*Tyromyces stipticus*	Dead woodlog	Polyporales	2.94
	M139	*Schizophyllum commune*	Dead woodlog	Agaricales	14.71
S29	M140	*Cantharellus cibarius*	Grassland	Cantharellales	11.76
	M141	*Crelophus cirrhatus*	Living tree trunk	Russullales	2.94
	M142	*Phellodon tomentosus*	Grassland	Thelophorales	2.94
S30	M143	*Sparassis crispa*	Dead woodlog	Polyporales	8.82
	M144	*Auricularia mesenrtica*	Dead woodlog	Auriculariales	5.88
	M145	*Bovista plumbae*	Grassland	Agaricales	2.94
	M146	*Tremella mesentrica*	Dead woodlog	Tremellales	2.94
S31	M147	*Chlorophyllum molybdites*	Leaf litter	Agaricales	11.76
	M148	*Laccaria laccata*	Leaf litter	Agaricales	11.76
	M149	*Irpex lacteus*	Deadwood log	Polyporales	5.88
	M150	*Calvatia utriformes*	Grassland	Agaricales	2.94
	M151	*Crepidotus variabilis*	Living tree trunk	Agaricales	14.71
	M152	*Cantharellus cibarius*	Grassland	Cantharellales	11.76
	M153	*Marasmius sullivanti*	Grassland	Agaricales	2.94
	M154	*Ganoderma resinaceum*	Deadwood log	Polyporales	8.82
	M155	*Agaricus bisporus*	Ground	Agaricales	2.94
S32	M156	*Ganoderma applantum*	Living tree trunk	Polyporales	14.71
	M157	*Chlorophyllum molybdites*	Leaf litter	Agaricales	11.76
	M158	*Laccaria laccata*	Grassland	Agaricales	11.76
	M159	*Stereum rugosum*	Deadwood log	Rusullales	14.71
S33	M160	*Macrolepiota procera*	Grassland	Agaricales	8.82
	M161	*Trametes versicolor*	Living Tree trunk	Polyporales	8.82
	M162	*Xylaria hypoxylon*	Deadwood log	Xylariales	8.82
S34	M163	*Coprinus domesticus*	Leaf litter	Agaricales	5.88
	M164	*Calvatia craniiformis*	Grassland	Agaricales	5.88
	M165	*Marasmius alliaceus*	Base of Stem	Agaricales	5.88
	M166	*Stereum rugosum*	Deadwood log	Rusullales	14.71

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Fig.2: Frequency of Mushroom Orders from studied region

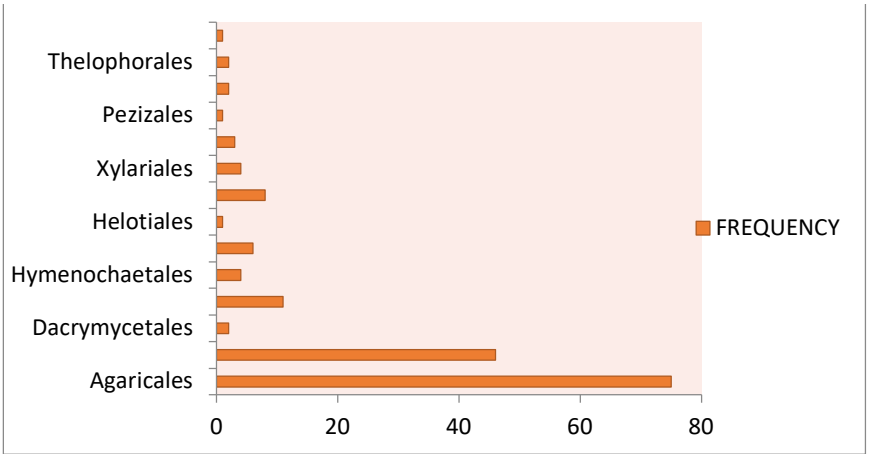

Fig.2: Some Photographs of the collected wild mushroom

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*Scientific names given in Table2.

5. Conclusions

This study was aimed to collect and identify wild mushroom that grow naturally in different habitats in Foothill region of Uttarakhand. High diversified mushroom were collected from the foothill where members of Agaricales and Polyporales were maximum indicating that this ecological site contains the high content of organic matter and these two orders has been reported to play important role into the recycling of lingo-cellulosic and hemi-cellulosic organic matter of forest (13,14). Moreover the high rainfall from mid June to July contributes a favorable environment for their growth and activity. During the study it has also being found that majority of the poor population depends on their food on these wild mushrooms. Such a diversified collection has been proved as one of the strongest source of rich nutrient and further study may result in new good sources of antioxidants and pharmaceutical compounds from these wild mushrooms.

statement if the study did not report any data.

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