COMPARATIVE STUDIES ON NUTRITIONAL ASPECTS OF SOME WILD EDIBLE MUSHROOMS FROM NAGALAND AND OPTIMIZATION OF CULTURE PROTOCOL FOR *LENTINULA EDODES* (BERK.) PEGLER

Thesis Submitted to the Department of Botany, Nagaland University, Lumami, Nagaland in Partial Fulfilment for the Requirement of Degree of Doctor of Philosophy in Botany

By

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DEPARTMENT OF BOTANY

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CERTIFICATE

This is to certify that, the thesis entitled, "**Comparative studies on nutritional aspects of some Wild Edible Mushrooms from Nagaland and optimization of culture protocol for *Lentinula edodes* (Berk.) Pegler**" is a record of original research work carried out by Miss Gloria Nyenthang, a research scholar bearing Registration No. Ph. D./Bot/00074 dated 24/8/2017 of the department of Botany under my supervision. She has fulfilled all the requirements of Ph.D. regulations of Nagaland University for submission of thesis. The work is original and neither the thesis nor any part of it has been submitted elsewhere for the award of any degree or distinctions. The thesis is therefore forwarded for adjudication and consideration for the award of Doctor of Philosophy in Botany under Nagaland University.

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DECLARATION

I, Miss Gloria Nyenthang bearing Registration No. Ph. D./Bot/00074 dated 24/8/2017 hereby declare that, the thesis entitled, "**Comparative studies on nutritional aspects of some Wild Edible Mushrooms from Nagaland and optimization of culture protocol for *Lentinula edodes* (Berk.) Pegler**", being submitted to Nagaland University, Lumami for the degree of Doctor of Philosophy in Botany is the record of an original and independent research work carried out by me under the supervision of Dr. Talijungla, Professor, Department of Botany, Nagaland University, Lumami.

I further declare that this thesis has not previously been submitted for award of any other degree or diploma to any University or other tertiary institutions. This declaration is hereby forwarded by my supervisor and Head of the Department.

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Introduction "Fungi" or "fungus" may stimulate a diverse range of psychological images in humans. One's organoleptic memory may be jolted to a memorable taste of an agaric mushroom or other savoury mushroom dishes. Some people may not return the sentiment very well since they associate them with infections and mouldy food. Yet there's also a group of individuals that see mushrooms as more than just a biological curiosity, and whose fascinating mythology, folk-tales, and traditional mycological rituals reflect this connection. Nonetheless, Fungi are an entirely unique and major class of organisms, and they are a critical component of ecosystem functioning and vitality; they also have an impact on people and human-related activities (Mueller et al., 2004). From the beginning, they have been known as "nature's garbage burner" and as "natural recycling bin" due to their function in decomposition. They are well-known for their function in the breakdown of organic components in nature, as causative agents of plant maladies and certain human diseases, and for their yeast activities, which produce alcohol, acetic acid, and antibiotic, among other substances (S. T. Chang & Miles, 1984, 1992). The use of mushrooms in the biosorption of industrial effluents (Demirbas, 2000) or the decomposition of organic persistent contaminants (Tran et al., 2013), might be of critical value in a severely threatened and polluted environment. And indeed, as mentioned earlier, perhaps their most significant contribution has been and will continue to be their involvement in the recycling of carbon and vital elements within the ecosystem.

1.1 History Humans' interactions with their environments have always been profoundly influenced by the availability of good food. Due to the fact that it is necessary for humans to eat in order to remain alive, people have always had an ingrained need to go on a constant quest for food. From prehistoric times until the advent of money, food was both a source of income and a source of power. It has sparked social evolution, social organisation, rivalry, development, conflict, and territorial expansion. It was also the cornerstone of the first religious beliefs and activities. Food has become one of the most important sources of enjoyment for humans, especially in more advanced civilization.

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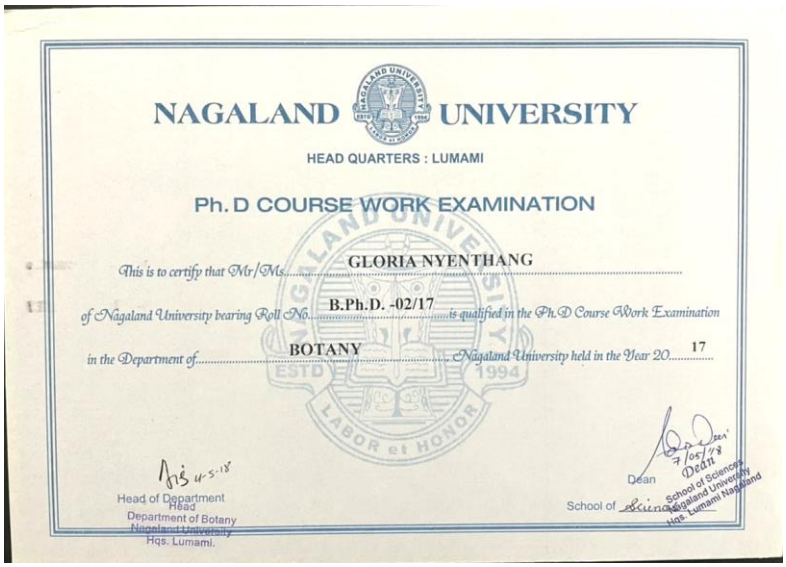

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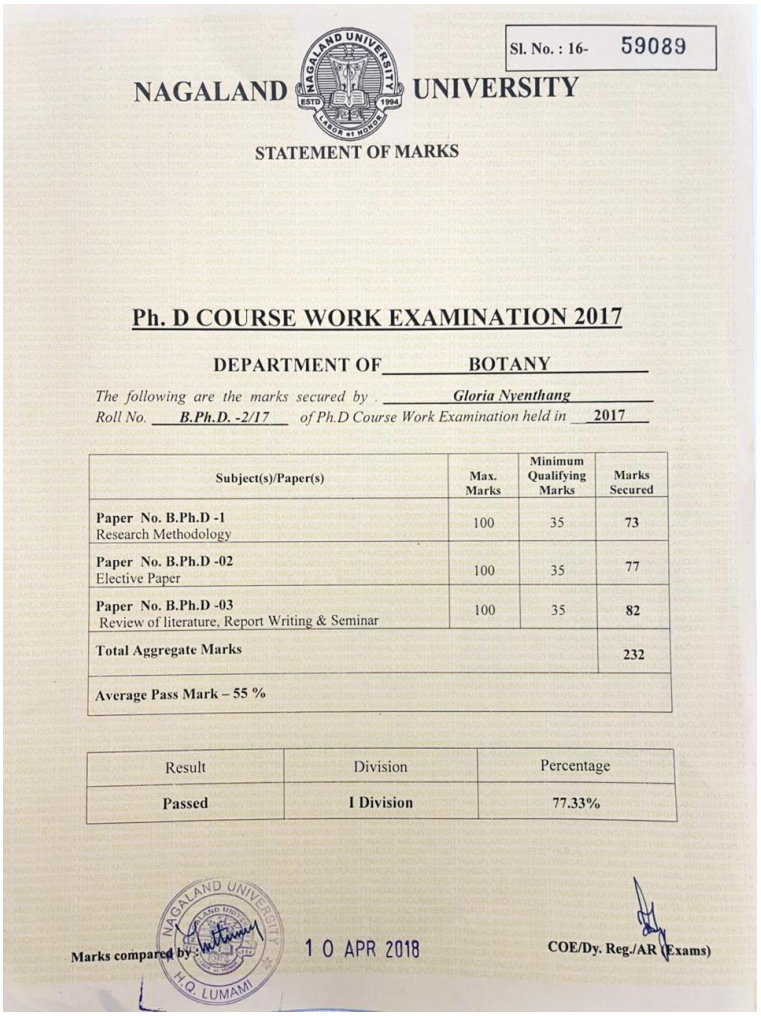

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Subject(s)/Paper(s)	Max. Marks	Minimum Qualifying Marks	Marks Secured
Paper No. B.Ph.D -1 Research Methodology	100	35	**73**
Paper No. B.Ph.D -02 Elective Paper	100	35	**77**
Paper No. B.Ph.D -03 Review of literature, Report Writing & Seminar	100	35	**82**
Total Aggregate Marks			**232**
Average Pass Mark – 55 %			

Result	Division	Percentage
Passed	**I Division**	**77.33%**

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CHAPTER - 1

INTRODUCTION

"Fungi" or "fungus" may stimulate a diverse range of psychological images in humans. One's organoleptic memory may be jolted to a memorable taste of an agaric mushroom or other savoury mushroom dishes. Some people may not return the sentiment very well since they associate them with infections and mouldy food. Yet there's also a group of individuals that see mushrooms as more than just a biological curiosity, and whose fascinating mythology, folk-tales, and traditional mycological rituals reflect this connection. Nonetheless, Fungi are an entirely unique and major class of organisms, and they are a critical component of ecosystem functioning and vitality; they also have an impact on people and human-related activities (Mueller et al., 2004). From the beginning, they have been known as "nature's garbage burner" and as "natural recycling bin" due to their function in decomposition. They are well-known for their function in the breakdown of organic components in nature, as causative agents of plant maladies and certain human diseases, and for their yeast activities, which produce alcohol, acetic acid, and antibiotic, among other substances (Chang & Miles, 1984, 1992)**.** The use of mushrooms in the biosorption of industrial effluents (Demirbas, 2000) or the decomposition of organic persistent contaminants (Tran et al., 2013), might be of critical value in a severely threatened and polluted environment. And

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1.1 History

Humans' interactions with their environments have always been profoundly influenced by the availability of good food. Due to the fact that it is necessary for humans to eat in order to remain alive, people have always had an ingrained need to go on a constant quest for food. From prehistoric times until the advent of money, food was both a source of income and a source of power. It has sparked social evolution, social organisation, rivalry, development, conflict, and territorial expansion. It was also the cornerstone of the first religious beliefs and activities. Food has become one of the most important sources of enjoyment for humans, especially in more advanced civilization.

Archaeological evidences indisputably lead us in the direction of the undeniable reality that, in addition to all of the other plants that have been unearthed from fossil records, humans have unquestionably used and ingested mushrooms from the beginning of time. The most recent evidence dates back to 18.7 kya (thousand years ago), which occurred during the Magdalenian era in Northern Iberia, Spain in the El Miron Cave. Calculus samples had microremains containing agaric as well as bolete spores, which suggested human ingestion of many types of mushrooms, either as food or for other uses (Power et al., 2015). Otzi Iceman, a 5300-year-old mummy (Figure 1.1) was discovered 3210 metres above sea level in the Alps between Austria and Italy,

is perhaps the earliest evidence of the usage of fungus as therapeutics. Using forensic and cutting-edge scientific tools, they were able to demonstrate that the so believed to be a warrior was both healthy and well-nourished. Tinder fungus (*Fomes fomentarius*) is utilised for both starting fires and, most likely, healing wounds. as well as *Piptoporus betulinus*, a medicative birch polypore (Peintner et al., 1998). There are other reports of mushroom use dating back to 13 kya in Chile (Rojas & Mansur, 1995) and 5-6 kya in China (Chang, 2006). The psychotropic and hallucinatory qualities of some mushrooms, particularly *Amanita muscaria* in Northern Europe, Siberia, , and the area of the Sahara, and *Panaeolus* spp. and *Psilocybe* spp. in Mesoamerica, were identified during the Paleolithic era. As a result, these mushrooms have long been integral components of ancient cultures' religious practises and rites (Samorini, 2001).

The use of mushrooms in our ancestors' culture undoubtedly resulted in the development of fascinating myths, beliefs, and rituals. Since the ancient Egyptians had the firm notion that mushrooms were unique and had a supernatural origin, they decreed that this delicacy could only be consumed by royalty and prohibited the common people from even coming into direct contact with them. They believed these mushrooms granted eternal life and were therefore given to them by the Deity Osiris. Mushrooms were revered as the "life elixir" by the ancient Chinese, and "the feasts of the Gods" by the ancient Romans. They were also thought to provide ancient Greek troops the energy they required to prevail in battle, according to some scholars (Arora, 1985). Despite the rise in popularity of truffles and porcini mushrooms, the tradition of gathering *Amanita caesarea* is still practised in many parts of Italy (Boa, 2004). The Ming dynasty herbalist Li Shizhen (1518-1593 AD) documented how to use mushrooms in traditional

Chinese medicine in the *Compendium of Materia Medica*. *Cordyceps sinensis*, an insect-infesting fungus that is still widely used as a Chinese medicinal ingredient, was one of more than 20 mushroom species that were catalogued demonstrating that the integrity of these traditions and principles that has not diminished throughout the centuries.

The first reference to mushrooms in Hindu scriptures occurs during the Vedic period. R. Gordon Wasson, an investment banker, suggested that the flyagaric (*Amanita muscaria*) was the source of the enigmatic Soma: Divine Mushroom of Immortality mentioned in the Rig Veda, which resulted in the spontaneous enlightenment for those who consumed it (R. G. Wasson, 1971) as shown in Figure 1.2. It's true that many Vedic experts didn't agree with his interpretation of the results, but his thorough investigation still remains. More recently, the characterization of the desert truffle mushroom, *Terfezia amenaria*, was interpreted to be found as "bread from heaven," also known as "Manna of the Israelites" in the Bible. Manna was the primary food that the Israelites consumed during their forty-year sojourn in the wilderness (Pegler, 2002). While it is true, as Arora states out, eating a mushroom is the sole way to determine if it's edible, it's unclear how ancient humans learned which species of mushrooms were safe to ingest. However, it's likely that they learned through trial - and - error, as is typical when learning about the dietary suitability of wild plants and animals (Arora, 1985).

On the other hand, there is a widespread and, at times, irrational fear of mushroom poisoning throughout all cultures. When it comes to the danger offered by dangerous and deadly species, people tend to exaggerate the situation. The usage of

wild edible fungus, however, has been demonstrated in studies to be both widespread and intense. Media and societal attitudes continue to create an underlying dread of wild mushrooms in certain communities, despite the fact that the reported incidences of poisoning and fatalities are very rare when compared to the frequent and safe eating of edible species (Boa, 2004). Therefore, as a way to explain the varying and often contradictory feelings individuals have with mushrooms across the globe, Wasson & Wasson (1957) were the ones who initially proposed the broad, dichotomous, and polar opposite names mycophilia and mycophobia. To those who like and value mushrooms, the term "mycophilia," meaning "love of mushrooms," is used, while the term "mycophobia," meaning "fear of mushrooms," is used to describe those who have an antipathy to them.

The term mycophobic describes those individuals and cultures who look upon fungi with fear and loathing. Mycophobic societies are best exemplified by the English and Irish. The opposite is true for mycophile communities, which may be found mostly in Eastern Europe and Asia, particularly among the Russian, Polish, and Italian citizens. Quite so many as a hundred different names are used to designate the numerous types of mushrooms that are popular in these cultures (Stamets, 2000).

Throughout history, we've seen that the Middle Ages saw a dramatic increase in the consumption of fungi fit for human consumption. People all around the globe utilised wild mushrooms as a staple diet, a savory complement to stews and soups and even as an ingredient in herbal tea. Mushrooms continue to be valued for the same reasons they were in ancient times: their unique taste, scent, and therapeutic properties.

Foraging for wild plants and mushrooms, both for food and fun, is still common in modern diets. However, traditional knowledge about wild mushroom edibility from rural and indigenous cultures continues to remain valuable.

Figure 1.1 Otzi, the site where it had been discovered. Photo: Paul Hanny

Figure 1.2 Image of Hindu sculptures breaking the mushroom code of the enigmatic Soma as mentioned in the Rig Veda as suggested by R. Gordon Wasson (1971).

1.2 Fungi/Mushroom

Until the latter part of the twentieth century, Linnaeus's classification of fungi into the four groups Phycomycetes, Basidiomycetes, Ascomycetes and Deuteromycetes (the latter are referred to as " Fungi Imperfecti " because of the absence of a sexual cycle in their physiology) within the plant kingdom (subkingdom Cryptogamia; Division Thallophyta) was widely accepted. This was mostly determined by the structure of the sexual organs, the presence or lack of hyphal septate, and the amount of chromosomal duplication in the centres of vegetative mycelia. The fact that they had a cell wall distinguished them from animals and placed them in the plant kingdom. Nevertheless, scientists re-evaluated and reaffirmed in the middle of the twentieth century that mushroom biota, alongside other fungi, have properties that are sufficiently and substantially unique to classify them in an independent fungal Kingdom Myceteae (Chang & Miles, 2004).

1.2.1 Definition

Fungi are spore-bearing, eukaryotic, achlorophyllous organisms. Fungi lack chlorophyll, the most fundamental plant characteristic that plants employ to make their own food and energy. Because of this, fungus must rely on the organic matter around them to get food. Fungi have what we term “thallus”, which is their vegetative structure. It comes in many sizes, from single-celled yeast to multi-celled filamentous moulds to large puffballs and mushrooms. The kingdom Fungi is one of the five eukaryotic kingdoms, along with the kingdoms Animalia, Plantae, Chromista, and Protozoa.

Despite the fact that the tiny Micromycetes are likewise an incredibly intriguing group, only the Macromycetes, or Macrofungi, the mushrooms, will be studied here.

"*With no Leaves, no buds, or without flowers, yet they generate fruit*," as expressed by Chang and Miles (2004), the versatility of mushrooms as a food, tonic, and medicine makes them one of nature's most spectacular creations.

The terms "mushroom" and "toadstool" date back hundreds of years. There is a possibility that the word "mushroom" and its variants originated out from French word "*mousserom*," which refers to moss (mausse). While not always, the name "toadstool" was most often used to refer to toxic mushrooms. The German word for "death's stool," "*todesstuhl"*, refers to those with the traditional umbrella-like top and stem design. Both terms, however, may be used interchangeably to refer to the fruiting body of any fleshy fungus; there is no defining scientific difference between them.

Mushrooms are those fruiting organisms that produce spores, and although most mushrooms belong to the class Hymenomycetes of the Basidiomycotina, there are a few Ascomycetes that are also classified as mushrooms. There are gilled fungi with or without stems. It deviates from traditional morphology by having more descriptive names, such as 'bolete,' 'puffball,' 'stinkhorn' and 'morel'. Mushrooms can also be defined as big, visible, and easily harvested fungi that have either an epigeous (above ground) or hypogeous (underground) fruiting body (Flegg et al., 1985). In reference to their resemblance to Agaricus or their classification as Agaricales, gilled mushrooms are often referred to as agarics (Kamra & Zadrazil, 1985). Seasonal fungi like

mushrooms have a wide range of ecological roles in forests. The abundance and quality of wild mushrooms provide key information about the state of a forest (Stamets, 2000).

1.2.2 Morphology

Figure 1.3 Fruiting body of a mushroom

Fruiting body of a mushroom occur in a wide range of forms but in general the fruiting body of a gilled mushroom (Figure 1.3), consists of the following parts: (i) Cap or pileus (ii) Gills/lamellae (iii) Stipe/stem/stalk (iv) Annulus/ ring (v) Volva

i. Cap or Pileus

The enlarged region of the stipe that forms the pileus may be found at the very tip of the stipe. A homogeneous structure is one in which all of the hyphae, both on the surface of the cap and in the flesh, have a uniform size and are interconnected. The cap structure can also be built in a wide range of configurations, including convex, conical, funnel-

shaped with a depressed centre, umbonate, removable loose veil scales, radially pleated, covered with fixed scales, striation on gills seen through cap, grooved margin, concentric colour zones, tightly packed and long layer of fibrous scales, sticky and slimy cap, cap edge rolls inwards, folded, saddle-shaped, and honeycombed.

ii. Gills or lamellae

Gills, also known as lamellae, are specialised compact layers of tissue that give birth to the hymenium. This layer of tissue is referred to by its technical name, the subhymenium. They are often distinguishable and may be seen on the underneath of the pileus, beginning at the head of the stipe and radiating out towards the border. Gills of several species have a coloration that is easily distinguishable. The surface of these gills is covered with spores, and the colour of the change corresponds to the colour of the spores. Free gills hardly touch the stipe. Adnate means they are immediately linked to the stem at almost a straight angle. They are annexed if just a section of the gills is attached. De-current gills stretch down the stem, whereas sinuate gills are near the stalk in a deep notch.

Trama: There is a mycelial thread in the middle of the gills that is known as Trama; these threads may either run parallel to one other or they can be interlaced. As a consequence of this, the length of the cells might vary.

Hymenium: The hymenium is made up of the cystidia, the basidia, and the paraphyses all working together.

Sub hymenium: When one moves further from the trama, the cells begin to divide into shorter cells, which eventually form a thin layer known as the sub hymenium.

Basidia: Long club-shaped cells are produced by the sub hymenium. These cells are parallel with one another and at a right angle to the outermost layer of the gills. These club-shaped structures are referred to as basidia, and they feature anywhere from two to four spine-like projections called sterigmata. Basidiospores are carried on the sterigmata.

Basidiospores: The basidiospores may be of a variety of shapes, ranging from globose to elongated, and can be anywhere from 2 to 40 microns in length. Moreover, their margins can be rough or smooth. The spores might range from being colourless to completely black in appearance. Iodine produces an amyloid reaction with a number of the spores. The categorization of Agaricales relies on the results of this test.

Cystidia: There are quite a few cells that are sterile among the basidia. Cystidia are those structures that seem like inflated bladders and protrude beyond the basidia.

Paraphyses: The Paraphyses are visible when scanning beyond the Basidia.

iii. Stipe:

The stipe is another name for the stalk that holds up the pileus. In general terms, the stipe consists of the outer cuticle and the interior cortex. Genus and species determine the specifics of the structure, although generally the hyphae, at particularly in the cortical area, run in a perpendicular direction. It's possible for the stem to be completely solid and fleshy, or it might be hollow with a pithy material packed into the hollow centre. Its appearance and attachment to the cap help identify genera. Most caps have a central stem. In eccentric cases, the attachment is lateral rather than central. Cylindrical stipes are swelling in the centre and taper towards both ends, whereas spindle-shaped ones expand at the top and taper at the base into root-like

shapes. The marginate stipe base extends into a saucer with a well-defined margin, while the bulbous base suddenly enlarges. The cuticle is made of longitudinally organised, tightly packed smooth thin hyphae that have or lack significantly thickened walls which are described as naked stipes. Other times cuticular hyphae protrude outward.

iv. Veil/Annulus

A developing pileus's edge, which is attached to the pileus's stem or stipe, is the veil. As the basidiocarp's top section swells into the cap or pileus, the inner veil splits and frequently gets torn from the border of the pileus and remains connected to the stalk in the style of something like a ring or annulus.

A rip in the inner veil causes a section of the cortina (the thin, cobwebby curtain) to hang from the cap of some mushrooms with an unusual growth pattern. It's easily damaged or even washed away by rain because of how fragile it is.

v. Volva

An early universal veil covers the whole body of the fruit before it differentiates. The volva forms a cup-shaped body around the frequently swollen stem base as the sporophore grows and the pileus eventually develops. Alternatively, the whole veil tissue can be left behind as scars or scales on the enlarged pileus.

Mushrooms may be divided into four groups based on whether or not they have an annulus and volva:

a) *Amanita*: has both the ring and volva

b) *Agaricus*: Only the ring is present, volva is not.

c) *Pleurotus*: neither the ring nor the volva is present

d) *Volvariella*: Only volva is present, the ring is absent

1.2.3 Types of Mushroom

Mushrooms may be classified into three primary ecological categories of mycorrhizal, parasitic, or saprophytic.

i. Mycorrhizal mushrooms

Mycorrhizal fungi develop a symbiotic association with the roots of their host plants, which vary from trees to grasses."Myco" refers to mushrooms, whilst "rhizal" refers to roots. Mycelium refers to the filaments of cells that develop into the mushroom's body. Mycelia of these mushrooms are ectomycorrhizal if they cover the plant's roots with an outer sheath. Alternatively, they might infect the root cells of the host plant from the inside, which is known as endomycorrhizal. In any scenario, this relationship benefits both creatures.

The majority of ecologists now acknowledge that the health of a forest is directly proportional to the existence, quantity, and diversity of mycorrhizal connections.

Some of the mycorrhizal mushrooms are Truffles, Chanterelles, Matsutake and Boletus. The consistency of cultivating saprophytic mushrooms like *Pleurotus* (Oyster) and Shiitake much outweighs the uncertainty of mycorrhizal culture. Mycological research has to be extended over a longer time period so that the commercial sector may profit from the knowledge gained.

ii. Saprophytic Mushrooms:

Most exquisite mushrooms are saprophytic fungus that decompose wood. These saprophytic fungi are the planet's leading recyclers. Fungi are essential to all ecosystems due to their rapid decomposition of organic plant materials. There are essentially three types of decomposers. Conditions may cause certain mushroom species to transition into a different group, namely, primary, secondary and tertiary decomposers. Primary decomposers are fast-growing and quickly grasp a twig, grass blade, wood chip, log, or stump connect and breakdown plant tissue using ropey mycelium. Most of them are woodland species like oyster mushrooms and shiitake mushrooms. Secondary decomposers are those mushrooms that can only grow successfully on substrates that have already been partly decomposed by the action of other types of fungus. Typically, secondary decomposers will grow from materials that has been composted. A classic example of a secondary decomposer is the White Button mushroom (*Agaricus brunnescens*). The tertiary decomposers are those fungus that are represented by the amorphous category and are generally soil-dwelling. Due to the action of primary and secondary decomposers, they live in ecosystems that have taken years to develop. The existence of fungi on these degraded substrates is noteworthy since the environment looks unfavorable to the majority of other fungi. *Aleuria aurantia* is a typical tertiary decomposer.

iii. Parisitic mushrooms

These fungi need a host plant in order to survive, and their presence may be detrimental to the host's health. Parasitic fungus has long been known to wreak havoc on ecosystems, but it's only recently that scientists have begun to appreciate their value

to forests. Just a small percentage of mushrooms are real parasites. Many parasitic fungi are very small, microscopic organisms. One of the best know parasitic mushroom is the honey mushroom, *Armillaria mellea.*

1.2.4 Diversity

The diversity of macrofungi is a significant part of the overall biodiversity of the world, and the natural beauty of macrofungi takes precedence. They are global in nature, as well as occurring seasonally and occupying a variety of niches in the natural environment. They are vital to the forest ecology due to their mycorrhizal, saprophytic, and parasitic relationships with trees. Diversity, distribution, and density of mushroom species are functional criteria for assessing a habitat's condition, which helps forest ecosystem management.

Determining the total quantity of mushrooms on the globe has been a subject of discussion, and a great number of research have been devoted to cataloguing the wide variety of fungus found around the globe (Crous et al., 2006). Just a small percentage of the overall fungal riches has been investigated by research, and mycologists are continually working to uncover the abundance that has not been discovered or exploited.

The study of the diversity of fungi has been conducted all over the globe (Crous et al.,2006), and it is estimated that there are 1.5 million species of fungi (Hawksworth, 2004), of which only fifty percent have been described. According to Chang & Miles, 2004, there are over 27,000 different species of fungi throughout the globe, and India alone is home to roughly 850 of those species (Manoharachary et al., 2005).

Among these, over 7000 species are estimated to have varied degrees of edibility, and roughly 3000 species hailing from 31 genus are acknowledged as excellent edible mushrooms (Verma et al., 2013). According to (Chittaragi et al., 2013), there are 283 species in India that may be used as food, among which some are grown, and around 650 species include qualities that can be used for medical purposes (Rai et al., 2005).

The whole northeastern part of India is rich in forest resources, with many different kinds of trees as well as other woody plants. Diverse macro fungi tend to coexist alongside a rich variety of woody plants. For many saprophytes—mushrooms included—the extreme humidity during the monsoon season is a boon to their growth. The agro-climatic conditions of Nagaland are ideal for the cultivation of a wide variety of wild mushrooms. As part of the Indo-Burma area, it is a prime location for plant and animal life and a gateway to the rest of India. In Nagaland, edible wild mushrooms may be collected at any time of the year; however, most of the harvesting takes place during the monsoon months. The native people enjoy these mushrooms as a culinary delicacy that is both nutritious and tasty. The wild mushrooms of Nagaland have been examined by a multitude of researchers and found that the state is very wealthy in that it is home to unique species of mushrooms (Ao et al., 2016; Borah & Borgohain, 2013; Chuzho & Dkhar, 2019; Nyenthang et al., 2019; Tanti et al., 2011). The indigenous communities have an extensive understanding of which mushrooms are safe to eat and which ones are harmful. In Nagaland, local mycological knowledge is highly valued and might provide insight on mushroom studies.

Taxonomy must be accurate so that the many benefits an organism provides can be effectively utilized (Odeyemi et al., 2014).Classifying and identifying fungi based on morphology (the size, shape, and margin of the carpophore; the length, diameter, location, and texture of the stipe; the spore-bearing surface; spore prints; etc.) is crucial and has functioned in the earlier days (Lima & Borba, 2001). However, this method can be ambiguous, considering the limitations brought on by a variety of reasons, including interbreeding, obscure speciation, and hybridization, which may affect genetics without inducing expression and sometimes, the biochemical traits of certain organisms do not match the characteristics of any recognised genus or species. (Kohn, 2005; Lian et al., 2008; Olson & Stenlid, 2002). As a result, there is a fair amount of misunderstanding between different species, which continues to this day. Hence, there is a pressing need for the development of a cutting-edge technique for the authentication of numerous mushroom species. Many strategies have been attempted by researchers to date in order to identify wild mushrooms. Emerging advancements in biotechnology have enabled for the application of molecular techniques to the identification of mushrooms. Mushrooms can be isolated and characterized using molecular markers like PCR (Polymerase Chain Reaction) based random amplified polymorphic DNA (RAPD), AFLP (amplified fragment length polymorphism), SSR (simple sequence repeat), and ISSR (inter-simple sequence repeat), as well as non-PCR based techniques like isozymes and restriction fragment length polymorphism (RFLP). But nonetheless, direct sequencing of a PCR result of a DNA barcode of mushrooms is a significant tool frequently adopted by researchers for identifying and phylogeny investigations. (S. K. Das et al., 2013; Fonseca et al., 2008; Nei, 1987; Pawlik et al., 2012; Savard et al.,

1994; Schoch et al., 2012). Internal Transcribed Spaces (ITS) have been suggested as the standard barcode for fungus. Perhaps the most thoroughly sequenced DNA area in fungus is the ITS region. This area has a greater degree of diversity than other genetic sections of rDNA and is polymorphic, hence providing sequence variability that permits differentiation between distinct mushroom species or strains (Gardes & Bruns, 1993). Several fungus may be reliably identified down to the species level by sequencing the internal transcribed spacer (ITS) regions 1 and 2, which are positioned in between highly conserved small (18S) and larger (28S) ribosomal subunit genes in the rRNA operon (James et al., 2006). The nucleic acid sequences of the 18S ribosomal RNA gene have been shown to be valuable for phylogenetic study of eukaryotic organisms. These molecules are ubiquitous and have been conserved throughout evolution, making them beneficial for suggesting distant phylogenetic connections and giving a method for analysing the relationship between organisms that lack any relevant identical morphological or developmental characteristics(A. Ramesh et al., 2012). Hence, a useful method for identifying mushroom species is the integration of morphological investigations with molecular phylogenetic analyses.

1.2.5 Nutritional and Medicinal Properties

Wild mushrooms have been revered as a delicious and nourishing culinary source since ancient times. Publication of data about the nutritional qualities and therapeutic benefits of mushrooms has increased both the scientific community's and the general public's recognition of the mushrooms' nutritive potential (Manzi et al., 2001). Mushrooms are also considered as an ideal addition to low-calorie diets due to

its high fiber, mineral, vitamin, protein, and carbohydrate content and low fat level. The moisture content of mushrooms is rather high, often falling within the range of 80 to 95 g/100 g. Edible mushrooms contain a wide variety of carbohydrates, including chitin, trehalose, glycogen, mannitol, fiber, hemicelluloses, β-glucans, and pectic compounds. Sugars such as mannitol, glucose, and trehalose are found in high concentrations in edible mushrooms grown for human consumption, but sucrose and fructose are present in much less proportions (Heleno et al., 2010; Mattila et al., 2001). Mushrooms have a high protein level in comparison to plant proteins and milk, which is why they are often regarded as decent vegetarian meat (FAO, 1990). Owing to their reduced starch and sugar content, they are great for obese people. Some lipids, like linoleic acid, are needed by the human body and must be acquired from diet. There are a number of illnesses and conditions related to high blood pressure, high triglyceride levels, and inflammation that may be influenced by these signal molecules. Hence patients suffering from diabetics, hypertensives, and others may utilise them as therapeutic meals (Bano, 1976; Wu & Xu, 2015). Mushroom proteins are a hybrid between animal and vegetable proteins because they possess all nine essential amino acids needed by the human body (Kurtzman, 1976; Wani et al., 2010). In developing nations such as India, where high-quality proteins from animal sources are either unavailable or unaccepted due to religious beliefs, the usage of mushrooms may help greatly to addressing protein deficit (Dunkwal & Jood, 2009). Mushrooms are rich source of essential minerals such as calcium, copper, iron, potassium, magnesium, phosphorus, selenium and zinc (Kalac, 2009; Ribeiro et al., 2008). Mushrooms contain ergosterol rather than cholesterol, which is metabolized to vit D in the human body. It often include vitamins C, D2, and

E as well as the B vitamin complex (nicotinic acid, thiamine, pyridoxine, riboflavin, pantothenic acid, folic acid, nicotinamide, and cobalamin). (Adedayo, 2011; Mattila et al., 2001). Mushrooms also possess several bioactive chemicals, such as polyketides, ascorbicacid, glycolipids,sesquiterpenes, terpenes,tocopherols, steroid s, and carotenoids (Reis et al., 2012).

Because of their remarkable nutritional properties, nutritionists, academics, and pharmacists have been interested in examining how they might be used to improve human health and have included them as essential dietary supplements in the human diet.

Research into dietary sources of natural antioxidants has attracted attention from scientists all around the world. In the last two decades, scientists have made great strides in their study of antioxidants. The origins of oxygen toxicity remained a mystery until 1954, when Gershman proposed the free radical theory (Gerschman et al., 1954). After that, in 1956, Harman proposed a theory that suggested a connection between free radicals and the natural process of ageing (Harman, 1956). Almost all living things are safeguarded against free radical damage by oxidative enzymes like catalase (CAT) and superoxide dismutase (SOD), as well as chemical substances including a-tocopherol, glutathione, carotenoids, ascorbic acid and polyphenol compounds (Niki et al., 1994).

Physiological decline, disease, and premature ageing are all possible outcomes of the antioxidant defense system being compromised due to factors such as ageing. Functional foods rich in natural antioxidants have phytochemicals that reduce oxidative stress in the body by maintaining an appropriate ratio of antioxidants to free radicals.

By consuming these foods, oxidative stress may be effectively mitigated. Regular consumption of natural antioxidant-rich foods may lower the risk of acquiring chronic diseases (Oboh & Shodehinde, 2009). The most widely used synthetic antioxidants today are butylhydroxytoluene (BHT), butylated hydroxyanisole (BHA), propyl gallate, and tert-butylhydroxyquinone. Nevertheless, BHA and BHT cannot be used in food because of concerns that they may be carcinogenic and cause liver damage. As a consequence, there has been a surge in interest in natural antioxidants from the business world, and there has been a similar uptick in consumer preference for these compounds over their synthetic counterparts. Interest in natural antioxidant sources has also increased because of the dietary ban on synthetic antioxidants. In medicine, plant-based antioxidants are known as nutraceuticals due to their beneficial effects on health and disease prevention (Noguchi & Niki, 2000). Not only are mushrooms prized as an essential component of a healthy diet due to their high protein content and high nutritional value, but they are also esteemed for the medicinal components inside them, which have been investigated for the major pharmacological relevance they exhibit (Bobek & Galbavy, 1999; Smania et al., 1995). Phenols and flavonoids, in addition, have been linked to have antibacterial and antioxidant effects (Barros, Ferreira, et al., 2007). Phenolic compounds are the product of metabolites that have various role in health and nutraceutical potential of mushrooms (Chan et al., 2014). From mushrooms, researchers have extracted a variety of medicinal ingredients, including beta glucans and polysaccharides, that may have therapeutic effects (Wasser & Weis, 1999). The main active components in mushrooms that have therapeutic value are polysaccharides. A variety of mushrooms are believed to have cancer-fighting and immune-boosting

effects (Borchers et al.,1999). Mushrooms also have immense nutraceutical properties and the key medicinal uses are antibacterial, antihypertensive, antifungal, hypo-cholesteromic antiallergic antiviral, immunomodulating, cardiovascular protector, antiparasitic, antioxidant, antidiabetic antiproliferative antihypertensive, anti-inflammatory, anticancer, antitumor, cytotoxic, anticoagulant anti-HIV and hepato-protective effects (Ajith & Janardhanan, 2001; Chang & Miles, 2004; Chang & Wasser, 2012; H. Wang et al., 1996; Wasser & Weis, 1999; Zhang et al., 2011)

According to a number of studies, edible wild mushrooms not only constitute significant resources for food and medicine, but they also have a significant impact on the economies of both developing countries and developed nations (Boa, 2004). Over the course of the last few decades, there has been a notable rise in the intake of mushrooms owing to the accumulation of scientific data demonstrating their capacity to aid the body in the treatment and prevention of a wide range of diseases (Ferreira et al., 2009; Kalac, 2009). Since mushrooms play such a significant role in so many areas (natural cycles, bioremediation, biofertilizers, agriculture, industry, medicine, and the food sector), fungal biotechnology has now become crucial to human well-being.

1.2.6 Mushroom Cultivation

Mushrooms have been farmed and harvested from the wild for commercial purposes across the world in recent decades (Boa, 2004). Throughout time, the demand for edible fungus has increased in many countries, prompting a search for the bounty of wild mushrooms. Hence, mushroom consumption has increased 21 times in the last 56 years. (Food and Agriculture Organization Statistical, 2017).

Sixty of the most sought-after edible mushrooms are grown for profit, and 10 of them have been mass-produced in many countries. Researchers have reportedly cultivated over 200 varieties of the most desired edible mushrooms under lab conditions (Chang & Wasser, 2012).

Shiitake mushrooms account for 22% of global mushroom production, followed by button mushrooms (*Agaricus bisporus*). *Lentinula edodes* is a Basidiomycete from the Tricholomataceae family of Agaricales. It not only tastes wonderful, but it also has a high nutritional value and components that strengthen the immune system. Shiitake mushrooms (*Lentinula edodes*) are being imported from China and Thailand since there is currently no commercial Shiitake mushroom producer in India. Prices range from Rs.1,000 to Rs. 1,500 per kilogramme for fresh and Rs. 2,400 to Rs. 2,500 per kilogramme for dry. It can be grown in the winter, and with the right conditions, it can be grown all year round (Chang and Miles 2004). Shiitake mushrooms have been prized for their medicinal potential in China for thousands of years (Chen & Seviour, 2007). Chihara reported lentinan had anticancer effects (Chihara et al., 1969). Therapeutic benefits such as anticancer activity, anti-inflammatory effects, and anti-diabetes effects are attributed mostly to the β-glucan found in lentinan (Wang et al., 2016). In 1985, lentinan was recognised as an adjunctive treatment for stomach cancer in Japan. It has been validated for use against a wide range of disorders, including cancer, hepatitis, and others. The drug lentinan may be taken orally in the form of capsules or pills, or intravenously. Treatments for hepatitis, HIV, malignant pleural effusion, and cancer have all been shown to benefit from lentinan's properties as a biological response

modulator and immunostimulant (Chang et al., 2013; Gordon et al., 1998; Ina et al., 2013; J. Wang, 1994)

The mushroom business in Nagaland remains to be in its development, with just a subset of the agricultural population involved in the seasonal, small-scale cultivation of mushrooms. Despite advances in production technology, the availability of high-quality spawn, and the ease of processing and marketing, the mushroom industry has failed to gain traction. The whole northeastern area of India is rich in forest resources, including several varieties of trees and woody plants. The diversity of woody plants is proportional to the variety of macrofungi. During the monsoon season, the high humidity offers optimal environment for the development of several saprophytes, including mushrooms. Nagaland is agro-climatically very rich and supports the growth of many wild mushrooms. A variety of wild mushrooms thrive in Nagaland due to the region's favourable agroclimate. Located in the Indo-Burma area, it is a gateway for many of India's flora and wildlife since it is a biodiversity hotspot. The natives of the area are known as Nagas. The people of this area have a wealth of traditional knowledge and customs pertaining to many different kinds of plants and animals, including mushrooms. The Naga Hills are home to an abundance of mushrooms, the full potential of which has yet to be discovered. No attempts have been undertaken to grow these wild mushrooms for commercial production, despite the fact that the tribal people of Nagaland eat a wide variety of macrofungi that they collect from the wild. Although certain studies have been conducted on specific aspects of these wild edible fungus (Ao et al., 2016; Ao & Deb, 2019b; Borah & Borgohain, 2013; Chuzho & Dkhar, 2019;

Nyenthang et al., 2019), the entire advantages of these studies have not been disseminated to improve the villagers' access to forest products for food security.

In addition to confirming the existence and distribution of the wild edible species in the area, the current research establishes a baseline for the mycofloristic macrofungi of Nagaland by characterising them using molecular methods and evaluating their nutraceuticals and antioxidant characteristics and it will also play a vital role to confirm the availability and distribution of the wild edible species in the region. As a result of the training programmes that will be provided to the locals, there will be a greater understanding of edible mushrooms, how to grow and preserve them, and how to put them to use.

1.2.7 Objectives

The present study was carried out with following objectives:

i. Documentation and molecular identification of wild mushrooms of Nagaland
ii. Nutritional analysis of some wild edible mushrooms of Nagaland
iii. Antioxidant and phytochemical analysis of some wild edible mushrooms of Nagaland
iv. Optimization of culture protocol for *Lentinula edodes* (berk.) Pegler

CHAPTER - 2

REVIEW OF LITERATURE

2.1 Diversity

Wild mushrooms, being among the most significant components of biodiversity, have piqued the interest of researchers due to their diversity, high nutritional value, therapeutic characteristics, low production technology, cultivation under varied agro-climatic conditions, and a variety of other factors. The following provides an overview of the significant findings published by several researchers.

2.2 Global Mushroom Diversity

In 1707, while examining mushroom growth and mycelial structure, De Tournefort published the first report on mushroom documentation (Spencer, 1985). Piern Antonio Micheli (1727), conducted the first comprehensive study of macrofungal spores and described their organisation in a sac-like structure termed an ascus (Micheli, 1729).

Fries was the first to incorporate morphological characteristics for the classification of mushrooms (Fries, 1821). The ground breaking research that was conducted by (Ray, 1686), (Micheli, 1729), (Linnnaeus, 1753) and (Persoon, 1801) led

to the development of a separate category of fungus in general and macrofungi in particular.

According to Hawksworth et al., (1995) mushrooms and other macromycetes belong to the classes Ascomycetes and Basidiomycetes under the divisions Ascomycotina and Basidiomycotina, respectively. A record of 98,998 species of fungus belonging to 8283 genera were identified by Kirk et al., 2008 in "Ainsworth and Bisby's Dictionary of the Fungi" (10th Edition), with 27,046 being considered large fungi.

Global efforts to catalogue fungi have resulted in the discovery of 1.5 million species (Hawksworth, 2004), of which half have been described (Crous et al., 2006; Manoharachary et al., 2005). There are estimated to be 27,000 different types of fungi in the globe (Chang, 2006).

The order Agaricales contains the most thoroughly researched macrofungi, with several researchers contributing to various aspects of this group (Fries, 1874; Pegler, 1977; Semwal, 2014; Walther et al., 2005; Wasser, 2010, 2011).

Both Teng, 1963 and Tai, 1979 are considered foundational publications in Chinese mycology since they produced the most comprehensive listings of higher fungus at the time.

Yongabi et al., (2004) did a survey in Central Africa's Cameroon. During the study, it was determined that various species belonging to the genera Agaricus, *Volvariella, Ganoderma, Flammulina, Auricularia, Pleurotus, and Termitomycetes* were used by the indigenous people as food or traditional medicine.

According to the research of Mueller et al., (2007) there are a total of 2675 species of macrofungi in temperate 'Asia, of which 37 are endemic to this area; in Tropical Asia, there are a total of 400 species, of which 43 are endemic to this region. The estimated number of Macro fungus species in Europe is between 15,000 and 20,000. Awareness of the importance of macro fungus considerably differed throughout European nations.

Mueller et al., (2007) stated that there are a total of 10,000 species in North America, of which 65 are endemic. There are 5,680 species in Tropical America (which includes Central and portions of South America), of which 70 are endemic to the area; and there are 915 species in Temperate America (includes part of South America), of which 64 are endemic to the region.

Mcmullan-Fisher et al., (2009) identified 22 taxa from Mount Wellington. Many researchers from all over the globe have conducted remarkable studies on non-gilled agarics, including *Bovista, Cyathus, Geastrum, Calvatia, Podaxis*, and *Crucibulum* species from Russia, Arizona, Thailand, China, Korea, and Turkey (Baseia & Milanez, 2002; Bates et al., 2009)

Turkoglu et al., (2015) hypothesised that Turkey possesses one of the most diverse macrofungal biota in the northern hemisphere. The region's unique climate makes for an environment that might support a wide variety of truffle species.

In the Kaghan valley, Pakistan, Sultana et al., (2015) identified 31 taxa of Ascomycetous mushrooms from 15 different genera and 44 types of Gasteromycetes

from 17 different families.. Among these, two genus, namely *Morchella* and *Tuber*, were edible and had a wide range of medical qualities.

Hassine & Stephenson (2016) compiled a tentative list of the macrofungal species observed in northwestern Tunisia. 331 sporocarps were gathered in total, representing 126 species from 11 orders and 40 families. Amanitaceae (8 species), Tricholomotaceae (9 species), Cortinariaceae (9 species), Russulaceae (15 species) and Agaricaceae (16 species) were the most significant families.

2.3 Mushroom Diversity in India

The scientific and systematic study of mushrooms in India may be traced back to Linnaeus, who collected and identified *Podaxis pistillaris* L. (Pers.) in the 18th century, followed by Sir J. D. Hooker, who amassed a large collection, and then to Berkeley, whose papers published between 1850 and 1882 (Natarajan, 1995). The first comprehensive list of fungal species in India, "Fungi of India," was published by E. J. Butler and G. R. Bisby (Butler & Bisby, 1931) and revised by Sharbhoy et al., 1996. It estimated that India contains over 27,000 fungal species, making it the second-largest biotic group after insects.

According to Purkayastha & Chandra (1985), India is home to 283 wild species of edible mushrooms, some of which are cultivated. In examining the worldwide effort, including the Indian subcontinent, Atri & Saini (1988) made significant contributions to the cataloguing of several mushroom species, such as *Agaricus, Russula, Termitomyces, Lactarius, Lepiota,* etc.(Atri et al., 1995, 1997; Atri, Saini, & Gupta,

1991; Atri, Saini, & Mann, 1991; Atri & Saini, 1988; Saini et al., 1988; Saini & Atri, 1995) .

Almost a third of the world's mushroom species are said to be found in India and approximately around 850 of mushrooms have been documented in India (Deshmukh, 2004; Manoharachary et al., 2005).

As reported by Upadhyay & Kaur (2004), four light-spored agarics— *Lactarius indigo, Hygrotrama microsporum, Pluteus punctipes,* and *Tricholomopsis crocobapha*—have been characterised as a new fungal record for India. Taxonomic analyses of newly obtained specimens from the North- Western Himalayan area in the Indian state of Himachal Pradesh provide the basis of their description.

Swapna et al., (2008) surveyed the semi-evergreen and wet deciduous woods of Karnataka, India, to determine the distribution of macro fungus in the Shimoga area (2008). Taxonomically, they determined that 280 genera from 41 families and 19 orders were found in moist deciduous woods, whereas 263 genera from 14 orders, 33 families, and 263 genera were found in semi evergreen forests.

In their 2009 study, Kumar & Manimohan reported twenty-two taxa from Kerala, India, all of which belonged to the agaric genus *Lepiota*. Their findings included comprehensive description and illustrations of 8 new species and one novel variant.

According to the study cited in Das (2010),126 different species of wild mushrooms were gathered from the Sikkim state's Barsey Rhododendron Sanctuary. He catalogued their Latin names, English names, geographical range, growth season,

and edibleness. The medical characteristics of 46 different mushrooms were also highlighted.

Around 68 mushroom flora representing 19 taxa were reported by (Gurudevan et al., 2011) during their exploration of the Western Ghats area, a worldwide renowned biodiversity hotspot.

Pushpa & Purushothama (2012) conducted studies on the biodiversity of mushrooms in Bangalore that belonged to the class Basidiomycetes. There were a total of 91 species discovered across 48 genera, 19 families, and 5 orders that were reported. Among these 91 species, there were 28 that were identified to be recorded in India for the very first time.

Amandeep et al., (2015) examined the taxonomy of nine mushroom species gathered from distinct dung sites in Punjab, India. All the species were from the family Agaricaceae of the order Agaricales, with *C. cordisporus, Coprinus comatus* var. c*aprimammillatus,* and *Agaricus halophilus*, being the first records from India. Whereas, *Leucocoprinus thrombophora, Leucocoprinus straminellus, Lepiota epicharis* var. *occidentalis, Leucocoprinus subincarnata, Leucocoprinus xanthophylla,* and *Agaricus cupreobrunneus* were newly recorded for North India.

Pavithra et al., (2017) studied Mangalore University's arboretum and botanical garden and reported that it is home to 11 different species of macrofungi. Common species found in the arboretum include *Tetrapyrgos nigripes* and *Collybia aurea*, and the botanical garden with *Clathrus delicatus, Entoloma serrulatum*, and *T. nigripes*. Critically endangered endemic tree species *Vateria indica* is home to a diverse fungal

community that includes five edible species (*Collybia aurea*, *Lepista* sp., *Russula adusta*, *R. atropurpurea*, and *Termitomyces microcarpus*) and one medicinal species (*T. microcarpus*)

Adarsh et al., (2019) examined polypore diversity and distribution in wet evergreen and shola forests of Silent Valley National Park, Kerala. The national park included 57 polypore species in 29 genera from seven families. With 30 species, Polyporaceae was the most abundant family, followed by Hymenochaetaceae with 16 and Meripilaceae and Fomitopsidaceae with three each. Meruliaceae had one species, whereas Ganodermataceae and Schizoporaceae had two each. New records for the southern Western Ghats were discovered during the investigation for three species (*Trametes menziesii*, *Phylloporia pectinata* and *Trametes ochracea*).

Debnath et al., (2020) enumerated 217 species of mushrooms found in the wild in eight districts of Tripura, India. In this ecological research, they categorised a total of 76 genera, representing 60 families, and 25 orders. The family Polyporaceae (30 nos) and the order Agaricales (103 specimens) were the most abundant among the macrofungi. The wild macrofungi were gathered from 56 locations throughout eight districts in this state, with the highest diversity found in the Sepahijala District.

Ullah et al., (2022) collected and identified 131 species of mushrooms in Azad, Jammu and Kashmir, with 97 of them being reported as new to the state. With 23 species, Russulaceae was the most frequent mushroom family, followed by the Agaricaceae with 16 varieties, *Amanita fulva*, *Coprinus comatus*, *Lycoperdon*

pyriforme, Lactarius sanguifluus, Armillaria gallica, Lycoperdon perlatum, and *Russula creminicolor* were among the most common mushroom types found.

2.4 Mushroom Diversity in Nagaland

Tanti et al., (2011) detailed the indigenous tribes' knowledge of the wild edible fungi in the Kohima area of Nagaland, India. Thirteen species of fleshy fungus belonging to nine genera and six families were discovered.

Kumar et al., (2013) gathered 15 varieties of wild edible mushrooms from 12 distinct districts of Nagaland. Four of these species belong to the Agaricaceae family, two to the Tricholomataceae family, and the remaining species to the Auriculariaceae, Boletaceae, Pleurotaceae, Cantharellaceae, Russulaceae, Schizophyllaceae, Sarcoscyphaceae, Polyporaceae, and Lycophyllaceae families.

Kumar et al., (2014) reported Six species of *Russula* (Russulales) from the woods of Puliebadzie, Jakhama, Pherima, Mankoi, Chungtia, and Tizit in India's Nagaland state. These six species, *R. alnetorum* Romagnesi, *Russula aeruginea* Lindblad; -Fr., *R. brevipes* Peck, Romagnesi, *R. nobilis* Velen., *R. fragrantissima* and *R. ochroleuca* (Pers.) Fr. Gray, were newly recorded for the Indian state of Nagaland.

Ao et al., (2016) examined the variety of macrofungi in several Nagaland districts. 87 kinds of wild mushrooms have been gathered and identified. In their local habitat, they were parasitic, saprophytic, and ecto-mycorrhizal. 37 species of the gathered mushrooms were recognised as edible, 21 as medicinal, 5 as poisonous, and 37 as inedible/unclassified.

Chuzho & Dhkar (2017) documented wood-rotting fungus from two forest stands in Kohima, Nagaland, India: a damaged forest stand (Lower Kitsubozou) and an intact forest stand (Mount Puliebadze). Based on the macro and micro features of the fruiting bodies, a record of 32 species belonging to eighteen groups were identified. They reported 3 species in the phylum Ascomycota, however there were 29 species in the phylum Basidiomycota. The majority, 68.96%, of the wood-rotting fungal samples came from logs, while 17.24% came from tree stumps, 15.51% came from twigs, and 12.06% came from living trees.

Chuzho & Dhkar (2018) investigated the richness and distribution of wood-rotting fungus on Mount Puliebadze, Nagaland, to determine the impact of environmental conditions and host characteristics. Forty-six species of wood-rotting fungus from 16 families were found.

Ao & Deb (2019a) documented a total of 141 species of mushrooms. These mushrooms belonged to a total of 80 different genera and 44 different families. Of these 141 mushroom species, 52 were known to be edible, 10 were known to be poisonous, and the remaining 79 were not edible.

According to Chuzho & Dkhar (2019) a total of 26 ascomycetous wood-rotting fungi were found in eight distinct forest areas throughout Nagaland, all of which were located at various elevations ranging from 221 to 2315 metres above sea level. Among them, the *Jackrogersella minutella* species, which belongs to the family Hypoxylaceae, is being described for the very first time from India.

Nyenthang et al., (2019) reported a new record for Nagaland of the red-listed, endemic, and critically endangered species *Fistulina hepatica* (Schaeff.) With., which is part of the family Fistulinaceae, order Agaricales, and class Agaricomycetes.

Chuzho & Dhkar (2020) reported *Porodisculus orientalis* and *Pholiota polychroa* for the first time from India from Kohima, Nagaland and was added to the woodrotting fungi collection of India. The report included detailed ecological, taxonomy, and morphological details of the two species.

In the study that Roy et al., (2022) carried out, a literature-based checklist of macrofungi that were found in the North East area of India was compiled. According to the comprehensive assessment, currently, there are a total of 237 different types of wild mushrooms in Nagaland.

2.5 Classical Taxonomy and Molecular Strategies in Studying Mushroom Diversity

From the beginning of mushroom study, the many overlapping features that characterise different mushroom species have made classification difficult. Morphological and microscopic description, followed by molecular taxonomy, are heavily dependent upon for species identification and delimitation.

While Singer (1986) acknowledged that the traditional circumscriptions of the Tricholomataceae and Lyophyllaceae were problematic, further research by Moncalvo et al. (2000, 2002) and Hofstetter et al., (2002) has revealed that these definitions are in fact too narrow.

Taxonomy and phylogenetic relationships among several species of *Leucoagaricus, Lepiota*, and *Leucocoprinus* have been resolved by the studies of Johnson & Vilgalys (1998) and Vellinga (2004).

Based on phylogenetic analyses, Wei et al., (2004) redefined the taxonomic position of Sinotermitomyces and combined the genus with the members of recognised Termitomyces species.

Yang et al., (2009) recovered white rot fungus, strain SQ01 from decomposing wood in a temperate forest. This fungus was determined to be a member of the genus *Trametes* based on the full sequencing of its 18S rRNA gene and its ITS region.

Van de Putte et al., (2010) investigated the coherence between morphological and phylogenetic species conceptions within *Lentinus volemus* sensu lato in northern Thailand by combining a comprehensive morphological examination with a multiple gene genealogy based on LSU, ITS, and rpb2 nuclear sequences. In this article, the authors describe six of these morphologically distinct monophyletic clades as new species:, *L. pinguis, L. crocatus, L. acicularis, L. distantifolius, L. longipilus* and *L. vitellinus.*

Li et al., (2011) on the basis of genetic and morphological findings, suggested the new Boletales genus *Zangia*, which has phenotypic similarities with *Tylopilus*. Maximum Parsimony, Maximum Likelihood, and Bayesian studies provided strong evidence for the monophyly of *Zangia* utilising two nuclear and three mitochondrial genes.

Schoch et al., (2012) identified fungus using six DNA markers as barcodes: cytochrome c oxidase, big and small subunits of RNA polymerase II, minichromosome maintainance protein-coding genes, ITS and LSU. Since they may restrict inter and intraspecific variation, only ITS and LSU were evaluated. ITS was preferable throughout most taxonomic groupings whereas LSU was better in others. Other four markers were less popular among mushroom taxonomists due to the technical difficulties of wet lab PCR amplification and sequencing.

For mushroom identification, Das et al., (2013) used ITS1 (Internal Transcribed Spacers 1) and ITS2 primers to amplify a rDNA-ITS (Ribosomal DNA Internal Transcribed Spacers) fragment from the genomic DNA of 8 wild edible mushrooms collected from the Eastern Chota Nagpur Plateau of West Bengal, India. Also, a phylogenetic tree depicting the relationships between the mushrooms was built using the Neighbor-Joining approach.

Parveen et al., (2017) on the basis of morphological and genetic features, provided a comprehensive and methodical analysis of the diversity and distribution of wild mushrooms in Assam,India. The collection includes 44 samples from diverse areas in Assam. In all, 16 different families of macrofungi were found among the 44 samples analysed by using rDNA -ITS- ((Internal transcribed spacer) sequences for molecular characterisation. Among the 44 samples, 23 were found to be edible, while the other 21 included 5 strains with medical qualities, 6 strains with hazardous effects, 2 with industrial applications, and the remainder had not been thoroughly investigated.

Adeniyi et al., (2018) used polymerase chain reaction (PCR) amplification of internal transcribed spacers (ITS) 1 and 4 from 19 different mushroom isolates obtained from the Environmental Pollution Research and Technology farm in Ilesa, Southwest Nigeria. Around 850 bp were obtained from the ITS1 and 4 mushroom isolates after they were amplified by PCR.

Alrubayae et al., (2022) collected mushrooms of different sorts from different areas of Basrah province and identified them using morphological and molecular data obtained from ITS1-ITS4 primers. Eight taxa were discovered in this study: wild *Agaricus bisporus, A. bitorquis, Coprinopsis picaceus, Panaeolus campanulatus, P. papilionaceus, Psathyrella candolleanl*, *Psathyrella* sp.1 and *Psathyrella* sp.2. Five novel strains of *A. bisporus* (two strains), *P. papilionaceus* (two strains), and *P. candolleana* were reported in the gene bank based on sequencing data.

Ao et al., (2020) Used molecular markers (ITS, 18S, and 28S rRNA genes), to characterise and study phylogenetic analyses of six popular wild edible mushroom (WEM) species of Nagaland, India: *Lentinula edodes, Lentinus squarrosulus, L. sajor-caju, L. tigrinus, Schizophyllum commune, Termitomyces heimii*, and one variety of *Lentinus squarrosulus.*

2.6 Nutritional and Neutraceutical Attributes Of Mushroom

Diez and Alvarez (2001) analysed nutritional value and chemical content of *Tricholoma portentosum* and *Tricholoma terreum*, two kinds of wild edible mushrooms found in the northwest of Spain. Both species had a high fiber content (around 45 percent of dry mass), protein content that was quite close to 16% of dry weight. In both

species, oleic and linoleic acids made up more than 75% of total fatty acids, despite the low fat content (around 6.6% for *T. terreum* and 5.7% for T. *portentosum*).

Barros et al., (2007) tested the antioxidant activity of *Sarcodon imbricatus, Eucopaxillus giganteus,* and *Agaricus arvensis* from Portugal. Methanolic extracts were evaluated for the reducing power, 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging capability, and prevention of erythrocytes hemolysis and using the β-carotene linoleate model system for antioxidant activity. Very low levels of ascorbic acid, β -carotene, and lycopene were discovered in mushroom extracts. *L. giganteus* contained the largest concentration of phenols and was the most potent antioxidant, with the lowest EC50 values across all experiments.

Wong & Chye (2009) analyzed wild edible mushrooms from the interior of East Malaysia for total phenolics, antioxidant capabilities, free radical scavenging, reducing power, and metal chelating. In vitro antioxidant activity of edible wild mushroom petroleum ether (PE) and methanolic extracts was equivalent to the produced oyster mushroom. PE extract of *Pleurotus porrigens* had the greatest radical scavenging activity (85%), whereas methanolic extract of *Hygrocybe conica* had the best chelating impact (94%) at 20 mg/ml. PE extracts scavenged DPPH radicals better than methanolic extracts, while methanolic extracts had lower EC50 values for decreasing power and chelating ferrous ions.

Liu et al., (2012) examined Southwest China's five wild edible mushrooms (*Stropharia rugoso-annulata, Catathelasma ventricosum, Craterellus cornucopioides, Clitocybe maxima,* and *Laccaria amethystea*) for chemical properties and

antihyperglycemic and antioxidant potential. These mushrooms' ethanolic and aqueous extracts were antioxidant and antihyperglycemic. In particular, the aqueous extract of *C. ventricosum* showed the highest a-glucosidase inhibitory activity (EC50-2.74 lg/mL), DPPH radical scavenging activity (EC50-2.86 mg/mL), and reducing power (EC50-0.96 mg/mL), while L. amethystea showed the highest a-amylase inhibitory activity (EC50-4.37 lg/mL) and metal chelating activity (EC50-2.13 mg/mL).

Hussein et al., (2015) studied *Polyporus tenuiculus, Lentinus sajor-caju* W (Wild), *Lentinus squarrosulus, Macrolepiota procera, Panus conchatus*, and *Auricularia auricular-judae* from a diverse selection of native Tanzanian forests to determine their antioxidant activity, total phenolic content (TPC), and total flavonoid content (TFC). The *Auricularia judae* methanolic extract had the highest radical scavenging activity (93.33%), while the *Panus conchatus* extract had the lowest (46.53%), based on their comparison.

Heleno et al., (2015), examined Polish edible mushrooms *Boletus edulis, Lentinus edodes*, and *Xerocomus badius* for chemical components and antioxidant properties. Proteins and ash followed carbohydrates in macronutrient abundance. Fructose, mannitol, and trehalose predominated, whereas glucose was detected only in *B. edulis*. Polyunsaturated fatty acids outnumbered mono and saturated. Three samples had high palmitic, oleic, and linoleic acids. All samples measured α- and β-tocopherols, but only *X. badius* detected -tocopherol. Oxalic and fumaric acids were detected in all three samples, however only *L. edodes* had quinic acid, and only *X. badius* had malic and citric acids. All species quantified p-hydroxybenzoic, protocatechuic, and cinnamic

acids, but only *B. edulis* quantified p-coumaric. This species and *X. badius* have the best antioxidant characteristics, with B. edulis being better at radical scavenging and reducing power and *X. badius* at lipid peroxidation inhibition due to their high phenolic component and tocopherol content.

Puttaraju et al., (2006) analysed fruiting bodies of 23 wild mushroom species from various regions of Himachal Pradesh and Kerala, India for their antioxidant activity in water and methanolic extracts

Kavishree et al., (2008) analyzed twenty-three species of naturally grown and collected mushroom fruiting bodies from different geographic locations of India for their total fat and fatty acid contents and mushroom species were found to contain 0.6-4.7% total fat. These mushroom varieties also have a high percentage of unsaturated fatty acids, ranging from 52% to 87%.

Ramesh & Pattar (2010) studied the bioactive chemicals and antioxidant activity in six species of wild mushrooms (*Lycoperdon perlatum, C. cibarius, Clavaria vermiculris, Ramaria formosa, Marasmius oreades, and P. pulmonarius*) from the Western Ghats of Karnataka, India. The antioxidant potential of all the mushrooms was greatly enhanced by their high phenolic and flavonoids.

Loganathan et al., (2010) using the reducing power, β -carotene bleaching, ABTS and DPPH radicals scavenging activity techniques, assessed the antioxidant and phytochemical activities of ethanolic extracts from the wild edible fungus *Termitomyces reticulatus* and their respective segments (Cap and Stipe).

Pushpa & Purushothama (2012) reported the protein content of *C. indica, Russula delica, A. bisporus, P. florida,* and *Lyophyllum decastes,* respectively, to be 21.60, 26.25, 41.06, 27.83, and 18.31%. *C. indica, R. delica, A. bisporus, P. florida,* and *L. decastes,* respectively, had 49.20%, 34.888%, 28.38%, 32.08%, and 34.36% carbohydrates. *C. indica, R. delica, A. bisporus, P. florida, ,* and *L. decastes* had fat percentages of 4.96, 5.38, 2.12, 1.54, and 2.14%, respectively.

Babu & Rao (2013) evaluated the antioxidant properties of methanolic extracts of the cap and stipe of commercially available mushrooms *Hypsizygus ulmarius*, *A. bisporus,* and *C. indica*. These properties included superoxide scavenging, reducing power, ferric reducing antioxidant power (FRAP), free radical scavenging, and peroxide scavenging, as well as metal chelating activities.

Singdevsachan et al., (2013) They reported the nutritional properties of *Lentinus sajor-caju* and *Lentinus torulosus* from the Similipal Biosphere Reserve in Odisha, India. They discovered that *L. sajor-caju* had the greatest protein content (28.36%), while *Lentinus torulosus* had the lowest (27.31%).

Khatun et al., (2015) They examined the nutritive value and antioxidant characteristics of three oyster mushrooms (*Pleurotus* spp.). *Pleurotus florida* (22–25%dw) has the most protein, next was *Pleurotus citrinopileatus* with 20–22%dw and then *Pleurotus pulmonarius* with 15–18%dw. They were protein-rich and low in cholesterol (0.6–0.8%dw). Three species had enzymatic and non-enzymatic antioxidant activities. *P.florida* had more reducing power, Fe2+ chelating activity, and total phenol than *P.pulmonarius* and *P.citrinopileatus. P.pulmonarius* exhibited the greatest

catalase activity and *P.florida* the best peroxidise and superoxide dismutase activity. *P.florida* was more antioxidant than *P.citrinopileatus* and *P.pulmonarius.*

Mridu & Atri (2017) gathered samples of three different species of wild edible mushrooms from Haryana (India), namely *Calocybe gambosa* (Fr.) Donk (PUN 3538), *Podaxis pistillaris* (L.) Fr.(PUN 7151) and *Lentinus squarrosulus* Mont. (PUN 3539), and found that *L. squarrosulus* had the highest concentration of composition and bioactive compounds.

Longvah & Deosthale (1998) examined Northeast Indian mushrooms *Schizophyllum commune* and *Lentinus edodes* for nutritional content. Both mushrooms have high protein (16%) and low fat (2%) content. Both mushrooms included 72-77% fat from oleic and linoleic acids. *S. commune* has 34% essential amino acids, *L. edodes* 39%. *L. edodes* had greater true protein digestibility than *S. commune*.

Kumar et al., (2013) collected 15 wild edible mushroom species' young and older carpophores from 12 different areas of Nagaland. In this research, mushroom moisture ranged from 52.11-95.13%. Some species have less moisture than *Agaricus*, *Pleurotus* and *Lepiota*. Except for *S. commune,* the dry matter content varied from 2.1-4.2%. Crude fibers ranged from 0.14% for *A. arvensis* to 12.9% for *H. tessulatus*. *S. commune* has 22.50% protein and *L. hygrophoroides* 44.93%. carbs were 32.43–52.07%.

Kumar et al., (2014) described six new unexplored *Russula* species from Nagaland, India, and included information on the nutritional content of the region.

Protein levels ranged from 28.12g to 42.86g, and carbohydrate levels from 49.33g to 55.5%.

Kumar et al., (2015) discovered *Pleurotus pulmonarius,* an edible basidiomycete in its native habitat for the first time in the Indian state of Nagaland, and its protein, carbohydrate, and fiber levels were analysed and found to be 37.63%, 43.40%, 1.93%, and 4.12%, respectively.

Ao & Deb (2019b) examined 10 well-liked WEM species for nutritional information such as total phenolics, flavonoids, and antioxidant activity. The range of total protein content was wide, from 18.77 g/100 g (*Lentinus squarrosulus* var. *squarrosulus*) to 62.27 g/100 g *(Lentinus sajor-caju*); the range of total carbohydrate content was wide, from 5.31 g/100 g (*Schizophyllum* commune) to 38.44 g/100 g (*Lentinula edodes*). As for the ash content, it varied from 3.12% (*A. auricula-judae*) to 10.66% (*L. squarrosulus*) to and 1.71% (*A. squarrosulus*) (*L. squarrosulus* var. *squarrosulus*) to 11.1% (A. auricula-judae). *Although L. squarrosulus* had the greatest phenolic content (18.7 g/100 g), *L. sulphureus* had the highest flavonoid content (9.3 g/100 g). While antioxidant activity against the DPPH free radical was seen in all 10 mushroom species, the maximum activity was found in *L. tigrinus* (47.5 lg/ml, IC50).

2.7 Shiitake Mushroom Cultivation

Mushrooms are great at breaking down lignocellulosic wastes from the agricultural sector Because of their powerful enzymes. Exhausted lignocellulosic wastes, with their lower C:N ratio, provide for great green manure to crops in addition to being used in the manufacturing of value-added food and/or medicine. Edible

mushrooms' nutrient profiles change depending on a wide variety of variables, including strain variation, growth medium composition, culture technique, and harvesting maturity (Benjamin, 1995). The cultivation of wild edible mushrooms is increasing its significance in tropical and subtropical regions of the world due to its effortless way of cultivation by using diverse agricultural wastes with high biological efficiency (K. L. Singh et al., 1990).

(Pire et al., 2001) tested eight locally accessible woods: "nire" (N. antarctica), "coihue" (*Nothofagus dombeyi*), pine (*Pinus ellioti*), "lenga" (*N. pumilio*), "roble pellín" (*N. obliqua*), "Paraná pine" (*Araucaria angustifolia*), *Eucalyptus camaldulensis* and willow (*Salix babylonica*). Two shiitake strains were investigated using 1 kg blocks of sawdust (80%), wheat bran (10%), millet seed (10%), chalk (1%), and 74% moisture. After a month at 25 C, blocks were cold-shocked at 5 degree celcius for 7-ten days to encourage fruiting. Following induction, the block was put in a room with 18 ± 3^{0}C, 9 h/day illumination, and daily watering. Most wood types produced fruit bodies except pine and "Parana pine". (60.4%)"Roble pellín", (52.3%)"lenga" and eucalyptus (26.5%) exhibited better biological efficiencies (BE) with BAFC-2250. BAFC-2250 yielded the most mushrooms.

(Ashrafuzzaman et al., 2009) cultivated Shiitake mushroom on several sawdust of *Acacia nilotica* L., *Michelia champaca* L., *Dipterocarpus alatus* Roxb., *Leucaena glauca* (Linn) Benth., *Artocarpus heterophyllus* Lam, *Mangifera indica* L., *Albizia saman* (Jacq.) F Müll, *Tectona grandis* L, *Bombax ceiba* L, *Dalbergia sissoo* Roxb and sawdust mixtures from all these trees with equal ratio/ rice straw to study the

development and productivity. Mycelial development was dramatically accelerated when *Artocarpus heterophyllus* was used as a substrate during cultivation. Culture on Jackfruit was highly recommended for shiitake mushroom cultivation in the tropics due to its high levels of biological efficiency and yield, as well as its economic output and dry yield at both the first and final harvests.

Alemu (2015) set out to evaluate the viability of growing *Lentinus edodes* for food on cheap and plentiful solid wastes (Coffee husk). The results showed that a high percentage of fruit pulp was collected. They reasoned that because this solid residue may be processed into foods containing medicinal agents, *Lentinus edodes* must be one of the finest mushrooms for this purpose.

(Nitta et al., 2016) examined the effects of kunugi (*Quercus acutissima*) sawdust medium mixed with sugi (*Cryptomeria japonica*) gaseous phase rate on shiitake fruiting body yields. Compared to commercial hardwood-sawdust-mixture (HSM) medium with 64% water content, kunugi media yielded considerably fewer fruiting bodies. Kunugi media has a lower gaseous stage rate than HSM media, according to three-phase-structure study. Kunugi media's fruiting body yield rose when the water content was decreased to 56% to boost the gaseous stage rate to that of HSM media. These findings revealed that kunugi sawdust might be utilised for shiitake culture if the gaseous phase rate was adjusted. Mixing up to 30% sugi sawdust with kunugi media increased the gaseous phase rate and fruiting body yield to the same level as HSM media.

Ranjbar & Olfati (2017) improved mushroom growing technique in Iran by utilising locally accessible lignocellulosic substrate and supplements. Such as maple sawdust, oak sawdust, wheat straw, fir sawdust, and wheat bran, rice bran, maize powder, and no extra material (control). Oak yielded 92.35% biological efficiency. When rice bran was supplemented, fruiting body weight was 33.51 g. Compared to wheat straw or fir sawdust or, oak sawdust decreased spawn running time by 29.82%. Wheat straw and oak sawdust had the most and fewest fruiting bodies. Rice bran yielded the same as the control. Wheat bran was the greatest supplement and oak sawdust was the best substrate.

Kobayashi et al., (2020) isolated and molecularly identified specific species of fungi from logs in use for shiitake culture in three different management circumstances (two artificial laid yards and a forest floor) and analysed their relationship to shiitake yield. Mycelial colonization of logs is a helpful indication of mushroom production, as seen by the frequency with which shiitake mycelia are isolated explaining the yield. White-rot fungi in particular were shown to be linked to mushroom productivity, and their presence helped explain why there were fluctuations in shiitake production.

Yu et al., (2022) assessed the viability of utilising corncob as a medium for *Lentinula edodes* development, with the ultimate goal of developing a cost-effective and environmentally responsible method for repurposing organic waste into delicious and nutritious mushrooms. Corncob had a significant yield-enhancing impact in formulas including 18-58% corncob compared to the sawdust comparison group. In terms of mycelia growth rate, log browning, yield (722.08 g/log), and biological

efficiency (80.23%), the mixture of 28% oak sawdust, 50% corncob, 20% wheat bran, and 2% gypsum performed the best. This substrate has a carbon to nitrogen ratio of 67.21 as measured. Body size (measured in pili) of fruits was not significantly impacted by the new formulations. The nutritional profile of mushrooms changed after being fed corncob. When the substrate is composed of 40% corncob, the fruit bodies have the maximum polysaccharide content (4.51 g/100 g). Based on these findings, corncob has great promise as a substrate component for *L. edodes* production.

CHAPTER - 3

MATERIALS AND METHODS

3.1 Study Site

Nagaland, a landlocked Indian sutate, is rich in both cultural and ecological diversity. It is located between the coordinates 25°13'35"N and 27°0'50"N, and 93°25'9"E and 94°58'41"E (as shown in Figure 3.1), and has a total area of 16.579 square kilometres, of which 8,623 square kilometres (or 52.01 percent) are reported forest areas (Forest Survey of India, 2021). Its northern, western, and southern borders are shared with Assam and Manipur, while its southern and eastern boundaries are shared with the South West Part of Myanmar. Because of its remote position and varied physiographic terrain, Nagaland is home to a wide range of forest types.

According to Champion and Seth's classification of forests, the following types may be found in Nagaland: The broadleaf wet hill and pine forest of the northern subtropics; the wet temperate and Alpine forest of the northern mountains; and the wet and semi-evergreen forest of the northern tropics (Department of Environment, Forest & Climate Change, Government of Nagaland, 2019). The monsoon season dominates the year, and the humidity is rather high. The bulk of the year's precipitation, typically between 1,800 and 2,500 millimetres (70 and 100 inches), falls between May and September. Temperatures average below 40 degrees Celsius (70 to 104 degrees

Fahrenheit) in the winter (39^0F). Because of its location in the Indo-Burma biodiversity hotspot, its agro-climatically rich forest richness, which includes many species of trees and woody plants, has been significantly influenced and set the scene for this. It has been shown that a high variety of woody plants is highly connected with a rich fungus community. The abundant mycoflora in the state benefits greatly from the aforementioned conditions.

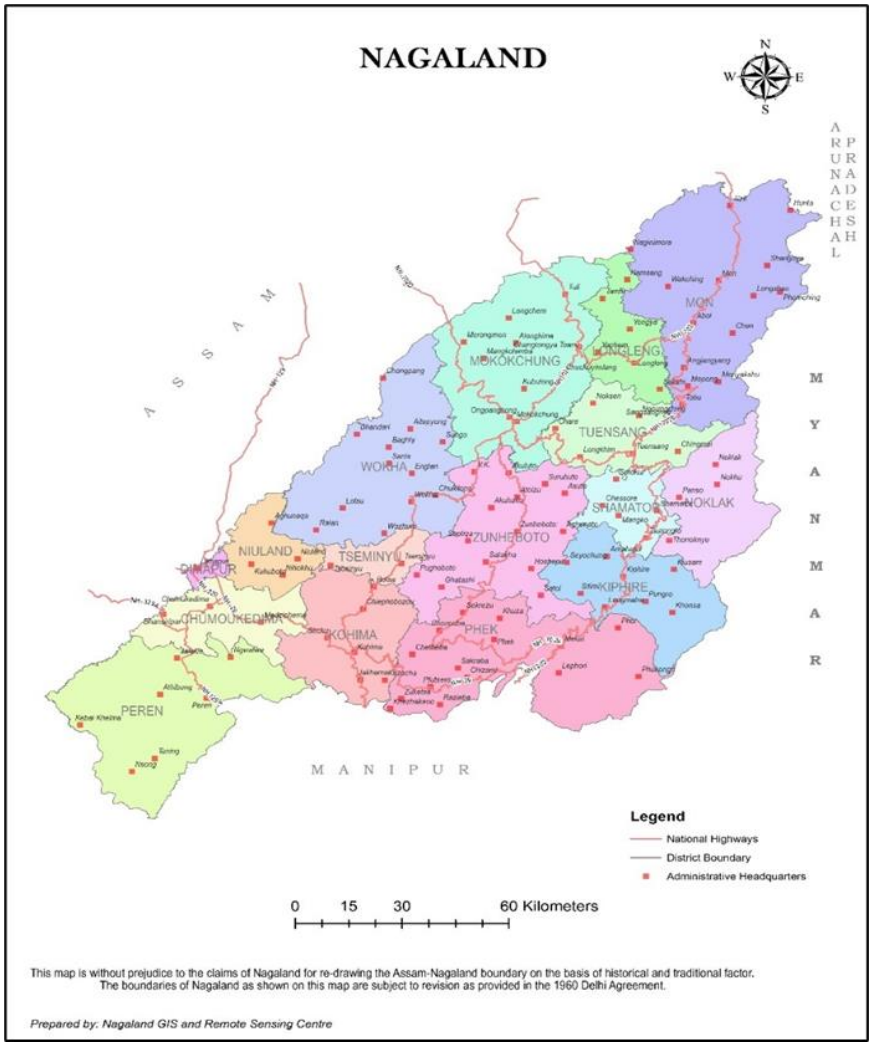


Figure 3.1 Study site map of Nagaland

3.2 Sample collection

A thorough, rigorous, and periodic survey of the woods of Nagaland was conducted over the course of five years, from 2017 to 2022, with key informants accompanying forest and grassland surveys at different times of the year throughout the state. The mushrooms were captured in the wild to serve as a visual illustration with camera-Nikon D5300. GPS (Garmin e-trex 20x) was used for tagging location. An assortment of instruments, including a hunting knife, scissors, digging implements, and zippered polythene packets for storage, were utilised in the harvesting of mushrooms. Specimens were adequately recorded for their morphological and ecological characteristics throughout the survey.

Fresh specimens of the fungus were characterised and identified using conventional mycological techniques based on their macroscopic characteristics such as dimensions of the pileus (typically its diameter and height, or its form if it is conic, campanulate, or parabolic), stipe (its length, its widest point, its globular base, if any), lamellae (their width), the pileal context (its thickness), and the volva (its height). Furthermore, the spore prints' colour and pattern were recorded. Notes were made about the associated hosts and habitats. After collection, samples are packed in sterile poly bags and stored in the laboratory at a constant temperature of 40 degrees Celsius.

Wet preservation of the sample was done using the liquid preservative formalin (5ml formaldehyde, 25ml rectified alcohol, and 70ml distilled water) for future research and taxonomic identity (Hawksworth et al., 1995). Specimens were dried in the sun or a mushroom drier at 40-50 degrees Celsius immediately after collection. The freshly

gathered samples were sun dried by putting them on white paper or a small dish in direct sunshine. Drying time in the mushroom drier ranged from thirty minutes to twelve hours, depending on the specimen's texture. Zip lock bags containing silica gel were used to store the items together with the collection number and date once they had dried. Each sealable bags holding the fruiting bodies was treated 1, 4-dichlorobenzene crystals to avoid contamination prevent insect infestation. Representative voucher specimens were deposited at the herbarium of Department of Botany, Nagaland University.

After being collected, these wild mushrooms have been compared to keys, official literatures and books to determine their morphological identities (Boa, 2004; Largent & Stuntz, 1977; Phillips, 2006; Singer, 1986). Relevant digital websites were also accessed to aid in the identification process and compile relevant data (www.mycokey.com , www.mushroomexpert.com). For more authentic identification, several eminent mushroom experts were also consulted. For current nomenclature requirements, CABI's Index Fungorum and Mycobank databases have been monitored for taxonomic aspects. Latest taxonomic names have been drafted in accordance with the ICNafp (Shenzen Code, 2017) International Code of Nomenclature for Algae, Fungi, and Plants. Fruiting bodies that have been dried out are preserved in the herbarium that is maintained in the Botany department of Nagaland University.

3.3 Molecular characterization

3.3.1 DNA extraction and agarose gel electrophoresis

Oven-dried samples at ± 40 °C were used for isolation of genomic DNA using standard CTAB protocol (Wani et al., 2010). Its quality was evaluated on 1.0 % agarose gel, a single band of high-molecular weight DNA has been observed. For amplifcation of ITS region, universal ITS primers (ITS1-F and ITS4-R) were used.

3.3.2 PCR analysis

A single discrete PCR amplicon band of 550-600 bp was observed when resolved on agarose gel. The PCR amplicon was purified to remove contaminants. Forward and reverse DNA sequencing reaction of PCR amplicon was carried out with ITS1-F and ITS4-R primers using BDT v3.1 Cycle sequencing kit on ABI 3730xl Genetic Analyzer by Future biotech.

3.3.3 PCR Amplification conditions

DNA: 1 µl, ITS1 Forward Primer: 400ng, ITS4 Reverse Primer:400ng,dNTPs (2.5mM each): 4 µl,10X Taq DNA polymerase Assay Buffer:10 µl, Taq DNA Polymerase Enzyme (3U/ µl): 1 µl, Water: X µl, Total reaction volume: 100 µl

3.3.4 Forward and reverse primer sequence which was used for amplification of ITS rDNA sequence:

Prokaryotes: ITS rDNA Universal primer (The PCR product size ~550 bp)

ITS1 Forward Primer: 5’ – TCCGTAGGTGAACCTGCGG – 3’

ITS4 Reverse Primer: 5’ – TCCTCCGCTTATTGATATGC – 3’

3.3.5 PCR Cycle Condition

The thermal cycling conditions was set to 95 °C for 5 min, 35 cycles each at 94 °C for 30 s, annealing at 50 °C

3.3.6 ITS nucleotide sequences submitted to NCBI (GenBank)

Search for homologous nucleic acid sequences was performed using the BLAST algorithm (http://www.ncbi.nlm.nih.gov). In order to get Accession numbers, several different nucleotide (ITS) sequences were submitted to NCBI GenBank mentioned in Table 3.1.

Table 3.1GenBank accession numbers of some wild mushrooms

Sl.no	Name of species	VOUCHER NUMBER	Gen bank accession number
1	*Lentinus badius*	NU-BOT-GN-LB-001	MZ389889
2	*Lentinula edodes*	NU-BOT-GN-LE-002	OM717957
3	*Phaeotremella* sp.	NU-BOT-GN-LE-003	OM884055
4	*Suillus luteus*	NU-BOT-GN-SL-004	OM714489
5	*Daldinia vernicosa*	NU-BOT-GN-DV-005	OM744414
6	*Lyophyllum fumosum*	NU-BOT-GN-LF-006	OM760490
7	*Pleurotus giganteus*	NU-BOT-GN-PG-007	OM717958
8	*Pleurotus tuber-regium*	NU-BOT-GN-PT-008	OM721745
9	*Ramaria thindii*	NU-BOT-GN-RT-009	OM760492
10	*Russula griseocarnosa*	NU-BOT-GN-RG-010	OM760493
11	*Boletus reticulatus*	NU-BOT-GN-BR-011	OM728307

Figure 3.2 (A-E): Collection of mushrooms in different sites during field survey along with field guides

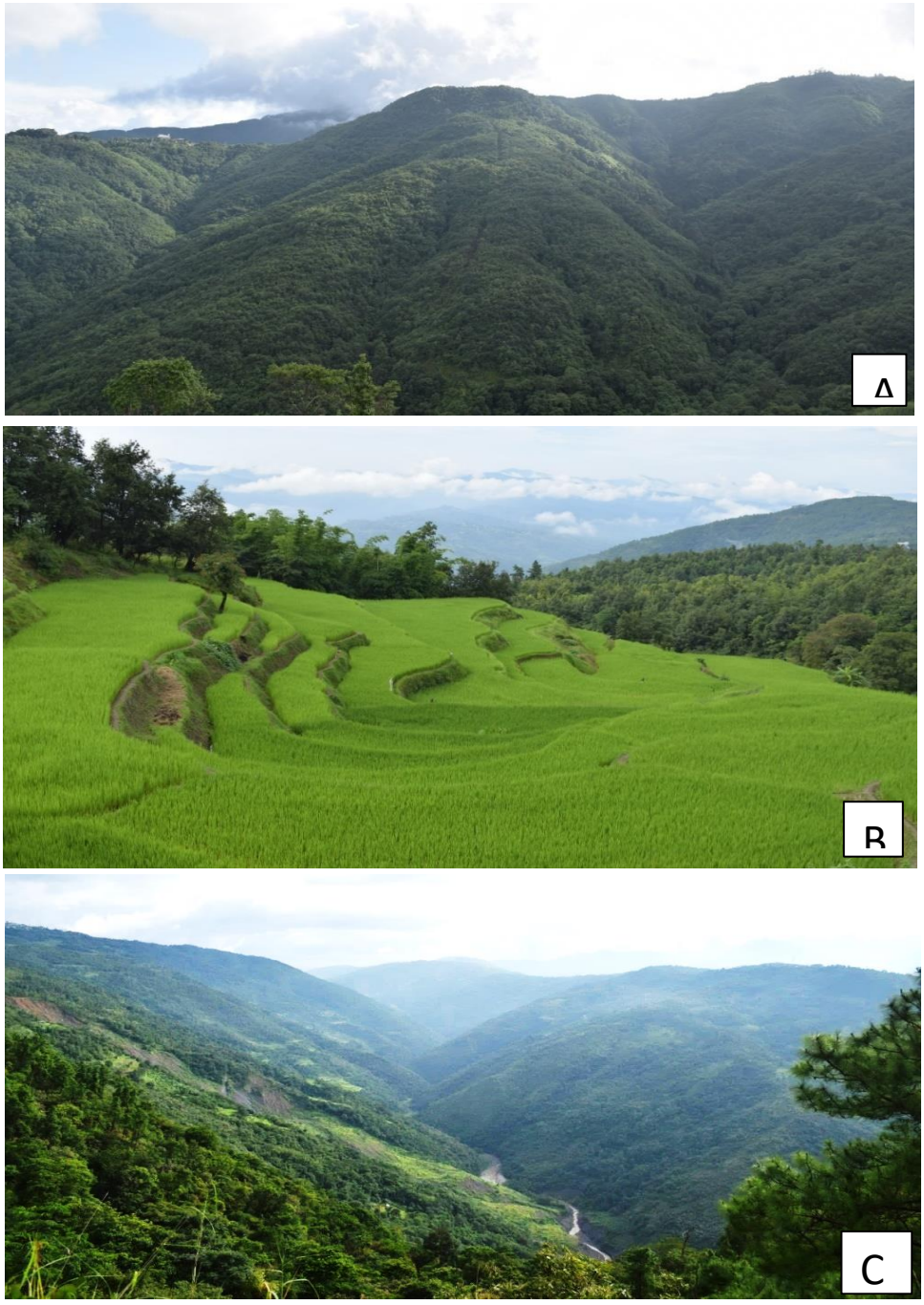


Figure 3.3 (A,B,C) Landscapes of forest during survey

3.4 Nutritional analysis of wild edible mushrooms

3.4.1 Moisture Analysis

For this experiment, twenty grams of fresh mushrooms was weighed, dried at 100^0 to 105^0 C, and then cooled in a dessicator. The cycle of heating and cooling was continued until a stable mass had been achieved. The obtained formula was used to calculate moisture percentages.

Moisture content formula (in percentage) = (Initial wet weight- final dry weight)/ Initial wet weight x 100

3.4.2 Crude fiber estimation

200 ml containing 0.255 N H2SO4 was heated in a beaker before being added to ten grammes of a sample that was devoid of moisture and fat. A consistent volume was maintained during the 30-minute boiling process by rehydrating at periodic intervals. The slurry was then strained through a mesh sieve, and the acid residue was completely removed from the leftover material by rinsing it in hot water. 200 ml of heated 0.313 N NaOH was then added to the previous beaker after the material had been moved there. The solution was then boiled for half an hour (while conserving the same volume as previously), strained through a mesh sieve, washed with hot water to remove any remaining alkali, and eventually cleansed with some alcohol. After drying overnight at 80–100°C, it was loaded to a crucible and measured using a measuring balance. The crucible was heated for approximately five to six hours at

600°C in a muffle furnace, cooled, and measured again. The difference between the weights represents the weight of crude fiber.

Crude fiber calculation (%) = $((W_b - W_c) / W_a) \times 100$

W_a = sample of the initial weight

W_b = crucible weight after drying with fiber and ashes,

W_c = final crucible weight with ashes

3.4.3 Total ash estimation

One gram of dried mushroom materials was weighed it into crucible. A muffle furnace was used to heat the crucible for the first five to six hours at 600°C, burning everything within completely. After chilling in a dessicator, it was weighed and then heated in the muffle furnace for an hour, allowed to cool, and then weighed to ensure that the ashing process was finished. This process was continued until the ash was nearly white or grey white in colour and two succeeding weights were equivalent Figure 3.6. To calculate the total amount of ash, the formula (Raghuramulu et al., 2003) shown below was used:

$$\text{Ash content calculation (mg/g) of sample} = \frac{\text{weight of ash}}{\text{weight of dried sample}} \times 100$$

3.4.4 Fat determination

Using Soxhlet extraction equipment Figure 3.4, crude fat was examined. 3g sample of dried, edible wild mushrooms was finely powdered, and it was put in the soxhlet extraction apparatus with petroleum ether which has boiling point of 60 - 80°C. The sample was then cooled by detaching the condensing unit out from extraction

equipment after 6 hours, and the solvent was then dried out. Formula based on the weight differential between the flask and the dried petroleum ether were used to calculate the quantity of fat.

$$\text{Crude fat content (\%)} = \frac{\text{Weight of flask and fat extracts} - \text{Weight of empty flask}}{\text{Weight of dried sample}} \times 100$$

3.4.5 Protein determination:

In 10 ml of cell extraction buffer, 0.5 g of mushroom samples were pulverised in a mortar and pestle. After centrifuging the samples for 10 minutes at 7000 rpm, the preparation was used to calculate the protein according to the protocol by Bradford's method (Bradford & Marion M, 1976).

3.4.6 Total carbohydrate

The sample extract was synthesized by hydrolyzing the test sample in 2.5N HCl in a boiling bath of water for three hours, which was then neutralised with sodium carbonate. After centrifuging it, the supernatant was gathered for examination. The analysis was done using the methodology described in (Hedge & Hofreiter, 1962).

3.4.7 Reducing Sugar (RS)

Dinitrosalicylic acid (DNS) reagent was used to calculate RS (Miller, 1972). In a test tube with a loose lid, 3 ml of the reagent and 3 mL of the sample were put together. The mixture was heated at 90°C for five to fifteen minutes to get a reddish-brown hue. Following that, Rochelle's salt solution (1 ml) was added to stabilise the colour. After reaching room temperature in a cold-water bath, absorbance was quantified at 575 nm

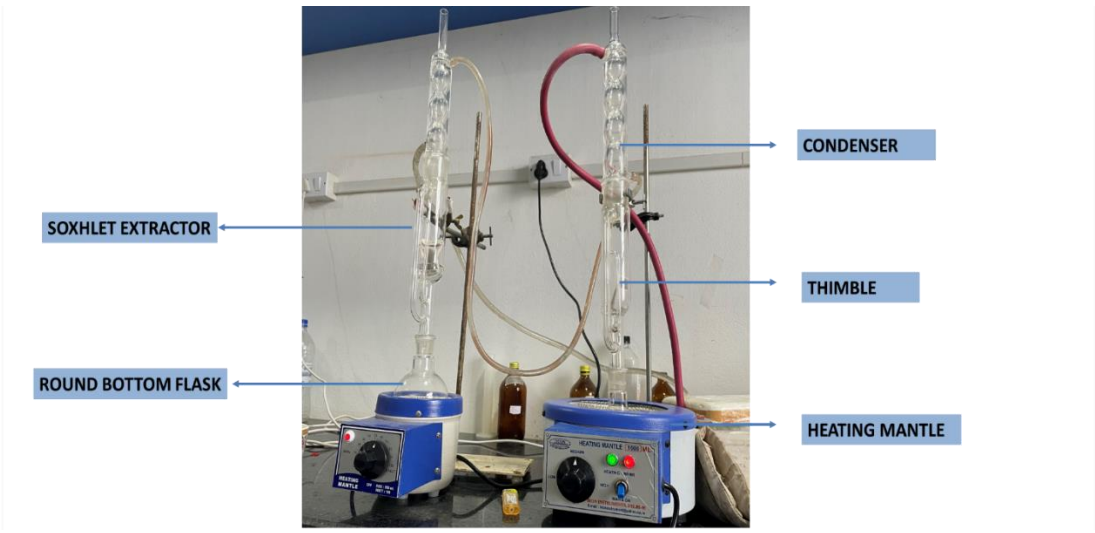


Figure 3.4 Soxhlet apparatus for fat extraction

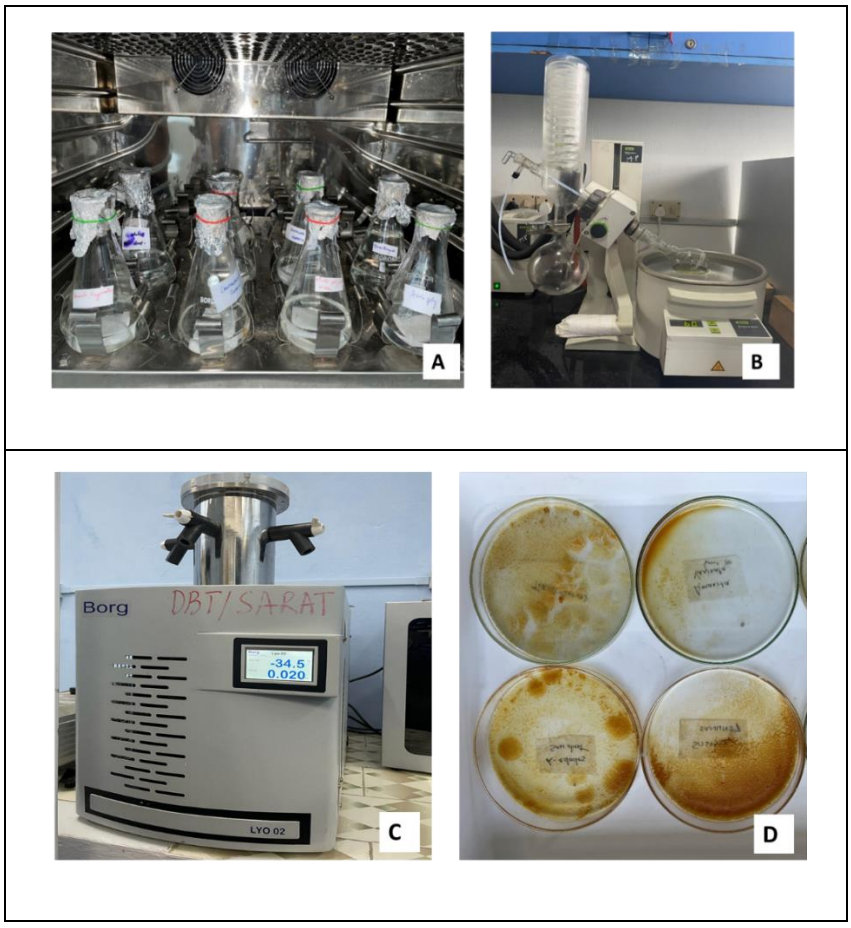


Figure 3.5 A) Soaking of extract at shaking incubator B) Concentration of sample at rotary evaporator, C) Freeze drying in Lyophilizer D) Fully dried extracts.

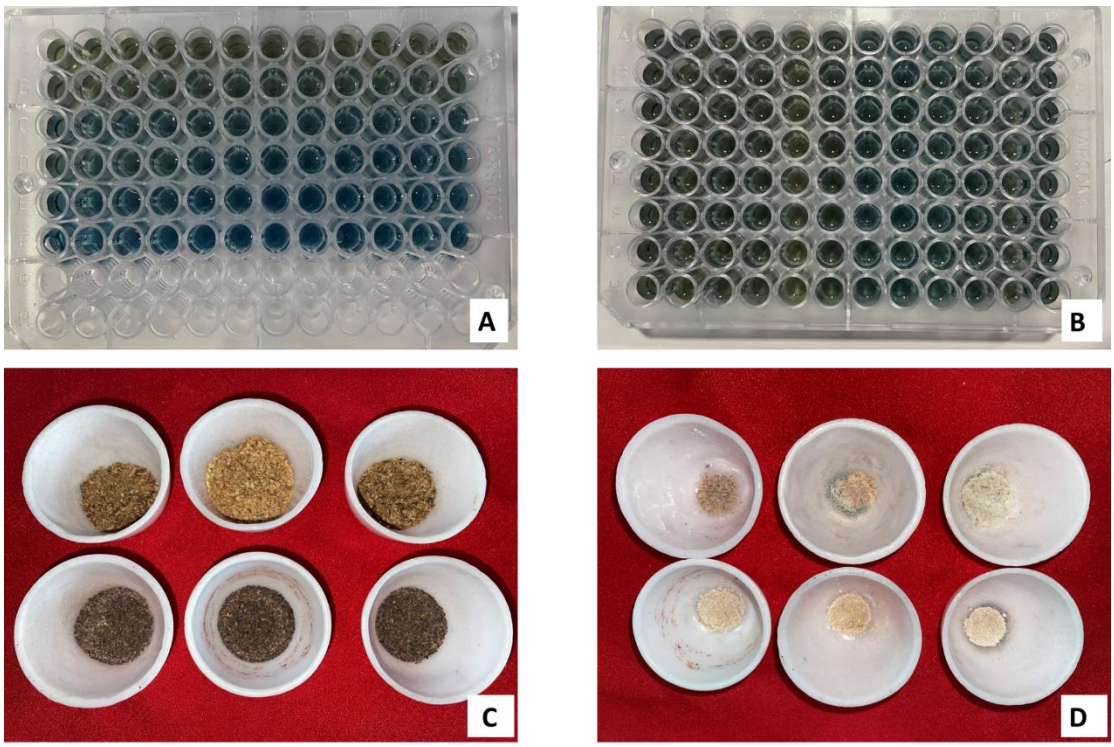


Figure 3.6 A) BSA Standard in microplate for reading. B) Sample in microplate for reading absorbance C) Sample in crucible for Ash content before ignition. D). Residual Ash content after ignition crucible after burning

3.5 Analysis of antioxidant activities, total phenolics, total flavonoid and total tannin profiles.

3.5.1 Preparation of mushroom extracts

Using the techniques previously detailed, samples were extracted (Barros, Baptista, et al., 2007). Briefly, ten grams of sample mushroom powder was extracted by shaking 100 ml of several solvents, including Methanol, Ethyl acetate, Petroleum ether, and Water, at 25°C at 150 rpm for 24 hours using a temperature shaker incubator, and then filtered using Whatman No. 4 paper. The residue was subsequently extracted using two or three 100 ml volumes of the solvents as previously indicated. The

individual solvent extracts were evaporated to dryness at 40°C using a rota evaporator (BUCHI Rotavapor R-100, Switzerland) and re-dissolved in their respective solvents at a concentration of 50 mg/ml before being frozen at 20°C for future studies (Figure 3.5)

3.5.2 DPPH free radial scavenging activity

The DPPH radical scavenging activity was measured according to (Gülçın et al., 2003) methodology with slight modification. Mixing 1 mL of each mushroom extract with 3 mL of DPPH solution yielded each sample (0.1 mM). The control consisted of a combination of 3 mL of DPPH radical solution and 1 mL of 80% methanol. Following 30 minutes of dark incubation, the absorbance of each combination was determined spectrophotometrically at 517 nm. Gallic acid was used as a standard compound. Using the following equation, the DPPH radical scavenging capacity was determined.

DPPH radical scavenging (%) = $[(Ab_0 - Ab_1)/ Ab_0] \times 100$

The DPPH radical scavenging activity was expressed as the Trolox equivalent antioxidant capacity (TEAC) per gram of dry weight (DW).

Where Ab_0 stands for the absorbance of the control, whereas Ab_1 stands for the absorbance of the sample.

The DPPH radical scavenging activity was quantified in terms of the Trolox equivalent antioxidant capacity (TEAC) per gram of dry weight.

3.5.3 ABTS free radical scavenging activity

The ABTS radical scavenging activity was evaluated using an adapted version of the approach described by (Re et al., 1999). The ABTS cation chromophore stock solution was made by reacting 7 mM ABTS solution with 2.45 mM Potassium Per sulphate at room temperature for 16 hours. To achieve an absorbance of 0.70 002 at 734 nm in the ABTS•+solution, phosphate buffer (50 mM, pH 7.4) was used. Absorbance at 734 nm was measured after an aliquot of each extract was added to 3 mL of an ABTS•+solution and the combination was incubated at room temperature for 30 minutes. The antioxidant activity was measured as the Trolox equivalent antioxidant capacity (TEAC) per gram of dry weight (DW), with Trolox serving as the reference standard.

3.5.4 Determining the effect of chelation on ferrous ion.

The chelating effects of metals on ferrous ions were determined according to Decker & Welch (1990). Extracts in methanol were added to a 2 mM FeCl2 solution at concentrations ranging from 0.05 to 1.5 mg/ml (0.05 ml). With the addition of 5 mM ferrozine, the reaction was set in motion (0.2 ml). After adding methanol to bring the total amount to 5 ml, the mixture was agitated vigorously for 10 minutes and then left at room temperature. The solution's absorbance was checked at a wavelength of 562 nm. As a control, a solution devoid of extract was used. The proportion of ferrozine Fe2+ compound inhibition was then determined by doing the following calculations:

$$\text{Metal Chelating Effect (\%)} = [(Ab_0 - Ab_1)/ Ab_0] \times 100$$

where Ab_0 is the reference absorbance and Ab_1 is the sample absorbance. The ability to chelate ferrous ions is shown by a decrease in absorbance. As a comparison, a control solution of 2, 2-bipyridyl, disodium ethylenediaminetetracetate (EDTA) was referred. Using a graph showing percentage inhibition of ferrous ions vs extract concentration, the EC50 value was determined.

3.5.5 Determination of Total Phenolic Content (TPC)

Folin Ciocalteau's technique was used to determine the total phenolic content of different extracts of materials (Singleton & Rossi, 1965). One millilitre of Folin Ciocalteau's reagent was mixed with one millilitre of the sample. After waiting 3 minutes, 1 millilitre of saturated Na2CO3 (35% concentration) was added to the aforesaid combination, and the remaining volume was brought up to 10 millilitres with distilled water. After 90 minutes in the dark, the tubes were examined for absorbance at 725 nm using a reagent blank. Gallic acid was the standard. The results were reported as the gallic acid equivalent (GAE) in milligrammes per gram of extract.

3.5.6 Determination of Total Flavonoid Content (TFC)

Flavonoid levels were calculated using a modified version of the aluminium chloride technique (S. Kumar et al., 2008).The sample volume was 0.5 ml and the volume of 5% sodium nitrite used was 0.3 ml. Thereafter, 0.3 ml of 10% aluminium chloride was then added after waiting 5 minutes. After a 6-minute incubation period, 2.0 ml of 1 M sodium hydroxide and the remaining volume in distilled water brought the final volume to 5.0 ml. At 510 nm, the mixture's absorbance was measured against

a blank reagent. The standard reagent was catechol. Flavonoid concentrations were reported in milligrams of Quercetinl equivalence (QE) per gram of extract.

3.5.7 Determination of Total Tannin Content (TTC):

Tannin concentration in various extracts was measured quantitatively using the method described by Price & Butler, (1977). The volume was adjusted to 10.0 ml with distilled water and 0.5 ml of the sample was combined with 1.0 ml of 1% potassium ferric cyanide and 1.0 ml of 1% ferric chloride. After letting the reaction mixture sit for 5 minutes at room temperature, the absorbance was measured using a reagent blank and a 720 nm wavelength. The amount of tannin was reported as the Catechin equivalent (CE) in milligrammes per gramme of extract.

3.6 Data analysis

Statistical analysis was performed using IBM Statistical Package for Social Sciences [(SPSS) Version 22 software]. The one way ANOVA was executed to investigate the possible existence of correlation between the presumptively identified wild mushroom. Correlations and test of significance were considered statistically significant when P values were < 0.05.

3.7 Preparation of Media

To isolate mushroom mycelia, various media was used to study the fastest growing mycelium run period. The following media were used:

i. Potato Dextrose Agar media
ii. Malt Extract agar

iii. Yeast Malt Agar
iv. Saboraud's Dextrose Agar
v. Nutrient Agar No.2 modified
vi. Nutrient agar

Extracts were made by boiling the necessary amount in distilled water for half an hour. After straining the extract, we added distilled water to bring the volume of the resulting filtrate up to 1000 ml. When all of the component was added, the medium's pH was kept at 6.8 and it was autoclaved for 15 minutes at 121 degrees Celsius, 15 pounds per square inch (PSI).

3.7.1 Inoculation and Incubation (Pure culture preparation)

Mycelia were extracted from mushroom fruiting bodies using tissue culture methods (Fig 3.7). In order to inoculate the various agar media, a little amount of tissue was removed from the pileus area using a sterile inoculating needle and placed in the centre of each petri dish. Petri dishes were inoculated with a fungus, then placed in an incubator at 25±2 degrees Celsius to examine the mycelium's growth for 7 days. After which the best media which supports vigour mycelium growth was selected for reinoculation and then incubated for another 20 days at 25±2 degrees Celsius in an incubator. This is how the pure culture was obtained.

3.8 Spawn production

3.8.1 Mother spawn preparation (Ram et al., 2013)

As a substrate for the preparation of mushroom mother spawn (Fig 3.7), the wheat grains that had been soaked overnight and boiled were used. These grains were

first subjected to shade drying and a moisture content of 52^0C was maintained. The grains were mixed with $CaCO_3$ (0.5%) on dry wt. basis. The wheat grains were plugged and sterilised in a pressure cooker at 20 pounds of pressure for 2 hours after being placed in a jar /poly propylene bag. The laminar flow, which had previously been treated with alcohol and UV radiation, was then used to store these polypropylene bags that had been sterilised.

The mycelium of *Lentinula edodes* that had appeared in the petri plates was transferred to a bag containing wheat grains, which was then heat-sealed. A small opening for air exchange was then sealed with a micropore tape or cotton plugs for jars, and were placed in an incubator at a temperature of at 25±2° C for 20-25 days. 10 to 15 days after inoculation, these jars and bags were shaken and left for incubation. This spawn obtained is called as the mother/master spawn.

3.8.1.1 **Wood plug preparation**

Similar steps as mother spawn preparation are involved for wood plug preparation with some addition. The soaked wheat grains are boiled and dried and then sterilized after mixing with $CaCO_3$. These polypropylene bags are then inoculated with the mycelium wedges of agar for colonization, which are heat sealed with a tiny opening sealed with micropore. They were placed in an incubator at a temperature of at 25±2° C for 20-25 days.

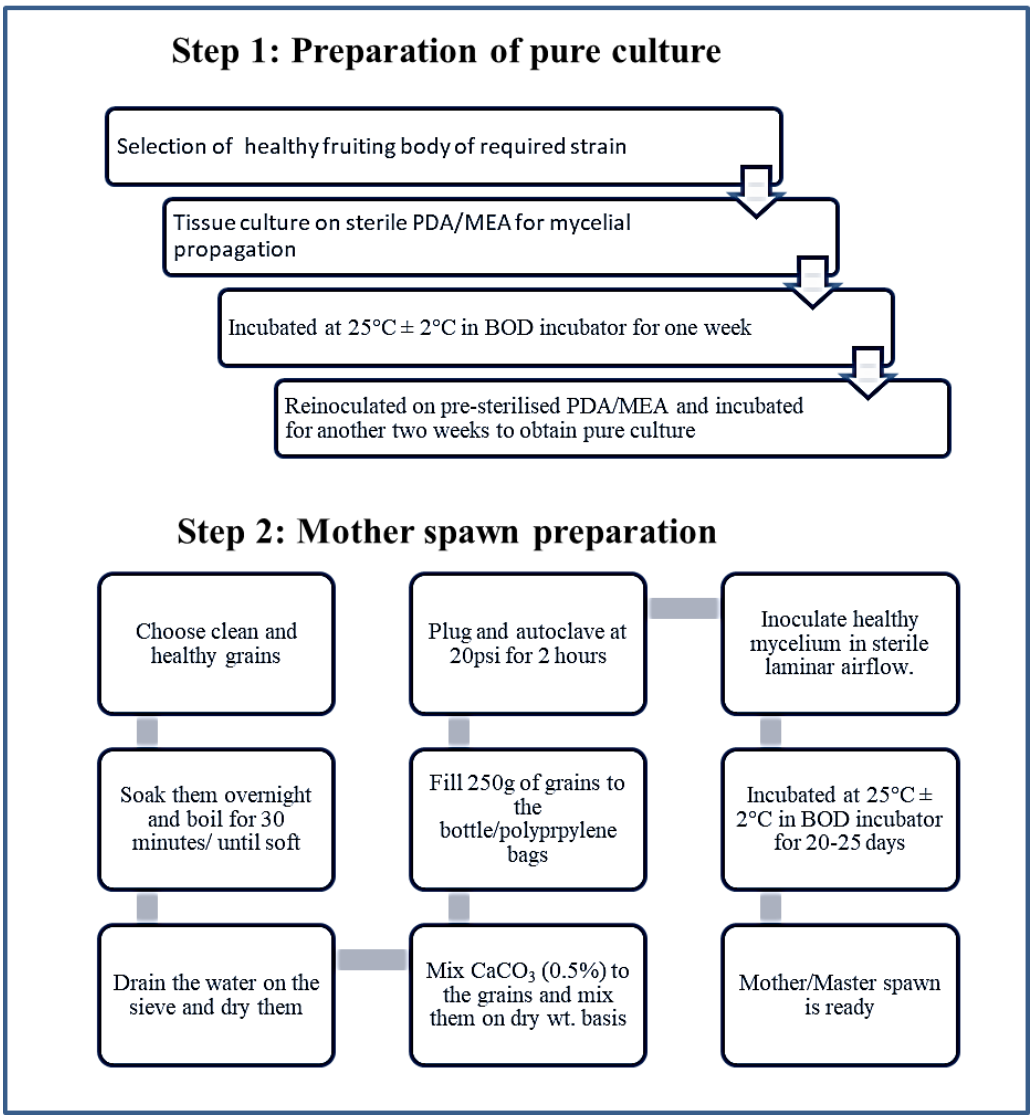


Figure 3.7 Flow chart of spawn preparation

As soon as the grains were completely colonised, they were transferred in a bag that contained sterile sawdust and then heat-sealed. Additionally, a micropore tape was used to create a small passageway for air exchange, and the bag was placed in an incubator at 25±2° C for an additional 20-25 days.

Saw-dust spawn preparation

Grains soaked overnight

overnight

Boiled then Autoclaved for 2 hrs

Incubated at 25^0C ± 2°C

Spawn on grain after 3 weeks of incubation

Transferred to sterilised saw dust

Grain spawn Inoculated on saw dust

Incubated for 20-25 days

Incubated at 25^0C ± 2°C

Saw dust spawn ready for cultivation

Figure 3.8 Saw-dust spawn preparation of commercial strain of *Lentinula edodes*

Similarly, completely colonised sawdust is ready to be inoculated into saw dust substrate for cultivation (Figure 3.8). Additionally, this fully colonized sawdust was inoculated into streilized wood plugs in a plastic bag, which was then heat-sealed, and a micropore tape was used to create a tiny opening for air exchange before the samples were incubated at 25±2° C for an additional 20-25 days. These completely colonised wood plugs are now ready for inoculation into logs (Figure 3.9)

Figure 3.9 Steps for spawn preparation for Shiitake wood plug preparation (A) Fully grown shiitake to be used for tissue culture, (B) Mycelium on Potato dextrose agar, (C) Fully colonized wheat spawn ready for inoculation, (D) Fully colonized Sawdust spawn ready for inoculation (E) Ready to use fully colonized Spawn plug

CHAPTER - 4

RESULTS AND DISCUSSIONS

4.1 Documentation on Wild Mushrooms of Nagaland and their Molecular Characterization

4.1.1 Documentation of wild mushrooms of Nagaland

A comprehensive study was conducted in many Naga districts, yielding samples of 376 diverse macrofungal species (Table 4.2). These districts include Chumukedima, Dimapur, Kohima, Peren, Mon, Phek, Zunheboto, Tuensang, Mokokchung, and Wokha. The survey was done mostly in rural forest settings and collected from their natural habitat with residents of such communities. Mushroom foragers' accounts of which wild mushrooms are edible and which ones aren't were compiled. The study revealed that 339 strains belonged to the division Basidiomycota while only 25 strains belonged to the division Ascomycota. The remaining 12 strains were reported as unidentified. These species of mushrooms were identified on the basis of their morpho-anatomical features and other related characteristics.

A total of 69 families were recorded and are mentioned as follows ; Agaricaceae- 17, Amanitaceae-11, Amylostereaceae-1, Auriculariaceae-4, Boletaceae-33, Boletinellaceae-1, Bulgariaceae-1, Cantharellaceae-6, Chlorociboriaceae-1, Clavariaceae-2, Coniophoraceae-1, Cordycipitaceae-4, Cortinariaceae-6,

Crepidotaceae-3, Dacrymycetaceae-2, Entolomataceae-3, Exidiaceae-3, Fistulinaceae-1, Fomitopsidaceae-4, Gloeophyllaceae-1, Gomphaceae-3, Gyroporaceae-1, Helotiaceae-1, Helvellaceae-1, Hydnaceae-1, Hydnangiaceae-7, Hygrophoraceae-6, Hymenochaetaceae-4, Hymenogastraceae-6, Hypoxylaceae-1, Inocybaceae-3, Ischnodermataceae-1, Leotiaceae-1, Lycoperdaceae-4, Lyophyllaceae-6, Marasmiaceae-13, Meripilaceae-1, Meruliaceae-1, Mollisiaceae-1, Mycenaceae-12, Omphalotaceae-9, Ophiocordycipitaceae-2, Panaceae-5, Pezizaceae-1, Phaeolaceae-1, Phaeotremellaceae-2, Phallaceae-3, Physalacriaceae-8, Pleurotaceae-11, Pluteaceae-3, Polyporaceae-38, Porotheleaceae-1, Psathyrellaceae-14, Pyronemataceae-1, Rhizopogonaceae-2, Russulaceae-28, Sarcosomataceae-3, Schizophyllaceae-1, Schizoporaceae-1, Sclerodermataceae-3, Steccherinaceae-1, Stereaceae-4, Strophariaceae-8, Suillaceae-5, Tapinellaceae-1, Thelephoraceae-2, Tremellaceae-2, Tricholomataceae-17 and Tubariaceae-2. Families belonging to Boletaceae, Polyporaceae and Russulaceae were recorded with the highest number of collection. Whereas, families such as, Schizoporaceae, Pyronemataceae, Pluteaceae, Ophiocordycipitaceae, Inocybaceae, Boletinellaceae and Amylostereaceae are new reports for the State's microflora.

All the surveyed macrofungal species belonged to 155 genera in total. The following 83 genera were reported with one each species, namely; *Abortiporus, Antrodia, Apioperdon, Armillaria, Arrhenia, Artomyces, Bisporella, Borofutus, Bresadolia, Bulgaria, Candolleomyces, Cerrena, Chlorociboria , Chlorophyllum, Clavulina, Clitopilus , Coltricia, Cookeina, Craterellus, Crinipellis, Cyathus, Cymatoderma, Cyptotrama, Daldinia, Delicatula, Exidia, Favolaschia, Filoboletus,*

Fistulina, Fomes, Galiella, Gloeophyllum, Gomphus, Gyrodontium, Gyroporus, Heimiomyces, Helvella, Hemistropharia, Hydnellum, Hydropus, Hygrocybe, Hymenochaete, Hymenopellis, Imleria, Inocybe, Irpex, Ischnoderma, Leccinum, Lentaria, Lentinula, Lenzites, Leotia, Lepista, Leucoagaricus, Lyophyllum, Mollisia, Mucronella, Neonothopanus, Nidula, Omphalia, Omphalina, Panellus, Peziza, Phaeolus, Phlebopus, Pseudofavolus, Pseudohydnum, Pseudomerulius, Pycnoporus, Ramaria, Ramariopsis, Resupinatus, Roridomyces, Rosellinia, Sarcoscypha, Schizophyllum, Schizopora, Scytinotus, Thelephora, Tremellodendron, Trichaleurina, Trogia, and *Xerula.*

The following 32 genera were reported with two species each, namely; *Boletellus, Campanella, Chrysomphalina, Clavatia, Collybia, Coprinopsis, Dacryopinax, Entoloma, Galerina, Hexagonia, Hygrophorus, Inosperma, Lactarius, Macrolepiota, Marasimellus, Melanoleuca, Microporus, Ophiocordyceps, Oudemansiella, Panaeolus, Phaeotremella, Phellinus, Phylloporus, Retiboletus, Rhizopogon, Strobilomyces, Strobilurus, Tremella, Trichaptum, Tricholoma, Tubaria* and *Xerocomellus;* 16 genera were reported with three species each, namely; *Amauroderma, Coprinellus, Crepidotus, Favolus, Fomitopsis, Ganoderma, Gymnopilus, Lactifluus, Leucocoprinus, Lycopedon, Panus, Phallus, Pluteus, Psilocybe, Scleroderma* and *Xerocomus*; 4 genera were reported with four species each, namely; *Auricularia, Clitocybe, Cordyceps* and *Stereum*; 5 genera were reported with five species each, namely; *Cantharellus, Hypholoma, Suillus, Termitomyces* and *Trametes*; 6 genera were reported with six species each, namely; *Agaricus, Cortinarius, Lentinus, Psathyrella, Tylopilus*, and *Xylaria*; 3 genera were reported with seven

species each, namely; *Gymnopus, Laccaria* and *Polyporus;* 2 genera were reported with eight species each, namely *Marasimus* and *Mycena*. Ten each were reported from the genera *Pleurotus* and eleven each from the genera *Amanita* and *Boletus*. The genera with the highest collection of 23 species was recorded from *Russula* followed by *Amanita* and *Boletus* with 11 each.

Due to suitable weather in Nagaland, numerous researchers have identified a plethora of fungi and have reported a total of 237 different species of wild mushrooms (Kumar et al., 2013; Ao et al., 2016; Chuzho & Dhkar, 2017; Ao & Deb, 2019; Chuzho & Dkhar, 2019). In this study we have reported a total of 135 newly recorded wild mushrooms in Nagaland, which is listed in Table 4.1, where 93 species were identified till the species level and notably 42 wild mushrooms identified till the genus level.

Table 4.1 List of newly reported wild mushroom species collected during (2017-2022)

Sl No	Species with author citation
1	*Agaricus placomyces* Peck.,
2	*Chlorophyllum molybdites* (G. Mey.) Massee.
3	*Leucocoprinus cretaceus* (Bull.) Locq.
4	*Macrolepiota olivascens* Singer & M.M.Moser.
5	*Amanita caesarea* (Scop.) Pers.
6	*Amanita gemmate* (Fr.) Bertill.
7	*Amanita pantherina* (DC.) Krombh.
8	*Amanita velosa* (Peck) Lloyd
9	*Amanita verna* (Bull.) Lam.
10	*Artomyces pyxidatus* (Pers.) Jülich.
11	*Boletellus emodensis* (Berk.) Singer.
12	*Boletus separans* Peck

13 *Imleria badia* (Fr.) Vizzini.
14 *Phylloporus catenulatus* Iqbal Hosen & T.H.Li.
15 *Retiboletus griseus* (Frost) Manfr.Binder & Bresinsky.
16 *Tylopilus plumbeoviolaceus* (Snell & E.A.Dick) Snell & E.A.Dick.
17 *Phlebopus marginatus* Watling & N.M Greg.
18 *Cantharellus cinnabarinus* (Schwein.) Schwein.
19 *Cantharellus lateritius* (Berk.) Singer.
20 *Cantharellus minor* Peck.
21 *Craterellus cornucopioides* (L.) Pers.
22 *Gyrodontium sacchari* (Spreng.) Hjortstam.
23 *Tremellodendron schweinitzii* (Peck) G.F. Atk.
24 *Antrodia albida* (Fr.) Donk.
25 *Bisporella citrina* (Batsch) Korf & S.E.Carp.
26 *Hygrophorus fuscopapillatus* C.Q. Wang & T.H. Li.
27 *Coltricia cinnamomea* Gray.
28 *Psilocybe cubensis* (Earle) Singer.
29 *Daldinia vernicosa* Ces. & De Not.
30 *Inosperma calamistratum* (Fr.) Matheny & Esteve-Rav.
31 *Lyophyllum fumosum* (Pers.) P.D. Orton.
32 *Campanella tristis* (G. Stev.) Segedin.
33 *Campanella junghuhnii* Mont.
34 *Trogia venenata* Zhu L.Yang, Y.C.Li & L.P.Tang
35 *Physisporinus lineatus* (Pers.) F. Wu, Jia J. Chen & Y.C. Dai.
36 *Mycena manipularis* (Berk.) Sacc.
37 *Mycena adscendens* Maas Geest.
38 *Panellus longinquus* (Berk.) Singer.
39 *Neonothopanus hygrophanus* (Mont.) De Kesel & Degreef.
40 *Ophiocordyceps longissima* Kobayasi
41 *Ophiocordyceps nutans* (Pat.)
42 *Cymatoderma dendriticum* (Pers.) D.A.Reid.
43 *Panus fasciatus* (Berk.) Pegler.

44 *Panus similis* (Berk. & Broome) T.W. May & A.E. Wood.
45 *Phaeotremella frondosa* (Fr.) Spirin & V. Malysheva.
46 *Phallus calongei* G. Moreno & Khalid.
47 *Phallus duplicatus* Bosc.
48 *Armillaria mellea* (Vahl) P.Kumm.
49 *Cyptotrama asprata* (Berk.) Redhead & Ginns.
50 *Oudemansiella exannulata* (Cleland & Cheel) R.H. Petersen.
51 *Oudemansiella furfuracea* (Speg.) Speg.
52 *Pleurotus dryinus* (Pers.) P.Kumm.
53 *Pleurotus giganteus* (Berk.) Karunarathna & K.D. Hyde.
54 *Pleurotus tuber-regium* (Rumph. ex Fr.) Singer.
55 *Pluteus cervinus* (Schäffer : Fr) P. Kumm.
56 *Cerrena unicolor* (Bull.) Murrill.
57 *Amauroderma rugosum* (Blume & T. Nees) Torrend.
58 *Bresadolia uda* (Jungh.) Audet.
59 *Favolus brasiliensis* (Fr.) Fr.
60 *Hexagonia tenuis* (Hook.) Fr.
61 *Lentinus badius* (Berk.)Berk.
62 *Lentinus crinitus* (L.) Fr.
63 *Lenzites elegans* (Spreng.)Pat.
64 *Polyporus arcularius* (Batsch)Fries.
65 *Coprinellus domesticus* (Bolton) Vilgalys, Hopple & Jacq.Johnson.
66 *Coprinopsis lagopus* (Fr.) Redhead, Vilgalys & Moncalvo.
67 *Psathyrella squamosa* (P. Karst.) A.H. Sm.
68 *Trichaleurina javanica* (Rehm) M. Carbone, Agnello & P. Alvarado.
69 *Rhizopogon luteolus* Fr.
70 *Lactarius quietus* (Fr.) Fr.
71 *Lactifluus luteolus* (Peck) Verbeken.
72 *Russula betularum* Hora.
73 *Russula crustosa* Peck.
74 *Russula foetens* Pers.

75 *Russula griseocarnosa* X.H.Wang, Zhu L.Yang & Knudsen.
76 *Russula luteotacta* Rea.
77 *Russula virescens* (Schaeff.) Fr.
78 *Galiella rufa* (Schwein.) Nannf. & Korf
79 *Scleroderma bovista* Fr.
80 *Scleroderma aurantium* L.
81 *Stereum subtomentosum* Pouzar.
82 *Galerina hypnorum* (Schrank) Kühner.
83 *Hemistropharia albocrenulata* (Peck) Jacobsson & E. Larss.
84 *Hypholoma fasciculare* (Huds.Fr.) P.Kumm.
85 *Suillus americanus* (Peck) Snell.
86 *Pseudomerulius curtisii* (Berk.) Redhead & Ginns.
87 *Thelephora palmata* (Scop.) Fr.
88 *Filoboletus manipularis* (Berk.) Sacc.
89 *Scytinotus longinquus* (Berk.) Thorn.
90 *Clitocybe fragrans* (With.) P. Kumm.
91 *Clitocybe nuda* (Bull.) H.E.Bigelow & A.H.Sm.
92 *Lepista flaccida* (Sowerby) Pat.
93 *Omphalia integrella* (Pers.) P.Kumm.
94 *Clavatia* sp.1
95 *Clavatia* sp.2
96 *Borofutus* sp.
97 *Leccinum* sp.
98 *Exidia* sp.
99 *Lentaria* sp.
100 *Gyroporus* sp.
101 *Chrysomphalina* sp.1
102 *Arrhenia* sp.
103 *Chrysomphalina* sp.2
104 *Crinipellis* sp.
105 *Abortiporus* sp.

106 *Favolaschia* sp.
107 *Heimiomyces* sp.
108 *Roridomyces* sp.
109 *Gymnopus* sp.1
110 *Gymnopus* sp.2
111 *Gymnopus* sp.3
112 *Gymnopus* sp.4
113 *Gymnopus* sp.5
114 *Gymnopus* sp. 6
115 *Gymnopus* sp.7
116 *Peziza* sp.
117 *Phaeotremella* sp.
118 *Strobilurus* sp.1
119 *Strobilurus* sp.2
120 *Xerula* sp.
121 *Pluteus* sp.1
122 *Pluteus* sp.2
123 *Amauroderma* sp.1
124 *Amauroderma* sp.2
125 *Candolleomyces* sp.
126 *Schizopora* sp
127 *Hydnellum* sp.
128 *Melanoleuca* sp.1
129 *Melanoleuca* sp.2
130 *Delicatula* sp.
131 *Omphalina* sp.
132 *Resupinatus* sp.
133 *Tubaria* sp.1
134 *Tubaria* sp.2
135 *Rosellinia* sp.

Table 4.2 List of Wild mushrooms from Nagaland

Family	Accession number	Species with Author citation	Site of collection
Agaricaceae.	NU/BOT/GLO-115	*Agaricus augustus* Fr.	Kikruma, Phek
	NU/BOT/GLO-021	*Agaricus* sp.1	Changki, Mokokchung
	NU/BOT/GLO-289	*Agaricus* sp.2	Mopungchuket, Mokokchung
	NU/BOT/GLO-319	*Agaricus* sp.3	Phesama, Kohima
	NU/BOT/GLO-359	*Agaricus* sp.4	Lumami, Zunheboto
	NU/BOT/GLO-041	*Agaricus placomyces* Peck.	Lumami, Zunheboto
	NU/BOT/GLO-046	*Chlorophyllum molybdites*(G. Mey.) Massee.	Toulazouma, Dimapur
	NU/BOT/GLO-020	*Clavatia* sp.1	Changki, Mokokchung
	NU/BOT/GLO-357	*Clavatia* sp.2	Pfutsero, Phek
	NU/BOT/GLO-136	*Cyathus striatus* (Huds.) Willd.	Mingkong, Mokokchung
	NU/BOT/GLO-273	*Leucoagaricus* sp.	Phangsang, Mokokchung
	NU/BOT/GLO-054	*Leucocoprinus birnbaumii* (Corda)Singer.	Lumami, Zunheboto
	NU/BOT/GLO-032	*Leucocoprinus cretaceus* (Bull.)Locq.	Lumami, Zunheboto
	NU/BOT/GLO-040	*Leucocoprinus* sp.	Lumami, Zunheboto
	NU/BOT/GLO-109	*Macrolepiota olivascens* Singer & M.M.Moser.	Kikruma, Phek
	NU/BOT/GLO-063	*Nidula* sp.	Kigwema, Kohima
	NU/BOT/GLO-360	*Macrolepiota* sp.	Lumami, Zunheboto
Amanitaceae	NU/BOT/GLO-372	*Amanita caesarea* (Scop.) Pers.	Kigwema, Kohima
	NU/BOT/GLO-346	*Amanita gemmata* (Fr.) Bertill.	Old Riphym, Wokha
	NU/BOT/GLO-084	*Amanita pantherina* (DC.) Krombh.	Kigwema, Kohima
	NU/BOT/GLO-002	*Amanita* sp. 1	Bongkolong, Peren
	NU/BOT/GLO-057	*Amanita* sp.2	Kigwema, Kohima
	NU/BOT/GLO-094	*Amanita* sp.3	Kikruma, Phek
	NU/BOT/GLO-343	*Amanita strobiliformis* (Paulet ex Vittad.) Bertill.	Old Riphym, Wokha
	NU/BOT/GLO-328	*Amanita vaginata* (Bull.) Lam.	Old Riphym, Wokha
	NU/BOT/GLO-106	*Amanita velosa* (Peck) Lloyd	Kikruma, Phek
	NU/BOT/GLO-276	*Amanita verna* (Bull.) Lam.	Mopungchuket, Mokokchung

	NU/BOT/GLO-277	*Amanita rubrovolvata* S. Imai,	Mopungchuket, Mokokchung
Amylostereaceae	NU/BOT/GLO-240	*Artomyces pyxidatus* (Pers.) Jülich.	Helipong, Tuensang
Auriculariaceae	NU/BOT/GLO-203	*Auricularia auricula-judae* (Bull.) J.Schröt.	Ngangpong, Tuensang
	NU/BOT/GLO-014	*Auricularia delicata* (Mont. ex Fr.) Henn.	Bongkolong, Peren
	NU/BOT/GLO-204	*Auricularia mesenterica* (Dicks.) Pers.	Ngangpong, Tuensang
	NU/BOT/GLO-202	*Auricularia nigricans* (Sw.) Birkebak, Looney & Sánchez-García.	Ngangpong, Tuensang
Boletaceae	NU/BOT/GLO-129	*Boletellus emodensis*(Berk.) Singer.	Lumami, Zunheboto
	NU/BOT/GLO-052	*Boletellus ananas* (M.A. Curtis) Murrill,	Lumami, Zunheboto
	NU/BOT/GLO-078	*Boletus edulis Bull.*	Kigwema, Kohima
	NU/BOT/GLO-097	*Boletus reticulatus* Schaeff.	Kikruma, Phek
	NU/BOT/GLO-101	*Boletus separans* Peck	Kikruma, Phek
	NU/BOT/GLO-048	*Boletus* sp.1	Lumami, Zunheboto
	NU/BOT/GLO-051	*Boletus* sp.2	Lumami, Zunheboto
	NU/BOT/GLO-085	*Boletus* sp.3	Kigwema, Kohima
	NU/BOT/GLO-284	*Boletus* sp.4	Mopungchuket, Mokokchung
	NU/BOT/GLO-286	*Boletus* sp.5	Mopungchuket, Mokokchung
	NU/BOT/GLO-293	*Boletus* sp.6	Mopungchuket, Mokokchung
	NU/BOT/GLO-304	*Boletus* sp.7	Mopungchuket, Mokokchung
	NU/BOT/GLO-329	*Boletus* sp.8	Old Riphym, Wokha
	NU/BOT/GLO-282	*Borofutus* sp.	Mopungchuket, Mokokchung
	NU/BOT/GLO-093	*Imleria badia*(Fr.) Vizzini.	Kikruma, Phek
	NU/BOT/GLO-120	*Leccinum* sp.	Lumami, Zunheboto
	NU/BOT/GLO-297	*Phylloporus catenulatus* Iqbal Hosen & T.H.Li.	Mopungchuket, Mokokchung
	NU/BOT/GLO-316	*Phylloporus* sp.	Phesama, Kohima
	NU/BOT/GLO-104	*Retiboletus griseus*(Frost) Manfr.Binder & Bresinsky.	Kikruma, Phek
	NU/BOT/GLO-324	*Retiboletus* sp.	Old Riphym, Wokha
	NU/BOT/GLO-121	*Strobilomyces* sp.	Lumami, Zunheboto

	NU/BOT/GLO-255	*Strobilomyces strobilaceus*(Scop.) Berk.	Kigwema, Kohima
	NU/BOT/GLO-352	*Tylopilus plumbeoviolaceus* (Snell & E.A.Dick) Snell & E.A.Dick.	Old Riphym, Wokha
	NU/BOT/GLO-064	*Tylopilus* sp.1	Kigwema, Kohima
	NU/BOT/GLO-082	*Tylopilus* sp.2	Kigwema, Kohima
	NU/BOT/GLO-083	*Tylopilus* sp.3	Kigwema, Kohima
	NU/BOT/GLO-292	*Tylopilus* sp.4	Mopungchuket, Mokokchung
	NU/BOT/GLO-298	*Tylopilus* sp.5	Mopungchuket, Mokokchung
	NU/BOT/GLO-367	*Xerocomellus chrysenteron* (Bull.) Šutara.	Lumami, Zunheboto
	NU/BOT/GLO-299	*Xerocomellus* sp.	Mopungchuket, Mokokchung
	NU/BOT/GLO-305	*Xerocomus* sp.1.	Mopungchuket, Mokokchung
	NU/BOT/GLO-344	*Xerocomus* sp.2	Old Riphym, Wokha
	NU/BOT/GLO-234	*Xerocomus subtomentosus* (L.) Quél.	Helipong, Tuensang
Boletinellaceae	NU/BOT/GLO-362	*Phlebopus marginatus* Watling & N.M Greg.	Bongkolong, Peren
Bulgariaceae	NU/BOT/GLO-241	*Bulgaria inquinans* (Pers.) Fr.	Helipong, Tuensang
Cantharellaceae	NU/BOT/GLO-089	*Cantharellus cibarius* Fr.	Kikruma, Phek
	NU/BOT/GLO-066	*Cantharellus cinnabarinus*(Schwein.) Schwein.	Kigwema, Kohima
	NU/BOT/GLO-119	*Cantharellus lateritius*(Berk.) Singer.	Kikruma, Phek
	NU/BOT/GLO-073	*Cantharellus minor* Peck.	Kigwema, Kohima
	NU/BOT/GLO-068	*Cantherllus* sp.	Kigwema, Kohima
	NU/BOT/GLO-061	*Craterellus cornucopioides*(L.) Pers.	Kigwema, Kohima
Chlorociboriaceae	NU/BOT/GLO-181	*Chlorociboria aeruginosa* (Oeder) Seaver.	Helipong, Tuensang
Clavariaceae	NU/BOT/GLO-257	*Mucronella* sp.	Helipong, Tuensang
	NU/BOT/GLO-157	*Ramariopsis kunzei* (Fr.) Corner.	Tanhai, Mon
Coniophoraceae	NU/BOT/GLO-023	*Gyrodontium sacchari* (Spreng.) Hjortstam.	Lumami, Zunheboto
Cordycipitaceae	NU/BOT/GLO-242	*Cordyceps* sp.1	Helipong, Tuensang
	NU/BOT/GLO-249	*Cordyceps* sp.2	Helipong, Tuensang
	NU/BOT/GLO-252	*Cordyceps* sp.3	Helipong, Tuensang

	NU/BOT/GLO-312	*Cordyceps* sp.4	Phesama, Kohima
Cortinariaceae	NU/BOT/GLO-114	*Cortinarius purpurascens*Fr.	Kikruma, Phek
	NU/BOT/GLO-116	*Cortinarius* sp.1	Kikruma, Phek
	NU/BOT/GLO-127	*Cortinarius* sp.2	Lumami, Zunheboto
	NU/BOT/GLO-200	*Cortinarius* sp.3	Helipong, Tuensang
	NU/BOT/GLO-238	*Cortinarius* sp.4	Helipong, Tuensang
	NU/BOT/GLO-303	*Cortinarius* sp.5	Mopungchuket, Mokokchung
Crepidotaceae	NU/BOT/GLO-043	*Crepidotus mollis* (Schaeff.) Staude.	Lumami, Zunheboto
	NU/BOT/GLO-140	*Crepidotus* sp.1	Mingkong, Mokokchung
	NU/BOT/GLO-226	*Crepidotus* sp.2	helipong, Tuensang
Dacrymycetaceae	NU/BOT/GLO-160	*Dacryopinax* sp.	Tanhai, Mon
	NU/BOT/GLO-118	*Dacryopinax spathularia*(Schwein.) G.W.Martin.	Kikruma, Phek
Entolomataceae	NU/BOT/GLO-165	*Clitopilus* sp	Helipong, Tuensang
	NU/BOT/GLO-179	*Entoloma murrayi* (Berk. & M.A. Curtis) Sacc.	Helipong, Tuensang
	NU/BOT/GLO-169	*Entoloma* sp.	Helipong, Tuensang
Exidiaceae	NU/BOT/GLO-167	*Exidia* sp.	Helipong, Tuensang
	NU/BOT/GLO-171	*Pseudohydnum gelatinosum* (Scop.) P.Karst.	Helipong, Tuensang
	NU/BOT/GLO-039	*Tremellodendron schweinitzii* (Peck) G.F. Atk.	Toulazouma, Dimapur
Fistulinaceae	NU/BOT/GLO-091	*Fistulina hepatica*(Schaeff.) With.	Old Riphym, Wokha
Fomitopsidaceae	NU/BOT/GLO-216	*Antrodia albida* (Fr.) Donk.	Ngangpong, Tuensang
	NU/BOT/GLO-135	*Fomitopsis ochracea* Ryvarden & Stokland.	Mingkong, Mokokchung
	NU/BOT/GLO-373	*Fomitopsis pinicola* (Sw.) P.Karst.	Phangsang, Mokokchung
	NU/BOT/GLO-163	*Fomitopsis* sp.	Tanhai, Mon
Gloeophyllaceae	NU/BOT/GLO-188	*Gloeophyllum* sp.	Helipong, Tuensang
Gomphaceae	NU/BOT/GLO-111	*Gomphus floccosus*(Schw.) Sing.	Kikruma, Phek
	NU/BOT/GLO-185	*Lentaria* sp.	Helipong, Tuensang
	NU/BOT/GLO-086	*Ramaria thindii* A. Parihar & A. Ghosh.	Kikruma, Phek
Gyroporaceae	NU/BOT/GLO-178	*Gyroporus* sp.	Helipong, Tuensang
Helotiaceae	NU/BOT/GLO-251	*Bisporella citrina* (Batsch) Korf & S.E.Carp.	Helipong, Tuensang

Helvellaceae	NU/BOT/GLO-358	*Helvella macropus* (Pers.) P. Karst.	Lumami, Zunheboto
Hydnaceae	NU/BOT/GLO-072	*Clavulina* sp.	Kigwema, Kohima
Hydnangiaceae	NU/BOT/GLO-071	*Laccaria amethystina* (Huds.) Cooke.	Kigwema, Kohima
	NU/BOT/GLO-088	*Laccaria laccata*(Scop.) Cooke.	Kikruma, Phek
	NU/BOT/GLO-056	*Laccaria* sp.1	Kigwema, Kohima
	NU/BOT/GLO-180	*Laccaria* sp.2	Helipong, Tuensang
	NU/BOT/GLO-214	*Laccaria* sp.3	Ngangpong, Tuensang
	NU/BOT/GLO-159	*Laccaria tortilis* (Bolton) Cooke.	Tanhai, Mon
	NU/BOT/GLO-190	*Laccaria vinaceobrunnea* G.M. Muell.	Kigwema, Kohima
Hygrophoraceae	NU/BOT/GLO-062	*Arrhenia* sp.	Kigwema, Kohima
	NU/BOT/GLO-060	*Chrysomphalina* sp.1	Kigwema, Kohima
	NU/BOT/GLO-263	*Chrysomphalina* sp.2	Phangsang, Mokokchung
	NU/BOT/GLO-125	*Hygrocybe cantharellus*(Schwein.) Murrill.	Lumami, Zunheboto
	NU/BOT/GLO-105	*Hygrophorus fuscopapillatus* C.Q. Wang & T.H. Li.	Kikruma, Phek
	NU/BOT/GLO-141	*Hygrophorus* sp.	Mingkong, Mokokchung
Hymenochaetaceae	NU/BOT/GLO-058	*Coltricia cinnamomea* Gray.	Kigwema, Kohima
	NU/BOT/GLO-313	*Hymenochaete* sp.	Phesama, Kohima
	NU/BOT/GLO-144	*Phellinus* sp.1	Mingkong, Mokokchung
	NU/BOT/GLO-274	*Phellinus* sp.2	Phangsang, Mokokchung
Hymenogastraceae	NU/BOT/GLO-197	*Gymnopilus* sp.1	Helipong, Tuensang
	NU/BOT/GLO-235	*Gymnopilus* sp.2	Helipong, Tuensang
	NU/BOT/GLO-307	*Gymnopilus* sp.3	Phesama, Kohima
	NU/BOT/GLO-008	*Psilocybe cubensis* (Earle) Singer.	Bongkolong, Peren
	NU/BOT/GLO-055	*Psilocybe* sp.1	Kigwema, Kohima
	NU/BOT/GLO-309	*Psilocybe* sp.2	Phesama, Kohima
Hypoxylaceae	NU/BOT/GLO-212	*Daldinia vernicosa* Ces. & De Not.	Ngangpong, Tuensang
Inocybaceae	NU/BOT/GLO-278	*Inocybe* sp.	Mopungchuket, Mokokchung
	NU/BOT/GLO-291	*Inosperma calamistratum* (Fr.) Matheny & Esteve-Rav.	Mopungchuket, Mokokchung
	NU/BOT/GLO-300	*Inosperma* sp.	Mopungchuket, Mokokchung
Ischnodermataceae	NU/BOT/GLO-262	*Ischnoderma resinosum* (Schrad.) P.Karst.	Phangsang, Mokokchung

Leotiaceae	NU/BOT/GLO-074	*Leotia lubrica*(Scop.) Pers.	Kigwema, Kohima
Lycoperdaceae	NU/BOT/GLO-195	*Apioperdon pyriforme* (Schaeff.) Vizzini.	Helipong, Tuensang
	NU/BOT/GLO-065	*Lycopedon* sp.1	Kigwema, Kohima
	NU/BOT/GLO-231	*Lycoperdon* sp.2	helipong, Tuensang
	NU/BOT/GLO-294	*Lycoperdon* sp.3	Mopungchuket, Mokokchung
Lyophyllaceae	NU/BOT/GLO-081	*Lyophyllum fumosum* (Pers.) P.D. Orton.	Kigwema, Kohima
	NU/BOT/GLO-022	*Termitomyces heimii* Natarajan.	Toulazouma, Dimapur
	NU/BOT/GLO-370	*Termitomyces microcarpus* (Berk. & Broome) R.Heim.	Toulazouma, Dimapur
	NU/BOT/GLO-123	*Termitomyces* sp.1	Zaphumi, Zunheboto
	NU/BOT/GLO-207	*Termitomyces* sp.2	Zaphumi, Zunheboto
	NU/BOT/GLO-341	*Termitomyces* sp.3	Old Riphym, Wokha
Marasmiaceae	NU/BOT/GLO-236	*Campanella tristis* (G. Stev.) Segedin.	Helipong, Tuensang
	NU/BOT/GLO-258	*Campanella junghuhnii* Mont.	Helipong, Tuensang
	NU/BOT/GLO-191	*Crinipellis* sp.	Helipong, Tuensang
	NU/BOT/GLO-314	*Marasimellus* sp.	Phesama, Kohima
	NU/BOT/GLO-323	*Marasmiellus candidus* (Bolt.) Singer.	Old Riphym, Wokha
	NU/BOT/GLO-035	*Marasmius* sp.1	Lumami, Zunheboto
	NU/BOT/GLO-166	*Marasmius* sp.2	Helipong, Tuensang
	NU/BOT/GLO-174	*Marasmius* sp.3	Helipong, Tuensang
	NU/BOT/GLO-192	*Marasmius* sp.4	Helipong, Tuensang
	NU/BOT/GLO-196	*Marasmius* sp.5	Helipong, Tuensang
	NU/BOT/GLO-247	*Marasmius* sp.6	Helipong, Tuensang
	NU/BOT/GLO-288	*Marasmius* sp.7	Kigwema, Kohima
	NU/BOT/GLO-151	*Trogia venenata* Zhu L.Yang, Y.C.Li & L.P.Tang	Mingkong, Mokokchung
Meripilaceae	NU/BOT/GLO-027	*Physisporinus lineatus* (Pers.) F. Wu, Jia J. Chen & Y.C. Dai.	Lumami, Zunheboto
Meruliaceae	NU/BOT/GLO-266	*Abortiporus* sp.	Phangsang, Mokokchung
Mollisiaceae	NU/BOT/GLO-184	*Mollisia* sp.	Helipong, Tuensang
Mycenaceae	NU/BOT/GLO-133	*Favolaschia* sp.	Mingkong, Mokokchung
	NU/BOT/GLO-164	*Heimiomyces* sp.	Helipong, Tuensang
	NU/BOT/GLO-016	*Mycena manipularis*(Berk.) Sacc.	Bongkolong, Peren
	NU/BOT/GLO-029	*Mycena* sp.1	Lumami, Zunheboto

	NU/BOT/GLO-152	*Mycena* sp.2	Mingkong, Mokokchung
	NU/BOT/GLO-155	*Mycena* sp.3	Mingkong, Mokokchung
	NU/BOT/GLO-194	*Mycena* sp.4	Helipong, Tuensang
	NU/BOT/GLO-215	*Mycena* sp.5	Kigwema, Kohima
	NU/BOT/GLO-318	*Mycena* sp.6	Phesama, Kohima
	NU/BOT/GLO-189	*Mycena adscendens* Maas Geest.	Helipong, Tuensang
	NU/BOT/GLO-331	*Panellus longinquus* (Berk.) Singer.	Old Riphym, Wokha
	NU/BOT/GLO-143	*Roridomyces* sp.	Mingkong, Mokokchung
Omphalotaceae	NU/BOT/GLO-045	*Gymnopus* sp.1	Lumami, Zunheboto
	NU/BOT/GLO-150	*Gymnopus* sp.2	Mingkong, Mokokchung
	NU/BOT/GLO-177	*Gymnopus* sp.3	Helipong, Tuensang
	NU/BOT/GLO-182	*Gymnopus* sp.4	Helipong, Tuensang
	NU/BOT/GLO-201	*Gymnopus* sp.5	Helipong, Tuensang
	NU/BOT/GLO-232	*Gymnopus* sp.6	Helipong, Tuensang
	NU/BOT/GLO-306	*Gymnopus* sp.7	Phesama, Kohima
	NU/BOT/GLO-187	*Lentinula* edodes (Berk.) Pegler.	Helipong, Tuensang
	NU/BOT/GLO-348	*Neonothopanus hygrophanus* (Mont.) De Kesel & Degreef.	Old Riphym, Wokha
Ophiocordycipitaceae	NU/BOT/GLO-102	*Ophiocordyceps longissima* Kobayasi	Kikruma, Phek
	NU/BOT/GLO-248	*Ophiocordyceps nutans*(Pat.)	Kigwema, Kohima
Panaceae	NU/BOT/GLO-019	*Cymatoderma dendriticum* (Pers.) D.A.Reid.	Bongkolong, Peren
	NU/BOT/GLO-327	*Panus fasciatus* (Berk.) Pegler.	Old Riphym, Wokha
	NU/BOT/GLO-013	*Panus similis* (Berk. & Broome) T.W. May & A.E. Wood.	Bongkolong, Peren
	NU/BOT/GLO-356	*Panus* sp.	Old Riphym, Wokha
Pezizaceae	NU/BOT/GLO-176	*Peziza* sp.	Helipong, Tuensang
Phaeolaceae	NU/BOT/GLO-285	*Phaeolus* sp.	Mopungchuket, Mokokchung
Phaeotremellaceae	NU/BOT/GLO-250	*Phaeotremella frondosa* (Fr.) Spirin & V. Malysheva.	Helipong, Tuensang
	NU/BOT/GLO-186	*Phaeotremella* sp.	Helipong, Tuensang
Phallaceae	NU/BOT/GLO-239	*Phallus calongei* G. Moreno & Khalid.	Helipong, Tuensang
	NU/BOT/GLO-047	*Phallus duplicatus* Bosc.	Toulazouma, Dimapur
	NU/BOT/GLO-335	*Phallus indusiatus* Vent.	Old Riphym, Wokha
Physalacriaceae	NU/BOT/GLO-245	*Armillaria mellea* (Vahl) P.Kumm.	Helipong, Tuensang

	NU/BOT/GLO-213	*Cyptotrama asprata* (Berk.) Redhead & Ginns.	Ngangpong, Tuensang
	NU/BOT/GLO-096	*Hymenopellis radicata* (Relhan) Dörfelt.	Kikruma, Phek
	NU/BOT/GLO-138	*Oudemansiella exannulata* (Cleland & Cheel) R.H. Petersen.	Mingkong, Mokokchung
	NU/BOT/GLO-059	*Oudemansiella furfuracea*(Speg.) Speg.	Kigwema, Kohima
	NU/BOT/GLO-077	*Strobilurus* sp.1	Kigwema, Kohima
	NU/BOT/GLO-142	*Strobilurus* sp.2	Mingkong, Mokokchung
	NU/BOT/GLO-287	*Xerula* sp.	Mopungchuket, Mokokchung
Pleurotaceae	NU/BOT/GLO-364	*Pleurotus citrinopileatus* Singer.	Zapami, Phek
	NU/BOT/GLO-354	*Pleurotus dryinus* (Pers.) P.Kumm.	Old Riphym, Wokha
	NU/BOT/GLO-365	*Pleurotus giganteus* (Berk.) Karunarathna & K.D. Hyde.	Toulazouma, Dimapur
	NU/BOT/GLO-139	*Pleurotus ostreatus*(Jacq. ex Fr.) P.Kumm.	Mingkong, Mokokchung
	NU/BOT/GLO-126	*Pleurotus pulmonarius*(Fr.) Quél.	Lumami, Zunheboto
	NU/BOT/GLO-124	*Pleurotus* sp. 1	Lumami, Zunheboto
	NU/BOT/GLO-153	*Pleurotus* sp.2	Mingkong, Mokokchung
	NU/BOT/GLO-260	*Pleurotus* sp.3	Phangsang, Mokokchung
	NU/BOT/GLO-308	*Pleurotus* sp.4	Phesama, Kohima
	NU/BOT/GLO-363	*Pleurotus tuber-regium* (Rumph. ex Fr.) Singer.	Phangsang, Mokokchung
Pluteaceae	NU/BOT/GLO-336	*Pluteus cervinus* (Schäffer : Fr) P. Kumm.	Old Riphym, Wokha
	NU/BOT/GLO-183	*Pluteus* sp.1	Helipong, Tuensang
	NU/BOT/GLO-220	*Pluteus* sp.2	Helipong, Tuensang
Polyporaceae	NU/BOT/GLO-283	*Amauroderma rugosum* (Blume & T. Nees) Torrend.	Mopungchuket, Mokokchung
	NU/BOT/GLO-310	*Amauroderma* sp.1	Phesama, Kohima
	NU/BOT/GLO-351	*Amauroderma* sp.2	Old Riphym, Wokha
	NU/BOT/GLO-010	*Bresadolia uda* (Jungh.) Audet.	Bongkolong, Peren
	NU/BOT/GLO-371	*Cerrena unicolor*(Bull.) Murrill.	Kigwema, Kohima
	NU/BOT/GLO-259	*Favolus brasiliensis* (Fr.) Fr.	Phangsang, Mokokchung
	NU/BOT/GLO-227	*Favolus* sp.1	Helipong, Tuensang
	NU/BOT/GLO-320	*Favolus* sp.2	Old Riphym, Wokha
	NU/BOT/GLO-244	*Fomes fomentarius* (L.) Fr.	Helipong, Tuensang

	NU/BOT/GLO-075	*Ganoderma lucidium* (Sheng H. Wu, Cao & Y.C. Dai).	Kigwema, Kohima
	NU/BOT/GLO-275	*Ganoderma* sp.1	Phangsang, Mokokchung
	NU/BOT/GLO-340	*Ganoderma* sp.2	Mopungchuket, Mokokchung
	NU/BOT/GLO-050	*Hexagonia* sp.	Lumami, Zunheboto
	NU/BOT/GLO-053	*Hexagonia tenuis*(Hook.) Fr.	Lumami, Zunheboto
	NU/BOT/GLO-018	*Lentinus badius* (Berk.)Berk.	Bongkolong, Peren
	NU/BOT/GLO-012	*Lentinus crinitus*(L.) Fr.	Bongkolong, Peren
	NU/BOT/GLO-009	*Lentinus sajor-caju* (Fr.) Fr.	Bongkolong, Peren
	NU/BOT/GLO-268	*Lentinus* sp.1	Phangsang, Mokokchung
	NU/BOT/GLO-339	*Lentinus squarrosulus* Mont.	Bongkolong, Peren
	NU/BOT/GLO-007	*Lentinus tigrinus* (Bull.) Fr.	Old Riphym, Wokha
	NU/BOT/GLO-025	*Lenzites elegans* (Spreng.)Pat.	Lumami, Zunheboto
	NU/BOT/GLO-161	*Microporus* sp.	Tanhai, Mon
	NU/BOT/GLO-026	*Microporus xanthopus* (Fr.)Kuntze.	Lumami, Zunheboto
	NU/BOT/GLO-031	*Polyporus arcularius* (Batsch)Fries.	Lumami, Zunheboto
	NU/BOT/GLO-103	*Polyporus* sp.1	Kikruma, Phek
	NU/BOT/GLO-130	*Polyporus* sp.2	Lumami, Zunheboto
	NU/BOT/GLO-265	*Polyporus* sp.3	Phangsang, Mokokchung
	NU/BOT/GLO-272	*Polyporus* sp.4	Phangsang, Mokokchung
	NU/BOT/GLO-366	*Polyporus* sp.5	Pfutsero, Phek
	NU/BOT/GLO-374	*Polyporus* sp.6	Phangsang, Mokokchung
	NU/BOT/GLO-080	*Pseudofavolus tenuis* (Fr.) G. Cunn.	Kigwema, Kohima
	NU/BOT/GLO-006	*Pycnoporus* sp.	Bongkolong, Peren
	NU/BOT/GLO-030	*Trametes hirsuta* (Wulfen)Lloyd.	Lumami, Zunheboto
	NU/BOT/GLO-209	*Trametes* sp.1	Ngangpong, Tuensang
	NU/BOT/GLO-246	*Trametes* sp.2	Helipong, Tuensang
	NU/BOT/GLO-267	*Trametes* sp.3	Phangsang, Mokokchung
	NU/BOT/GLO-315	*Trametes* sp.4	Phesama, Kohima
	NU/BOT/GLO-210	*Trichaptum biforme* (Fr.) Ryvarden.	Ngangpong, Tuensang
	NU/BOT/GLO-254	*Trichaptum* sp.	helipong, Tuensang
Porotheleaceae	NU/BOT/GLO-222	*Hydropus* sp.	Helipong, Tuensang
Psathyrellaceae	NU/BOT/GLO-028	*Candolleomyces* sp.	Lumami, Zunheboto

	NU/BOT/GLO-219	*Coprinellus disseminates* (Pers.) J.E.Lange.	Helipong, Tuensang
	NU/BOT/GLO-205	*Coprinellus domesticus* (Bolton) Vilgalys, Hopple & Jacq.Johnson.	Ngangpong, Tuensang
	NU/BOT/GLO-044	*Coprinellus* sp.1	Lumami, Zunheboto
	NU/BOT/GLO-158	*Coprinopsis lagopus* (Fr.) Redhead, Vilgalys & Moncalvo.	Tanhai, Mon
	NU/BOT/GLO-005	*Coprinopsis* sp.	Bongkolong, Peren
	NU/BOT/GLO-017	*Panaeolus antillarum*(Fr.) Dennis.	Bongkolong, Peren
	NU/BOT/GLO-001	*Panaeolus* sp.	Bongkolong, Peren
	NU/BOT/GLO-228	*Psathyrella piluliformis* (Bull.) P.D.Orton.	Helipong, Tuensang
	NU/BOT/GLO-168	*Psathyrella* sp.1	Helipong, Tuensang
	NU/BOT/GLO-233	*Psathyrella* sp.2	Helipong, Tuensang
	NU/BOT/GLO-317	*Psathyrella* sp.3	Phesama, Kohima
	NU/BOT/GLO-342	*Psathyrella* sp.4	Old Riphym, Wokha
	NU/BOT/GLO-221	*Psathyrella squamosa* (P. Karst.) A.H. Sm.	Helipong, Tuensang
Pyronemataceae	NU/BOT/GLO-369	*Trichaleurina javanica* (Rehm) M. Carbone, Agnello & P. Alvarado.	Bongkolong, Peren
Rhizopogonaceae	NU/BOT/GLO-113	*Rhizopogon luteolus*Fr.	Kikruma, Phek
	NU/BOT/GLO-122	*Rhizopogon* sp.	Lumami, Zunheboto
Russulaceae	NU/BOT/GLO-067	*Lactarius quietus*(Fr.) Fr.	Kigwema, Kohima
	NU/BOT/GLO-070	*Lactarius* sp.	Kigwema, Kohima
	NU/BOT/GLO-076	*Lactifluus luteolus* (Peck) Verbeken.	Kigwema, Kohima
	NU/BOT/GLO-090	*Lactifluus piperatus*(L.) Roussel.	Kikruma, Phek
	NU/BOT/GLO-036	*Lactifluus volemus* (Fr.)Kuntze.	Lumami, Zunheboto
	NU/BOT/GLO-333	*Russula betularum* Hora.	Old Riphym, Wokha
	NU/BOT/GLO-033	*Russula crustosa* Peck.	Lumami, Zunheboto
	NU/BOT/GLO-069	*Russula cyanoxantha*(Schaeff.) Fr.	Kigwema, Kohima
	NU/BOT/GLO-107	*Russula emetica* (Schaeff.)Pers.	Kikruma, Phek
	NU/BOT/GLO-321	*Russula foetens* Pers.	Old Riphym, Wokha
	NU/BOT/GLO-376	*Russula griseocarnosa* X.H.Wang, Zhu L.Yang & Knudsen.	Mopungchuket, Mokokchung
	NU/BOT/GLO-349	*Russula luteotacta* Rea.	Old Riphym, Wokha
	NU/BOT/GLO-347	*Russula ochroleuca* Fr.	Old Riphym, Wokha

	NU/BOT/GLO-004	*Russula* sp.1	Bongkolong, Peren
	NU/BOT/GLO-037	*Russula* sp.2	Lumami, Zunheboto
	NU/BOT/GLO-038	*Russula* sp.3	Lumami, Zunheboto
	NU/BOT/GLO-095	*Russula* sp.4	Kikruma, Phek
	NU/BOT/GLO-100	*Russula* sp.5	Kikruma, Phek
	NU/BOT/GLO-108	*Russula* sp.6	Kikruma, Phek
	NU/BOT/GLO-131	*Russula* sp.7	Lumami, Zunheboto
	NU/BOT/GLO-281	*Russula* sp.8	Mopungchuket, Mokokchung
	NU/BOT/GLO-296	*Russula* sp.9	Mopungchuket, Mokokchung
	NU/BOT/GLO-325	*Russula* sp.10	Old Riphym, Wokha
	NU/BOT/GLO-326	*Russula* sp.11	Old Riphym, Wokha
	NU/BOT/GLO-330	*Russula* sp.12	Old Riphym, Wokha
	NU/BOT/GLO-350	*Russula* sp.13	Old Riphym, Wokha
	NU/BOT/GLO-368	*Russula* sp.14	Kikruma, Phek
	NU/BOT/GLO-092	*Russula virescens*(Schaeff.) Fr.	Kikruma, Phek
Sarcoscyphaceae	NU/BOT/GLO-148	*Cookeina tricholoma* (Mont.) Kuntze	Changki, Mokokchung
	NU/BOT/GLO-132	*Sarcoscypha coccinea*(Scop.) Lambotte	Mingkong, Mokokchung
	NU/BOT/GLO-261	*Galiella rufa* (Schwein.) Nannf. & Korf	Phangsang, Mokokchung
Schizophyllaceae	NU/BOT/GLO-206	*Schizophyllum commune* Fr.	Ngangpong, Tuensang
Schizoporaceae	NU/BOT/GLO-024	*Schizopora* sp.	Lumami, Zunheboto
Sclerodermataceae	NU/BOT/GLO-338	*Scleroderma bovista* Fr.	Old Riphym, Wokha
	NU/BOT/GLO-375	*Scleroderma* sp.	Phangsang, Mokokchung
	NU/BOT/GLO-128	*Scleroderma aurantium* L.	Lumami, Zunheboto
Steccherinaceae	NU/BOT/GLO-270	*Irpex lacteus* (Fr.) Fr.	Phangsang, Mokokchung
Stereaceae	NU/BOT/GLO-042	*Stereum hirsutum* (Willd.)Pers.	Lumami, Zunheboto
	NU/BOT/GLO-208	*Stereum* sp.1	Ngangpong, Tuensang
	NU/BOT/GLO-279	*Stereum* sp.*2*	Mopungchuket, Mokokchung
	NU/BOT/GLO-264	*Stereum subtomentosum* Pouzar.	Phangsang, Mokokchung
Strophariaceae	NU/BOT/GLO-229	*Galerina hypnorum* (Schrank) Kühner.	Helipong, Tuensang
	NU/BOT/GLO-173	*Galerina* sp.	Helipong, Tuensang
	NU/BOT/GLO-361	*Hemistropharia albocrenulata* (Peck) Jacobsson & E. Larss.	Helipong, Tuensang

	NU/BOT/GLO-170	*Hypholoma fasciculare* (Huds.Fr.) P.Kumm.	Helipong, Tuensang
	NU/BOT/GLO-162	*Hypholoma* sp.1	Tanhai, Mon
	NU/BOT/GLO-172	*Hypholoma* sp.2	Helipong, Tuensang
	NU/BOT/GLO-193	*Hypholoma* sp.3	Helipong, Tuensang
	NU/BOT/GLO-198	*Hypholoma* sp.4	Helipong, Tuensang
Suillaceae	NU/BOT/GLO-332	*Suillus americanus* (Peck) Snell.	Old Riphym, Wokha
	NU/BOT/GLO-098	*Suillus luteus*(L.) Roussel.	Kikruma, Phek
	NU/BOT/GLO-117	*Suillus* sp.1	Kikruma, Phek
	NU/BOT/GLO-280	*Suillus* sp.2	Mopungchuket, Mokokchung
	NU/BOT/GLO-290	*Suillus* sp.3	Mopungchuket, Mokokchung
Tapinellaceae	NU/BOT/GLO-099	*Pseudomerulius curtisii* (Berk.)Redhead & Ginns.	Kikruma, Phek
Thelephoraceae	NU/BOT/GLO-087	*Hydnellum* sp.	Kikruma, Phek
	NU/BOT/GLO-338	*Thelephora palmata* (Scop.) Fr.	Old Riphym, Wokha
Tremellaceae	NU/BOT/GLO-175	*Tremella fuciformis* Berk.	Helipong, Tuensang
	NU/BOT/GLO-211	*Tremella mesenterica* Retz.	Ngangpong, Tuensang
Tricholomataceae	NU/BOT/GLO-110	*Clitocybe fragrans*(With.) P.Kumm.	Kikruma, Phek
	NU/BOT/GLO-345	*Clitocybe nuda* (Bull.) H.E.Bigelow & A.H.Sm.	Old Riphym, Wokha
	NU/BOT/GLO-003	*Clitocybe* sp.1	Bongkolong, Peren
	NU/BOT/GLO-237	*Clitocybe* sp.2	Helipong, Tuensang
	NU/BOT/GLO-015	*Collybia* sp.1	Bongkolong, Peren
	NU/BOT/GLO-225	*Collybia* sp.2	Helipong, Tuensang
	NU/BOT/GLO-199	*Delicatula* sp.	Helipong, Tuensang
	NU/BOT/GLO-011	*Filoboletus manipularis*.(Berk.) Sacc.	Bongkolong, Peren
	NU/BOT/GLO-147	*Lepista flaccida*(Sowerby) Pat.	Mingkong, Mokokchung
	NU/BOT/GLO-049	*Melanoleuca* sp.1	Lumami, Zunheboto
	NU/BOT/GLO-355	*Melanoleuca* sp.*2*	Old Riphym, Wokha
	NU/BOT/GLO-154	*Omphalia integrella* (Pers.) P.Kumm.	Mingkong, Mokokchung
	NU/BOT/GLO-149	*Omphalina* sp.	Mingkong, Mokokchung
	NU/BOT/GLO-146	*Resupinatus* sp.	Mingkong, Mokokchung
	NU/BOT/GLO-218	*Scytinotus longinquus* (Berk.) Thorn.	Helipong, Tuensang
	NU/BOT/GLO-112	*Tricholoma* sp.1	Kikruma, Phek

	NU/BOT/GLO-302	*Tricholoma* sp.2	Mopungchuket, Mokokchung
Tubariaceae	NU/BOT/GLO-079	*Tubaria* sp.1	Kigwema, Kohima
	NU/BOT/GLO-230	*Tubaria* sp.2	Helipong, Tuensang
Unknown	NU/BOT/GLO-145	Unidentified sp.1	Mingkong, Mokokchung
	NU/BOT/GLO-217	Unidentified sp.2	Helipong, Tuensang
	NU/BOT/GLO-223	Unidentified sp.3	Helipong, Tuensang
	NU/BOT/GLO-224	Unidentified sp.4	Helipong, Tuensang
	NU/BOT/GLO-243	Unidentified sp.5	Helipong, Tuensang
	NU/BOT/GLO-256	Unidentified sp.6	Helipong, Tuensang
	NU/BOT/GLO-269	Unidentified sp.7	Phangsang, Mokokchung
	NU/BOT/GLO-295	Unidentified sp.8	Mopungchuket, Mokokchung
	NU/BOT/GLO-301	Unidentified sp.9	Mopungchuket, Mokokchung
	NU/BOT/GLO-322	Unidentified sp.10	Old Riphym, Wokha
	NU/BOT/GLO-337	Unidentified sp.11	Old Riphym, Wokha
	NU/BOT/GLO-353	Unidentified sp.12	Old Riphym, Wokha
Xylariaceae	NU/BOT/GLO-134	*Rosellinia* sp.	Mingkong, Mokokchung
	NU/BOT/GLO-253	*Xylaria hypoxylon* (L.) Grev	Helipong, Tuensang
	NU/BOT/GLO-311	*Xylaria longipes* Nitschke	Phesama, Kohima
	NU/BOT/GLO-137	*Xylaria polymorpha*(Pers.) Grev.	Mingkong, Mokokchung
	NU/BOT/GLO-034	*Xylaria* sp.1	Lumami, Zunheboto
	NU/BOT/GLO-156	*Xylaria* sp.2	Mingkong, Mokokchung
	NU/BOT/GLO-271	*Xylaria* sp.3	Phangsang, Mokokchung

The table presented above (Table 4.2) comprises the various species of wild mushrooms that were gathered and identified over the course of the study period spanning from 2017 to 2022. The identification process was facilitated through the utilisation of relevant literature sources and the incorporation of traditional knowledge obtained from local communities.

Plate 1: Pictures of wild mushrooms

(1) *Panaeolus* sp. (2) *Amanita* sp. 1

(3) *Clitocybe* sp.1 (4) *Russula* sp.1

(5) *Coprinopsis* sp. (6) *Pycnoporus* sp.

(7) *Lentinus tigrinus* (8) *Psilocybe cubensis.*

Plate 2 Pictures of wild mushrooms

(9). Lentinus sajor-caju *(10)Bresadolia uda*

(11) Filoboletus manipularis. *(12) Lentinus crinitus*

(13) Panus similis *(14) Auricularia delicata*

(15) Collybia sp.1 *(16) Mycena manipularis*

.

Plate 3 Pictures of wild mushrooms

(17) Panaeolus antillarum

(18) Lentinus badius

(19) Cymatoderma dendriticum

(20) Clavatia sp.1

(21) Agaricus sp.1

(22) Termitomyces heimii

(23) Gyrodontium sacchari

(24) Schizopora sp.

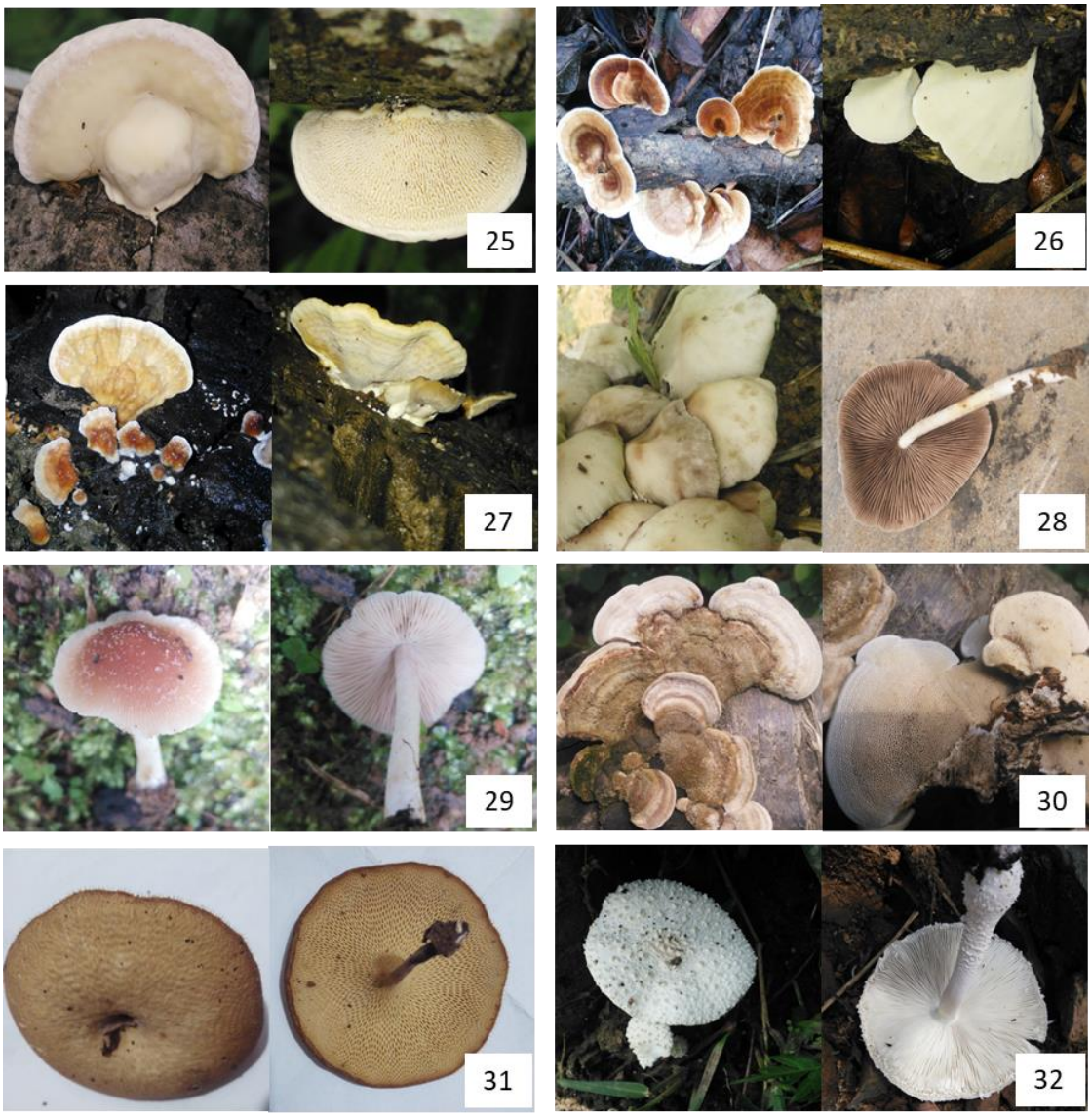


Plate 4. Pictures of wild mushrooms

(25) Lenzites elegans

(26) Microporus xanthopus

(27) Physisporinus lineatus

(28) Candolleomyces sp.

(29) Mycena sp.1

(30) Trametes hirsuta

(31) Polyporus arcularius

(32) Leucocoprinus cretaceus

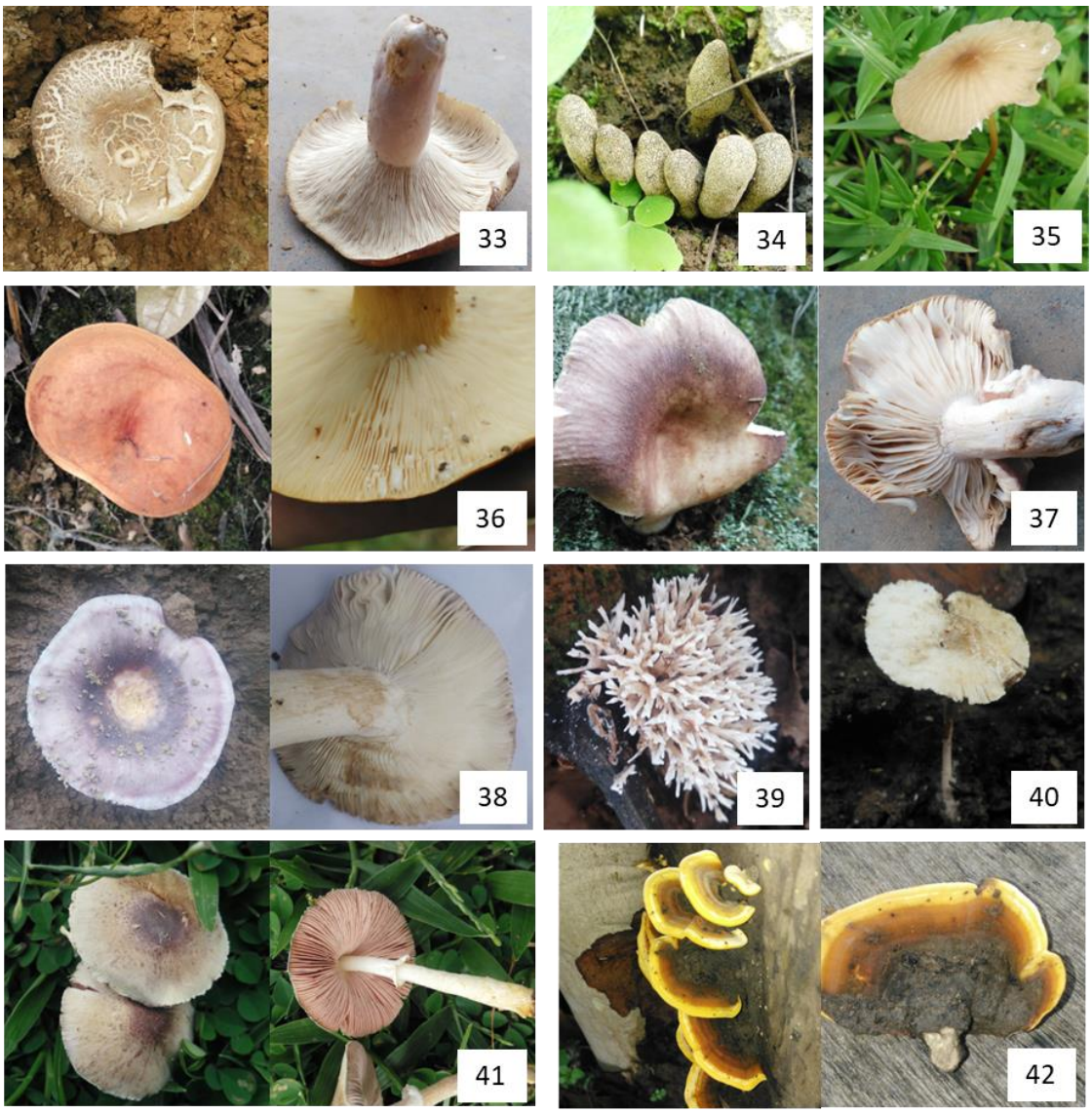


Plate 5 Pictures of wild mushrooms

(33) Russula crustosa *(34) Xylaria* sp.1

(35) Marasmius sp 1 *(36) Lactifluus volemus*

(37) Russula sp.2 *(38) Russula* sp.3

(39) Tremellodendron schweinitzii *(40) Leucocoprinus* sp

(41) Agaricus placomyces *(42) Stereum hirsutum*

Plate 6 Pictures of wild mushrooms

(43) Crepidotus mollis

(44) Coprinellus sp.1

(45) Gymnopus sp.1

(46) Chlorophyllum molybdites

(47) Phallus duplicatus

(48) Boletus sp.1

(49) Melanoleuca sp.1

(50) Hexagonia sp.

Plate 7 Pictures of wild mushrooms

(51) Boletus sp.2 *(52) Boletellus ananas*

(53) Hexagonia tenuis *(54) Leucocoprinus birnbaumii*

(55) Psilocybe sp.1 *(56) Laccaria* sp.1

(57) Amanita sp.2 *(58) Coltricia cinnamomea*

Plate 8 Pictures of wild mushrooms

(59) Oudemansiella furfuracea

(60) Chrysomphalina sp.

(61) Craterellus cornucopioides

(62) Arrhenia sp.

(63) Nidula sp.

(64) Tylopilus sp.1

(65) Lycopedon sp.

(66) Cantharellus cinnabarinus

(67) Lactarius quietus

Plate 9 Pictures of wild mushrooms

(68) Cantherllus sp.

(69) Russula cyanoxantha.

(70) Lactarius sp.

(71) Laccaria amethystina

(72) Clavulina sp.

(73) Cantharellus minor

(74) Leotia lubrica

(75) Ganoderma lucidium

Plate 10 Pictures of wild mushrooms

(76) Lactifluus luteolus. *(77) Strobilurus* sp.1

(78)) Boletus edulis. *(79) Tubaria* sp.1

(80) Pseudofavolus tenuis *(81) Lyophyllum fumosum*

(82) Tylopilus sp.2 *(83) Tylopilus* sp.3

Plate 11 Pictures of wild mushrooms

(84) Amanita pantherina

(85) Boletus sp.3

(86) Ramaria thindii

(87) Hydnellum sp.

(88) Laccaria laccata

(89) Cantharellus cibarius

(90) Lactifluus piperatus

(91) Fistulina hepatica

(92) Russula virescens

Plate 12 Pictures of wild mushrooms

(93) Imleria badia *(94) Amanita* sp.3

(95) Russula sp.4 *(96) Hymenopellis radicata*

(97) Boletus reticulatus *(98) Suillus luteus*

(99) Pseudomerulius curtisii *(100) Russula sp. 5*

(101) Boletus separans

Plate 13 Pictures of wild mushrooms

(102) Ophiocordyceps longissimi *(103) Polyporus* sp.1

(104) Retiboletus griseus *(105) Hygrophorus fuscopapillatus*

(106) Amanita velosa *(107) Russula emetica*

(108) Russula sp.6 *(109) Macrolepiota olivascens*

(110) Clitocybe fragrans

Plate 14 Pictures of wild mushrooms

(111) Turbinellus floccosus

(112) Tricholoma sp.1

(113) Rhizopogon luteolus

(114) Cortinarius purpurascens

(115) Agaricus augustus

(116) Cortinarius sp.1

(117) Suillus sp.1

(118) Dacryopinax spathularia.

(119) Cantharellus lateritius

Plate 15 Pictures of wild mushrooms

(120) Leccinum sp.

(121) Strobilomyces sp.

(122) Rhizopogon sp.

(123) Termitomyces sp. 1

(124) Pleurotus sp. 1

(125) Hygrocybe cantharellus

(126) Pleurotus pulmonarius

(127) Cortinarius sp.2

Plate 16 Pictures of wild mushrooms

(128) Scleroderma aurantium

(129) Boletellus emodensis

(130) Polyporus sp. *2*

(131) Russula sp. 7

(132) Sarcoscypha coccinea

(133) Favolaschia sp.

(134) Rosellinia sp.

(135) Fomitopsis ochracea

(136) Cyathus striatus

(137) Xylaria polymorpha

(138) Oudemansiella exannulata

Plate 17 Pictures of wild mushrooms

(139) Pleurotus ostreatus *(140) Crepidotus* sp.1 *(141) Hygrophorus* sp.

(142) Strobilurus sp.2 *(143) Roridomyces* sp.

(144) Phellinus sp.1 *(145) Unidentified* sp.1

(146) Resupinatus sp. *(147) Lepista flaccida*

(148) Cookeina tricholoma *(149) Omphalina* sp.

(150) Gymnopus sp.2 *(151) Trogia venenata*

Plate 18 Pictures of wild mushrooms

(152) Mycena sp.2

(153) Pleurotus sp.2

(154) Omphalia integrella

(155) Mycena sp.3

(156) Xylaria sp.2

(157) Ramariopsis kunzei

(158) Coprinopsis lagopus

(159) Laccaria tortilis

(160) Dacryopinax sp.

(161) Microporus sp.

(162) Hypholoma sp.1

Plate 19 Pictures of wild mushrooms

(163) Fomitopsis sp. *(164) Heimiomyces* sp.

(165) Clitopilus sp *(166) Marasmius* sp.2

(167) Exidia sp. *(168) Psathyrella* sp.1

(169) Entoloma sp. *(170) Hypholoma fasciculare*

(171) Pseudohydnum gelatinosum

Plate 20 Pictures of wild mushrooms

(172) Hypholoma sp.2 *(173) Galerina* sp.

(174) Marasimus sp.3 *(175) Tremella fuciformis*

(176) Peziza sp. *(177) Gymnopus* sp.3

(178) Gyroporus sp. *(179) Entoloma murrayi*

(180) Laccaria sp.2

Plate 21 Pictures of wild mushrooms

(181) Chlorociboria aeruginosa *(182) Gymnopus* sp.4

(183) Pluteus sp.1 *(184) Mollisia* sp.

(185) Lentaria sp. *(186) Phaeotremella* sp.

(187) Lentinula edodes *(188) Gloeophyllum* sp.

(189) Mycena adscendens *(190) Laccaria vinaceobrunnea*

(191) Crinipellis sp.

Plate 22 Pictures of wild mushrooms

(192) Marasmius sp.4 *(193) Hypholoma* sp.3

(194) Mycena sp.4 *(195) Apioperdon pyriforme*

(196) Marasmius sp.5 *(197) Gymnopilus* sp.1

(198) Hypholoma sp.4 *(199) Delicatula* sp.

(200) Cortinarius sp.3

Plate 23 Pictures of wild mushrooms

(201) Gymnopus sp.5

(202) Auricularia nigricans

(203) Auricularia auricula-judae

(204) Auricularia mesenterica

(205) Coprinellus domesticus.

(206) Schizophyllum commune.

(207) Termitomyces sp.2

(208) Stereum sp.1

(209) Trametes sp.1

(210) Trichaptum biforme

(211) Tremella mesenterica

(212) Daldinia vernicosa

(213) Cyptotrama asprata

(214) Laccaria sp.3

(215) Mycena sp.5

Plate 24 Pictures of wild mushrooms

(216) Antrodia albida *(217)* Unidentified sp.2

(218) Scytinotus longinquus *(219) Coprinellus disseminates*

(220) Pluteus sp.2 *(221) Psathyrella squamosa*

(222) Hydropus sp. *(223) Unidentified* sp.3

(224) Unidentified sp.4 *(225) Collybia* sp.2

Plate 25 Pictures of wild mushrooms

(226) Crepidotus sp.2

(227) Favolus sp.1

(228) Psathyrella piluliformis

(229) Galerina hypnorum

(230) Tubaria sp.2

(231) Lycoperdon sp.

(232) Gymnopus sp. 6

(233) Psathyrella sp .2

(234) Xerocomus subtomentosus

Plate 26 Pictures of wild mushrooms

(235) Gymnopilus sp.2 *(236) Campanella tristis*

(237) Clitocybe sp.2 *(238) Cortinarius* sp.4

(239) Phallus calongei *(240) Artomyces pyxidatus*

(241) Bulgaria inquinans *(242) Cordyceps* sp.1

(243) Unidentified sp.5 *(244) Fomes fomentarius*

(245) Armillaria mellea

Plate 27 Pictures of wild mushrooms

(246) Trametes sp.2

(247) Marasmius sp. 6

(248) Ophiocordyceps nutans

(249) Cordyceps sp.2

(250) Phaeotremella frondosa

(251) Bisporella citrina

(252) Cordyceps sp.3

(253) Xylaria hypoxylon

(254) Trichaptum sp.

(255) Strobilomyces strobilaceus

(256) Unidentified sp.6

(257) Mucronella sp.

(258) Campanella junghuhnii

Plate 28 Pictures of wild mushrooms

(259) Favolus brasiliensis

(260) Pleurotus sp.3

(261) Galiella rufa

(262) Ischnoderma resinosum

(263) Chrysomphalina sp.

(264) Stereum subtomentosum

(265) Polyporus sp.3

(266) Abortiporus sp.

Plate 29 Pictures of wild mushrooms

(267) Trametes sp.3

(268) Lentinus sp.

(269) Unidentified sp.7

(270) Irpex lacteus

(271). Xylaria sp.3

(272) Polyporus sp.4

(273) Leucoagaricus sp.

(274) Phellinus sp.2

(275) Ganoderma sp.1

Plate 30 Pictures of wild mushrooms

(276) Amanita verna

(277) Amanita rubrovolvata

(278) Inocybe sp.

(279) Stereum sp.2

(280) Suillus sp.2

(281) Russula sp.8

(282) Borofutus sp.

Plate 31 Pictures of wild mushrooms

(283) Amauroderma rugosum *(284) Boletus* sp.4

(285) Phaeolus sp. (286) *Boletus* sp.5

(287) Xerula sp. *(288) Marasimus* sp 7

(289) Agaricus sp.2 *(290) Suillus* sp.3

(291) Inosperma calamistratum *(292) Tylopilus* sp.4

Plate 32 Pictures of wild mushrooms

(293) Boletus sp. 6 *(294) Lycoperdon* sp.

(295) Unidentified sp.8 *(296) Russula* sp.9

(297) Phylloporus catenulatus (298) Tylopilus sp.5

(299) Xerocomellus sp. *(300) Inosperma* sp.

(301) Unidentified sp.9

Plate 33 Pictures of wild mushrooms

(302) Tricholoma sp.2 *(303) Cortinarius* sp.5

(304) Boletus sp.7 *(305) Xerocomus* sp.1.

(306) Gymnopus sp.7 *(307) Gymnopilus* sp 3.

(308) Pleurotus sp.4 *(309) Psilocybe* sp.2

Plate 34 Pictures of wild mushrooms

(310) Amauroderma sp.1 *(311) Xylaria longipes*

(312) Cordyceps sp.4 *(313) Hymenochaete* sp.

(314) Marasimellus *(315) Trametes* sp.4

(316) Phylloporus sp. *(317) Psathyrella* sp .3

(318) Mycena sp.6

Plate 35 Pictures of wild mushrooms

(319) Agaricus sp.3

(320) Favolus sp.2

(321) Russula foetens

(322) Unidentified sp.10

(323) Marasmiellus candidus

(324) Retiboletus sp.

(325) Russula sp. 10

(326) Russula sp. 11

Plate 36 Pictures of wild mushrooms

(327) Panus fasciatus *(328) Amanita vaginata*

(329) Boletus sp.8 *(330) Russula* sp.12

(331) Panellus longinquus *(332) Suillus americanus*

(333) Russula betularum *(334) Scleroderma bovista*

Plate 37 Pictures of wild mushrooms

(335) Phallus indusiatus

(336) Pluteus cervinus

(337) Unidentified sp.11

(338) Thelephora palmata

(339) Lentinus squarrosulus

(340) Ganoderma sp.2

(341) Termitomyces sp.3

(342) Psathyrella sp.4

(343) Amanita strobiliformis

Plate 38 Pictures of wild mushrooms

(344) Xerocomus sp.2

(345) Clitocybe nuda

(346) Amanita gemmate

(347) Russula ochroleuca

(348) Neonothopanus hygrophanus

(349) Russula luteotacta.

(350) Russula sp.13

(351) Amauroderma sp.2

Plate 39 Pictures of wild mushrooms

(352) Tylopilus plumbeoviolaceus *(353)* Unidentified sp.12

(354) Pleurotus dryinus *(355) Melanoleuca* sp.2

(356) Panus sp. *(357) Clavatia* sp.2

(358) Helvella macropus *(359) Agaricus* sp.4

(360) Macrolepiota sp.

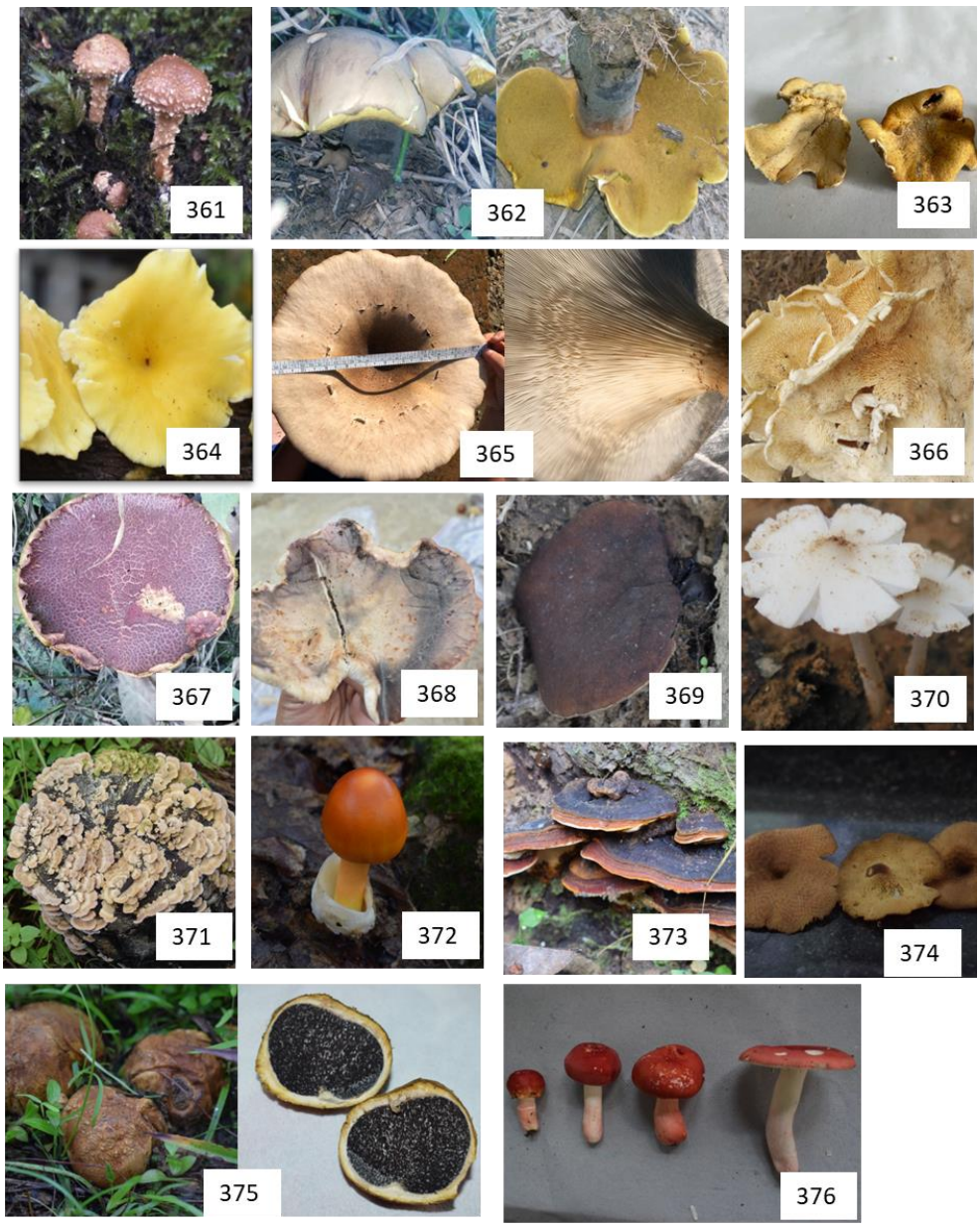


Plate 40 Pictures of wild mushrooms

(361)Hemistropharia albocrenulat *(362)Phlebopus marginatus*

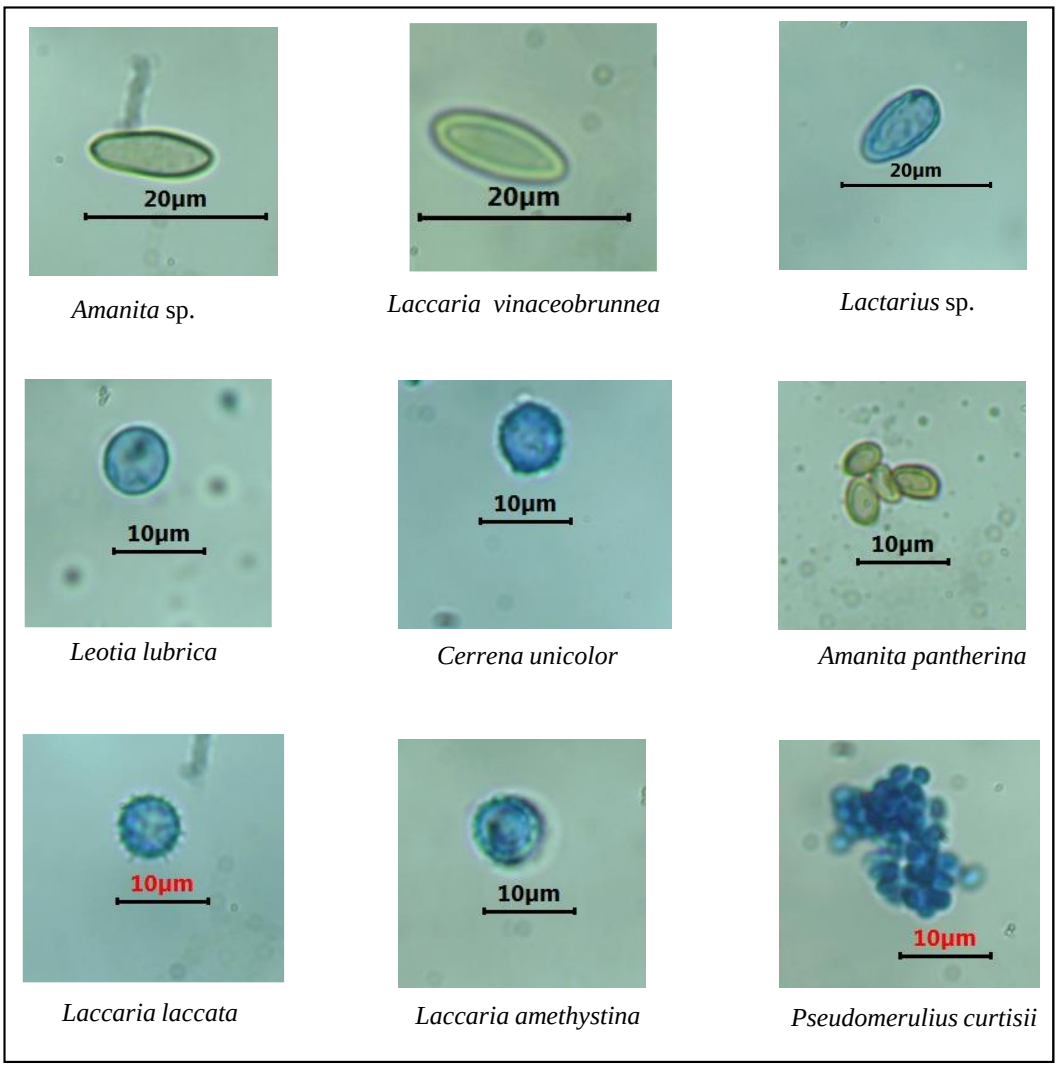
(363)Pleurotus tuber-regium *(364)Pleurotus citrinopileatus*

(365)Pleurotus giganteus *(366)Polyporus* sp. 5 *(367)Xerocomellus chrysenteron*

(368)Russsula sp.14 *(369)Trichaleurina javanica* *(370)Termitomyces microcarpus*

(371)Cerrena unicolor *(372)Amanita caesarea* *(373)Fomitopsis pinicola*

*(374)Polyporus sp.*6 *(375)Scleroderma* sp. *(376) Russula griseocarnosa*

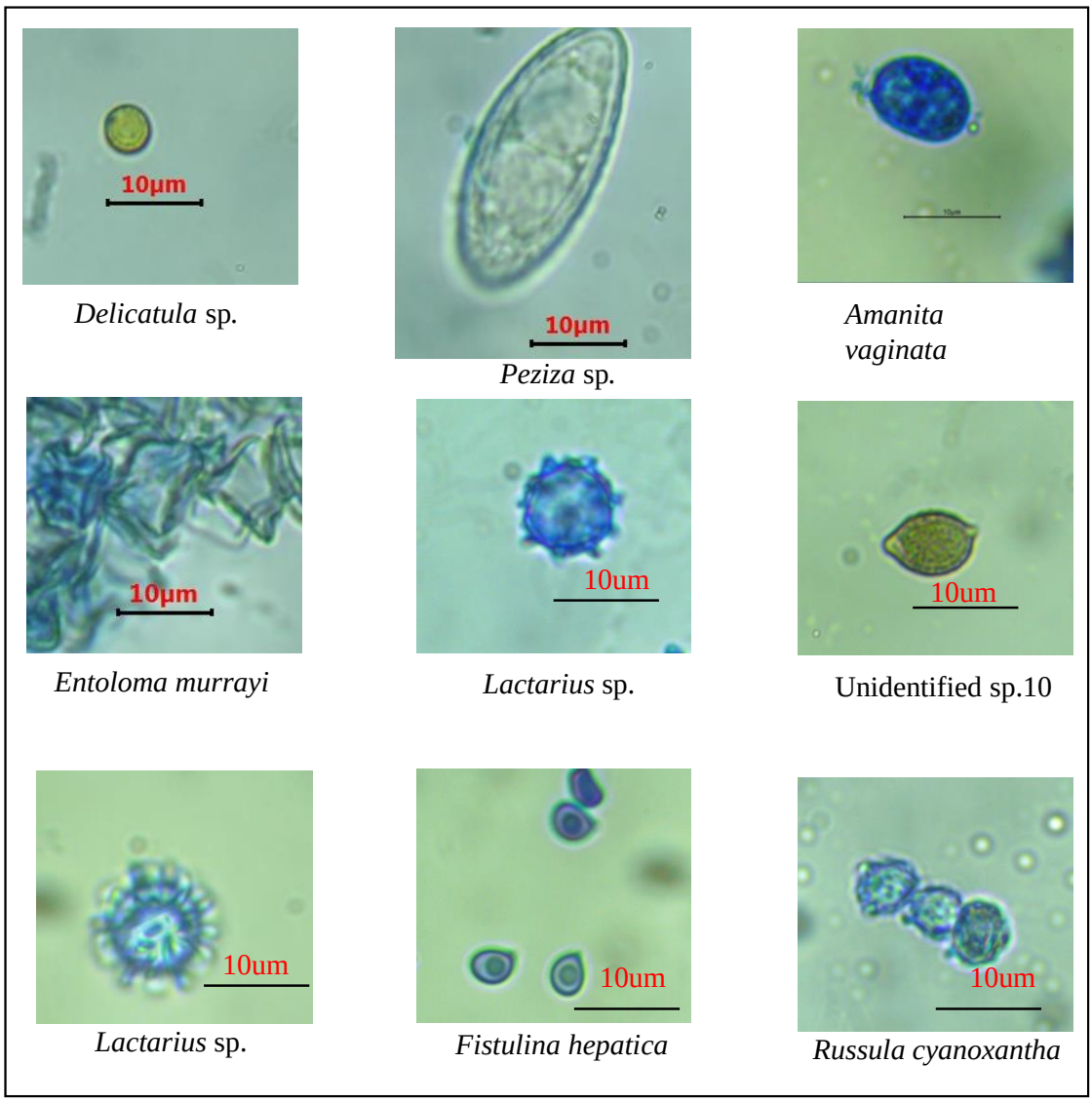


Amanita sp. *Laccaria vinaceobrunnea* *Lactarius* sp.

Leotia lubrica *Cerrena unicolor* *Amanita pantherina*

Laccaria laccata *Laccaria amethystina* *Pseudomerulius curtisii*

Plate 41: Spore micrographs of some wild mushrooms

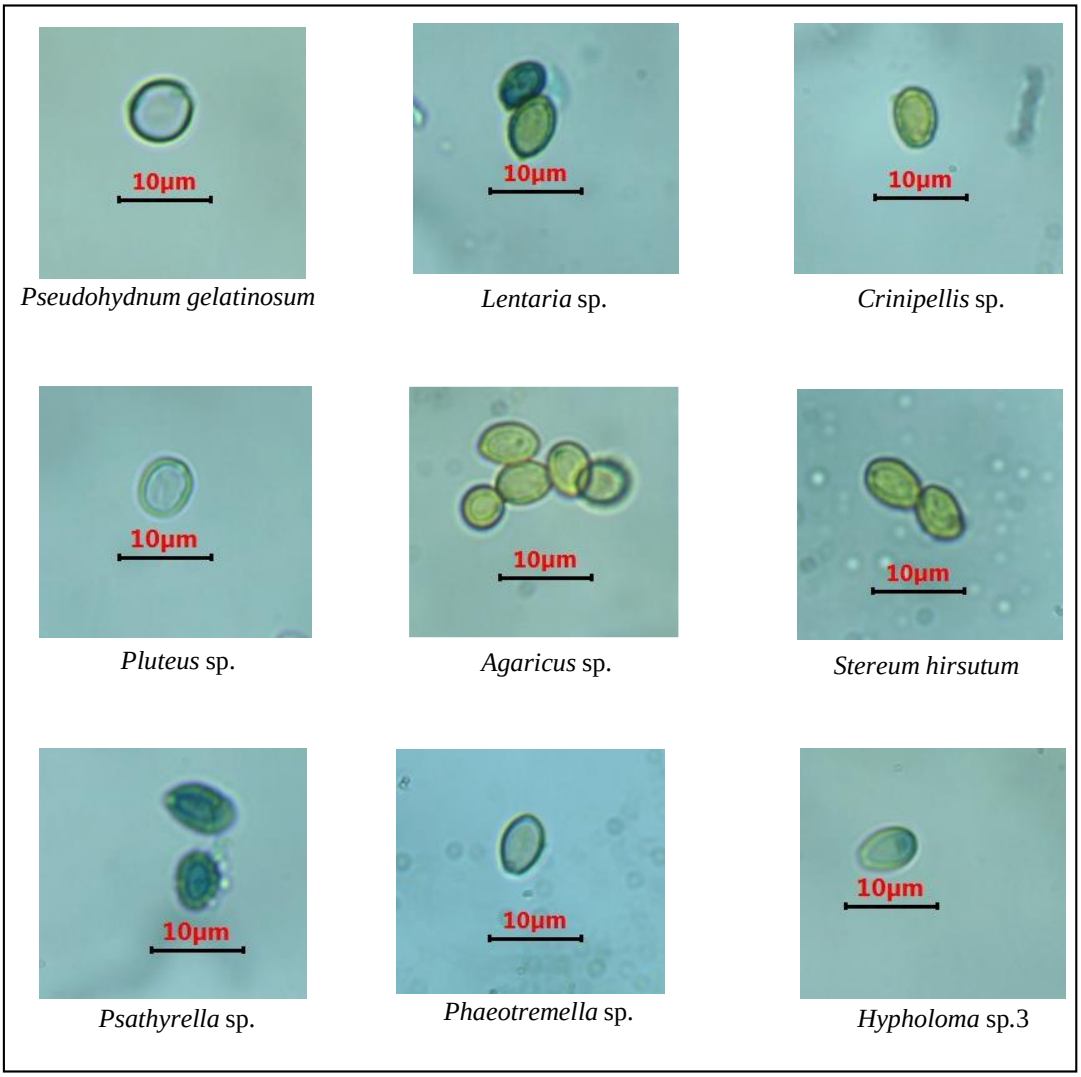


Delicatula sp. *Peziza* sp. *Amanita vaginata*

Entoloma murrayi *Lactarius* sp. Unidentified sp.10

Lactarius sp. *Fistulina hepatica* *Russula cyanoxantha*

Plate 42 spore micrographs of some wild mushrooms

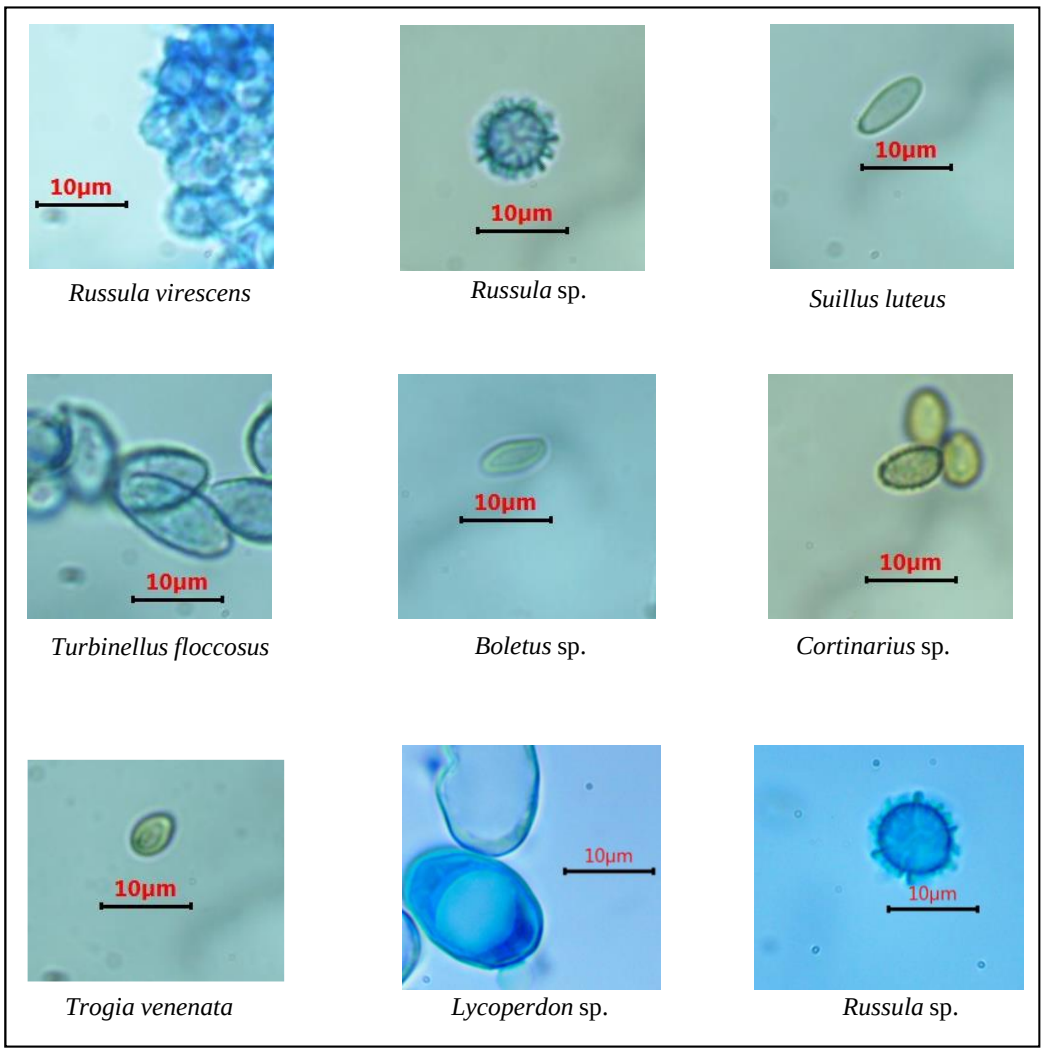


Pseudohydnum gelatinosum *Lentaria* sp. *Crinipellis* sp.

Pluteus sp. *Agaricus* sp. *Stereum hirsutum*

Psathyrella sp. *Phaeotremella* sp. *Hypholoma* sp.3

Plate 43 spore micrographs of some wild mushrooms

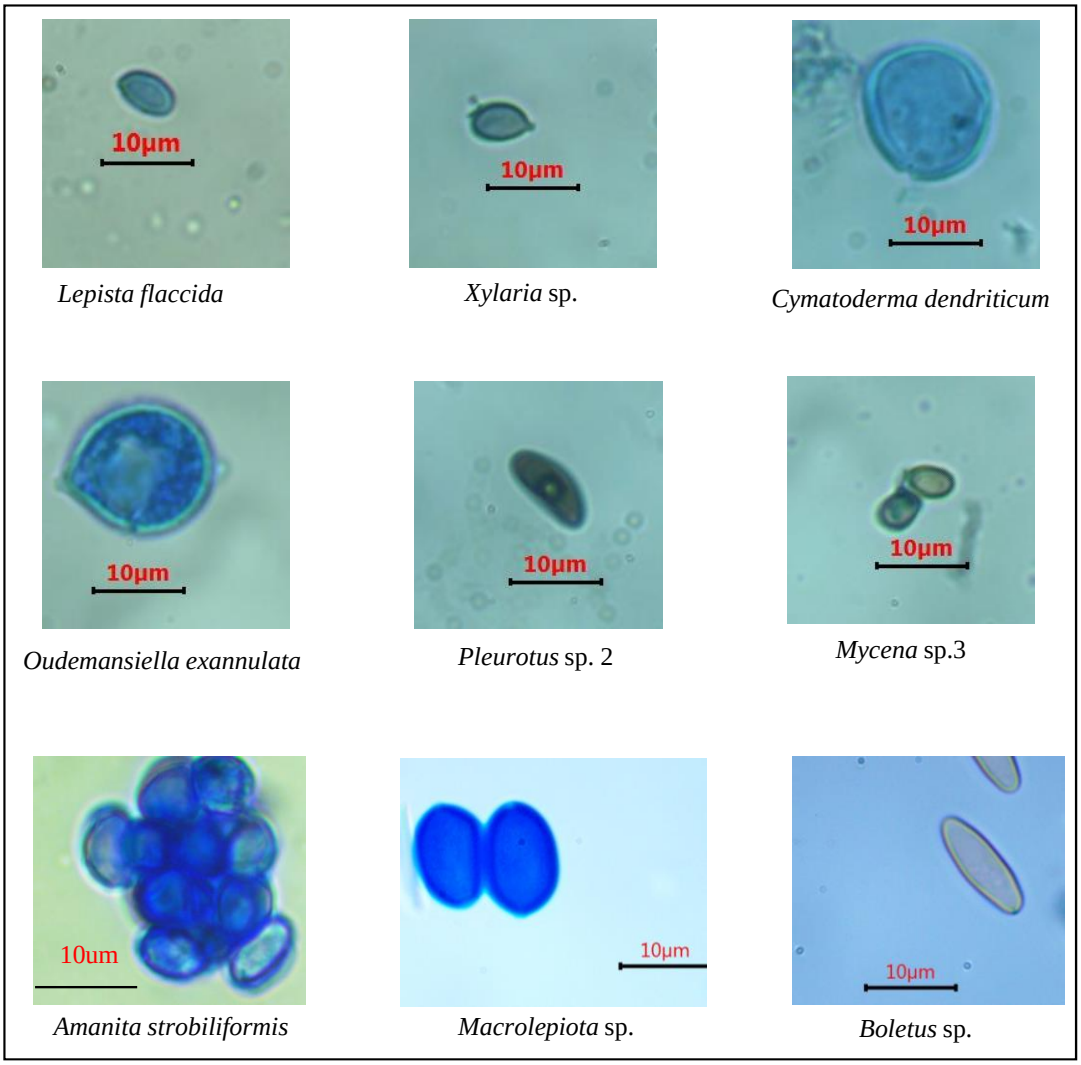


Russula virescens | *Russula* sp. | *Suillus luteus*

Turbinellus floccosus | *Boletus* sp. | *Cortinarius* sp.

Trogia venenata | *Lycoperdon* sp. | *Russula* sp.

Plate 44 spore micrographs of some wild mushrooms

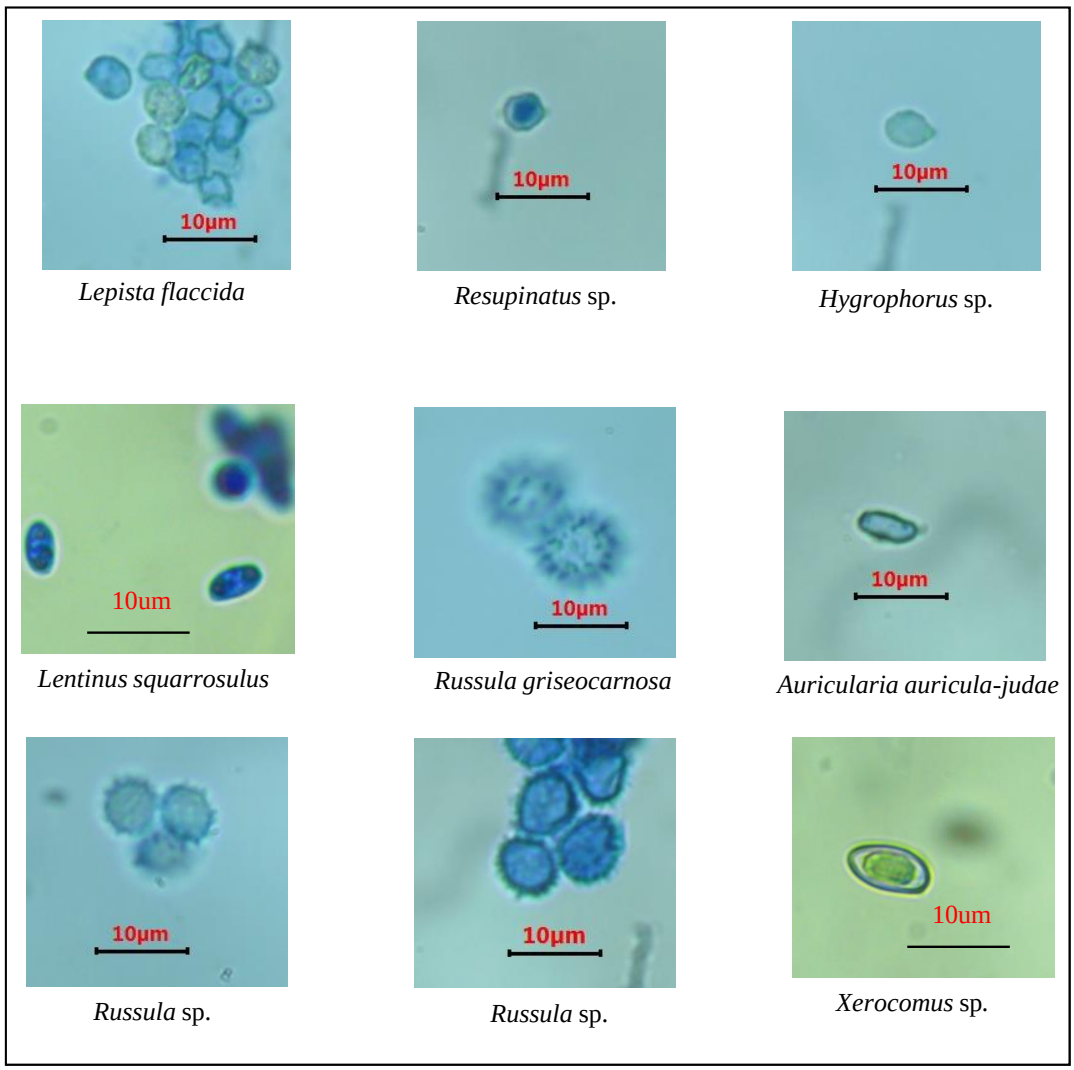


Lepista flaccida | *Xylaria* sp. | *Cymatoderma dendriticum*

Oudemansiella exannulata | *Pleurotus* sp. 2 | *Mycena* sp.3

Amanita strobiliformis | *Macrolepiota* sp. | *Boletus* sp.

Plate 45 Spore micrographs of some wild mushrooms

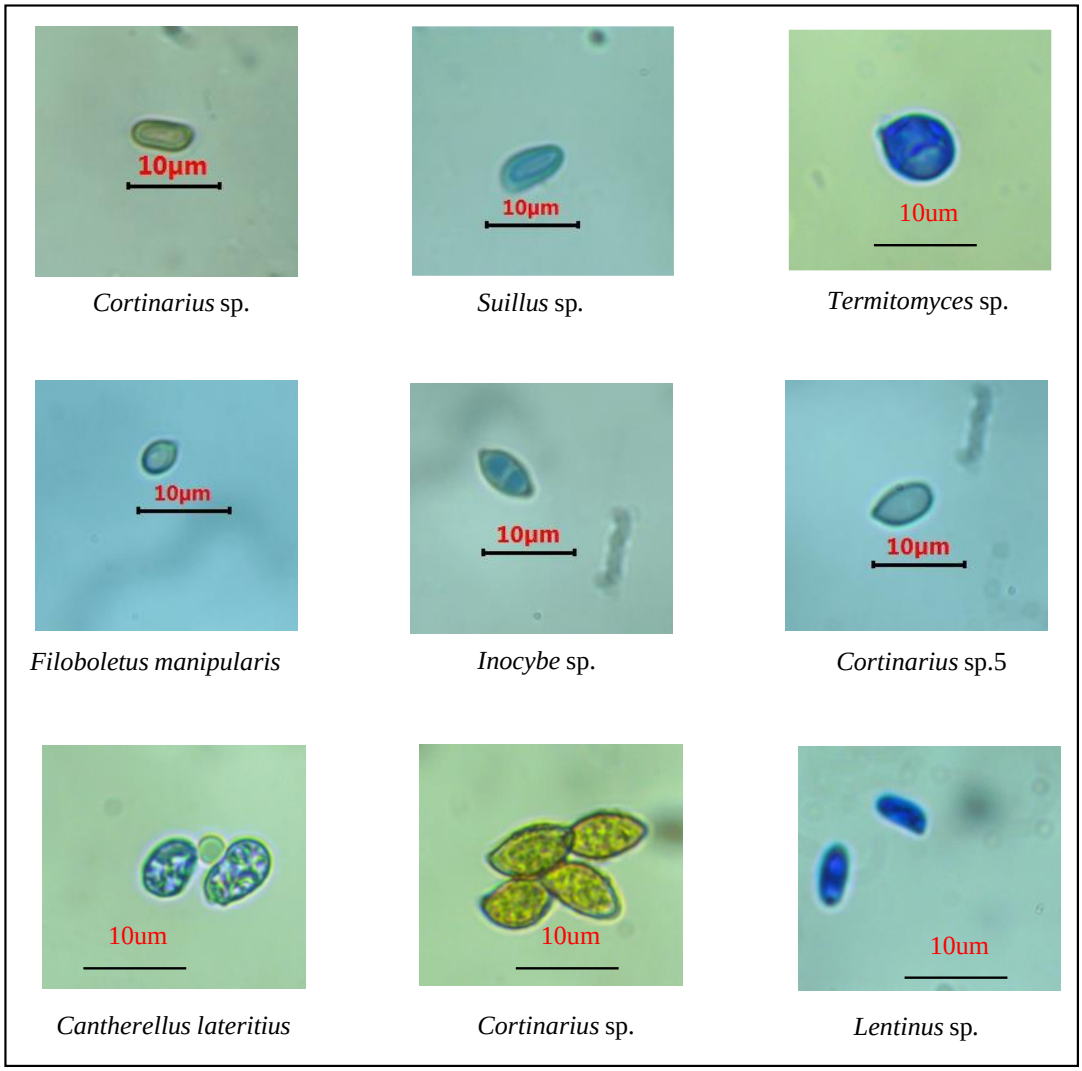


Lepista flaccida | *Resupinatus* sp. | *Hygrophorus* sp.

Lentinus squarrosulus | *Russula griseocarnosa* | *Auricularia auricula-judae*

Russula sp. | *Russula* sp. | *Xerocomus* sp.

Plate 46 spore micrographs of some wild mushrooms

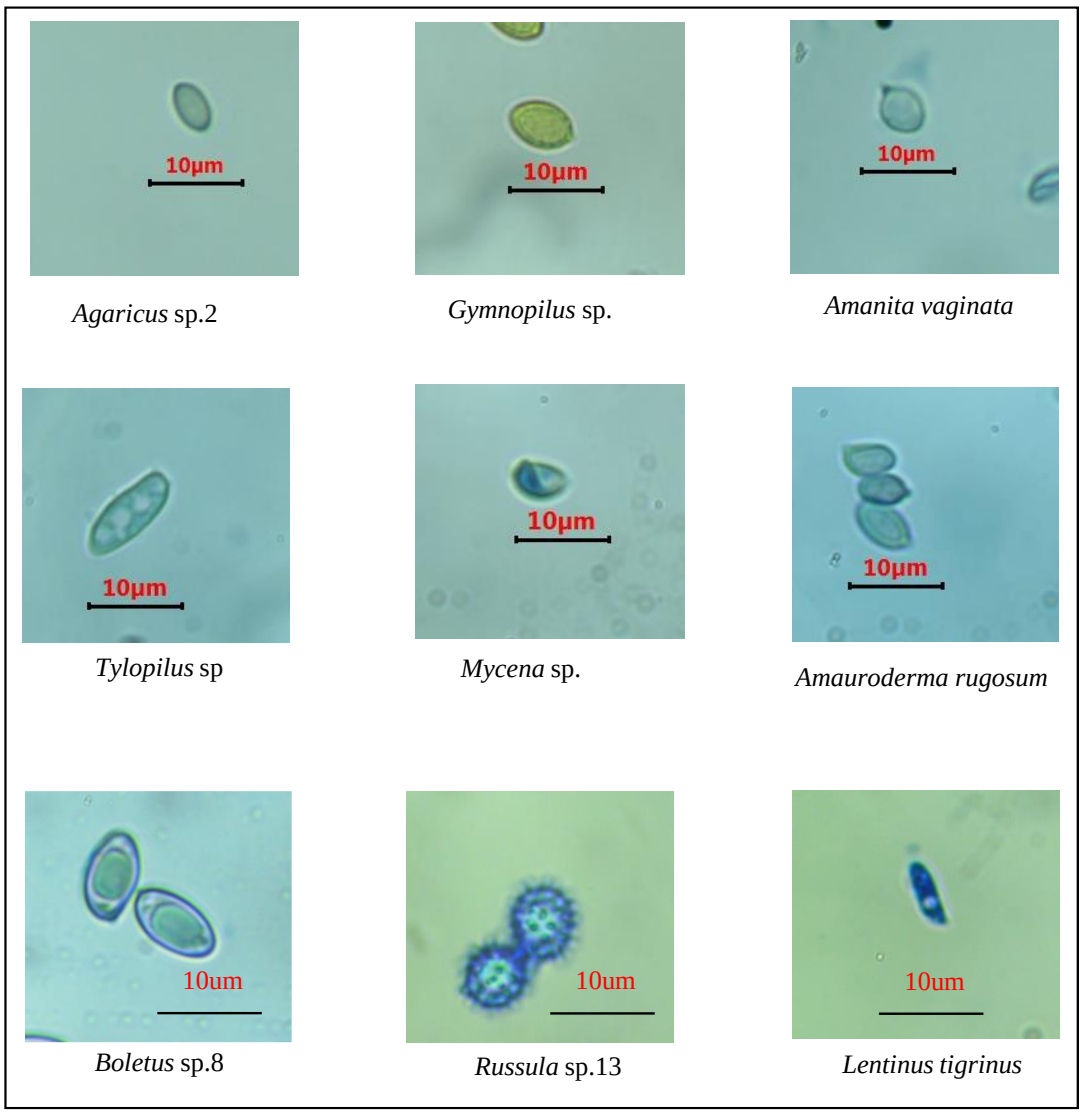


Cortinarius sp. *Suillus* sp. *Termitomyces* sp.

Filoboletus manipularis *Inocybe* sp. *Cortinarius* sp.5

Cantherellus lateritius *Cortinarius* sp. *Lentinus* sp.

Plate 47 Spore micrographs of some wild mushrooms

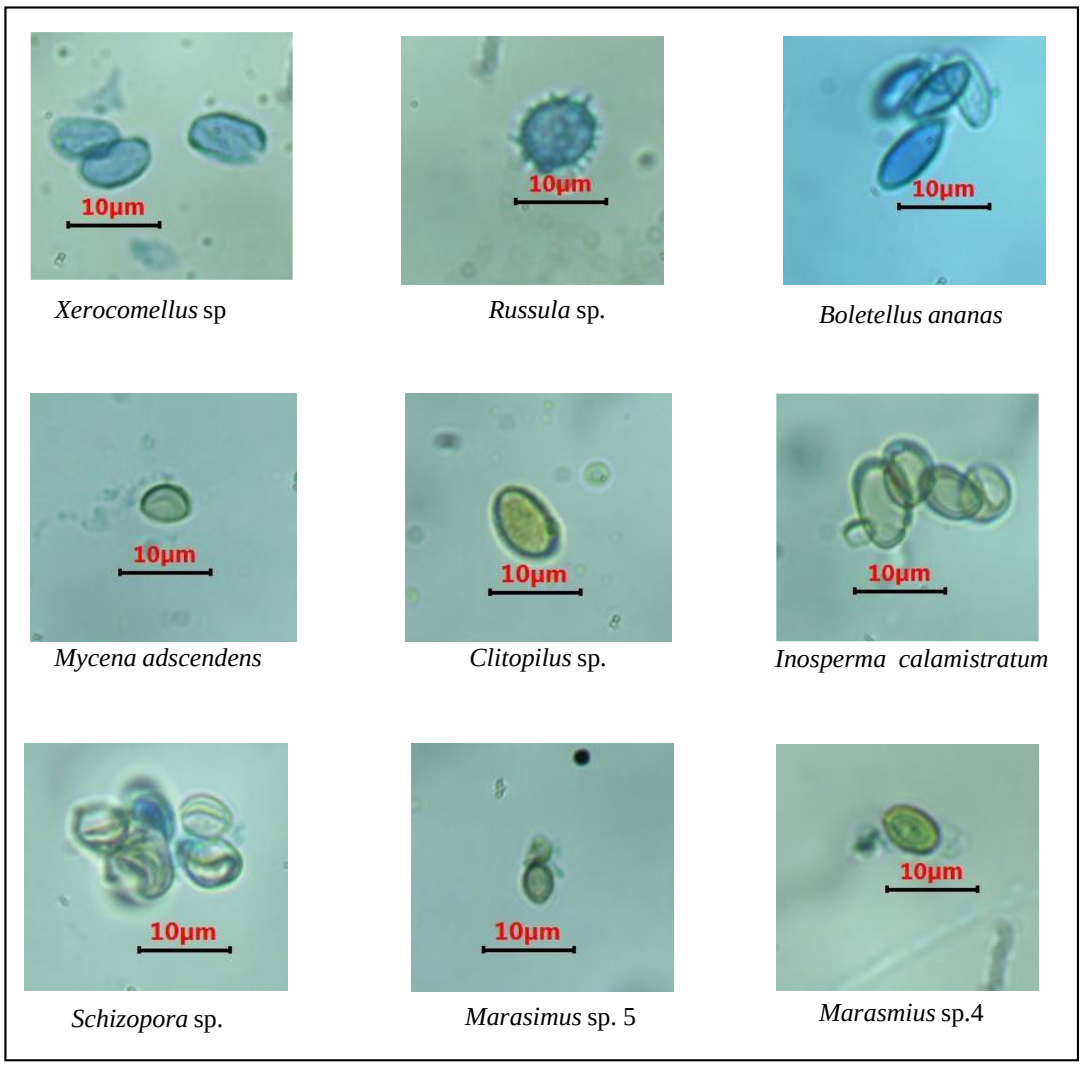


Agaricus sp.2 | *Gymnopilus* sp. | *Amanita vaginata*

Tylopilus sp | *Mycena* sp. | *Amauroderma rugosum*

Boletus sp.8 | *Russula* sp.13 | *Lentinus tigrinus*

Plate 48 Spore micrographs of some wild mushrooms



Xerocomellus sp *Russula* sp. *Boletellus ananas*

Mycena adscendens *Clitopilus* sp. *Inosperma calamistratum*

Schizopora sp. *Marasimus* sp. 5 *Marasmius* sp.4

Plate 49 Spore micrographs of some wild mushrooms

Plate 50 Spore prints of some wild mushrooms.

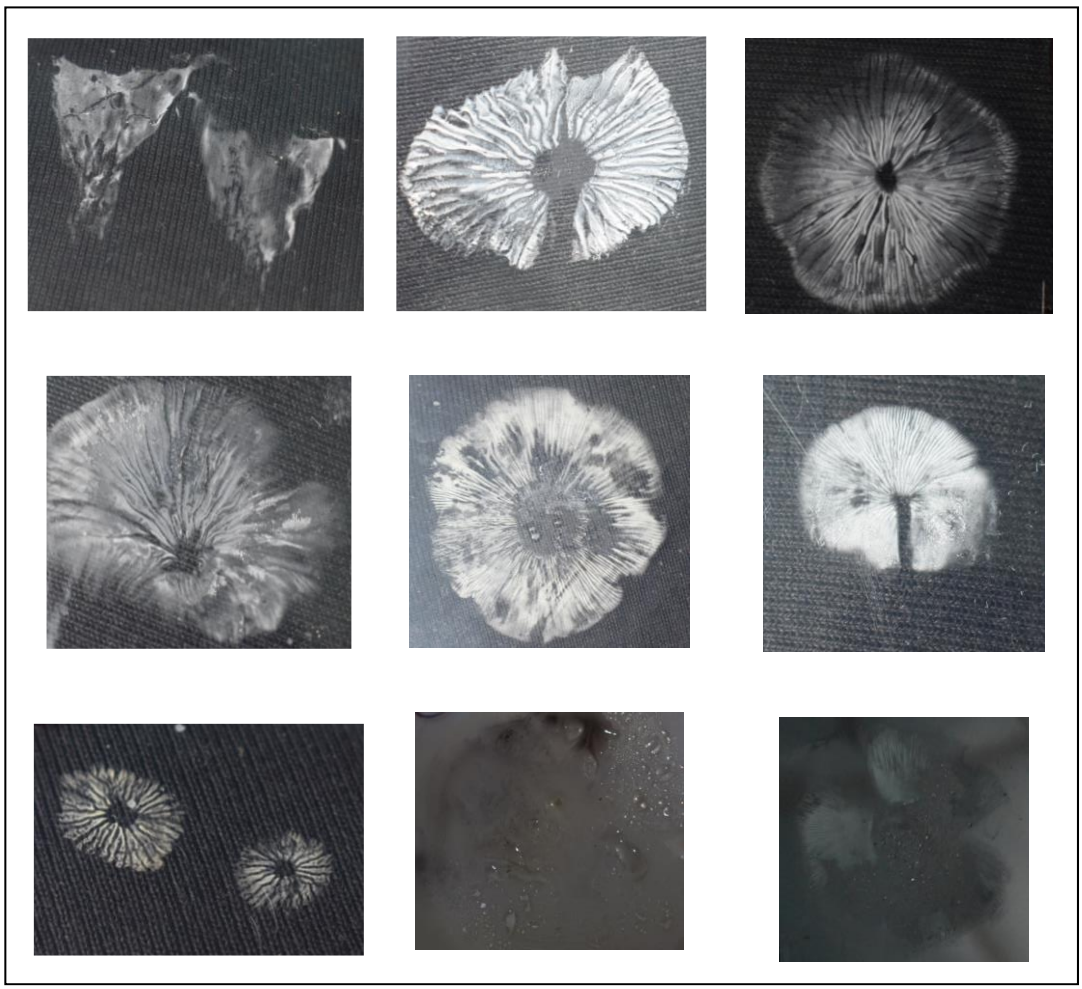


Plate 51 spore prints of some wild mushrooms.

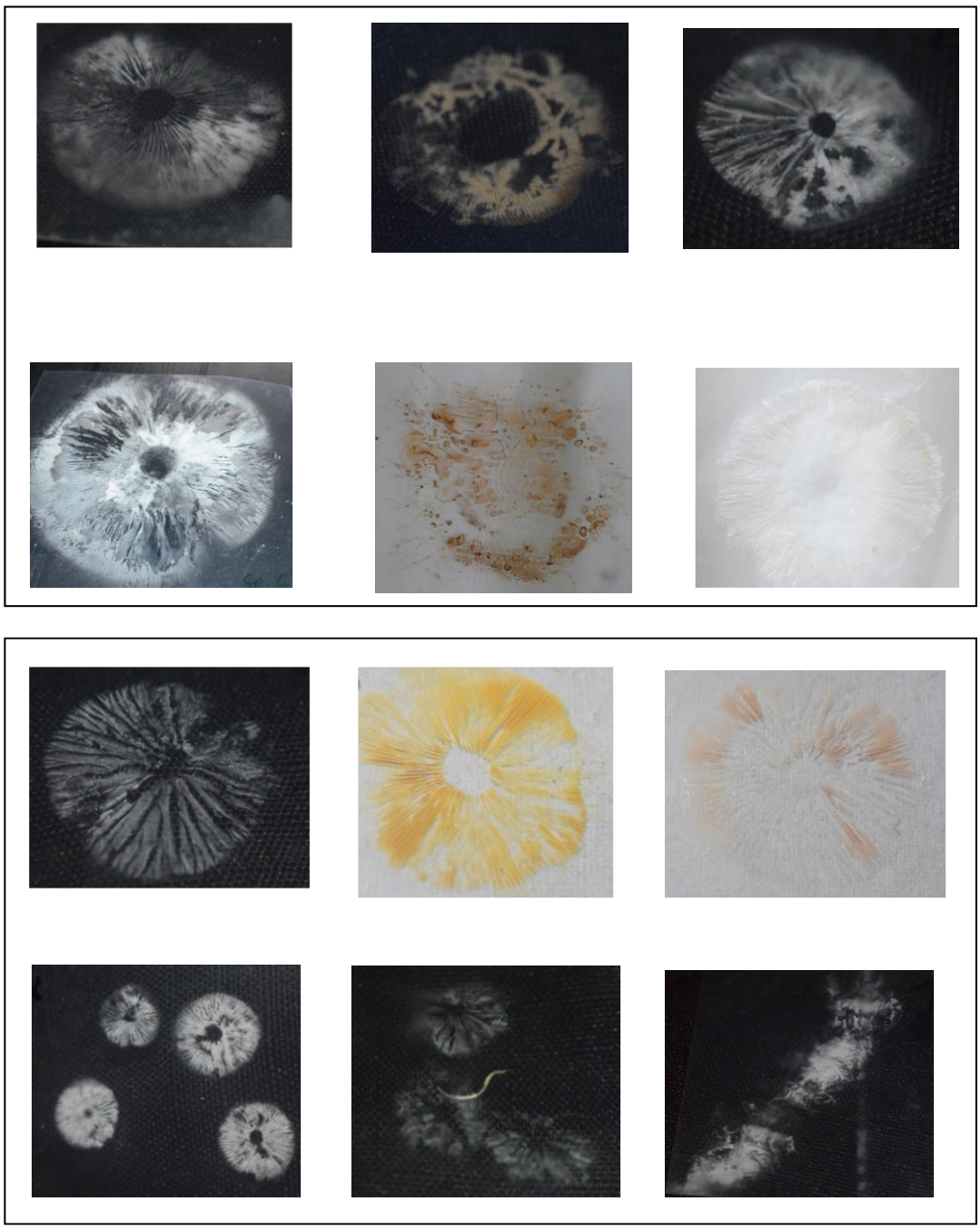


Plate 52 Spore prints of some wild mushrooms.

4.1.2 Morphological characterization of wild edible mushrooms.

During the study, out of the 376 species collected, a total of 73 species were identified to be edible by the locals of the state. The following are the detailed description of the wild edible mushrooms collected: -

1. Accession no: **NU/BOT/GLO-339** ***Lentinus squarrosulus*** **Mont**

Kingdom	Fungi
Phylum	Basidiomycota
Class	Agaricomycetes
Order	Polyporales
Family	Polyporaceae
Genus	*Lentinus*
Species	*squarrosulus*

Pileus 4.8-6.3 cm, yellowish whitish, incurved or enrolled inside, scabrous surface, deeply infundibuliform on maturity, dry surface**. Gills** decurrent, crowded, creamish white, **Stipe** 20-50 mm x 4-8 mm, equal or bulbous towards base; concolorous with pileus, same as the pileus or paler. Creamish spore-print.

Habitat: on decaying logs, summer to autumn. **Site of collection**: Bongkolong, Peren, Nagaland. **GPS Co-ordinates**: Latitude N $25^0$31’16” and longitude E $93^0$30’60”. **Elevation**: 418 m asl.

2. Accession no: **NU/BOT/GLO-018** ***Lentinus badius*** **(Berk.) Berk.**

Kingdom	Fungi
Phylum	Basidiomycota
Class	Agaricomycetes
Order	Polyporales
Family	Polyporaceae
Genus	*Lentinus*
Species	*badius*

Pileus 6-12 cm, chestnut brown, centrally stipitate, pileus infundibuliform, finely pubescent with dark or light-colored warty or horny scales, dry, slightly inrolled margin, **Gills**, crowded slightly curved, light brown but concolorous with cap on drying, dense, forked, unequal in length, **Stipe** 10-40 mm x 5-8.2 mm, creamish-white, short, scaly. thick, hard, with chaff-like or annular scales. spore-print.

Habitat: on decaying logs, summer to autumn. **Site of collection**: Bongkolong, Peren, Nagaland**. GPS Co-ordinates**: Latitude N $25^0$32’47” and longitude E $93^0$31’26”. **Elevation**: 357 m asl.

3. Accession no: **NU/BOT/GLO-009 *Lentinus sajor-caju* (Fr.) Fr.**

Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes
Order	Polyporales
Family	Polyporaceae
Genus	*Lentinus*
Species	*sajor-caju*

Pileus: 4.1-6.8 cm across, smooth, thin, infundibuliform with regular margin, grey-brown, margin initially incurved to involute and soon straight, very thin, **Gills** deeply decurrent densely crowded, not furcate, whitish or concolorous with the pileus, or becoming darker towards the edge, often darkening on drying. **Stipe:** 13-23 mm x 7-11mm, annulus ring present prominent when young but disappears on maturity, the ring is enrolled up.

Habitat : on fallen logs of deciduous tree, summer to autumn. **Site of collection**: Bongkolong, Peren, Nagaland**. GPS Co-ordinates**: Latitude N $25^0$31'51" and longitude E $93^0$31'29". **Elevation**: 367 m asl.

4. **Accession no: NU/BOT/GLO-022 *Termitomyces heimii* Natarajan**

Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes
Order	Agaricales
Family	Lyophyllaceae
Genus	*Termitomyces*
Species	*heimii*

Pileus 6-12 cm, Silky white,smooth, creamy greyish to light brownish at maturity, irregular cap margin, convex to flat as it matures with centrally raised bumps. **Gills:** free, white, crowed, with lamellulae of two lengths, edge entire, of the splitting **Stipe** 60-100 mm x 15-25 mm, annulus double and persistent, cylindrical, solid, surface white, scabrous below the annulus, smooth, striate elsewhere. Pseudorhiza 12-38 cm

long, white, smooth, hollow, partial veil fleshy, persistent, double, attached to upper quarter of stipe.

Habitat: on termite mounds. Summer to autumn. S**ite of collection:** Zapami, Phek, Nagaland. **GPS Co-ordinates**: Latitude N $25^0$31’23” and longitude E $93^0$15’37”

Elevation: 1695 m asl.

5. **Accession no: NU/BOT/GLO-014 *Auricularia delicata* (Mont. ex Fr.) Henn.**

Kingdom	Fungi
Division	Basidiomycota
Class	Basidiomycetes
Order	Auriculales
Family	Auriculariaceae
Genus	*Auricularia*
Species	*delicata*

Description: Gregarious, cespitose. whitish to pale yellow to dark brown, flabelliform, orbicular or reniform, pinkish when fresh, 2-8cm across, glabrous to pilose, hymenophore wrinkled or merulioid, reticulate and substipitate.

Habitat: on dead logs, stumps or branches of deciduous trees, summer to late autumn. **Site of collection**: Mingkong reserve forest, Mokokchung, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$21’33” and longitude E $94^0$33’376”. Elevation: 1359 m asl.

6. **Accession no: NU/BOT/GLO-036 *Lactifluus volemus* (Fr.) Kuntze.**

Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes

Order	Russulales
Family	Russulaceae
Genus	*Lactifluus*
Species	*volemus*

Pileus: 3-9 cm; at first convex with an inrolled margin; becoming flat, with a central depression, even margin; finely velvety to smooth; brownish orange, orangish brown, darker towards the center; milky exudates when injured later staining brown. **Gills**: Adnate to slightly decurrent, closely spaced, creamy white; discoloring brown where injured; often forking near the margin, brittle, narrow and whitish flesh. **Stipe**: 50-80 mm long; 8-15mm thick; concolorous with the pileus or paler; equal or tapering to base; smooth; sometimes vaguely "ribbed" longitudinally; solid or becoming hollowing.

Habitat: Mycorrhizal with oaks and other hardwoods, as well as conifers; growing alone, scattered, or gregariously; summer and autumn. **Site of collection:** Lumami, Zunheboto, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$13’17” and longitude E $94^0$28’34”. **Elevation**: 959m asl.

7. **Accession no: NU/BOT/GLO-012 *Lentinus crinitus* (L.) Fr.**

Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes
Order	Polyporales
Family	Polyporaceae
Genus	*Lentinus*
Species	*crinitus*

Pileus 3.1-6 cm, strigose, thin, thicker at the disc, infundibuliform, brownish to pallid ochraceous, radially covered by concolorous, margin curved distinctly ciliate. **Stipe** 43-46 mm x 5-8 mm, concolorous with pileus, sub bulbous base/cylindrical base; covered by fibrillose hairs. Lamellae deeply decurrent, crowded, ochraceous buff.

Habitat lignocellulose substratum, summer to late autumn Site of collection: Bongkolong, Peren, Nagaland. **GPS co-ordinates** Latitude: N $25^0$31'51" Longitude: E $93^0$31'29". **Elevation**: 367 m asl.

8. **Accession no: NU/BOT/GLO-118 *Dacryopinax spathularia* (Schwein.) G.W.Martin.**

Kingdom	Fungi
Division	Basidiomycota
Class	Dacrymycetes
Order	Dacrymycetales
Family	Dacrymycetaceae
Genus	*Dacryopinax*
Species	*spathularia*

Description: 1-5 cm tall and 3-10 mm wide, fruit body gelatinous and tough, yellow-orange to orange, gregarious, often clustered, have a distinct stipe (stem) and fertile head that is flattened and fan-like (spathulate) or less commonly palmate.

Habitat: on wood substrate: Saprobic; in groups or clusters on decaying wood; July through October**. Site of collection**: Mon, Nagaland. **GPS co-ordinates**: Latitude N $26^0$39'27" and longitude E $95^0$12'44". **Elevation** 1475m asl

9. **Accession no: NU/BOT/GLO-139 *Pleurotus ostreatus* (Jacq.) P. Kumm**

Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes
Order	Agaricales
Family	Pleurotaceae
Genus	*Pleurotus*
Species	*ostreatus*

Pileus: 3-12 cm across, creamish brown, broadly convex gradually becoming centrally depressed, usually bracket-like, kidney-shaped to fan-shaped in outline, wavy margin, somewhat greasy when young and fresh; often in overlapping groups but with each stem separately attached to the substrate. **Gills**: White, turning pale ochre with age; crowded; decurrent. **Stipe**: 10-30 x 10-20 mm, whitish or creamy, pseudo stem

Habitat: Saprobic; on dead logs and living trees, summer, autumn and early winter. **Site of collection**: Pfutsero, Nagaland. **GPS co-ordinates:** Latitude N $25^0$34’23” and longitude E $94^0$12’24”. **Elevation**: 1469 m asl

10. **Accession no: NU/BOT/GLO-067 *Lactarius quietus* (Fr.) Fr.**

Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes
Order	Russulales
Family	Russulaceae
Genus	*Lactarius*
Species	*quietus*

Pileus: 5-6.2 cm, dull reddish brown with a tint of cinnamon, convex then funnel-shaped or becoming flat, a small depression in the center with subtly faint darker concentric zones. **Gills**: brownish-white, slightly decurrent, exude milk is white or cream in colour when injured. **Stipe**: 40-90 x 8-11 mm, cylindrical, concolorous with cap or darker, stem ring absent, fibrillose. Site of collection: Pfutsero, Nagaland

Habitat: Mycorrhizal with oak trees, solitarily or in scattered groups, in soil, Late summer to early winter. **GPS co-ordinates:** Latitude N $25^0$34’23” and longitude E $94^0$12’24” . **Elevation**: 1469 m asl

11. **Accession no: NU/BOT/GLO-069 *Russula cyanoxantha* (Schaeff.) Fr.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Russulales
Family:	Russulaceae
Genus:	*Russula*
Species:	*cyanoxantha*

Pileus: 4-12 cm; purple and brown to grey, smooth, spherical at first then convex when young, with slight depression, margin usually not lined. **Gills**: creamish white, crowded, adnexed to slightly decurrent. **Stipe**: 50-80 x 10-20 mm white, but occasionally flushed with lilac; brittle; dry; smooth.

Habitat: Mycorrhizal with hardwoods or conifers; solitarily or in scattered groups or gregariously; summer and fall. **Site of collection**: Kikruma, Phek, Nagaland. **GPS co-ordinates:** Latitude N $25^0$31’23” and longitude E $94^0$15’37” . **Elevation**: 1695 m asl.

***12. Accession no*: NU/BOT/GLO-255 *Strobilomyces strobilaceus* (Scop.) Berk.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Boletales
Family:	Boletaceae
Genus:	*Strobilomyces*
Species:	*strobilaceus*

Pileus: 4-9 cm, the convex caps flatten out with age, involute margin, upright blackish scales, woolly when young becoming firmer with age. **Stipe**: 60-80 x 10-20 mm, concolorous with the cap and covered with woolly scales. The hymenophore is tubular, white or grayish in color, darkening to almost black with age.

Habitat: found solitary or in groups under deciduous as well as coniferous forests, summer to late autumn. **Site of collection**: Kikruma, Phek, Nagaland. **GPS co-ordinates:** Latitude N $25^0$31’23” and longitude E $94^0$15’37” . **Elevation**: 1695 m asl.

***13. Accession no*: NU/BOT/GLO-071 *Laccaria amethystina* (Huds.) Cooke**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Agaricales
Family:	Hydnangiaceae
Genus:	*Laccaria*
Species:	*amethystina*

Pileus: 1-5 cm, deep purplish lilac, initially convex, later flattening, often centrally depressed, pale striations at the margin. **Gills**: concolorous with the cap, widely spaced and interspersed with shorter gills, sinuate attachment. **Stipe**: 40-90 x 5-10 mm, concolorous with the cap, tough, fibrous, hollow, hairy towards the base.

Habitat: solitary to scattered, mycorrhizally associated with deciduous and coniferous trees. Summer to early winter. **Site of collection**: Changki forest, Mokokchung, Nagaland. **GPS co-ordinates:** Latitude N $26^0$25'50" and longitude E $94^0$23'19" Elevation: 446 m asl.

14. Accession no: NU/BOT/GLO-91. *Fistulina hepatica* (Schaeff.) With.

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Fistulinaceae
Genus: *Fistulina*
Species: *hepatica*

Pileus: 9–20 × 12–25 cm to 2–5 cm thick. A large fleshy, tongue-like, upper surface spongy, gelatinous when wet; flesh with alternating light and dark streaks and juicy. Flesh red, 'bleeds' a reddish juice when squeezed. Pores are circular, whitish cream to yellowish, often with guttation drops. Stipe: Absent, or rudimentary and lateral. **Ecology**: Saprobic and sometimes weakly parasitic on the wood of oaks and other hardwoods; causing a brown rot; annual; growing alone or in small groups near the bases of trees and on stumps; summer and autumn.

Site of collection: Old Riphym, Wokha ,Nagaland**. GPS co-ordinates:** Latitude N 26°12′06.9″ Longitude E 94°28′16.4″ **Elevation**: 1055 m asl.

15. **Accession no: NU/BOT/GLO-073 *Cantharellus minor* Peck**.

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Cantharellales

Family: Cantharellaceae

Genus: *Cantharellus*

Species: *minor*

Pileus 8-14 mm across, wide, convex, yellow to orange-yellow, umbonate. **Gills** decurrent hymenophore, concolorous with pileus, **Stipe** 25-50 mmx 2-4 mm, slender; equal or tapering slightly to base; orange-yellow, same as the pileus or paler. Yellow spore-print.

Habitat: Mycorrhizal with oaks and other hardwoods; growing alone, scattered, or occasionally gregariously in moss; late spring through autumn. **Site of collection**: Kohima, Nagaland. **GPS co-ordinates:** Latitude N $25^0$37’17” and longitude E $94^0$8’4”. **Elevation**: 1322.8 m asl

16. **Accession no: NU/BOT/GLO-076 *Lactifluus luteolus* (Peck) Verbeken**.

Kingdom: Fungi

Division: Basidiomycota

Class: Basidiomycetes

Order: Russulales

Family: Russulaceae

Genus: *Lactifluus*

Species: *luteolus*

Pileus: 10-20 cm across, convex with a deep funnel-shaped central depression, creamish brown, thick fleshy. **Gills** decurrent, pale pinkish ochre-buff. **Stipe** 40-70 mm x 20-42 mm, pale yellowish buff, narrowing towards the base or cylindrical, hard, rigid. **Habitat**: on soil under conifer woods. summer to early autumn. **GPS co-ordinates:** Latitude N $25^0$37’23” and longitude E $94^0$08’6”. Elevation: 1322.8 m asl. **Site of collection** Kohima, Nagaland,

17. **Accession no: NU/BOT/GLO-078 *Boletus edulis* Bull.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Boletales

Family: Boletaceae

Genus: *Boletus*

Species: *edulis*

Pileus: 4-10 cm, yellow-brown to reddish-brown, white in areas near the margin, convex when young and flattens on maturity. **Tubes and Pores**: white when young but turns pale yellow or olive-brown, do not change colour when bruised. **Stipe**: 8-12 x 4-

7 cm, club-shaped to centrally bulbous creamish background with finely reticulate on the upper portion, but smooth or irregularly ridged on the lower part.

Habitat: grows on soil beneath trees, notably beech and birch as well as oaks and pine, singly or in small clusters, summer to autumn. **GPS co-ordinates**: Latitude N $25^0$37'23" Longitude E $094^0$8'6" Elevation: 1335m asl. **Site of collection:** Kigwema, Kohima, Nagaland.

18. **Accession no: NU/BOT/GLO-089** ***Cantharellus cibarius*** **Fr.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Cantharellales
Family: Cantharellaceae
Genus: *Cantharellus*
Species: *cibarius*

Pileus: 3-8 cm, egg-yolk yellow to orange-yellow or orange, broadly convex when young, funnel-shaped cap and becomes shallowly depressed when mature , wavy irregular margin. **Gills**: false gills, orange to yellow; narrow; thick-edged ridges; forked; cross-veined; decurrent. **Stipe**: 20-40 x 6-12 mm, smooth concolorous with the pileus, central, fleshy.

Habitat: On soil under deciduous and coniferous forests, summer to autumn. **GPS co-ordinates**: Latitude N $25^0$37'23" Longitude E $094^0$8'6" Elevation: 1335 m asl. **Site of collection:** Kigwema, Kohima, Nagaland

19. **Accession no: NU/BOT/GLO-081** ***Lyophyllum fumosum*** **(Pers.) P.D. Orton.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Lyophyllaceae
Genus: *Lyophyllum*
Species: *fumosum*

Pileus: 3.2-4.5 cm, brown to yellowish brown, fleshy, convex, umbonate to very depressed, smooth, radially fibrous, wavy margin with paler edge. **Gills**, concolorous to cap, thin, dense. **Stipe**: 60-80 x 15-25 mm, creamish, smooth, thick, cylindrical, tightly clustered.

Habitat: Saprobic; grows in dense clusters in disturbed soil such as paths, landscaping areas, etc; late summer to autumn. **GPS co-ordinates**: Latitude N $25^0$37'23" Longitude E $094^0$8'6" Elevation: 1335 m asl. **Site of collection**: Kigwema, Kohima, Nagaland.

20. **Accession no: NU/BOT/GLO-090 *Lactifluus piperatus* (L.) Roussel.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Russulales
Family: Russulaceae
Genus: *Lactifluus*
Species: *piperatus*

Pileus: 6-10cm across, creamy-white, glabrous and not glossy, convex to flat as it matures with funnel shaped centre, tightly inrolled margin, forms reddish patches on older species. **Gills:** whitish to creamy, crowded, decurrent, exudes white milk on injury and narrow. **Stipe:** white, smooth, thick and cylindrical, sometimes tapering towards the base.

Habitat: on soil under mixed woodland, summer to early winter. **GPS co-ordinates**: Latitude N $25^0$37'23" Longitude E $094^0$8'6" Elevation: 1335 m asl. **Site of collection**: Kigwema, Kohima, Nagaland.

21. **Accession no: NU/BOT/GLO-227 *Favolus* sp.1**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Polyporales
Family:	Polyporaceae
Genus:	*Favolus* sp.1

Bracket 3-5 cm across, creamy white, hard and leathery, wavy and splitting in the margin, single or in small overlapping groups. **Tubes** 2-6mm deep. Pores circular to elongate, whitish to cream. Creamish spore-print.

Habitat: singly in overlapping groups, or in fused clusters on decaying woods, summer to autumn. **GPS co-ordinates** Latitude N $26^0$12'190" and longitude E $94^0$44'993". **Elevation**: 2170 m asl. **Site of collection:** Tuensang, Nagaland

22. **Accession no: NU/BOT/GLO-087 *Hydnellum* sp.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Thelephorales
Family: Bankeraceae
Genus: *Hydnellum* sp

Pileus range from 5 to 10 cm across, multi-lobed, fused with other caps, radially arranged ridges, velvety bumpy surface, brownish pink concentrically zoned, white near the margin, The flesh is tough and fibrous. The stem's underside is white at first, becoming purple brown, and is lined with densely packed spines that are 1–3 mm long; **Stipe** 40 mm-60 mm x 5-12 mm, tapered or bulbous at the base, velvety, concolorous with the undersurface.

Habitat: under coniferous woods, summer to early autumn. **GPS co-ordinates** Latitude N $25^0$34’23” and longitude E $094^0$12’24” Elevation: 1469 m asl. **Site of collection**: Kikruma, Phek, Nagaland.

23. **Accession no: NU/BOT/GLO-088 *Laccaria laccata* (Scop.) Cooke**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Hydnangiaceae
Genus: *Laccaria*
Species: *laccata*

Pileus: 3-4.6 cm, convex, becoming flat and sometimes uplifted; often with a central depression; smooth margin and even; orangish brown, fading to buff. **Gills**: buff colour, widely spaced, shorter gills, attached to the stem. **Stipe**: 40-65 x 4-6 mm, equal or tapering towards the base, smooth to finely hairy.

Habitat: Mycorrhizal with hardwoods or conifers, growing alone or gregariously. Summer to early winter. **GPS co-ordinates** Latitude N $25^0$34’23” and longitude E $094^0$12’24” Elevation: 1469 m asl. **Site of collection**: Kikruma, Phek, Nagaland.

24. **Accession no: NU/BOT/GLO-033** ***Russula crustosa*** **Peck.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Russulales
Family:	Russulaceae
Genus:	*Russula*
Species:	*crustosa*

Pileus 5–9 cm across, greenish patches, initially convex, flattens out in age, cracked cap with pale yellow depressed center, gills brittle. In maturity. Gills whitish cream, adnate attachment to the stem. **Stipe** 30–70mm x 1.3–2.2 cm, white to pale yellow. whitish

Habitat in mixed woods, summer to early autumn. **Site of collection** Phek, Nagaland. **GPS co-ordinates** Latitude N $25^0$34’23” and longitude E $094^0$12’24” **Elevation**: 1469 m asl

25. **Accession no: NU/BOT/GLO-092** ***Russula virescens*** **(Schaeff.) Fr.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Russulales
Family: Russulaceae
Genus: *Russula*
Species: *virescens*

Pileus 5.4- 8.5 cm across, globose to convex when young to broadly convex, shallow depression; the surface cracks into small patches with age; verdigris to dull green; scurfy scales, slightly lined margin. **Stipe** 26-46 mm x 15-25 mm Pale cream to whitish, brittle, powdery. Gills crowded creamish, attachment almost free, brittle.

Habitat on soil with broad leaved trees, summer to autumn. **Site of collection** Phek, Nagaland. **GPS co-ordinates** Latitude N $25^0$34’23” and longitude E $094^0$12’24” Elevation: 1469 m asl

26. **Accession no: NU/BOT/GLO-365 *Pleurotus giganteus* (Berk.) Karunarathna & K.D. Hyde**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Pleurotaceae
Genus: *Pleurotus*
Species: *giganteus*

Pileus: 27-31cm across, infundibuliform, light brown, convex to plano-concave with depressed center fibrillose scaly at the center, with brownish-orange to reddish-golden, uniformly dark at the surface at the center or depress zone. concentrically arrange remnants of the veil; **Gills**: decurrent, white to pale yellow in age, narrow, moderately crowded, with concolorous entire edge. **Stipe**: 100-120 x 20-30 mm, equal, with tapering pseudorrhiza, with glabrous surface, squamules concolorous with pileus. Spore print: whitish

Habitat: Saprotrophic on soil with a long pseudorrhiza, connected with dead wood or decay wood buried in the soil, solitary or in groups of a few basidiomata in deciduous forests. summer to autumn. **Site of collection:** Dimapur, Nagaland. **GPS co ordinates** Latitude: N $26^0$52'3" Longitude: E $094^0$43'29''. Elevation:147 m asl.

27. **Accession no: NU/BOT/GLO-093** ***Imleria badia*** **(Fr.) Vizzini.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Boletales
Family: Boletaceae
Genus: *Imleria*
Species: *badia*

Pileus: 3–9 cm across; convex, becoming broadly convex, bald, with a kid-leathery feel; brown to pinkish brown or reddish brown. **Pore:** Pale dull yellow, becoming yellow and eventually dirty yellowish brown; bruising grayish blue; 2–3 pores per mm

at maturity; tubes to 1 cm deep, olive at maturity. **Stipe**: 60-110 x 15-30mm, enlarged at the base; bald; not reticulate; pale brownish near the apex; brown to reddish brown below; basal mycelium white white spore-print.

Habitat: Mycorrhizal with conifers, growing alone, scattered, or gregariously. Autumn to winter. **Site of collection:** Lumami, Zunheboto, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$13'17" and longitude E $94^0$28'34". **Elevation**: 959 m asl.

28. **Accession no: NU/BOT/GLO-171 *Pseudohydnum gelatinosum* (Scop.) P.Karst**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Auriculariales
Family:	Incertae sedis
Genus:	*Pseudohydnum*
Species:	*gelatinosum*

Pileus: 2.9–4.5 cm across; tongue-shaped or spatulate shaped; broadly convex or flat; gelatinous; upper surface translucent, white to grayish. Underside: pale grey, consisting of minute conic spines on which the spores are formed; flesh rubbery-gelatinous. Stipe: 20-35 x 10-20 mm, broad, lateral, tapering downward, covered with fine hair, gelatinous; smooth, concolorous with cap or paler. Spore print: white

Habitat: Saprobic on the wood or woody debris of conifers, growing alone, scattered, or gregariously; late summer and autumn. **GPS co-ordinates** Latitude N $26^0$12'18" and longitude E $94^0$44'57". Elevation: 2213 m asl**. Site of collection** Tuensang, Nagaland.

29. **Accession no: NU/BOT/GLO-130 *Polyporus* sp. 2**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Polyporales

Family: Polyporaceae

Genus: *Polyporus* sp.2

Pileus: 10-16 cm across, rosette like, common base with short stems, repeatedly branching system, fan shaped caps, singly or several on a branched stem, wavy at the margin, whitish. 1cm thick. Creamish pores.

Habitat on dead deciduous wood. Site of collection Phek, Nagaland. **GPS Co-ordinates** Latitude N 25^{0}34’23” and longitude E 094^{0}12’24” Elevation: 1469 m asl

30. **Accession no: NU/BOT/GLO-367 *Xerocomellus chrysenteron* (Bull.) Sutara.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Boletales

Family: Boletaceae

Genus: *Xerocomellus*

Species: *chrysenteron*

Pileus: 2-8 cm; convex to plane on maturity; velvety when young, becoming cracked in age, with reddish to pinkish flesh showing in the cracks; brown to olive brown on maturity. **Pore Surface**: Yellow when young, becoming brownish or olive; bruising

blue; tubes upto 5 mm deep. **Stipe**: 40-80 x 8-15 mm, equal, tapering to a pinched base; solid; pinkish reddish below; purplish red at base, with broad longitudinal ridges.

Habitat: Mycorrhizal with hardwoods, especially oaks, summer to autumn**. Site of collection:** Lumami, Zunheboto, Nagaland**. GPS Co-ordinates**: Latitude N $26^0$13'17" and longitude E $94^0$28'34". Elevation: 959m asl.

31. **Accession no: NU/BOT/GLO-098** ***Suillus luteus*** **(L.) Roussel.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Boletales
Family:	Suillaceae
Genus:	*Suillus*
Species:	*luteus*

Pileus: 4-8 cm across, convex to nearly flat with age, slimy when fresh to glossy when dry, reddish brown to yellow-brown, when young with partial veil tissue often hanging from the margin. **Pores**: upto 4mm deep, lemon yellow but turn olive to dark yellow when mature. **Stipe:** 50-100 x 17-25 mm, pale yellow, more or less cylindrical, initially whitish partial veil links the stipe with the edge of the cap which after rupture forms hanging ring. Ochraceous spore print.

Habitat: Mycorrhizal; beneath conifers in damp, usually shaded places. Summer to early winter. Site of collection: Phek, Nagaland. **GPS Co-ordinates** Latitude N $25^0$31'23" and longitude E $094^0$15'37" **Elevation**: 1469 m asl

32. **Accession no: NU/BOT/GLO-115** ***Agaricus augustus*** **Fr.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Agaricaceae
Genus: *Agaricus*
Species: *augustus*

Pileus: 9-15 cm across, chestnut brown, obtusely ovate then expanding to convex, surface with reddish-brown fibrous scales arranged concentrically. **Gills**: Free, pale pink, crowded, bears a delicate white partial veil with dark-coloured warts. **Stipe**: 90-120x 17-30 mm, dull white to yellowish, thick; more or less equal, whitish, whitish ring adorning the stipe, above the ring, the stem is white to yellow and smooth. Below, it is covered with numerous small scales. Chocolate brown spore print.

Habitat: on coniferous and deciduous woods, summer to autumn. **Site of collection**: Phek, Nagaland. **GPS Co-ordinates** Latitude N $25^0$31’23” and longitude E $094^0$15’37” Elevation: 1469 m asl.

33. **Accession no: NU/BOT/GLO-119 *Cantharellus lateritius* (Berk.) Singer.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Cantharellales
Family: Cantharellaceae
Genus: *Cantharellus*
Species: *lateritius*

Pileus: 2-6 cm across, bright orange-yellow, vase-shaped, incurved, wavy, and irregular margin, curve downwards. **Undersurface**: concolorous with cap but paler, initially smooth, but gradually develops ridges. **Stipe:** 30-60 x 10-30 mm, tapering towards the base; bald, concolorous with the cap, white basal mycelium, light yellow spore print.

Habitat: Mycorrhizal, on soil under mixed woodland, summer to autumn. **GPS co-ordinates**: Latitude N $25^0$37'23" Longitude E $094^0$8'6" Elevation: 1335m asl. **Site of collection**: Kigwema, Kohima, Nagaland.

34. **Accession no: NU/BOT/GLO-007 *Lentinus tigrinus* (Bull.) Fr.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Polyporales
Family:	Polyporaceae
Genus:	*Lentinus*
Species:	*tigrinus*

Pileus: 5-8.2 cm across, wide, convex, with a prominent, navel-like central depression; dry; fibrillose-scaly with small, brown radial scales over a tan to brown background; incurved margin, tough and firm. **Gills**: White or creamy; decurrent, crowded, edges slightly serrated. **Stipe**: 20-40 x 3-7 mm, whitish to creamy, wide; equal, or slightly tapered toward the base; dry; scaly with fine brown scales and appearing fibrillose on maturity. White spore print.

Habitat: Saprobic; growing alone, scattered, or, more frequently, gregariously to loosely clustered on the wood of hardwoods, Summer and autumn. Site of collection, Old Riphym, Wokha, Nagaland. **GPS co-ordinates:** Latitude N $26^0$10’60” Longitude E $094^0$16’10” Elevation: 1055m asl.

35. **Accession no: NU/BOT/GLO-123 *Termitomyces* sp.1.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Lyophyllaceae
Genus: *Termitomyces* sp.1

Pileus: 4–6.2 cm across, grey-brown, smooth, fades to whitish at the margins, convex with centrally raised bumps, margin irregular and splitting. **Gills:** white to creamish, crowded, free to adnate. Stipe: 59-82 mm x 8-10 mm equal, tapering pseudorrhiza, solid and fibrillose Pinkish spore print.

Habitat : on termite soil, summer after rain. Site of collection: Zaphumi, Zunheboto, Nagaland. **GPS co-ordinates:** Latitude N $26^0$28’42” Longitude E $094^0$47’46” Elevation: 867m asl.

36. **Accession no: NU/BOT/GLO-341 Termitomycs sp.3.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Lyophyllaceae

Genus: *Termitomyces* sp.3

Pileus: 4.2-7 cm across, greyish brown, applanate with a round perforatorium, glabrous and shiny, splitting cap-margin. Gills: white, crowded, free, white spore print. Stipe: 120-140 x 20-30 mm, white towards the apex to slightly light brown towards the base, uniformly thick stipe thickening slightly towards the base. Pseudorhiza 5-10 cm, tapering, terminating with pale yellowish sclerotic disk. Site of collection: Old Riphym village, Wokha, Nagaland.

Habitat: symbiotically in and on termite nests, grows in groups, grows in Summer. **GPS co-ordinates:** Latitude N $26^0$11'16" Longitude E $094^0$16'22" Elevation: 1058 m asl

37. **Accession no: NU/BOT/GLO-368 *Russula* sp.14**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Russulales
Family: Russulaceae
Genus: *Russula* sp.14

Pileus: 9.8-13.5 cm across, convex, later flattening, irregularly wavy, greyish-liliac to pale wine border. **Gills**: almost free, pale cream, crowded, pale cream spore print. **Stipe**: 30-70 x 15-30 mm, concolorous with stipe faintly tinged with violet. Site of collection: Kikruma, Phek, Nagaland.

Habitat: on soil in both deciduous forests and mixed forests, grows in groups, Summer to early autumn. **GPS co-ordinates:** Latitude N $25^0$37'2" Longitude E $94^0$13'14" Elevation: 1323m asl

38. **Accession no: NU/BOT/GLO-356 *Panus* sp.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Polyporales
Family:	Polyporaceae
Genus:	*Panus* sp.

Pileus 6.2-8 cm across, light creamy brown, densely hispid and squamulose, cap in-rolled when young, infundibuliform on maturity. **Gills**: deeply decurrent gills, light brown, crowded gills, **Stipe** 23-45 mm x 4-8 mm, short and robust, squamulose, concolorous with cap. The spores have a white print.

Habitat on decaying logs, summer to autumn. **Site of collection** : Wokha Nagaland. **GPS** Latitude: N $26^0$10'60" Longitude: E $094^0$16'10" Elevation: 1055 m asl

39. **Accession no: NU/BOT/GLO-126 *Pleurotus pulmonarius* (Fr.) Quél**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Agaricales
Family:	Pleurotaceae
Genus:	*Pleurotus*

Species: *pulmonarius*

Pileus: 3-10 cm across, convex, becoming flat or somewhat depressed, overlaps in groups, wavy margin. **Gills**: creamish, decurrent when present, crowded. White spore print. **Stipe**: 10-40 x 5-10 mm, absent or rudimentary, short, lateral.

Habitat in clusters on decaying logs. Site of collection: Kikruma, Phek, Nagaland. **GPS co-ordinates:** Latitude N $25^0$37'2" Longitude E $94^0$13'14" Elevation: 1323m asl.

40. **Accession no: NU/BOT/GLO-187 *Lentinula edodes* (Berk.) Pegler.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Omphalotaceae
Genus: *Lentinula*
Species: *edodes*

Pileus: 5-10 cm across, convex to eventually plane at maturity, light-coloured to reddish brown or black, even to irregular margin, inrolled at first then incurved. Gills: white, even at first then becomes serrated with age, bruises brown when injured, white spore print. Stipe: 40-80 x 1-2 mm, reddish brown, fibrous, centrally attached, tough.

Habitat saprophytic, on the deadwood of broad-leaved trees. Site of collection: Kikruma, Phek, Nagaland. **GPS co-ordinates:** Latitude N $25^0$31'23" Longitude E $94^0$15'37" Elevation: 1695 m asl

41. **Accession no: NU/BOT/GLO-268 *Lentinus* sp.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Polyporales

Family: Polyporaceae

Genus: *Lentinus* sp.

Pileus: 11-17 cm across smooth, infundibuliform, light brown, darker towards the depressed zone, convex to plano-concave, becomes tougher with age, regular cap margin. **Gills:** creamish white, decurrent, crowded, creamish spore print. **Stipe**:30-50 x 10-15 mm, dark brown, annulus present, woody, short.

Habitat : on stump of deciduous wood, summer to autumn. Site of collection: Phangsang, Mokokchung, Nagaland. **GPS co-ordinates:** Latitude N $26^0$25’45” Longitude E $94^0$39’40” Elevation: 1187m asl

42. **Accession no: NU/BOT/GLO-266 *Abortiporus* sp.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Polyporales

Family: Meruliaceae

Genus: *Abortiporus* sp.

Pileus 8–15 cm across; fan-shaped or kidney-shaped to infundibuliform, wavy, often clustered,rosette-like, irregular in outline reddish brown or tan with white margin, dry, zoned with shades of brown bands. Tubes 2-6 mm long, decurrent, **Pores**1-2 per mm, maze like, angular and irregular, whitish, pinkish towards the margin. **Stipe** 30-70mm x 10-30mm, poorly developed, lateral, tapering to base; brownish, well rooted and incrusted with dirt.

Habitat Solitary in soil or grass near hardwood stumps, autumn, annual. Site of collection: Phangsang, Mokokchung, Nagaland **GPS** Latitude: N $26^0$25’21” Longitude: E $94^0$39’13” Elevation: 1072 m asl

43. **Accession no: NU/BOT/GLO-375 *Scleroderma* sp.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Boletales

Family: Sclerodermataceae

Genus: *Scleroderma* sp.1

Fruit body 4-10 cm across, sub globose or potato-shaped, attached to the substrate by cord-like mycelial threads, yellowish brown to ochre-brown, thick, tough, wart-like surface, thick leathery peridium. Gleba almost white when young, turns purplish-black on maturity patterned with whitish veins.

Habitat. on heathland and sometimes in short grass, under hardwoods and conifers,

late summer to early winter **Site of collection**: Wokha Nagaland. **GPS** Latitude: N $26^0$10’60” Longitude: E $094^0$16’10” Elevation: 1055 m asl

44. **Accession no: NU/BOT/GLO-259 *Favolus brasiliensis* (Fr.) Fr.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Polyporales

Family: Polyporaceae

Genus: *Favolus*

Species: *brasiliensis*

Pileus: 5–9.2 cm across, 3 mm thick, semicircular to round, dimidiate, reniform, lobed in outline; clustered, surface radially lined, azonate, glabrous, creamish, leathery texture, creamish white, thin, dry. Pores elongated and hexagonal, white to pale yellowish, not bruising.

Habitat On the deadwood of various hardwoods; annual. Stipe 10-20 mm x 5 mm, solid, lateral to substipitate or almost sessile, cylindrical to flattened or reduced, tough; white, concolorous with the pileus, White spore print. **Site of collection**: Phangsang, Mokokchung, Nagaland **GPS** Latitude: N $26^0$25’21” Longitude: E $94^0$39’13” **Elevation**: 1072 m asl

45. **Accession no: NU/BOT/GLO-320 *Favolus* sp.2**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Polyporales

Family: Polyporaceae

Genus: *Favolus* sp.2

Pileus: 2-5 cm across, white, semicircular, reniform; surface radially lined,thin, dry. Pores hexagonal, concolorous with the pileus, not bruising. Stipe: 8-15 mm x 4 mm, almost sessile, cylindrical to flattened, tough, concolorous with the pileus, White spore print.

Habitat: On the deadwood of various hardwoods; summer to winter. **Site of collection**: Old Riphym village, Wokha, Nagaland. **GPS**: Latitude: N $26^0$11’17” Longitude: E $94^0$16’20” Elevation: 1069 m asl.

46. **Accession no: NU/BOT/GLO-260 *Pleurotus* sp. 3**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Agaricales

Family: Pleurotaceae

Genus: *Pleurotus* sp.3

Pileus 2 cm across, convex, dark to tan brown, widely spaced, velvety, incurved margin, gills decurrent, whitish. White spore print. **Stipe** 4 cm, fleshy, creamish.

Habitat: on roots and decaying remains, spring to autumn. Site of collection: Phangsang, Mokokchung, Nagaland **GPS co-ordinates:** Latitude N $26^0$25’45” Longitude E $94^0$39’40” Elevation: 1187 m asl.

47. **Accession no: NU/BOT/GLO-369 *Trichaleurina javanica* (Rehm) M. Carbone, Agnello & P. Alvarado**

Kingdom: Fungi

Division: Ascomycota

Class: Pezizomycetes

Order: Pezizales

Family: Pyronemataceae

Genus: *Trichaleurina*

Species *javanica*

Fruiting body 6.6 mm across, 5.5–6.5 cm high, goblet or cup-shaped, occurs in clusters or single, surface greyish brown to brownish-black, velvety, rough, tapering or cylindrical, downwards, hirsute hairs are few and far between across the surface, but they get denser as they approach the rim of the cup. Gelatinous, transparent, and rubbery inner tissue.

Habitat on the rotten wood. Site of collection: Bongkolong, Peren, Nagaland. **GPS co-ordinates** Latitude: N $25^0$31’51” Longitude: E $93^0$31’29” Elevation: 367 m asl.

48. **Accession no: NU/BOT/GLO-208 *Pleurotus* sp.4**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Agaricales

Family: Pleurotaceae

Genus: *Pleurotus* sp.4

Pileus: 1-4 cm, kidney-shaped, smooth, faintly hairy near the point of attachment; thinly sticky to slimy; brownish to pale cinnamon brown. **Gills**: crowded, creamish brown, radiates from the point of attachment with substrate, brownish spore print. **Habitat**: Saprobic, growing gregariously on hardwood logs, summer and autumn. Site of collection: Phesama, Kohima, Nagaland. **GPS co-ordinates** Latitude: N $25^0$37'52" Longitude: E $94^0$6'15" Elevation: 1505 m asl.

49. **Accession no: NU/BOT/GLO-376 *Russula griseocarnosa* X.H.Wang, Zhu L.Yang & Knudsen**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Russulales

Family: Russulaceae

Genus: *Russula*

Species: *griseocarnosa*

Pileus: 6.2-10 cm across, tinted red to palish cherry red with yellowish tinge in small patches, solitary or scattered, convex when young to plano-convex when matured, surface greasy when wet, smooth when dry, slightly depressed in the centre, easily

peeling skin. **Gills:** whitish to yellowish white, wide, crowded, slightly adnate, white spore print. **Stipe:** 50-100 x 16-26 mm, cylindrical, yellowish white or flushed pink or red in part or entirely,

Habitat: on soil, solitary or in groups in deciduous forests, summer to early autumn. **Site of collection**: Mopungchuket, Mokokchung, Nagaland. **GPS co-ordinates** Latitude: N $26^0$23'29" Longitude: E $94^0$32'4" Elevation: 1229 m asl

50. **Accession no: NU/BOT/GLO-206** ***Schizophyllum commune*** **Fr.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Agaricales
Family:	Schizophyllaceae
Genus:	*Schizophyllum*
Species:	*commune*

Pileus: 10-35 x 5-10 mm, white greyish brown and densely hairy, sometimes tinged purple, bracket shaped, irregular margin. Gills: Pinkish grey, radiates from the point of attachment, splits when the mushroom dries out. Stipe is rudimentary. White spore print.

Habitat: on fallen dead decaying logs and branches, throughout the year. Site of collection: Ngangpong, Tuensang, Nagaland. **GPS co-ordinates** Latitude: N $26^0$12'56" Longitude: E $94^0$47'40" Elevation: 1753 m asl

51. **Accession no: NU/BOT/GLO-325** ***Mycena*** **sp.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Mycenaceae
Genus: *Mycena* sp.

Pileus: 1-2 cm across, white with pale cream centre, convex, margin wavy and irregular, Gills: creamish white, free, wide, white spore print. **Stipe**: 10-50 x 2-3 mm, white, white fibers at base.

Habitat: on bark, summer. Site of Site of collection: Phesama, Kohima, Nagaland. **GPS co-ordinates** Latitude: N 25037'52" Longitude: E 9406'15" Elevation: 1505 m asl

52. **Accession no: NU/BOT/GLO-364** ***Pleurotus citrinopileatus*** **Singer.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Pleurotaceae
Genus: *Pleurotus*
Species: *citrinopileatus*

Pileus: 4-9 cm across, bright to medium yellow, convex, shallow central depressed, smooth surface, irregular and cracked cap margin, whitish margin. Gills: decurrent; ivory-white. Pale-pinkish spore print. Stipe: 20-5- x 4-10 mm, white, cylindrical, often branched, covered with the gills nearly to the base.

Habitat: Saprophytic, growing in clusters. Growing on the deadwood of hardwoods; summer and autumn. S**ite of collection:** Zapami, Phek, Nagaland. **GPS Co-ordinates**: Latitude N $25^0$31’23” and longitude E $93^0$15’37”. Elevation: 1695 m asl.

53. **Accession no: NU/BOT/GLO-211 *Tremella mesenterica* Retz**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Tremellomycetes
Order:	Tremellales
Family:	Tremellaceae
Genus:	*Tremella*
Species:	*mesenterica*

Fruiting Body: 2–5 cm across, golden yellow, irregular, rounded to variously lobed, brain-like, gelatinous, slimy, smooth, translucent lobes. Whitish to pale yellow spore print.

Habitat: parasitic, growing alone or in amorphous clusters, on dead timber and fallen branches; summer to winter. Site of collection: Ngangpong forest, Tuensang, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$12’58” and longitude E $94^0$47’45” Elevation: 1712 m asl.

54. **Accession no: NU/BOT/GLO-328 *Amanita vaginata* (Bull.) Lam.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Agaricales
Family:	Amanitaceae

Genus: *Amanita*

Species: *vaginata*

Pileus: 7-11 cm across, gray to grayish-brown, progresses from oval, to conical then convex, and eventually flattened as it matures with a central bump, edge has comb-like radial ridges. Gills: white, sometimes with greyish tint, crowded, adnexed to free, white spore print. Stipe: 100-150 x 10-21mm, covered with a finely powdered bloom, narrower near the cap, tapers slightly at the base, becomes hollow on maturity, large and loose white or tinged with grey sack-like volva, ring is absent.

Habitat: on the heaths of deciduous forest; summer to autumn Site of collection: Old Riphym, Wokha, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$11'11" and longitude E $94^0$16'30" Elevation: 960 m asl

55. **Accession no: NU/BOT/GLO-372 *Amanita caesarea* (Scop.) Pers.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Agaricales

Family: Amanitaceae

Genus: *Amanita*

Species: *caesarea*

Pileus: 4–9 cm across; orange-red, oval at first, then expands to convex and, later, planoconvex; glabrous; without warts or patches; striate margin. **Gills**: pale yellow, free or slightly adnexed, crowded, white spore print. **Stipe**: 80–110 x 15-25 mm, yellow to

whitish, finely silky, attached orange veil fragments, whitish bag-like volva, becomes hollow as it matures, slightly tapers on the apex.

Habitat: on soil under oaks in mixed woodland; summer to autumn. Site of collection: Kigwema, Kohima, Nagaland. **GPS Co-ordinates**: Latitude N $25^0$37’23” and longitude E $94^0$8’7” Elevation: 1336 m asl.

56. **Accession no: NU/BOT/GLO-203 *Auricularia auricula-judae* (Bull.) J.Schröt.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Auriculariales

Family: Auriculariaceae

Genus: *Auricularia*

Species: *auricula-judae*

Fruiting body: 6-8.2 cm across, wavy and irregular, oval to ear shaped, tan brown to reddish brown, gathered and attached at the central position, thin, gelatinous-rubbery; becomes hard and black on drying, wrinkled in places, white spore print.

Habitat: Saprophytic, on stumps, logs and twigs of decaying hardwood trees. Summer to winter. Site of collection: Ngangpong forest, Tuensang, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$12’58” and longitude E $94^0$47’45” Elevation: 1712 m asl.

57. **Accession no: NU/BOT/GLO-219 *Coprinellus disseminates* (Pers.) J.E.Lange.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Agaricales

Family: Psathyrellaceae

Genus: *Coprinellus*

Species: *disseminatus*

Pileus: 1-2 cm across, convex, white to beige when young, then turns greyish to blackish as it matures, pleated caps, very fine hair when young, margins slightly upturned. Gills: adnate, white at first, but turns gray as the spores matures, spore print black. Stipe: 20-35 x 1-2 mm, equal, white, thin, fragile, hollow, often curved.

Habitat : Saprobic, grows in clusters on rotten wood or litter, Spring to autumn. Site of collection: Ngangpong forest, Tuensang, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$12’58” and longitude E $94^0$47’45” Elevation: 1712 m asl.

58. **Accession no: NU/BOT/GLO-202 *Auricularia nigricans* (Sw.) Birkebak, Looney & Sánchez-García**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Auriculariales

Family: Auriculariaceae

Genus: *Auricularia*

Species: *nigricans*

Fruiting body: 5-8.2cm across, ear-shaped, upper surface densely tomentose with dark grayish brown, underside is wrinkled and pinkish to brown, rubbery-gelatinous, loosely attached.

Habitat : Saprobic, grows singly or in clusters on decaying logs, sticks, stumps, Spring to autumn. Site of collection: Ngangpong forest, Tuensang, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$12’58” and longitude E $94^0$47’45” Elevation: 1712 m asl.

59. **Accession no: NU/BOT/GLO-158 *Coprinopsis lagopus* (Fr.) Redhead, Vilgalys & Moncalvo.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Agaricales
Family:	Psathyrellaceae
Genus:	*Coprinopsis*
Species:	*lagopus*

Pileus: 3-4 cm across, grey-brown, broad, umbonate, conical, then flat with a striate margin, covered in ephemeral hairy white scales; short lived, edges curved upward. Gills: free, close, narrow, white soon greyish, becoming black, deliquescing from the rim within a few hours of becoming fully expanded, black spore print. Stipe:40-80 x 2-4 mm, equal, fragile, hollow, white, tomentose from universal veil remnants.

Habitat: grows solitarily or in groups in soil compost straw heaps or cattle dung; autumn to mid-winter. Site of collection: Tanhai, Mon, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$39’27” and longitude E $95^0$12’44” Elevation: 1475 m asl.

60. **Accession no: NU/BOT/GLO-250 *Phaeotremella frondosa* (Fr.) Spirin & V. Malysheva**

Kingdom:	Fungi

Division: Basidiomycota
Class: Tremellomycetes
Order: Tremellales
Family: Phaeotremellaceae
Genus: *Phaeotremella*
Species: *frondosa*

Fruiting Body: upto 7 cm across, 8cm high and 1-2 mm thick, gelatinous, reddish-brown to dark brown, lettuce-like clusters of flattened lobes, with branched, undulating fronds without a stipe; flesh gelatinous,

Habitat on the deadwood of hardwoods; July through November. Site of collection: Helipong, Tuensang, Nagaland. **GPS Co-ordinates**: Latitude: N $26^0$12'6" Longitude: E $94^0$44'56" Elevation: 2181 m asl.

61. **Accession no: NU/BOT/GLO-111 *Turbinellus floccosus* (Schwein.) Earle ex Giachini & Castellano**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Gomphales
Family: Gomphaceae
Genus: *Turbinellus*
Species: *floccosus*

Pileus: 4-9 cm across, yellowish-orange to reddish-orange fading in age, initially cylindrical, maturing to trumpet- or vase-shaped, fleshy; nearly smooth when young, squamulose to coarsely scaly at maturity, flesh moderately thick. Fertile surface

wrinkled or with blunt ridges and veins, yellow, fading to cream-buff. Orange yellow spore print.

Stipe: 6-9 cm high, dull yellow shades, thick, stout, attachment variable, central or slightly eccentric, tapering downward, hollow to near the base.

Habitat saprophytic, on the deadwood of broad-leaved trees. Site of collection: Kikruma, Phek, Nagaland. **GPS co-ordinates**: Latitude N $25^0$37'2" Longitude E $94^0$13'14" Elevation: 1327 m asl.

62. **Accession no: NU/BOT/GLO-335** ***Phallus indusiatus*** **Vent.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Phallales
Family:	Phallaceae
Genus:	*Phallus*
Species:	*indusiatus*

Cap: upto 4cm high, flat-topped conico-convex cap, broader than the stem, covered in olive-brown spore-bearing gleba. The raised honeycomb texture of the cap is visible beneath the gleba. Stem: 10-20 x 2-3cm, cylindric, whitish; hollow; base enclosed in a whitish to pinkish volva; attached to white or pinkish rhizomorphs. Veil or indusium from the stem apex, a lace-like skirt or indusium billows out and descends often to substrate level. Like the rest of the fruitbody, the lace is short lived.

Habitat: Saprobic; growing alone or gregariously in woods, especially in disturbed-ground areas, all year round. Site of collection: Old Riphym, Wokha, Nagaland . **GPS Co-ordinates**: Latitude N $26^0$11'11" and longitude E $94^0$16'30" Elevation: 960 m asl

63. **Accession no: NU/BOT/GLO-204 *Auricularia mesenterica* (Dicks.) Pers.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Auriculariales
Family:	Auriculariaceae
Genus:	*Auricularia*
Species:	*mesenterica*

Fruiting body: 4-8 cm across, bracket-like, first appear pale, rubbery, and button-like in shape, later expands and hardens with age. The upper surface is gray to brown, tomentose to hispid with concentric zones, while the underside is thickly gelatinous, irregularly folded radially, wavy and putty-like, and reddish-brown. White spore print.

Habitat: on fallen trunks and stumps of deciduous trees, summer to mid-winter. **GPS Co-ordinates** Latitude: N $26^0$12'22" Longitude: E $94^0$44'58" Elevation: 2200m asl.

64. **Accession no: NU/BOT/GLO-212 *Daldinia vernicosa* Ces. & De Not**

Kingdom:	Fungi
Division:	Ascomycota
Class:	Sordariomycetes
Order:	Xylariales
Family:	Hypoxylaceae
Genus:	*Daldinia*

Species: *vernicosa*

Fruiting body: 2-7 cm across, silver-grey to greyish black, very hard, round to subglobose, vinaceous-brown, subsequently blackening, varnished, when old, tissue below the perithecial layer composed of alternating darker and lighter zones; darker zones blackish grey to black, pithy to woody; lighter zones whitish, initially gelatinous, subsequently disintegrating and becoming loculate. Black spore print.

Habitat: fallen branches of ash trees, spring to winter. Site of collection: Ngangpong forest, Tuensang, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$12’58” and longitude E $94^0$47’45” Elevation: 1712 m asl.

65. **Accession no: NU/BOT/GLO-370 *Termitomyces microcarpus* (Berk. & Broome) R.Heim.**

Kingdom: Fungi
Division: Basidiomycota
Class: Agaricomycetes
Order: Agaricales
Family: Lyophyllaceae
Genus: *Termitomyces*
Species: *microcarpus*

Pileus: 1.5-2.5 cm across, creamish white to light grey and darker within the centre, convex, applanate, small spiniform perforatorium and umbo, without papilla, cap splits from its margins. Gills: free, white to creamy, crowded, thick,. Stipe: 40-80 x 3-6 mm, Central, slender, hollow, white, fleshy-fibrous and smooth.

Habitat: On termite nests, summer to autumn. Site of collection: Toulazouma village, Dimapur, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$52'3" and longitude E $94^0$43'29" Elevation: 147 m asl.

66. **Accession no: NU/BOT/GLO-159** ***Laccaria tortilis*** **(Bolton) Cooke.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Agaricales
Family:	Hydnangiaceae
Genus:	*Laccaria*
Species:	*tortilis*

Pileus: 1-2 cm across, pinkish-brown caps, convex at first becoming irregularly flattened, centrally depressed, margins are irregularly wavy, striate from margin to centre. Gills: pale pink, distant. White pore print. Stipe: 20-60 x 2-4 mm, concolorous with cap, usually bent, fine white hairs towards the base when young.

Habitat: grows on tree trunk in bulk on the roadside, summer to autumn. Site of collection: Tanhai, Mon, Nagaland. **GPS Co-ordinates**: Latitude N $26^0$39'27" and longitude E $95^0$12'44" Elevation: 1475m asl.

67. **Accession no: NU/BOT/GLO-175** ***Tremella fuciformis*** **Berk.**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Tremellomycetes
Order:	Tremellales
Family:	Tremellaceae

Genus: *Tremella*

Species: *fuciformis*

Fruiting Body: 7-8 cm across, gelatinous, translucent whitish, thin but fairly firm, branching fronds, surface smooth and shiny. White spore print

Habitat on the deadwood of hardwoods; summer to autumn. Site of collection: Helipong, Tuensang, Nagaland. **GPS Co-ordinates**: Latitude: N $26^0$12’22” Longitude: E $94^0$44’58” Elevation: 2200 m asl.

68. **Accession no: NU/BOT/GLO-097 *Boletus reticulatus* Schaeff.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Boletales

Family: Boletaceae

Genus: *Boletus*

Species: *reticulatus*

Pileus: 7-12 cm across, broadly convex with age, brownish to pale brown, well-worn leather texture, smooth to deep prominent cracks with maturity, does not bruise or discolor; the margin inrolled to splitting with age, **Tubes and Pores:** white, becoming greenish yellow when old, does not change colour when bruised, recedes from the stipe. Olive brown spore print. **Stipe:** 6-10 cm high, upto 5cm in diameter at its widest point, central, finely reticulate with a variable white to brown colour, occasionally clavate but more often barrel-shaped, solid.

Habitat mycorrhizal, on soil beneath mainly broadleaf trees, notably oaks; summer to autumn. Site of collection: Kikruma, Phek, Nagaland. **GPS co-ordinates**: Latitude N $25^0$34’29” Longitude E $94^0$12’22” Elevation: 1479 m asl.

69. **Accession no: NU/BOT/GLO-061 *Craterellus cornucopioides* (L.) Pers.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Cantharellales

Family: Cantharellaceae

Genus: *Craterellus*

Species: *cornucopioides*

Fruiting body 3.4-7.4 cm height, no separation into stalk and cap, initially tubular, becoming deeply funnel shaped, inrolled margin, thin-fleshed, brittle and leathery. Inner(infertile) surface grey-brown to dark grey or black upper surface with wrinkled marginal striations. Under/Outer (fertile or hymenial) Surface: Smooth or very longitudinally finely wrinkled; dark grey to black, with a whitish bloom, hollow down to the base and slightly tapers.

Habitat: dispersed, gregariously, or (often) in dense clusters, grow on soil under deciduous trees; summer and autumn. Spore Print: whitish-creamy. Site of collection : Phek, Nagaland. **GPS** Latitude N $25^0$37’23” and longitude E $094^0$08’06” Elevation: 1335.8 m asl

70. **Accession no: NU/BOT/GLO-086 *Ramaria thindii* A. Parihar & A. Ghosh.**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Gomphales

Family: Gomphaceae

Genus: *Ramaria*

Species: *thindii*

Pileus: Fruiting body: 6-10 cm high, 4-8cm wide, cylindrical-coraloid like, fleshy and glutinous when fresh, densely branched, deeply grooved at juncture of fused branches, glabrous, hollow or pithy, pale yellow to pastel yellow, mostly white towards rooting underground, rhizomorph white base, numerous dichotomous branches, primary branch 3-8 in numbers, ascending to flaring; ultimate branchlet 2-7 mm long, dichotomous, elongated, apices acute to obtuse, unchanging when bruised.

Habitat: humicolous on debris of coniferous and deciduous trees, gregarious to solitary, summer to autumn. **Site of collection**: Phek, Nagaland. **GPS co-ordinates**: Latitude N $25^0$34’22” Longitude E $94^0$12’24” Elevation: 1470m asl.

71. **Accession no: NU/BOT/GLO-113 *Rhizopogon luteolus* Fr**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Boletales

Family: Rhizopogonaceae

Genus: *Rhizopogon*

Species: *luteolus*

Fruit body 1-4.5cm across, ovate to globose or an oblate spheroid, outer wall thick and tough, with irregular cracks as it expands. Initially off-white, then ochre-yellow, finally olive brown, no stipe, but cord-like mycelial threads spread into the soil, with tawny mycelial strands covering. Gleba olivaceous at maturity.

Habitat Generally occur singly or in small groups in coniferous wood, found in late summer and early autumn. **Site of collection** : Phek, Nagaland. **GPS** co-ordinates Latitude N $25^0$34’23” and longitude E $94^0$12’24” Elevation: 1469 m asl.

72. **Accession no: NU/BOT/GLO-207 *Termitomyces* sp.3**

Kingdom: Fungi

Division: Basidiomycota

Class: Agaricomycetes

Order: Agaricales

Family: Lyophyllaceae

Genus: *Termitomyces* sp.3

Pileus: 36-40 cm across, light brown, darker toward the centre, densely covered with tiny dark brown scales, convex to depressed at the centre, wavy and splitting margin. Gills: decurrent, crowded, creamish. Stipe: 150-200 x 30-50mm, equal, with tapering pseudorrhiza, with glabrous surface, squamules concolorous with pileus. Spore print: whitish. Habitat: Saprotrophic on soil with a long pseudorrhiza, solitary or in groups of

a few basidiomata in deciduous forests. summer to autumn. **Site of collection** : Zaphumi, Zunheboto, Nagaland. **GPS co-ordinates:** Latitude N $26^0$28’42” Longitude E $094^0$47’46” Elevation: 867 m asl.

73. **Accession no: NU/BOT/GLO-365:** ***Pleurotus dryinus*** **(Pers.) P.Kumm**

Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Agaricales
Family:	Pleurotaceae
Genus:	*Pleurotus*
Species:	*dryinus*

Pileus: 4.2-8 cm across, convex,velvety, incurved margin. **Gills**: White, decurrent,veil remnants adhere to the edge. **Stipe**: 20-60 x 6-9 mm, whitish to creamy, wide; tapering towards base, membranous ring present. White spore print.

Habitat: Saprobic; on the wood of hardwoods, Lare summer and autumn. Site of collection, Old Riphym, Wokha, Nagaland. **GPS co-ordinates:** Latitude N $26^0$10’60” Longitude E $094^0$16’10” Elevation: 1055m asl.

Varying physiographic and geo-climatic conditions has attributed to the occurrence of the State’s diverse flora of macrofungi. From the above listed 73 wild edible mushrooms relished by the tribals, 38 are new reports for the state namely:- *Abortiporus* sp., *Amanita caesarea, Cantharellus lateritius, Cantharellus minor, Coprinopsis lagopus, Coprinopsis lagopus, Craterellus cornucopioides, Daldinia vernicosa, Favolus brasiliensis, Favolus* sp.2, *Hydnellum* sp., *Imleria badia, Laccaria*

amethystine, Lactarius quietus, Lactifluus luteolus, Lentinus badius, Lentinus crinitus, Lentinus sp., *Lyophyllum fumosum, Panus* sp, *Phaeotremella frondosa, Pleurotus dryinus, Pleurotus giganteus, Pleurotus* sp., *Pleurotus* sp.3, *Polyporus* sp., *Ramaria thindii, Rhizopogon luteolus, Russula crustose, Russula griseocarnosa, Russula* sp.1, *Russula virescens, Scleroderma* sp.1, *Termitomyces* sp.3, *Termitomycs* sp.2., *Termitoyces* sp.1, *Trichaleurina javanica* and *Turbinellus floccosus* There are also some species which were collected and are reported to be edible worldwide but are not taken as food by the locals as they do not have the knowledge of it . Such species are as follows: *Apioperdon pyriforme, Boletus separans, Bresadolia uda, Cantharellus cinnabarinus, Clitocybe nuda, Coprinellus disseminates, Cortinarius purpurascens, Hygrocybe cantharellus, Lepista flaccida, Panaeolus antillarum, Phallus indusiatus, Psilocybe cubensis, Ramariopsis kunzei, Suillus americanus, Xerocomellus chrysenteron, Xerocomus subtomentosus and Sarcoscypha coccinea.* This study has made significant contributions in adding to the mycoflora diversity of the state. This study has also brought light that the forest in Nagaland supports a rich mycoflora which are still untapped with major of the knowledge still uncovered from the tribals. Though efforts were made in this research to inculcate as much information as possible, the potential of these forest are magnanimous and therefore more serious study is required to uncover this wealth.

During the survey it was observed that different types of forest supported different species of wild mushrooms. They were generally found growing in two major habitats, i.e., ligneous and terrestrial. The mushroom diversity and its abundance varied between months, habitat and seasons with the record of highest mushroom species

collection during the rainy season, which shows similar results with the report of (Nwordu et al., 2013) who stated that the highest occurrence of mushroom falls between April and June. The least collected was during the winter season. The highest number of samples were collected from Tuensang, Pfutsero followed by Kohima and Wokha districts of Nagaland. It was also observed that the terrestrial habitat supported more mushrooms during summer, while that of the ligneous during the winter. The best source of diverse macrofungal species was found to be from the soil followed by tree and deadwood. The flora of these macrofungi observed in the forest may not be accurate of all the mushrooms prevailing as some mycelia remain dormant underground or in their substrate until there is a prevailing environmental condition favourable for its growth (Adedayo, 2011; Andrew et al., 2013).

The survey findings revealed that the local population possessed extensive knowledge regarding the wild edible mushrooms that were found in their specific geographical region. The transmission of this knowledge occurred intergenerationally. The forest serves as a direct source for their collection of sustenance, which is then consumed with great enjoyment. The individuals prefer to gather the specimens within their own jurisdiction, citing instances of poisoning resulting from mistaken identification. As a result, individuals tend to limit themselves to their existing knowledge and typically refrain from consuming unfamiliar species, despite their potential edibility in other regions. Mushroom harvesting typically occurs during the rainy season, and many individuals refrain from consuming wild mushrooms during the dry season due to the belief that consuming them out of season can lead to poisoning. Nevertheless, species such as *Schizophyllum commune and Auricularia* sp. are

collected althrought the year for food. In this particular society, it appears that the women possess a greater degree of knowledge than their male counterparts regarding the edibility of wild mushrooms. As a result, they tend to take a leading role in the foraging of these mushrooms. These women are selling a considerable number of species in the market to provide financial support for their families. It is worth noting that the composition of mushroom species in a given region is heavily influenced by factors such as vegetation type, topography, and altitude. Consequently, the specific species consumed by local populations may vary across different localities. Despite this variation, some of the common species relished and popular mushroom consumed by the locals are varieties of *Lentinus* sp, *Termitomyces* sp, *Cantharellus* sp, *Schizophyllum commune, Auricularia* sp, *Pleurotus* sp *and Lactifluus* sp. Despite the general mycophilia of society, individuals remain steadfast in their reluctance to sample or acknowledge the edibility of unfamiliar fungal species, deeming them potentially toxic. The individuals possess a high level of awareness regarding the numerous fatalities resulting from ingesting erroneously identified fungi. Consequently, the indigenous population exercises great caution and refrains from ingesting any fungi beyond their territorial boundaries, even if they resemble local species. Numerous edible species that fall under Russulaceae, Amanitaceae, Boletaceae, and Tricholomataceae were regarded as toxic by most of the local respondents. Simultaneously, certain species documented as inedible in scientific studies and publications have been ingested by a population segment. This research presents novel findings on the consumption of certain mushrooms, namely *Daldinia vernicosa, Amanita vaginata,* and *Scleroderma* sp., by the local population. These mushrooms

have been previously classified as inedible by various authors. Due to their extensive traditional knowledge and practises, they also possess expertise regarding the medicinal applications of these macrofungi. Local healers possess extensive traditional medicinal knowledge, yet they opt to withhold this information and maintain its confidentiality. However, their knowledge is exclusively transmitted to individual healers and their immediate descendants rather than being disseminated to the wider community. Insufficient data could be gathered regarding the therapeutic applications. However, commonly, *Ganoderma lucidium* is utilised in the treatment of migraine, while *Suillus bovinus* is employed for the management of gastritis and as an incense.

In the current world scenario, mushrooms are considered as superfood of the present generation and is heading towards adopting it as a substitution to meat as well as protein diet and many more due to their rich nutritional benefits. Most importantly they are in the limelight for many of their medicinal and pharmaceutical properties. In Nagaland however, mushrooms have been a traditional component of their diet and have been enjoyed and passed down through generations. Culinary tradition has long held this particular food item in high esteem, placing it within the upper echelon of gastronomic hierarchy. The activity of mushroom hunting is a prevalent practise, particularly among the local inhabitants of the village during the advent of the rainy season. The rarity of this delicacy, which is exclusively found in forested areas beyond its typical hunting grounds, gives rise to a highly competitive foraging activity for these prized mushrooms. To secure these highly coveted mushrooms ahead of others, a forager typically embarks on their quest prior to sunrise, often as early as 2 A.M. In communities where the practise of sharing is deeply ingrained, individuals ensure that

their modest meals are distributed among one another when a sufficient quantity of mushrooms has been gathered. Upon engaging with multiple participants, it was observed that the yield of said mushrooms is experiencing a swift decline as a result of climatic and seasonal fluctuations. The authors additionally documented fluctuations in the temporal distribution of mushrooms and conveyed their distress regarding the fact that a significant portion of their subsistence during the season is reliant upon it, while daily foraging in the arduous mountainous landscapes is not a viable alternative. The sombre situation wherein their sole source of sustenance comprises solely of mushrooms procured from the forest is disheartening and alarming.

There is a gradual loss of immensely diverse and significant groups of organisms due to various natural and anthropogenic factors. Consequently, it is incumbent upon us to furnish an alternative means by which they may obtain their requisite nourishment, as the continued overuse of resources will inevitably result in significant environmental deterioration and the eventual extinction of said species. The dissemination of knowledge is imperative due to its continual erosion and loss resulting from the ageing population, dispossession of customary lands, waning interest among younger generations, deforestation, and burgeoning urbanisation. Hence, it is imperative to implement robust strategies and educational initiatives aimed at preserving and regulating these natural resources with respect to this particular group of organisms among the general populace. Thus, considering the current situation, the cultivation of mushrooms presents the sole opportunity to fulfil the current demand. The investigation of the scientific evidence regarding the potential of *Lentinula edodes*

mushrooms to aid in the prevention and treatment of various diseases has prompted the initiation of their cultivation, which will be elaborated upon in the following discussion.

4.2 Identification of some important mushrooms based on Molecular characterization

In the present study, eleven important genera of Basidiomycota and Ascomycota were identified based on molecular characterization in order to remove the ambiguity observed in their identification based on morphological and other characteristics. Eleven wild mushrooms belonging to genera *Lentinus*, *Lentinula*, *Phaeotremella, Suillus, Daldinia, Lyophyllum, Pleurotus, Pleurotus, Ramaria, Russula* and *Boletus* were analysed at molecular level using various molecular tools and techniques to further confirm their identity, following molecular methods were employed.

4.2.1 PCR amplification of ITS region

The DNA isolation was performed for the above mentioned 11 wild mushroom species and subjected to electrophoresis for confirmation. The Initial amplifications of ITS1, 5.8S and ITS2 region of the rDNA were performed using the universal primers ITS1 and ITS4 which produced bands fluctuating from 475 to 914 bp genomic sequences. Those PCR products were gel purified and run in 1% agarose gel as shown in figure 4.1. The figure also showed the purity of the samples. The samples were further processed for DNA sequencing. It was observed from the results that all the species showed ITS sizes of ~500 kb as shown in figure 4.2.

4.2.2 Nucleotide BLAST analysis

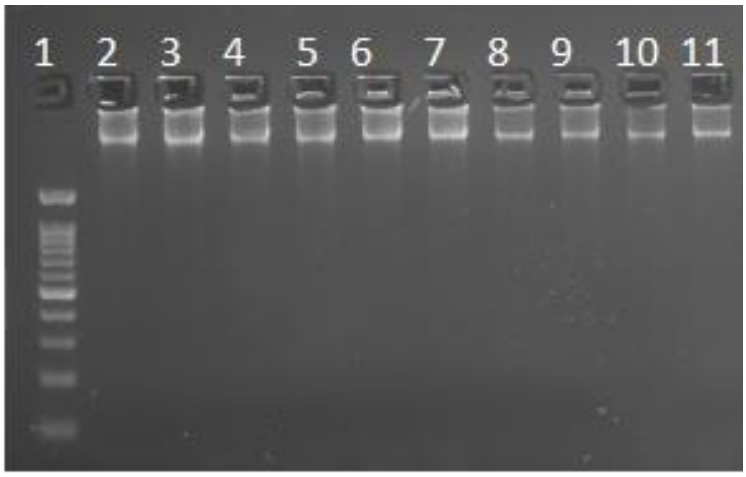


Figure 4.1 Gel electrophoresis image for genomic DNA

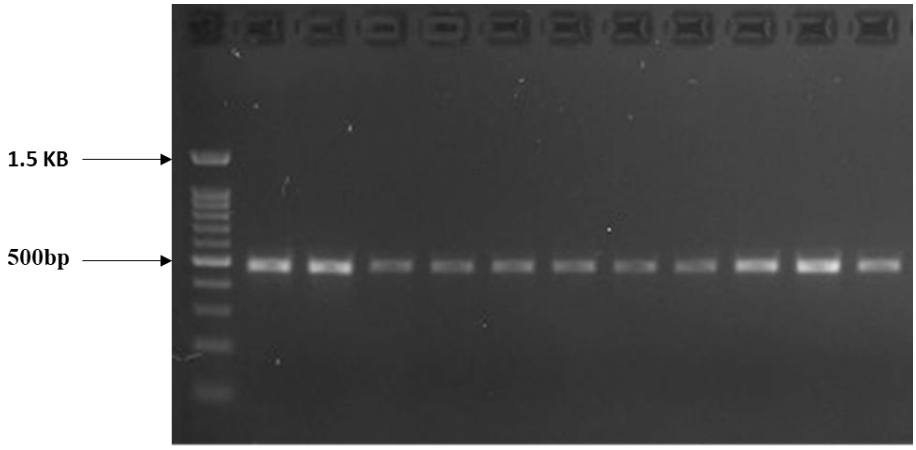


Figure 4.2 Gel electrophoresis images of ITS-PCR products of eleven wild mushrooms with ITS1 and ITS4 primers.

Sequence analysis using nucleotide BLAST was done to bargain the resemblance of nucleotide sequences in NCBI (National Center for Biotechnology Information) records (Altschul et al., 1997). Sequences obtained were edited and submitted to GenBank. Description on the query cover and percent identical with the

closest match and with the accession numbers with other details are mentioned in the **Error! Not a valid bookmark self-reference.** and Table 4.4.

Table 4.3 GenBank accession numbers with sequence length of some wild mushrooms.

Sl.no	Name of species	VOUCHER NUMBER	Sequence length	Gen bank accession number
1	*Lentinus badius*	NU-BOT-GN-LB-001	653 bp	MZ389889
2	*Lentinula edodes*	NU-BOT-GN-LE-002	914 bp	OM717957
3	*Phaeotremella* sp.	NU-BOT-GN-LE-003	475bp	OM884055
4	*Suillus luteus*	NU-BOT-GN-SL-004	692 bp	OM714489
5	*Daldinia vernicosa*	NU-BOT-GN-DV-005	506 bp	OM744414
6	*Lyophyllum fumosum*	NU-BOT-GN-LF-006	628 bp	OM760490
7	*Pleurotus giganteus*	NU-BOT-GN-PG-007	633 bp	OM717958
8	*Pleurotus tuber-regium*	NU-BOT-GN-PT-008	515 bp	OM721745
9	*Ramaria thindii*	NU-BOT-GN-RT-009	598 bp	OM760492
10	*Russula griseocarnosa*	NU-BOT-GN-RG-010	707bp	OM760493
11	*Boletus reticulatus*	NU-BOT-GN-BR-011	745 bp	OM728307

Table 4.4 Table showing the Query cover and percent identical with the closest accession number

Sl.no	Name of species	Query cover	Percent identical	Closest match with Accession no
1	*Lentinus badius*	99%	99.69%	OM780265 (*Lentinus badius*)
2	*Lentinula edodes*	78%	100%	KY494598 (*Lentinula edodes*)
3	*Phaeotremella* sp.	99%	98.51%	MF076905(*Phaeotremella foliaceae*)
4	*Suillus luteus*	100%	99.57%	OM236613 (*Suillus luteus*)
5	*Daldinia vernicosa*	100%	99.80%	MN535762 (*Daldinia vernicosa*)
6	*Lyophyllum fumosum*	100%	99.52%	JX966310 (*Lyophyllum fumosum*)
7	*Pleurotus giganteus*	100%	99.68%	LC068800 (*Pleurotus giganteus*)
8	*Pleurotus tuber-regium*	100%	99.81 %	MT358594 (*Pleurotus tuber-regium*)
9	*Ramaria thindii*	98%	96.50%	MN046115 (*Ramaria thindii*)
10	*Russula griseocarnosa*	100%	99.29%	NR_158880(*Russula griseocarnosa*)
11	*Boletus reticulatus*	99%	96.76	OK642581(*Boletus reticulatus*)

4.2.3 Phylogenetic tree analysis from ITS sequences generated

The presented tree depicts the optimal configuration, exhibiting a cumulative branch length of 3.133. The construction of the phylogenetic tree was based on the inference of evolutionary distances, and the proportional representation of these distances is reflected in the size of its branches. The study used the Kimura 2-parameter (Kimura, 1980) method to calculate evolutionary distances, expressed as the average number of base substitutions per site. The rapid bootstrap algorithm was employed on the dataset, generating 1000 duplicates or bootstraps. The ultimate dataset comprised of 475 distinct locations. The software programme MEGA 11 was utilised for conducting the evolutionary analyses. (Tamura et al., 2021).

Based on phylogenetic reestablishments, the sequences were classified into two clades (Basidiomycota and Ascomycota). *Rozella* sp. sequences bearing the accession number AY997086 were employed as an outgroup genus to establish the tree's root. The Basidiomycota clade has been categorised into various groups, including *Phaeotremella* sp. and *Suillus luteus* cluster and *Lentinus badius, Lentinula edodes, Lyophyllum fumosum, Pleurotus giganteus, Pleurotus tuber-regium, Ramaria thindii,* and *Russula griseocarnosa*, among others. Concurrently, the Ascomycota clade underwent further division, forming a solitary subgroup featuring *Daldinia vernicosa.* Significant bootstrap (BP) values supported all of the aforementioned alliances, as demonstrated by the data presented

.

While conventional fungal taxonomy serves as a useful tool for identifying various mushroom species, certain ambiguities cannot be adequately resolved through this approach. Consequently, the present study incorporated morpho-anatomical facets and molecular characterization through phylogenetic analysis. During our study, we identified three species of wild mushrooms, namely *Suillus luteus, Lentinula edodes,* and *Boletus reticulatus*. Other researchers have previously reported these species, who relied on morphological taxonomy for identification. (Ao & Deb, 2019a). The present study also documented the consumption of *Daldinia vernicosa* by certain members of the local population residing in the Mokokchung district, who reportedly roast the fungus in the embers of a burning firewood prior to consumption. Despite being less palatable than other mushroom varieties, they are often ingested as a snack. The

findings of this report are at odds with existing literature, which indicates that the subject in question is not fit for consumption (R. P. Singh et al., 2016, 2017). The reason for people considering it not worth consuming may be attributed to its low nutritional value or unfamiliarity, or due to doubts regarding its edibility. The present study has identified and confirmed the taxonomic classification of a highly favoured mushroom in Mopungchuket village, located in the Mokokchung district. The mushroom, known locally as "*Ali konger*" or "soil mushroom," belongs to the *Russula* genus and has been identified as *Russula griseocarnosa* through the use of molecular studies. *Lyophyllum fumosum*, a highly sought-after mushroom known locally as "*Pikwe*," was recently discovered in Kigwema village. This rare and delectable fungus has been identified and confirmed as a distinct species. Furthermore, it was quite evident from the present study that both classical and molecular taxonomy revealed *Lentinus badius, Daldinia vernicosa, Lyophyllum fumosum*, *Phaeotremella* sp., *Pleurotus giganteus, Pleurotus tuber-regium, Ramaria thindii, Russula griseocarnosa*, to be reported for the first time from Nagaland. Whereas the ambiguity observed in *Suillus luteus, Lentinula edodes and Boletus reticulatus* were also removed and confirmed at molecular level. Thus, the investigation of mushroom variety in Nagaland is expanding day by day, and our study will aid in exploring the diversity of undiscovered species of wild mushrooms from all uncharted locations of Nagaland.

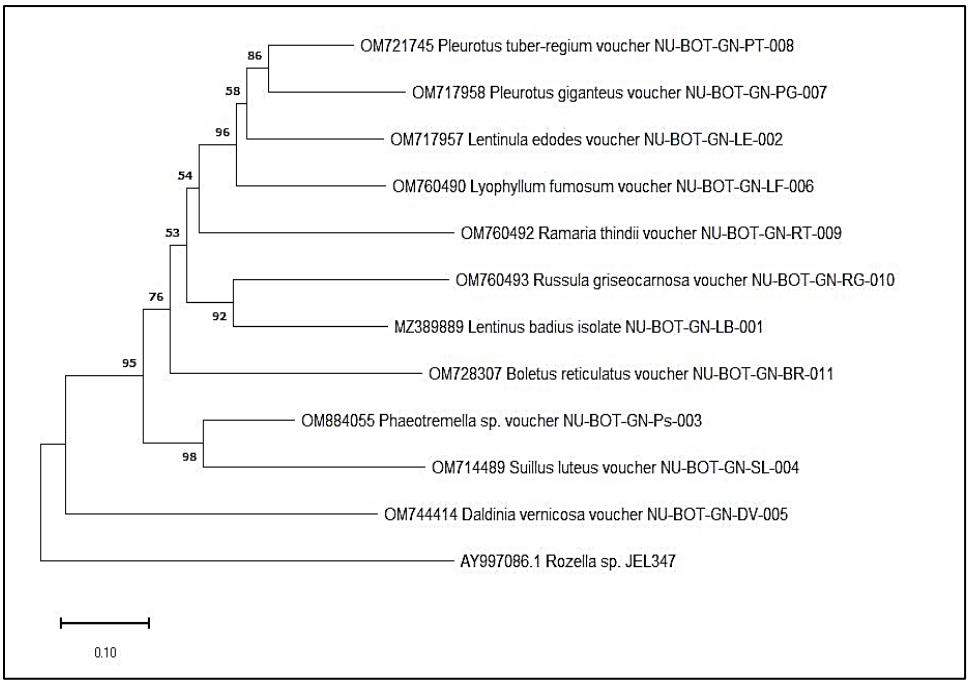


Figure 4.3 Phylogenetic analysis based ITS sequences of 11 wild mushrooms obtained in this study. The tree was reconstructed using Neighbour Joining method as implemented in Mega11. Different clades with Bootstrap values shown at the nodes

4.3 Nutritional Assessment

Wild edible mushrooms are considered a delicacy by the Nagas and are commonly consumed in households due to their exceptional taste and numerous health advantages. The present study reports the results of a chemical analysis conducted on the fruiting bodies of thirty (30) mushrooms, out of which twenty-eight (28) were wild edible mushrooms procured from the forest. The two remaining specimens under consideration are commercial strains of *Lentinula edodes*. These strains were obtained from the Directorate of Mushroom Research located in Solan, Himachal Pradesh. They were cultivated on logs of *Quercus serrata* and formulated sawdust substrate, respectively. The resulting fruiting bodies were utilised for subsequent analysis and

comparative study. The findings are shown in Table 4.5 and Table 4.6 and are calculated based on the dry weight of the samples. Calibration curve for standards prepared for reducing sugar, protein estimation and total carbohydrate are also shown on Figure 4.4. Graphical representation of the various nutritional values can be observed in Figure 4.5.

4.3.1 Moisture

Mushrooms are recognised for their diverse nutritional properties. The present investigation involved the quantitative screening of thirty mushrooms, as reflected by the table, wherein significant variations in nutritional values were observed. The high moisture content of mushrooms is a contributing factor to their limited shelf life, as they are prone to rapid deterioration post-harvest in the absence of appropriate preservation techniques. (Fasidi & Kadiri, 2016) Moisture content of mushrooms studied varied between 66.51±0.07% (*Lentinus tigrinus*) and 94.41 0.31% (*Suillus luteus*) (Table 4.5). which corresponds to the work done by other workers as well (Kalač, 2009; Mattila et al., 2001). The moisture percentage of mushrooms appears to be influenced by their respective substrates. The mushrooms found on leaf litter or soil viz, *Turbinellus floccosus, Lyophyllum fumosum, Suillus luteus and Amanita vaginata* exhibit higher levels of moisture content when compared to those that prefer wood viz, *Lentinus crinitus*, *Lentinus tuber-regium* and *Favolus* sp.

The evaluation of nutritional constituents necessitates consideration of the dry matter content of food items, which is crucial for determining proximate characteristics and minerals on a dry mass basis. Typically, newly harvested mushrooms contain a dry

matter content ranging from 5% to 15% (Beluhan & Ranogajec, 2011). *Ramaria thindii* (27.06±0.05 g/100g d.w), *Amanita vaginata* (26.86±0.01 g/100g d.w), *Auicularia polytricha* (33.49±0.03 g/100g d.w) and *Termitomyces* sp.3 (25.62±0.07 g/100g d.w) were among the species that contained the highest dry matter content. Whereas species such as *Lyophyllum fumosum* (8.19±0.01 g/100g d.w), *Russula virescens* (6.1±0.42 g/100g d.w), *Suillus luteus* (5.59±0.54 g/100g d.w) and *Fistulina hepatica* (6.96±0.33 g/100g d.w) reported with the lowest dry matter content.

4.3.2 Total Carbohydrate

The mushroom's fruiting body primarily comprises carbohydrates, and its carbohydrate content, ranging from 35% to 70%, is highly prized in edible mushrooms. (Manzi et al., 2001; Johnsy et al., 2011). In this study as well, similar to previous workers (Ao & Deb, 2019b; Pushpa & Purushothama, 2010). Total carbohydrate content was observed to be between 19% to 58% It was highest with *Lentinula edodes* (Saw dust substrate) (58.3±0.01 g/100g d.w), *Russula virescens* (58±0.01 g/100g d.w), *Lentinus crinitus* (50±0.03 g/100g d.w) and *Ramaria thindii* (48±0.01 g/100g d.w), while the lowest were found in *Amanita vaginata* (23.3±0.00 g/100g d.w), *Favolus* sp. (23±0.03 g/100g d.w), *Boletus edulis* (21.7±0.00 g/100g d.w) and *Boletus reticulatus* (19±0.03 g/100g d.w) (Table 4.5).

4.3.3 Protein

Mushrooms are recognised as a source of protein and have been colloquially referred to as "Poor man's protein". Protein is a vital constituent of the human diet, serving the crucial function of cellular repair and construction. The incorporation of a

protein-rich diet consisting of edible mushrooms is beneficial for the health of individuals who follow a vegetarian lifestyle (Armassa et al., 2005). The protein content of mushrooms is contingent upon both the environmental conditions and the specific growth stages of the species (Ayaz et al., 2011). In our study crude protein content ranged from 1.66% to 6.45% which is lesser as compared with reports by earlier authors that mushroom consists of a good 12–29.3% (Dıez & Alvarez, 2001; Wang et al., 2014). In our study, *Lentinus sajor-caju* (6.45±0.45 g/100g d.w), *Lentinus badius* (6.36±0.07 g/100g d.w) *Lentinus tuber-regium* (5.88±0.17 g/100g d.w) and *Lentinula edodes* (Saw dust substrate) (5.67±0.03 g/100g d.w) were found to contain the highest protein and the least content were found in *Pleurotus citrinopileatus* (2±0.03 g/100g d.w), *Termitomyces heimii* (1.96±0.01 g/100g d.w), *Russula virescens*(1.92±0.03 g/100g d.w) and *Favolus* sp. (1.66±0.03 g/100g d.w) (Table 4.5). The observed disparity in protein content could potentially be attributed to varying agro-climatic conditions in the geographic regions where species of mushrooms were grown.

4.3.4 Reducing sugar

A sugar that has the ability to function as a reducing agent is referred to as a reducing sugar (Pratt & Cornely, 2014). We observed the lowest reducing sugar content ranging from *Lentinus crinitus* (0.44±0.07 g/100g d.w), *Pleurotus citrinopileatus* (1.01±0.00 g/100g d.w), *Auricularia auricula-judae* (1.22±0.34 g/100g d.w), *Laccaria laccata* (1.23±0.02 g/100g d.w), *Favolus brasiliensis* (1.24±0.23 g/100g d.w) and *Lentinus tuber-regium* (1.25±0.01 g/100g d.w) to highest from *Fistulina hepatica* (13.5±0.01 g/100g d.w), *Suillus luteus* (9.52±0.07 g/100g d.w), *Boletus edulis*

(9.1±0.05 g/100g d.w) and *Boletus reticulatus* (8.4± 0.01 g/100g d.w) (Table 4.5). Previous workers have also reported similar results ranging from 2g to 17 g/100g (Ao & Deb, 2019b; Gaur et al., 2016).

4.3.5 Crude fiber

The present study showed a wide range of fiber content in thirty mushrooms. The total crude fiber content was highest among *Favolus* sp. 2 (10.3±0.29 %), *Favolus brasiliensis* (10.28±0.01 %) *Lentinus squarrosulus* (8.7±0.26 %) and *Lentinus crinitus* (8±0.15 %). While *Auricularia auricula judae* (3.4±0.32 %), *Laccaria laccata* (3.25±0.01 %), *Lentinus sajor-caju* (2.54±0.01 %) and *Turbinellus floccosus (*1.66±0.01 %) reported with the least content (Table 4.6). These results are comparable to already reported from the same region (Ao & Deb, 2019b; Borah & Borgohain, 2013; R. Kumar et al., 2013). Mushrooms are recognised for their composition of both insoluble and soluble fibers. The insoluble fibers facilitate the digestion process, while the soluble fibers contribute to the prevention of cardiovascular diseases by reducing cholesterol levels (Manzi et al., 2001). Wild edible mushrooms are a source of dietary fiber and are recognised for their anti-tumorogenic and hypocholesterolaemic properties (Chihara, 1993; Wasser & Weis, 1999).

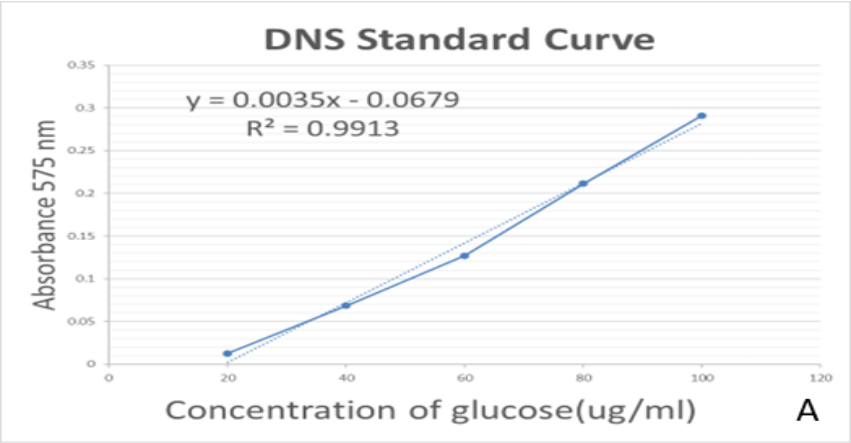
4.3.6 Crude fat

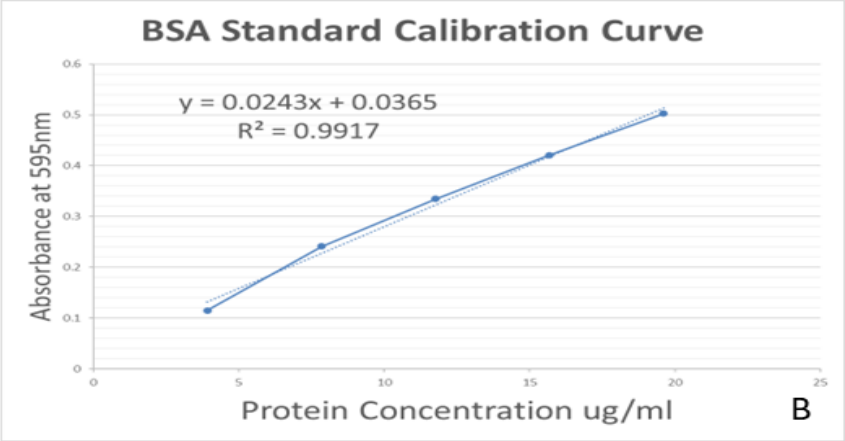
Mushrooms possess a low fat content, rendering them a highly advantageous dietary option for individuals afflicted with diabetes or heart disease. (Bano, 1976; Wu & Xu, 2015). As per previous studies, mushrooms typically exhibit a fat content ranging from less than 1% to as high as 15-20% of their dry weight, with an average range of

2-8%. (Kavishree et al., 2008; Longvah & Deosthale, 1998; Pushpa & Purushothama, 2012). In our study, we have observed that the crude fat content reported to be in the range from 1.18% to 9%. *Amanita vaginata* (9.90±0.07 %), *Suillus luteus* (7.8±0.01 %), *Pleurotus giganteus* (7.73±0.01 %) and *Russula griseocarnosa* (4.33±0.01 %) reported to be the highest range. Whereas the least total fat content was reported from *Lentinus badius* (1.6±0.07 %), *Termitomyces heimii* (1.3±0.02 %), *Lentinula edodes* (log) (1.18±0.01 %) and *Lentinula edodes* (Wild) (1.028±0.01 %) (Table 4.6). Therefore, these wild fungi have the potential to serve as a dietary option for individuals with diabetes.

4.3.7 Ash

Ash is a mineral-rich inorganic residue and so this study reports high content from *Turbinellus floccosus* (10.5±0.01 %), *Lyophyllum fumosum* (11±0.09 %), *Cantherellus lateritius* (18.05±0.16 %) and *Amanita vaginata* (15.08±0.01 %). The least was reported from *Favolus brasiliensis* (3.23±0.01 %), *Lentinus tuber-regium* (2.77±0.05 %), *Lentinus squarrosulus* (3.98±0.01 %) and *Favolus* sp. 2 (4.13±0.02 %) (Table 4.6). Similar results were procured from other workers as well (Ao & Deb, 2019b; Heleno et al., 2015).





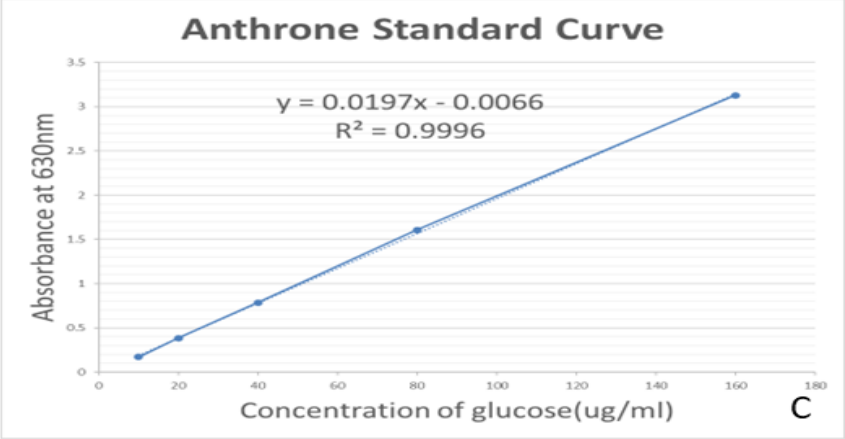


Figure 4.4 Calibration curve for (A) Reducing Sugar (B) Protein estimation (C) Total Carbohydrate

Table 4.5 Nutritional composition of wild edible species in a dry weight (d.w.) basis.

Mushroom species	Reducing sugar (g/100g)	Crude Protein (g/100g)	Carbohydrate (g/100g)
Russula griseocarnosa	2±0.06	4.68±0.03	24±0.01
Boletus reticulatus	8.4± 0.01	4.08±0.00	19±0.03
Lentinus badius	1.9±0.03	6.36±0.07	33±0.07
Pleurotus giganteus	8.12±0.13	3±0.02	45±0.01
Pleurotus citrinopileatus	1.01±0.00	2±0.03	41±0.11
Laccaria laccata	1.23±0.02	3.36±0.01	33±0.06
Turbinellus floccosus	2.55±0.06	2.64±0.13	26±0.03
Ramaria thindii	3.77±0.07	2.28±0.01	48±0.01
Favolus brasiliensis	1.24±0.23	2.28±0.01	35±0.01
Lyophyllum fumosum	2.5±0.03	4.32±0.01	36±0.01
Cantherellus lateritius	1.27±0.01	3.12±0.06	41.7±0.00
*Lentinula edodes (*log)	2.8±0.01	4.68±0.00	33.3±0.09
Russula virescens	4±0.26	1.92±0.03	58±0.01
Lentinus crinitus	0.44±0.02	5.52±0.00	50±0.03
Lentinus tuber-regium	1.25±0.01	5.88±0.17	38.3±0.01
Suillus luteus	9.52±0.07	2.64±0.01	28.3±0.27
Favolus sp.2	1.29±0.08	1.66±0.03	23±0.03
Amanita vaginata	1.81±0.01	2.88±0.23	23.3±0.00
Fistulina hepatica	13.5±0.01	4.2±0.09	30±0.03
Boletus edulis	9.1±0.05	3.96±0.00	21.7±0.00
Lentinus tigrinus	1.54±0.49	4.41±0.01	36.1±0.01
Auricularia polytricha	1.38±0.01	2.23±0.01	36.1±0.00
Termitomyces sp.3	5.9±0.01	2.17±0.00	46.9±0.17
Lentinus sajor-caju	2.53±0.17	6.45±0.45	47±0.03
Lentinula edodes (Saw dust)	6.5±0.03	5.67±0.03	58.3±0.01
Auricularia auricula judae	1.22±0.34	4.63±0.03	39.1±0.00
Lentinus squarrosulus	1.32±0.12	4.04±0.01	45±0.23
Cantherellus cibarius	6.4±0.09	2.01±0.00	41.4±0.01
Termitomyces heimii	1.31±0.01	1.96±0.01	29±0.03
Lentinula edodes (Wild)	*4.53±0.39*	*2.04±0.01*	*37±0.03*

Each value is expressed as Mean ± Standard deviation (SD) (n=3)

Table 4.6 Nutritional composition of wild edible species in a dry weight (d.w.) basis. (*Each value is expressed as Mean ± Standard deviation (SD) (n=3))*

Mushroom species	Moisture (%)	Dry matter (%)	Crude fiber (%)	Crude Fat (%)	Ash(%)
Russula griseocarnosa	84.5±0.01	15.5±0.01	6.18±0.01	4.33±0.01	6.9±0.21
Boletus reticulatus	87.86±.23	12.14±.23	5.72±0.00	3.60±0.01	9.91±0.02
Lentinus badius	91.74±0.11	8.26±0.11	7.29±0.00	1.6±0.07	6.07±0.01
Pleurotus giganteus	78.25±0.01	21.75±0.01	6.18±0.07	7.73±0.01	7.55±0.01
Pleurotus citrinopileatus	87.31±0.7	12.69±0.7	3.84±0.02	2.75±0.07	9.17±0.04
Laccaria laccata	79.1±0.06	20.9±0.06	3.25±0.01	2.9±0.01	8.76±0.01
Turbinellus floccosus	91.5±0.12	8.5±0.12	1.66±0.01	3.54±0.05	10.5±0.01
Ramaria thindii	72.94±0.05	27.06±0.05	4.16±0.23	2.74±0.01	8.96±0.01
Favolus brasiliensis	84.58±0.01	15.42±0.01	10.28±0.01	2.17±0.02	3.23±0.01
Lyophyllum fumosum	91.81±0.01	8.19±0.01	5.88±0.01	1.86±0.06	11±0.09
Lentinula edodes(Wild)	84.61±0.03	15.39±0.03	5.67±0.02	1.028±0.01	4.93±0.03
Cantherellus lateritius	84.34±0.09	15.66±0.09	7.91±0.02	2.02±0.05	18.05±0.16
Lentinula edodes (log)	85.33±0.5	14.67±0.5	5.18±0.01	1.18±0.01	4.15±0.02
Russula virescens	93.9±0.42	6.1±0.42	7.4±0.35	6.7±0.01	9.09±0.01
Lentinus crinitus	89.68±0.01	10.32±0.01	8±0.15	2.73±0.03	6.52±0.01
Lentinus tuber-regium	78.9±0.03	21.1±0.03	6.02±0.03	2.08±0.03	2.77±0.05
Suillus luteus	94.41±0.54	5.59±0.54	5.5±0.31	7.8±0.01	10.25±0.01
Amanita vaginata	73.14±0.01	26.86±0.01	5.7±0.04	9.90±0.07	15.08±0.01
Fistulina hepatica	93.04±0.33	6.96±0.33	5.7±0.12	4.70±0.02	10.45±0.34
Boletus edulis	83.34±0.06	16.66±0.06	4.4±0.25	2.7886±0.01	7.47±0.06
Lentinus tigrinus	85.12±0.12	14.88±0.12	4.67±0.17	2.95±0.01	4.9±0.08
Auicularia polytricha	66.51±0.03	33.49±0.03	4.714±0.07	2.15±0.01	5.93±0.03
Termitomyces sp.3	74.38±0.07	25.62±0.07	7±0.08	3.3±0.00	9.47±0.01
Lentinus sajor-caju	86.605±0.12	13.395±0.12	2.54±0.01	2.8±0.01	6.07±0.05
Lentinula edodes (Sawdust)	84.335±0.01	15.665±0.01	4±0.1	2.98±0.03	6.84±0.00
Auricularia auricula judae	91.5±0.03	8.5±0.03	3.4±0.32	2.78±0.03	8.09±0.01
Lentinus squarrosulus	88.145±0.06	11.855±0.06	8.7±0.26	2.22±0.02	3.98±0.01
Cantherellus cibarius	87.115±0.04	12.885±0.04	7±0.29	2.1±0.00	7.65±0.03
Termitomyces heimii	84.61±0.01	15.39±0.01	7.7±0.03	1.3±0.02	5.1±0.01
Favolus sp. 2	85.86±0.01	14.14±0.01	10.3±0.29	2.70±0.01	4.13±0.02

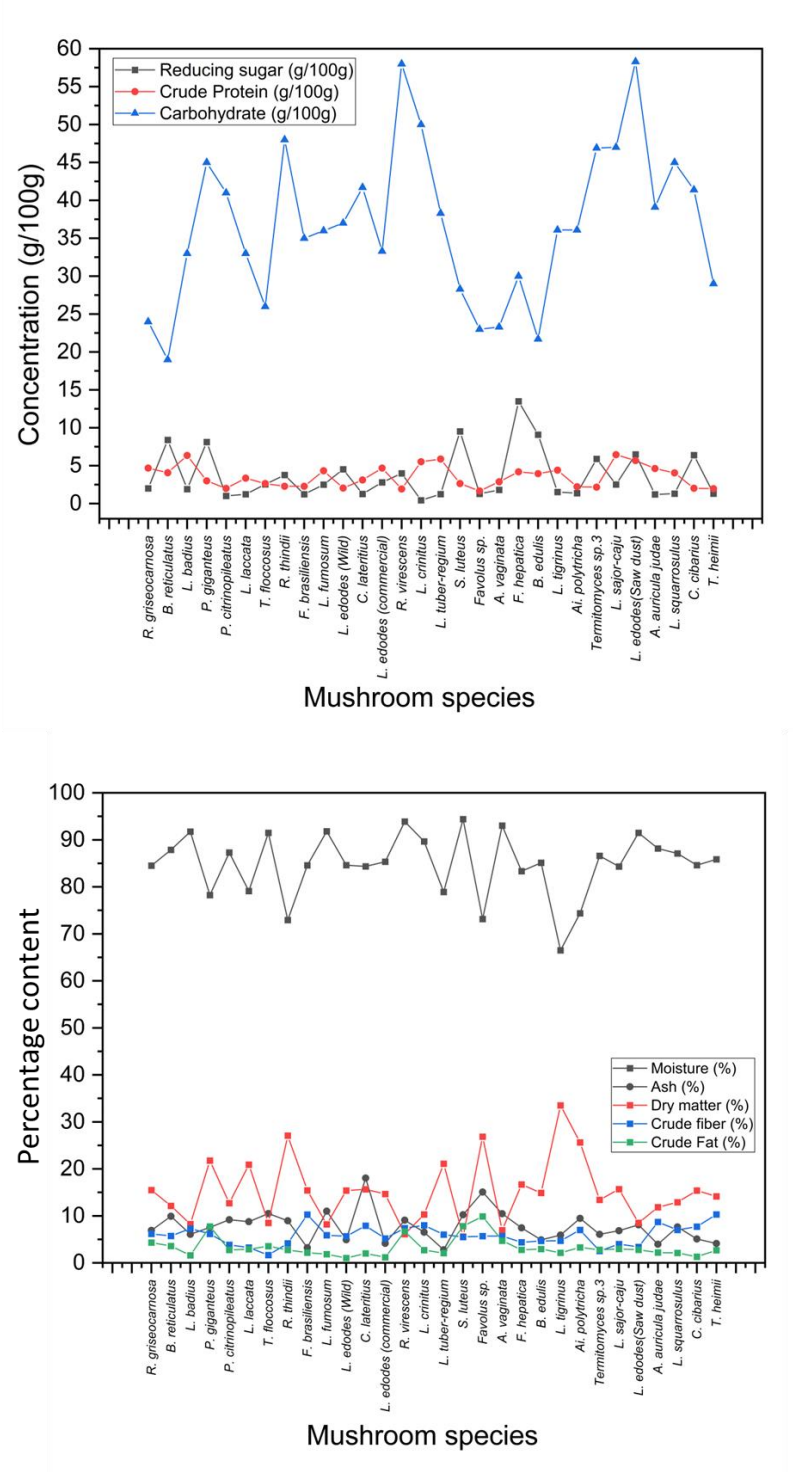


Figure 4.5: Graphical representation of the nutritional composition of thirty edible mushrooms.

4.4 ANTIOXIDANT AND PHYTOCHEMICAL ANALYSIS

The role of antioxidants in safeguarding human health is remarkable due to their ability to eliminate free radicals within the body. Furthermore, a phenolic compound derived from mushrooms has been identified as a potent antioxidant and synergistic agent that lacks mutagenic properties (Ishikawa et al., 1984).

Numerous authors have reported that methanolic extracts derived from various edible therapeutic mushroom fruiting bodies exhibit significant radical DPPH scavenging activity compared to other extracts, including ethyl acetate, ethanol, dichloromethane, and water (Cheung et al., 2003). Hence, the primary objective of this investigation was to evaluate the antioxidant characteristics, overall phenolic, flavonoid, and tannin levels in diverse extracts of chosen untapped wild edible fungi.

The results of different antioxidant and phytochemical analysis of Thirty (30) mushrooms of which twenty eight (28) are wild variety and two commercial variety of *Lentinula edodes* (one cultivated on logs of *Quercus serrata* and another on saw dust substrate) whose strains were retrieved from Directorate of Mushroom Research: Solan, (Himachal Pradesh) were studied. The fruiting bodies were collected for further analysis and comparative analysis. Their standard (positive controls) were reported in figure 4.6 for DPPH free radical scavenging activity, Chelating effect. And ABTS free radical scavenging activity.

Simultaneously, eleven mushroom species were subjected with extractions from four different solvents with their varying increasing polarities from petroleum ether, ethyl acetate, methanol to water. However, the extracts of petroleum ether solvent were

insignificant to be quantified and therefore only three solvent extracts were studied. The study employed one-way ANOVA to examine the potential correlation between the wild mushroom identified over a period of three years. Statistical significance was determined based on correlations and significance tests, with P values below 0.05 being considered significant according to Duncan's method.

4.4.1 DPPH free radial scavenging activity

The present investigation involved the evaluation of the radical scavenging potential of mushroom extracts through the utilisation of a methanolic solution of the 'stable' free radical, DPPH. Upon preparation, a solution of DPPH displays a distinct violet hue, with a peak absorption value of 517 nm. Figure 4.7 (A) shows the difference in free radical scavenging activity of methanolic extracts of mushroom species evaluated. The obtained results showed that methanol extract of the nineteen wild edible mushrooms had antioxidant potential. We have calculated the IC50 value of all tested samples and are displayed in table 4.7. It is well known that a lower IC50 value signifies higher activity. Some of the mushroom samples like *Lentinus squarrosulus* (0.163 mg/ml), *Lentinus tigrinus* (0.2147 mg/ml), *Russula virescens* (0.338 mg/ml) and *Lentinus strigosus* (0.3523 mg/ml) displayed a very lower IC50 signifying high antioxidant potential. Among all wild mushrooms, *Ramaria thindii* and *Lentinus tuber-regium* showed the highest IC50 value with 1.143 mg/ml and 1.0808 mg/ml respectively, which means it is the least potent mushroom strain. Similar to other studies, the scavenging effect of the methanolic extract increased with concentration and was highest for *Suillus luteus* with 95% at 250 mg/ml comcentration. Of all the

samples analyzed *Cantherellus cibarius* had the least scavenging power with 51.73 %. inhibition at 250 mg/ml.

Table 4.8 shows the IC50 values of various extracts from wild edible mushrooms for their antioxidant properties. Among the three solvent extracts, methanolic extracts gave the lowest IC50 value signifying it to be a better solvent for extraction. The table showed that all the samples showed high antioxidant potential with low IC50 value. Fruiting body of *Lentinula edodes* that were harvested from the log of *Quercus serrata* showed the lowest IC50 with 0.35 mg/ml followed by *Russula griseocarnosa* with IC50 value of 0.48 mg/ml and *Boletus reticulatus* with 0.49 mg/ml.

The scavenging effect of the extract also increased with concentration and fruiting body of *Lentinula edodes* that were harvested from saw dust gave the highest with 90.53% at 200ug/ml and the least was seen in *Lentinus badius* with inhibition % of 54.64% (Fig 4.8, B). For the ethyl acetate extract *Pleurotus giganteus* showed the highest potent strain with IC50 of 1.14 mg/ml. and the least was seen in *Lentinus badius* with 3.41 mg/ml fig 4.9 A. For the water extract, *Laccaria laccata* gave the highest antioxidant potential with IC50 of 1.45 mg/ml (Fig 4.9 B). Similar results were observed where methanol extract gave the best results by previous authors as well (Barros, Ferreira, et al., 2007; Wong & Chye, 2009).

4.4.2 Metal chelating activity

Ferrous ions, which are highly efficient pro-oxidants, are frequently present in various food systems. Ferrozine has the ability create complexes with Fe2+ in a quantitative manner. The introduction of chelating agents leads to the disruption of complex

formation, which subsequently causes a decrease in the intensity of the red coloration of the complex. The estimation of the chelating activity of the interacting chelator can be achieved by measuring the colour reduction. (Yamaguchi et al., 1998). The current investigation aimed to assess the chelation capacity of mushroom extracts towards ferrous ions through the evaluation of their interference with the production of ferrous and ferrozine complex. Figure 4.7 B shows the chelating effects of the methanolic extract of the wild edible mushroom species. Chelating effect was highest for *Cantherellus cibarius* with 98.57 % inhibition at 100 µg/ml concentration to support its superior scavenging and reducing activity. On the contrary, *Auricularia polytricha* had the least metal chelating effect with only 37.6% at 100 ug/ml concentration. Chelating effects of methanolic extracts from all the wild edible mushrooms on ferrous ions increased with the increased concentrations.

Table 4.9 shows the chelating effects of the various extract of the wild and cultivated edible mushroom species. The methanolic extract by far gave the best result for the antioxidant potential followed by the water extract. Chelating effect was highest for methanolic extract in *Cantherellus lateritius* with IC50 of 0.38 mg/ml and the least was recorded in *Termitomyces* sp.3 with IC50 of 1.69 mg/ml. Chelating effect of methanolic extract for *Pleurotus giganteus* was highest for among all the three solvents with 87.43 % inhibition concentration to support its superior scavenging and reducing activity (Figure 4.11). On the other hand, *Boletus reticulatus* had the least metal chelating effect with 44.4% concentration. For the ethyl acetate extract, highest chelating activity was noted in *Lentinus badius* with 77.7 % inhibition at While the lowest was observed in *Lentinula edodes* (wild) with 35.1% (Fig 4.12A). For water

extract, highest chelating activity was noted in *Turbinellus floccosus* with 98.8% inhibition. Whereas the lowest was recorded with *Laccaria lacata* with 52.4% inhibition (Fig 4.12 B). The findings indicate that diverse extracts exhibit a proficient ability to bind with iron, implying their potential as inhibitors of peroxidation, which could be associated with their iron-binding capability.

4.4.3 ABTS free radical scavenging ability

The ABTS cation free radical is utilised in a rapid and precise methodology for assessing antioxidant capacities via the scavenging activity of the ABTS free radical. The ABTS methodology exhibits versatility across various pH levels and demonstrates solubility in both water-based and solvent-based organic compounds. Antioxidants can transfer an electron and a hydrogen atom to an erratic ABTS+ cation radical, forming a stable ABTS radical form. Furthermore, the measurement of the reduction of the ABTS+ radical coloured solution in blue-green hue can be conducted at a wavelength of 734 nm. (Shalaby & Shanab, 2013).

The ABTS free radical scavenging ability of various extracts of the nineteen wild edible mushrooms is presented in Fig. 4.8A. The highest ABTS free radical scavenging activity was found in the methanolic extract of *Lentinus squarrosulus* (IC50 0.163 mg/ml), followed by *Suillus luteus* (IC50 0.23mg/ml), While the least ABTS free radical scavenging activity was found in *Cantherellus cibarius* (IC50 0.93 mg/ml). However, the rest of the species extracts also showed good ABTS free radical scavenging activity. Table 4.10. Shows the ABTS free radical scavenging activity of various extracts. Among the three extracts, the highest ABTS free radical scavenging

activity was found in the methanolic extract of *Boletus reticulatus* (IC50 0.24 mg/ml) followed by *Russula griseocarnosa* (IC50 0.28 mg/ml). Similar results were also achieved by other authors as well (Sudha et al., 2012). However, for the species *Laccaria laccata* the water extracts showed better results with IC50 of 0.5 mg/ml and was followed closely by the methanolic extract with IC 50 0.6 mg/ml. In comparison, the ABTS free radical scavenging activity of the water extracts was superior to that of the ethyl acetate extracts.

The findings suggest that the methanolic extracts possess the capability to scavenge neutral and cation free radicals. Thus, it has been ascertained that the antioxidant potential of different mushroom fractions is significantly influenced by the specific mushroom species, the solvents used for extraction, and the methods employed for conducting the assays. The aforementioned observation suggests that the diverse extracts possess ABTS radical scavenging activity, which enables them to eliminate free radicals and consequently impede lipid oxidation through a chain breaking mechanism.

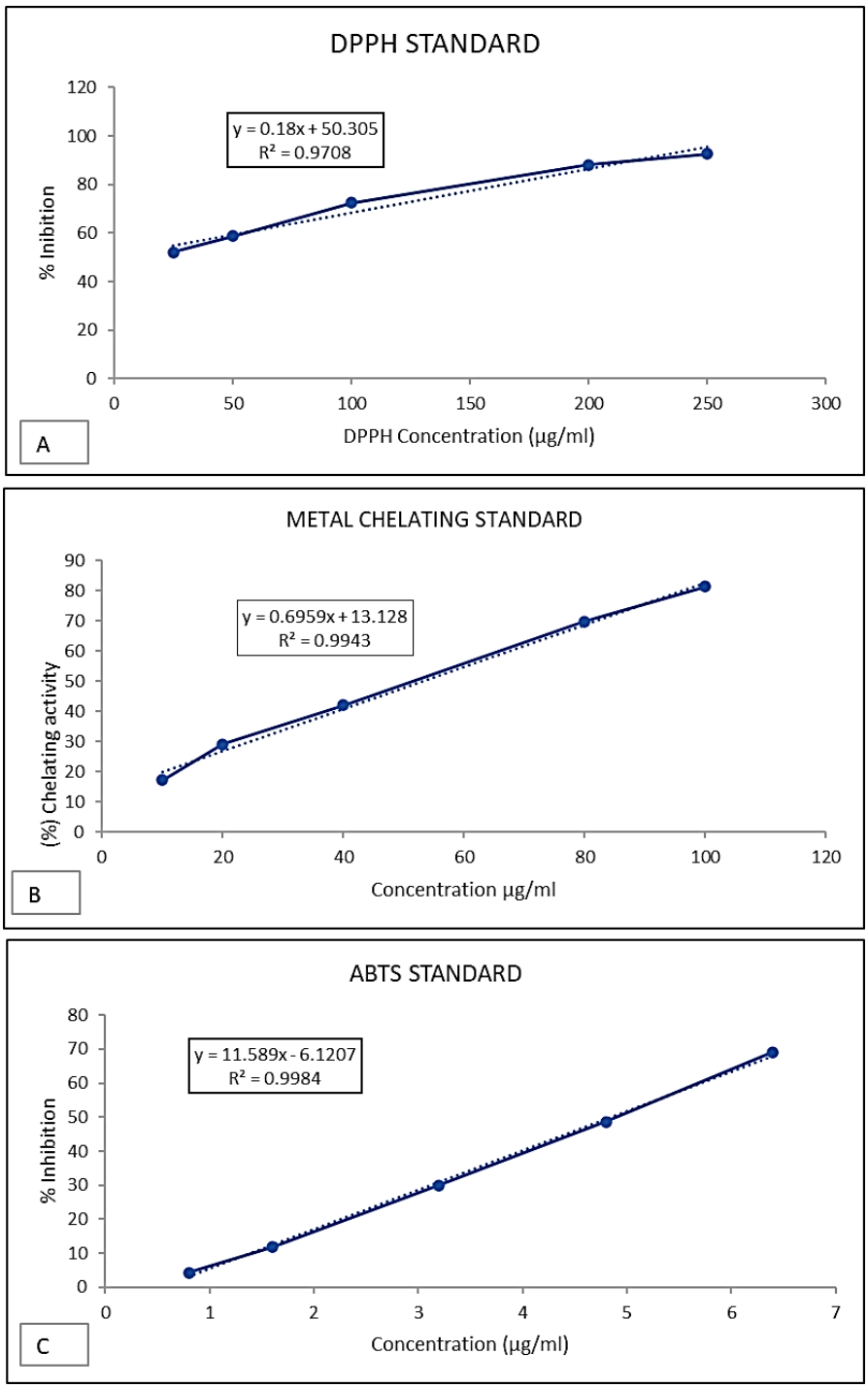


Figure 4.6 Calibration standard curve for (A)DPPH free radial scavenging activity. (B) Metal chelating activity (C) ABTS free radial scavenging activity

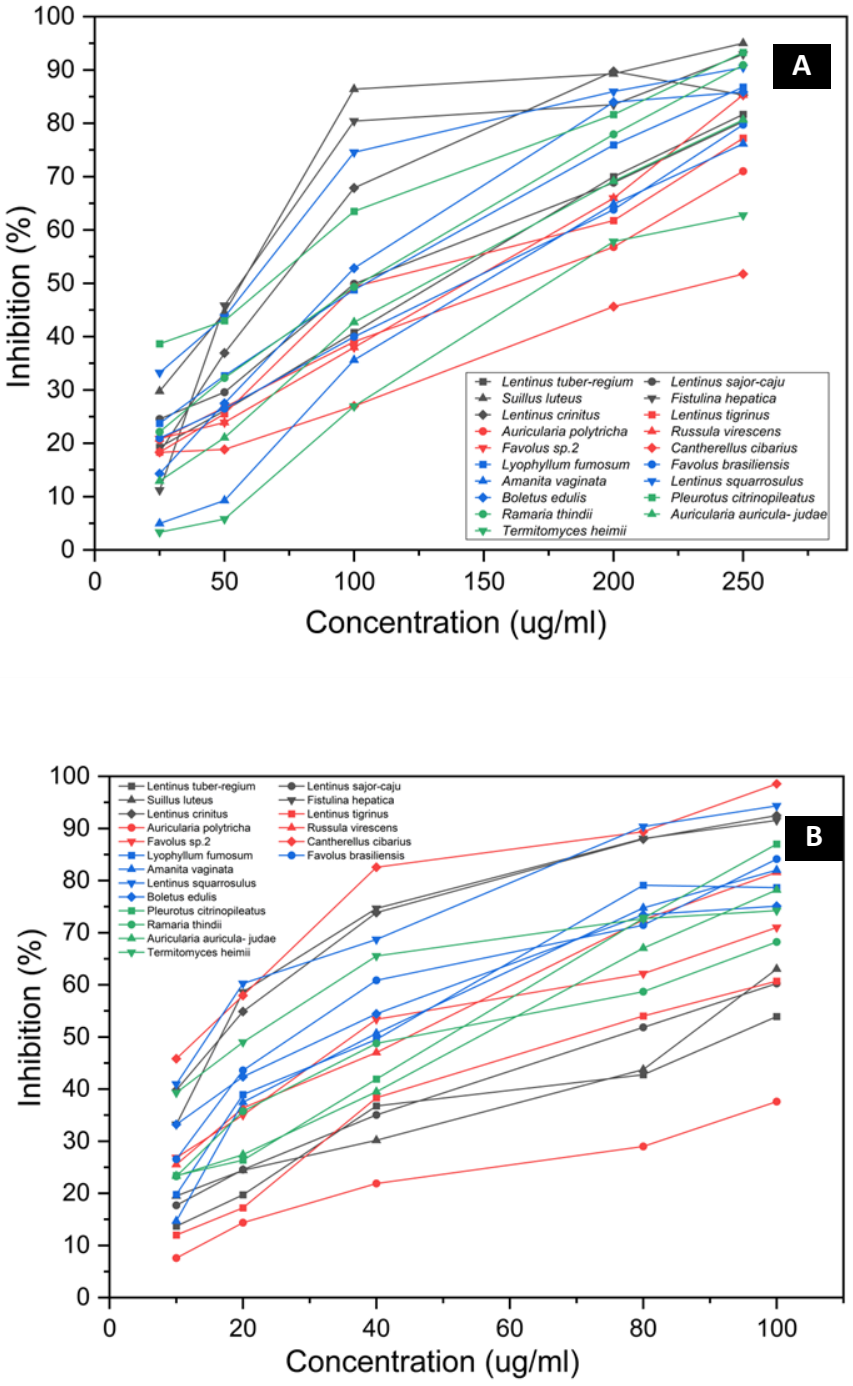


Figure 4.7 (A) DPPH free radical scavenging of methanolic extract of nineteen wild edible mushrooms. (B) Chelating activity of methanolic extract of nineteen wild edible mushrooms

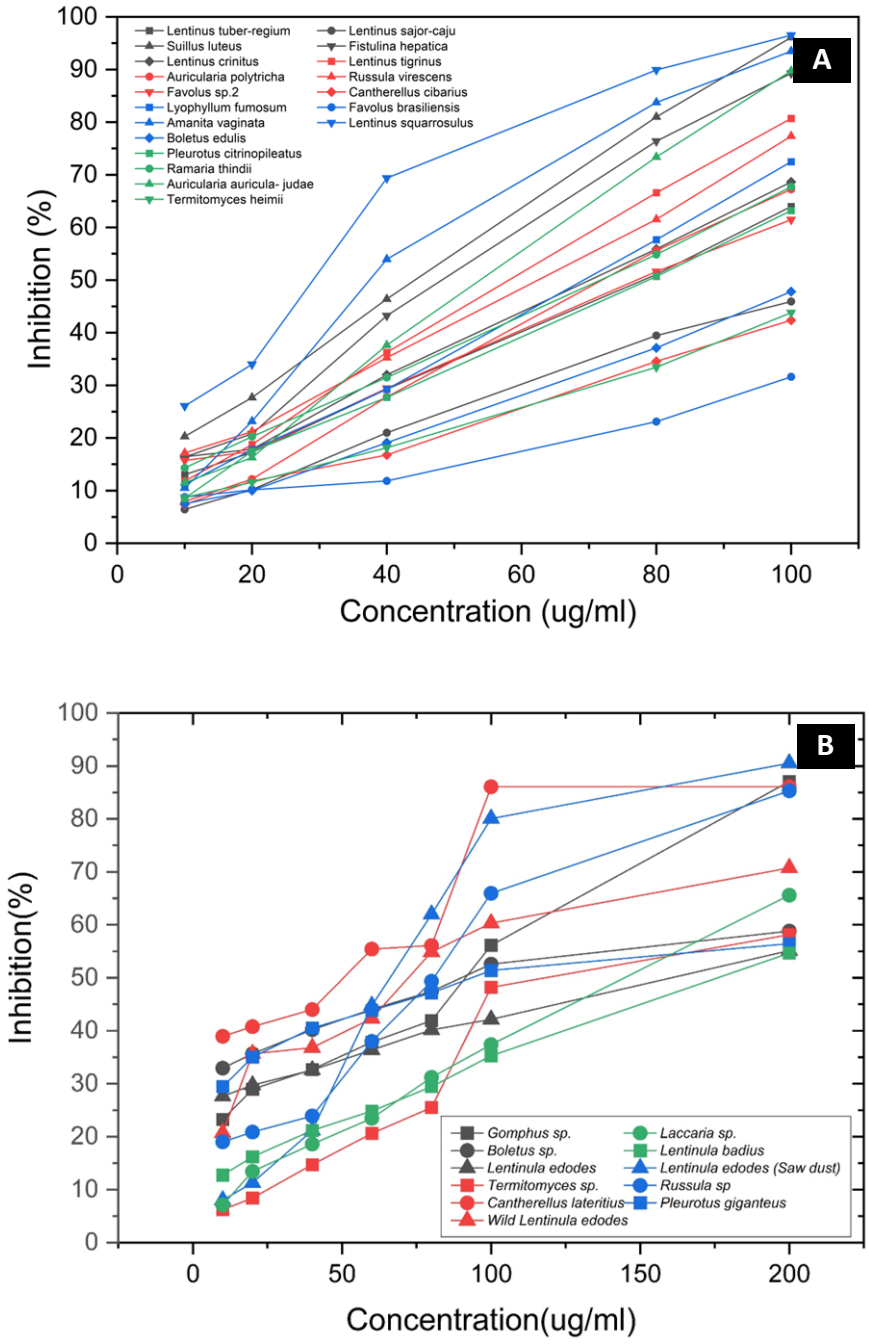


Figure 4.8 (A) ABTS radical scavenging of ethanolic extract of nineteen wild edible mushrooms. (B) DPPH free radical scavenging of methanolic extract of eleven edible mushrooms

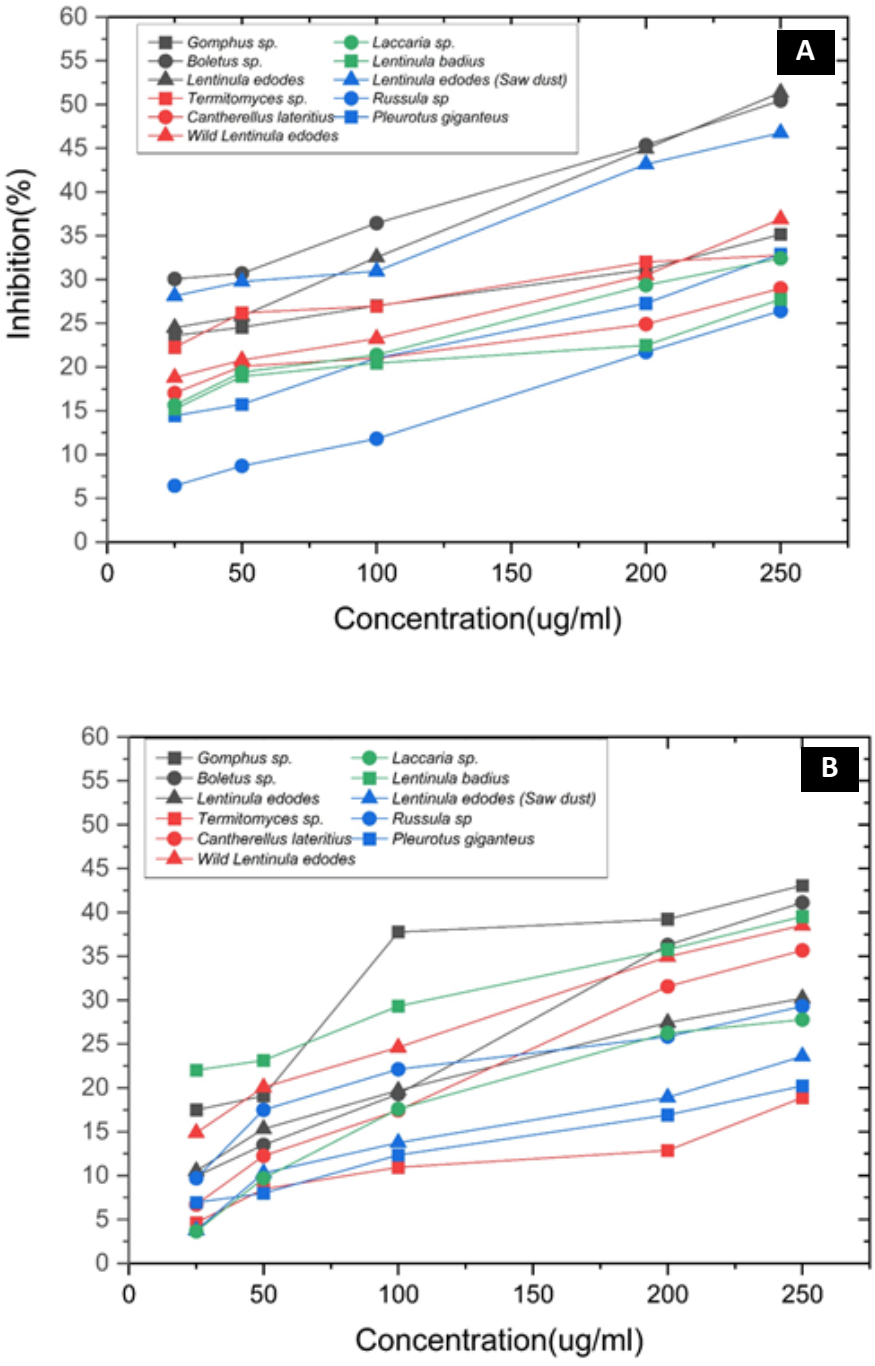


Figure 4.9 (A) DPPH free radical scavenging of ethyl acetate extract of eleven edible mushrooms. (B) DPPH free radical scavenging of water extract of eleven edible mushrooms.

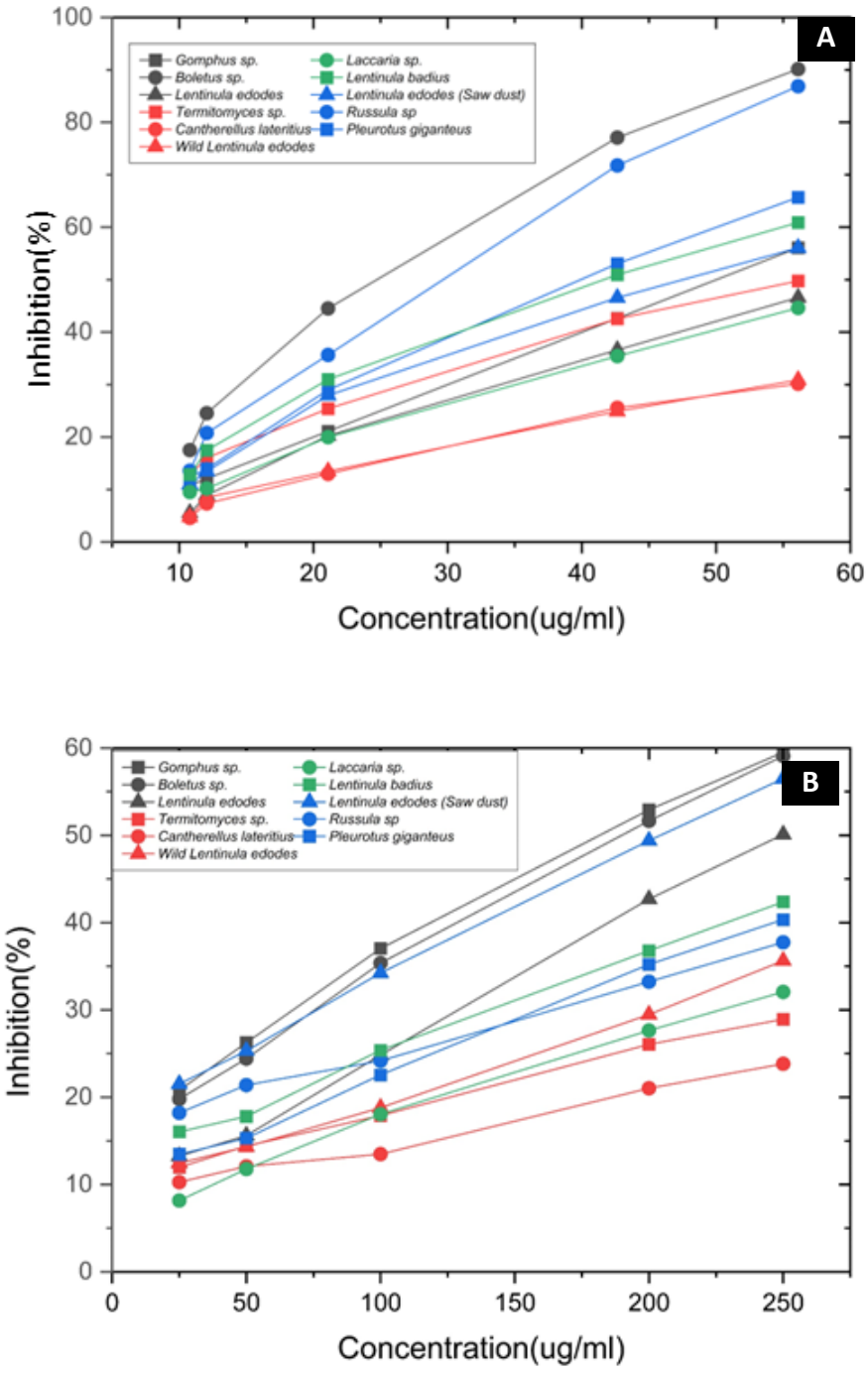


Figure 4.10 (A) ABTS radical scavenging of Methanolic extract of eleven edible mushrooms. (B) ABTS radical scavenging of ethyl acetate extract of eleven edible mushrooms.

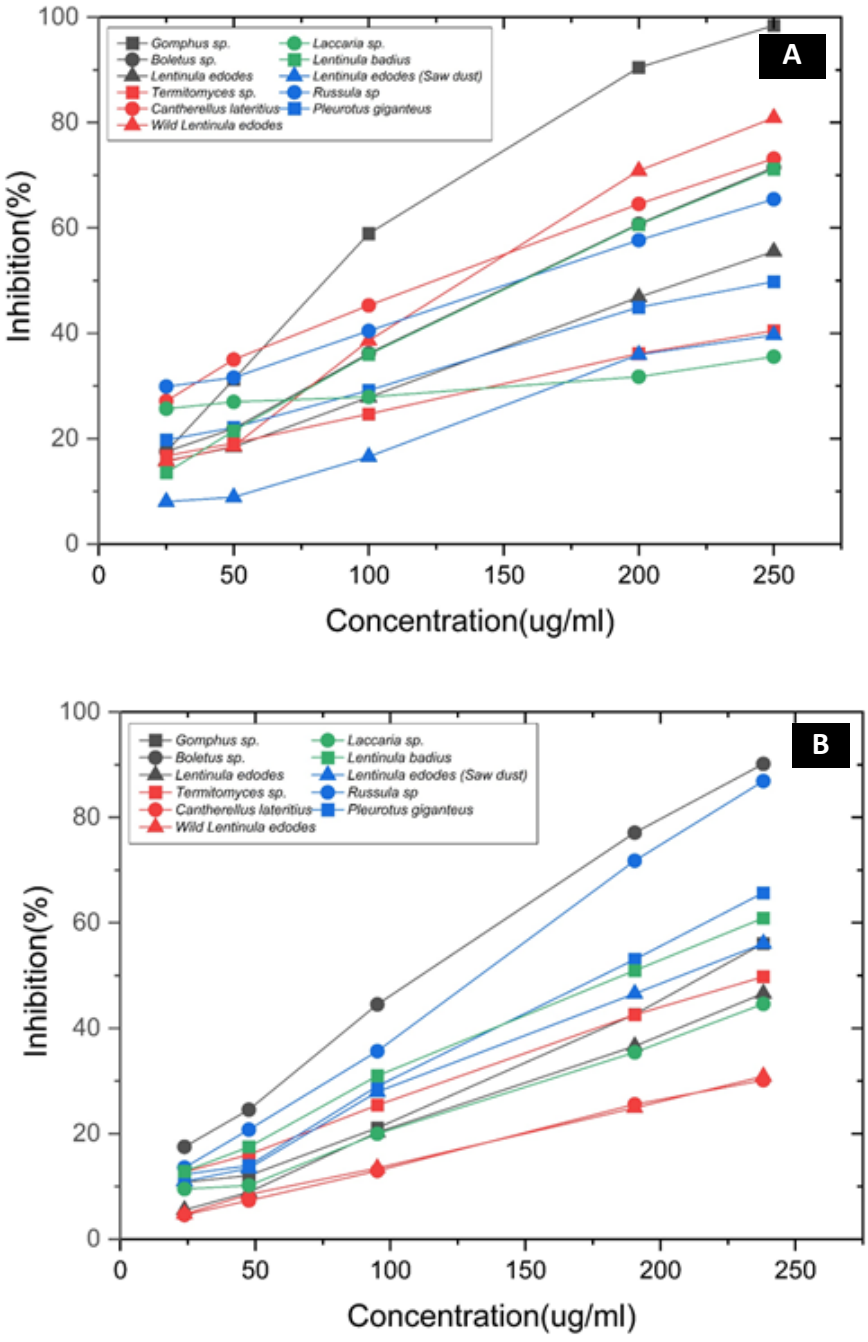


Figure 4.11 (A) ABTS radical scavenging of water extract of eleven edible mushrooms. (B) Chelating activity of methanolic extract of eleven edible mushrooms.

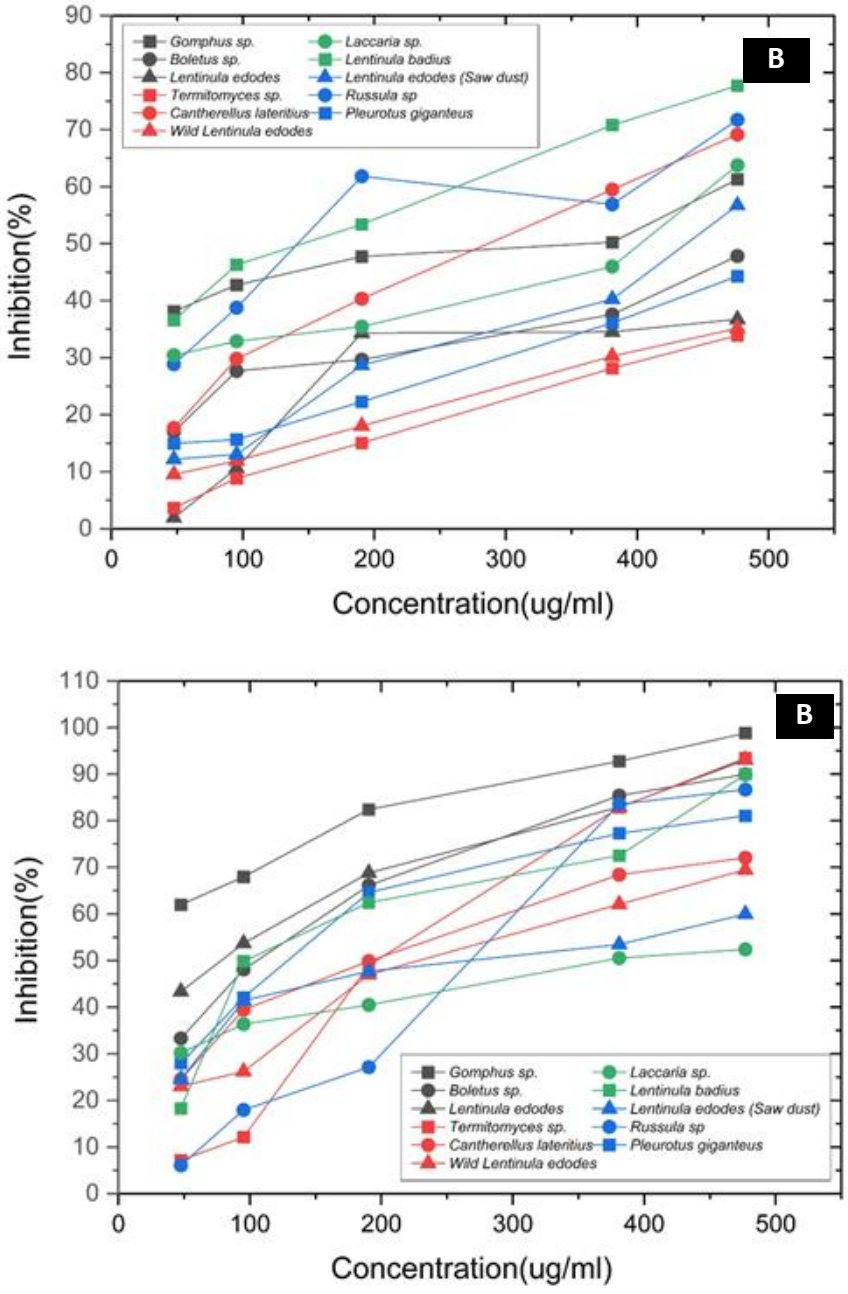


Figure 4.12 (A) Chelating activity of ethyl acetate extract of eleven edible mushrooms. (B) Chelating activity of water extract of eleven edible mushrooms.

Table 4.7. IC50 values of methanolic extracts from wild edible mushrooms for antioxidant properties

Mushroom species	ABTS	DPPH	Chelating activity
	IC_{50}(mg/ml)	IC50(mg/ml)	IC50(mg/ml)
Lentinus tuber-regium	0.3774±.00[f]	1.0808±0.03[l]	1.07±0.02[k]
Lentinus tigrinus	0.2935±.00[c]	0.2147±0.00389[b]	0.66±0.04[i]
Lyophyllum fumosum	0.3368±.00[d,e]	0.7186±0.01908[h]	0.85±0.02[j]
Pleurotus citrinopileatus	0.3806±.00[f,g]	0.8155±0.00849[i]	0.5±0.01[e,f,g]
Lentinus sajor-caju	0.5239±0.01[h]	0.6961±0.00949[h]	0.85±0.01[n]
Auricularia polytricha	0.3564±.00[e,f]	0.4157±0.01904[e]	0.43±0.00[e]
Russula virescens	0.9645±0.03[k]	0.338±0.01364[c]	0.44±0.00[e]
Favolus teniculus	0.3734±0.01[e,f]	0.9773±0.0326[k]	0.67±0.01[i]
Suillus luteus	0.2323±.00[b]	0.4288±0.01459[e]	0.88±0.03
Ramaria thindii	0.315±.00[c,d]	1.143±0.01893[m]	0.53±0.00[f,g]
Amanita vaginata	0.3387±.00[d,e]	0.5983±0.0089[g]	0.56±0.00[g,h]
Auricularia auricula- judae	0.4139±.00[g]	0.4139±0.00215[e]	0.64±0.00[h,i]
Fistulina hepatica	0.388±.00[f,g]	0.388±0.0045[d,e]	0.19±0.01[b,c]
Favolus sp.2	0.5934±.00[i]	0.5934±0.00615[g]	0.65±0.02[i]
Lentinus squarrosulus	0.163±.00[a]	0.163±0.0043[a]	0.14±0.01[a,b]
Termitomyces heimii	0.9256±0.01[j]	0.9256±0.01513[j]	0.3±0.05[d]
Lentinus strigosus	0.3523±.00[e,f]	0.3523±0.00297[c,d]	0.22±0.03[c]
Cantherellus cibarius	0.9316±0.01[j]	0.9316±0.01587[k]	0.08±0.04[a]
Boletus edulis	0.5181±0.01[h]	0.5181±0.01179[f]	0.48±0.02[e,f]

Means followed by same letter in the same column are not significantly different($p<0.05$) according to Duncan's method. Data are mean±SD of three parallel measurements(n=3).

Table 4.8 IC50 values of various extracts from wild and cultivated edible mushrooms for DPPH free radial scavenging activity

Mushroom species	DPPH		
	Extract		
	IC50(mg/ml)		
	Methanol	Ethyl acetate	Water
Turbinellus floccosus	0.5069±0.07^{a,b}	2.4616±0.17^{h,i}	2.933±0.08^{j}
Termitomyces sp.3	0.578±0.04^{a,b}	3.1413±0.26^{j,k}	2.358±0.08^{h,i}
Pleurotus giganteus	0.8034±0.05^{b}	3.4629±0.20^{k}	3.4189±0.19^{k}
Lentinula badius	0.4992±0.08^{a,b}	1.2409±0.01^{c}	1.8525±0.03^{e,f}
Boletus reticulatus	0.6675±0.06^{a,b}	3.275±0.16^{k}	2.2749±0.10^{g,h,i}
Cantherellus lateritius	0.6385±0.01^{a,b}	2.5567±0.06^{i}	1.4591±0.02^{l,m}
Russula griseocarnosa	0.6453±0.12^{a,b}	1.1402±0.03^{c}	1.7055±0.04^{d,e,f}
Laccaria laccata	0.4897±0.08^{a,b}	1.9982±0.10^{f,g}	2.2167±0.23^{g,h,i}
Lentinula edodes(log)	0.3501±0.01^{a}	2.49±0.09^{h,i}	1.7021±0.03^{d,e,f}
Lentinula edodes (wild)	0.6595±0.04^{a,b}	2.1996±0.07^{g,h}	4.2777±0.07^{l}
Lentinula edodes (Saw dust)	0.6345±0.00^{a,b}	1.4518±0.02^{c,d}	1.6006±0.03^{d,e}

Means followed by same letter in the same column are not significantly different($p<0.05$) according to Duncan's method. Data are mean±SD of three parallel measurements($n=3$).

Table 4.9 : IC50 values of various extracts from wild and cultivated edible mushrooms for Metal chelating activity

Mushroom species	Chelating activity		
	Extract		
	IC50(mg/ml)		
	Methanol	Ethyl acetate	Water
Turbinellus floccosus	1.04±0.04^{d,e,f}	1.54±0.09^{i,j}	0.78±0.03^{b,c,d}
Termitomyces sp.3	1.69±0.01^{j,k}	3.23±0.13^{o}	1.5386±0.00^{i,j}
Pleurotus giganteus	0.44±0.02^{a}	2.99±0.14^{o}	1.07±0.09^{e,f,g}
Lentinula badius	0.92±0.03^{c,d,e}	1.1401±0.16^{e,f,g}	0.81±0.07^{b,c,d}
Boletus reticulatus	1.33±0.08^{g,h,i}	2.63±0.12^{n}	1.9±0.08^{k,l}
Cantherellus lateritius	0.38±0.01^{a}	1.44±0.03^{h,I,j}	0.56±0.01^{a,b}
Russula griseocarnosa	0.43±0.02^{a}	3.85±0.14^{p}	1.13±0.03^{e,f,g}
Laccaria laccata	0.74±0.01^{b,c}	1.98±0.18^{l,m}	0.53±0.02^{a,b}
Lentinula edodes(log)	0.62±0.03^{a,b}	1.08±0.01^{e,f,g}	0.64±0.03^{a,b}
Lentinula edodes (wild)	0.59±0.00^{a,b}	3.09±0.17^{0}	1.2±0.10^{f,g,h}
Lentinula edodes (Saw dust)	0.53±0.016^{a,b}	2.17±0.03^{m}	1.4±0.01^{h,i}

Means followed by same letter in the same column are not significantly different($p<0.05$) according to Duncan's method. Data are mean ± SD of three parallel measurements(n=3).

Table 4.10 IC50 values of various extracts from wild and cultivated edible mushrooms ABTS free radical scavenging ability

Mushroom species	ABTS		
	IC_{50}(mg/ml)		
	Extract		
	Methanol	Ethyl acetate	Water
Turbinellus floccosus	0.44 ±0.01^{a,b,c,d,e}	0.95±0.00^{g,h,i}	1.56±0.01^{k}
Termitomyces sp.3	0.49±0.00^{a,b,c,d,e}	2.74±0.09^{m}	3.5±0.36^{n}
Pleurotus giganteus	0.39±0.00^{abcd}	1.60±0.02^{k}	1.25±0.03^{j}
Lentinula badius	0.24±0.00^{a}	1.13±0.15^{i,j}	0.82±0.01^{f,g,h}
Boletus reticulatus	0.82±0.01^{f,g,h}	3.77±0.19^{o}	1.11±0.02^{i,j}
Cantherellus lateritius	0.6±0.00^{c,d,e,f}	2.10±0.04^{l}	0.5±0.00^{a,b,c,d,e}
Russula griseocarnosa	0.37±0.00^{a,b,c}	1.20±0.03^{i,j}	0.65±0.00^{d,e,f}
Laccaria laccata	0.28±0.00^{a,b}	1.99±0.03^{l}	0.80±0.03^{f,g,h}
Lentinula edodes(log)	0.84±0.01^{f,g,h}	2.04±0.06^{l}	0.71±0.00^{e,f,g}
Lentinula edodes (wild)	0.52±0.01^{b,c,d,e}	1.62±0.02^{k}	1.74±0.04^{k}
Lentinula edodes (Saw dust)	0.67±0.00^{e,f}	1.04±0.00^{h,I,j}	0.81±0.00^{f,g,h}

Means followed by same letter in the same column are not significantly different($p<0.05$) according to Duncan's method. Data are mean±SD of three parallel measurements(n=3).

4.4.4 Total flavonoid content

Flavonoids represent the predominant and extensively dispersed class of botanical phenolic compounds, typically exhibiting potent antioxidant properties (Yanishlieva, 2001). Clinical research has demonstrated that they exhibit a diverse array of pharmacological and biochemical effects, including but not limited to

antimicrobial, antithrombotic, antimutagenic, and anticarcinogenic properties (Cook & Samman, 1996).

The total flavonoid content of methanolic extract of the nineteen wild edible mushrooms was also determined and expressed as milligram quercetin equivalent (QE) per gram of dry weight (DW). (Table 4.11) The content of flavonoid compounds in various wild edible mushroom extracts ranged from 0.8 to 10.7 mg QE/g DW. The results showed that the highest content of flavonoid compounds was found in *Lentinus tuber-regium* (10.7 mg QE/g DW), followed by *Suillus luteus* (8.8 mg QE/g DW). Other researchers reported a total flavonoid content for mushrooms ranging from 1.65 to 3.88 mg CE/g of extract (Barros et al., 2008) and 1.78–33.00 mg CE/g extract (Pereira et al., 2012)

Table 4.12 shows the results of flavonoid content of nine wild and two cultivated mushrooms. The highest content of flavonoid compounds was found in ethyl acetate extract of *Russula griseocarnosa* with 38.5 mg QE/g DW. It was followed by water extract with 11.3 mg QE/g DW and finally of methanolic extract with 4.3 mg QE/g DW. Remarkably, our results showed that the use of solvent with different polarities resulted in different patterns of the main active compounds that are present in mushroom species. Therefore, it is important to consider both the association of the phenolic and flavonoid compounds and the biological activities that are found in various wild edible mushroom extracts

4.4.5 Total Phenolic Content

Numerous prior research works have indicated a positive correlation between the overall phenolic contents of mushroom materials and their antioxidant activity (Lin et al., 2015; Ren et al., 2014; Velioglu et al., 1998). Hence, it is imperative to take into account the quantity of phenolic compounds present in diverse wild edible fungi and also contemplate the suitable technique for organic solvent extraction. The Folin-Ciocalteu reagent was utilised to quantitatively determine the total phenolic content, expressed as gallic acid equivalent. Total phenolic content is expressed as mg gallic acid equivalent per gram dry extract weight. Table. 4.11 shows the content of the phenolic compounds of methanolic extract in nineteen wild edible mushroom ranging from 3.79 to 67.58 mg GAE/g DW. *Lentinus squarrosulus* has the highest phenolic content (67.58 mg GAE/g) among the mushroom species evaluated. This was followed by *Lentinus strigosus*, *Boletus reticulatus* with a value of 44.78 and 42.73 mg GAE/g, respectively, indicating the correlation of total phenolics with antioxidant activity. On the other hand, *Russula virescens* with least antioxidant activity also had the least phenolic content. Other studies on mushrooms also reported total phenolics ranging from 2.09 to 58.14 mg GAE/g extract (Barros et al., 2008; Pereira et al., 2012; Wong & Chye, 2009). Thus, the mushrooms evaluated in this study are somewhat comparable with the other reports.

Table 4.13 shows the content of the phenolic compounds of various solvent extracts of the eleven edible mushrooms. The content of the phenolic compounds ranges from 11.20 to 116.41 mg GAE/g DW. The results revealed that the methanolic

extraction procedure showed higher efficiency than water and ethyl acetate solvents for all mushroom species. The highest extractable phenolic content was found in the menthanolic extract of *Boletus reticulatus* (116.41 mg GAE/g DW), followed by the water extract (26.84 mg GAE/g DW) and the ethyl acetate extract (8.43 mg GAE/g DW). The lowest antioxidant activity was also found to have the lowest phenolic content, demonstrating the link between total phenolics and antioxidant activity. These findings could demonstrate how the various extraction solvents affect the amount of extractable phenolic. Furthermore, the extraction procedure for wild edible mushrooms may be completed using the methanol extraction technique.

4.4.6 Total tannin content

Tannins, which are extensively distributed in virtually all plant species and have several beneficial bioactivities including antioxidants, are a part of our daily diet since they are so prevalent. It is generally known that tannins are potent antioxidants, and as a result, they lower the chance of developing cancer and cardiovascular illnesses (Zhang & Lin, 2008). In this study, all of the mushroom species were evaluated for their tannin content. Tannin content of the methanolic extract of nineteen mushroom samples as given in table 4.11 were in the range of 7.95 to 73.28 mg CE/g. The highest tannin content was observed in *Lentinus squarrosulus* with 73.28 mg CE/g followed by *Suillus luteus* with 66.64 mg CE/g and *Boletus reticulatus* with 65.67 mg CE/g and the least was recorded from *Lentinus tuber-regium* with 7.95 mg CE/g followed by *Russula virescens* with 12.92 mg CE/g . Similar results were observed by earlier authors as well (Sifat et al., 2020; Yıldız et al., 2017).

Table 4.11 Total Flavonoid, Total Phenol & Total Tannin content of methanolic extracts from wild edible mushrooms

Mushroom species	Flavonoid mg GAE/g	Total Phenol mg QE/ml	Total Tannin mg CA/g
Lentinus tuber-regium	10.7±0.02^{k}	11.08±0.02^{b}	7.95±0.04
Lentinus tigrinus	6.6±0.04^{i}	30.32±0.06^{h}	39.42±0.04
Lyophyllum fumosum	8.5±0.02^{j}	19.78±0.06^{d,e}	14.12±0.07
Pleurotus citrinopileatus	5±0.01^{e,f,g}	18.37±0.06^{d}	22.76±0.00
Lentinus sajor-caju	8.5±0.01^{n}	13.60±0.03^{c}	28.78±3.06
Auricularia polytricha	4.3±0.00^{e}	21.65±0.04^{e,f}	22.57±0.05
Russula virescens	4.4±0.00^{e}	3.79±0.02^{a}	12.92±0.02
Favolus teniculus	6.7±0.01^{i}	22.80±0.03^{f}	13.91±0.12
Suillus luteus	8.8±0.03	21.65±0.05^{e,f}	66.64±0.02
Ramaria thindii	5.3±0.00^{f,g}	20.91±0.03^{e,f}	27.5±0.05
Amanita vaginata	5.6±0.00^{g,h}	26.53±0.02^{g}	43.71±0.00
Auricularia auricula-judae	6.4±0.00^{h,i}	30.66±0.06^{h}	22.74±0.00
Fistulina hepatica	1.9±0.01^{b,c}	29.43±0.05^{h}	32.48±0.00
Favolus sp.2	6.5±0.02^{i}	29.32±0.06^{h}	62.14±0.01
Lentinus squarrosulus	1.4±0.01^{a,b}	67.58±0.20^{k}	73.28±0.02
Termitomyces heimii	3±0.05^{d}	20.62±0.05^{e,f}	13.11±0.04
Lentinus strigosus	2.2±0.03^{c}	44.78±0.07^{j}	46.09±0.06
Cantherellus cibarius	0.8±0.04^{a}	12.20±0.01^{b,c}	39.07±0.05
Boletus edulis	4.8±0.02^{e,f}	42.73±0.09^{i}	65.67±0.03

Means followed by same letter in the same column are not significantly different($p<0.05$) according to Duncan's method. Data are mean±SD of three parallel measurements(n=3).

Table 4.14 shows Tannin content of the eleven mushroom species of the various extracts. The highest tannin content was observed from the ethyl acetate extract of log

cultivated *Lentinula edodes* with 85.93 mg CE/g followed by the value of 28.52 mg CE/g of water extract and lastly by the value of 8.07 mg CE/g of methanolic extract. The results of the present study concluded that higher antioxidant activity with low EC50 values was observed in the studied samples.

Table 4.12 Total flavonoid content of various extracts from wild and cultivated edible mushrooms

Mushroom species	Total flavonoid content (mg QE/g)		
	Extract		
	Methanol	Ethyl acetate	Water
Turbinellus floccosus	$10.4\pm0.04^{d,e,f}$	$15.4\pm0.09^{i,j}$	$7.8\pm0.03^{b,c,d}$
Termitomyces sp.3	$16.9\pm0.01^{j,k}$	32.3 ± 0.13^{o}	$15.386\pm0.00^{i,j}$
Pleurotus giganteus	$9.2\pm0.03^{c,d,e}$	$11.401\pm0.16^{e,f,g}$	$8.1\pm0.07^{b,c,d}$
Lentinula badius	$13.3\pm0.08^{g,h,i}$	26.3 ± 0.12^{n}	$19\pm0.08^{k,l}$
Boletus reticulatus	3.8 ± 0.01^{a}	$14.4\pm0.03^{h,I,j}$	$5.6\pm0.01^{a,b}$
Cantherellus lateritius	$7.4\pm0.01^{b,c}$	$19.8\pm0.18^{l,m}$	$5.3\pm0.02^{a,b}$
Russula griseocarnosa	4.4 ± 0.02^{a}	29.9 ± 0.14^{o}	$10.7\pm0.09^{e,f,g}$
Laccaria laccata	4.3 ± 0.02^{a}	38.5 ± 0.14^{p}	$11.3\pm0.03^{e,f,g}$
Lentinula edodes(log)	$6.2\pm0.03^{a,b}$	$10.8\pm0.01^{e,f,g}$	$6.4\pm0.03^{a,b}$
Lentinula edodes (wild)	$5.9\pm0.00^{a,b}$	30.9 ± 0.17^{0}	$12\pm0.10^{f,g,h}$
Lentinula edodes (Saw dust)	$0.53\pm0.016^{a,b}$	21.7 ± 0.03^{m}	$14\pm0.01^{h,i}$

Means followed by same letter in the same column are not significantly different($p<0.05$) according to Duncan's method. Data are mean ± SD of three parallel measurements(n=3).

Based on the findings, it was concluded that the researched wild edible mushrooms are a powerful source of antioxidants and advantageous for human health. Additionally, since they have the ability to significantly lower the high-tech, costly

illness treatment procedures now used in healthcare, mushroom antioxidants are very beneficial to the current generation.

Table 4.13 Total phenolic content of various extracts from wild and cultivated edible mushrooms

Mushroom species	Total Phenolic content (mg GAE/g)		
		Extract	
	Methanol	Ethyl acetate	Water
Turbinellus floccosus	28.30±0.01^{i}	7.62±0.02^{d,e,f,g}	7.23±0.01^{c,d,e,f}
Termitomyces sp.3	18.27±0.03^{h}	2.83±0.00^{a,b}	9.20±0.01^{f,g}
Pleurotus giganteus	61.33±0.14^{k,l}	5.20±0.02^{a,b,c,d,e}	17.06±0.04^{h}
Lentinula badius	116.41±0.35^{m}	8.43±0.00^{e,f,g}	26.84±0.08^{i}
Boletus reticulatus	10.07±0.09^{f,g}	3.82±0.00^{a,b,c}	3.08±0.00^{a,b}
Cantherellus lateritius	29.49±0.03^{i}	2.45±0.01^{a}	7.89±0.01^{d,e,f,g}
Russula griseocarnosa	60.21±0.28^{k}	9.66±0.01^{g,h}	9.80±0.04^{f,g}
Laccaria laccata	63.97±0.20^{l}	4.30±0.00^{a,b,c,d}	9.86±0.01^{f,g}
Lentinula edodes (log)	11.20±0.05^{g}	3.80±0.01^{a,b,c}	4.92±0.02^{a,b,c,d,e}
Lentinula edodes (wild)	28.60±0.05^{i}	6.35±0.01^{b,c,d,e,f}	9.58±0.02^{f,g}
Lentinula edodes (Saw dust)	43.19±0.32^{j}	8.45±0.00^{e,f,g}	9.97±0.02^{f,g}

Means followed by same letter in the same column are not significantly different($p<0.05$) according to Duncan's method. Data are mean±SD of three parallel measurements(n=3).

Table 4.14 Total tannin content of various extracts from wild and cultivated edible mushrooms

Mushroom species	Total Tannin (mg CA/g)		
		Extract	
	Methanol	Ethyl acetate	Water
Turbinellus floccosus	16.67±0.23^{d,e}	61.12±0.42^{l}	24.39±0.14^{g,h}
Termitomyces sp.*3*	6.25±0.11^{a}	12.43±0.10^{c}	13.99±0.03^{c,d}
Pleurotus giganteus	17.72±0.02^{d,e,f}	17.08±0.03^{d,e,f}	18.51±0.01^{e,f}
Lentinula badius	105.1±0.29^{p}	69.8±0.22^{m}	20.96±0.01$^{e,f.g.h}$
Boletus reticulatus	16.76±0.02^{d,e}	20.85±0.05^{e,f,g,h}	16.93±0.01^{d,e,f}
Cantherellus lateritius	20.8±0.00^{e,f,g,h}	20.34±0.10^{e,f,g}	49.47±0.01^{k}
Russula griseocarnosa	36.14±0.13^{j}	23.56±0.14^{g,h}	11.48±0.01^{b,c}
Laccaria laccata	35.58±0.13^{j}	24±0.08^{g,h}	23.57±0.02^{g,h}
Lentinula edodes (log)	8.07±0.01^{a,b}	85.93±0.11^{o}	28.52±0.05^{i}
Lentinula edodes (wild)	77.92±0.23^{n}	25.13±0.02^{h,i}	13.53±0.02^{c,d}
Lentinula edodes (Saw dust)	21.23±0.02^{g,h,i}	18.94±0.00^{e,f}	18.94±0.00^{a,b}

Means followed by same letter in the same column are not significantly different($p<0.05$) according to Duncan's method. Data are mean ± SD of three parallel measurements($n=3$).

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4.5 Optimization of culture protocol for *Lentinula edodes* (berk.) Pegler

4.5.1 Cultivation

The strain of *Lentinula edodes* that was retrieved from Directorate of Mushroom Research: Solan, Himachal Pradesh were cultured on the following six different media to study the best media for the vigorous growth of the mycelium viz, (A) Potato Dextrose Agar (B) Malt Extract Agar (C) Yeast Malt Agar (D)Saboraud's Dextrose Agar (E) Nutrient Agar No. 2 Modified (F) Nutrient Agar (G) Blank. Table 4.15 shows the growth achieved by the mycelium on a span of 7 days.

The table 4.15 shows that the Malt extract agar showed the fastest growth of the mycelium with a radius of 2.13 cm followed by Potato Dextrose Agar with the radius of 1.96 cm. The least growth of the mycelium was seen on Nutrient agar with the growth of the mycelium of only 0.13 cm. Fig 4.13 also shows the growth of mycelium on petri dish after incubation for a week. This result suggests that Malt extract Agar is the best media for vigorous growth of the mycelium as suggested by earlier authors as well. Alternatively, Potato Dextrose Agar can be used as well for the growth of the mycelium culture. This mycelium was then inoculated in the sterile wheat media as mentioned earlier for spawn preparation and the development of mycelium was carried out for the mushroom sample. Then the spawn of the mushroom samples were inoculated in the already formulated saw dust that consisted of Saw dust and wheat bran in the ratio of 2;1, Calcium carbonate (0.2%) and a moisture level of 65% was maintained and the growth of mycelium and fruit body development was observed. Fig:4.14 A shows the

colonization of mycelium on the substrate after 14 days. Fig 4.14 B shows the successful fruiting of the mushroom on the substrate after 57-60 days. These fruiting bodies were harvested, dried and extracted for further comparative study of nutritional and antioxidant activity which is already mentioned above. fruiting of the mushroom on the substrate after 57-60 days. These fruiting bodies were harvested, dried and extracted for further comparative study of nutritional and antioxidant activity which is already mentioned above.

Table 4.15. Growth of mycelium achieved on different media

Sl.no	**Media**	**Radius (in cm) of the mycelium achieved after 7 days**
1	Potato Dextrose Agar	1.96±0.05
2	Malt Extract Agar	2.13±0.05
3	Yeast Malt Agar	1.93±0.05
4	Saboraud's Dextrose Agar	1.33±0.4
5	Nutrient Agar No. 2 Modified	0.37±0.05
6	Nutrient Agar	0.13±0.23

Each value is expressed as Mean ± Standard deviation (SD) (n=3)

The present investigation aimed to develop a cost-effective substitute material to replace wood in the production of plugs utilised for log inoculation. The utilisation of wood as a source of material is currently deemed unsustainable due to its contribution to deforestation and its lengthy regeneration period. Thus, upon examining this particular scenario, bamboo has been utilised to fabricate the wooden plug. This

approach is not only environmentally sustainable but also cost-effective in comparison to traditional wood materials. Bamboo presents several advantages over wood. Firstly, it grows at a rate that is 30 times faster than wood. Additionally, it does not require replantation and is abundantly available throughout Nagaland.

The bamboo plugs were employed for the purpose of *inoculating Quercus serrata* logs, as it has been documented by early authors to yield superior outcomes. Additionally, local testimony suggests that the taste of the product is enhanced when grown on oak trees. Figure 4.14 C&D, depicts the positive outcome of the conducted experiment wherein bamboo plugs were utilised, as evidenced by the emergence of fruiting bodies on the logs after a duration of ten months. The fruiting bodies were collected, dehydrated, and subjected to additional comparative analysis of their nutritional and antioxidant properties in relation to both the naturally occurring *Lentinula edodes* and the *Lentinula edodes* cultivated on sawdust substrate. This was done to investigate potential variations and distinctions in their nutritional composition.

A brief practical training session was carried out at the Botany Department of Nagaland University, focusing on the cultivation of Shiitake and Oyster mushrooms. The training was attended by both students and local residents from the nearby village Fig 4.14, E-H. The aforementioned measure was implemented with the dual purpose of enhancing the individuals' proficiency and disseminating an educational and informative initiative that will furnish substantial prospects for the indigenous populace to establish small-scale businesses and cultivate entrepreneurial skills, thereby generating income.

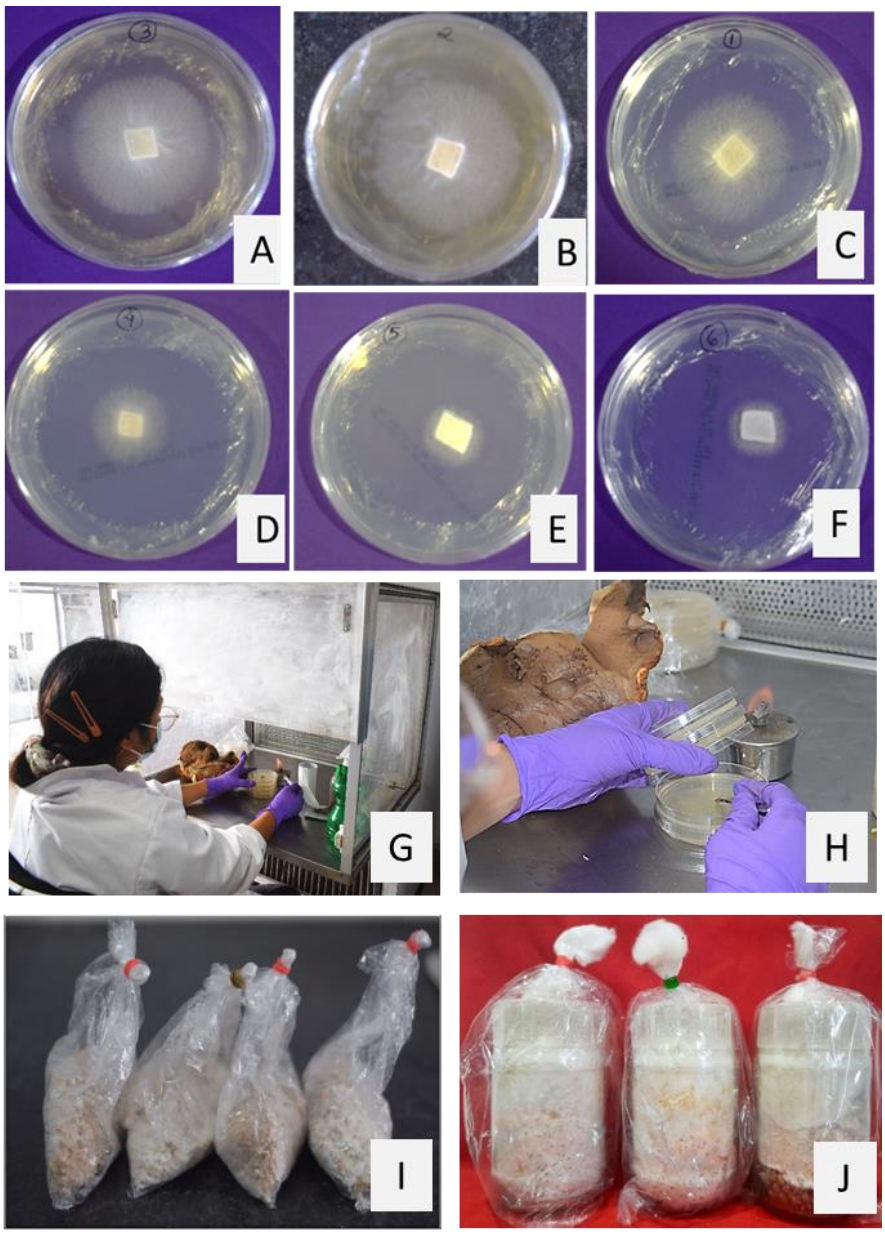

Figure 4.13 Mycellium colonising different media on a span of a week at 22-250C; (A) Potato Dextrose Agar (B) Malt Extract Agar (C) Yeast Malt Agar (D)Saboraud's Dextrose Agar (E) Nutrient Agar No. 2 Modified (F) Nutrient Agar (G) Scholar working under sterile laminar air flow cabinet (H) Innoculation of tissue on the petri-plate (I&J) Mother spawn

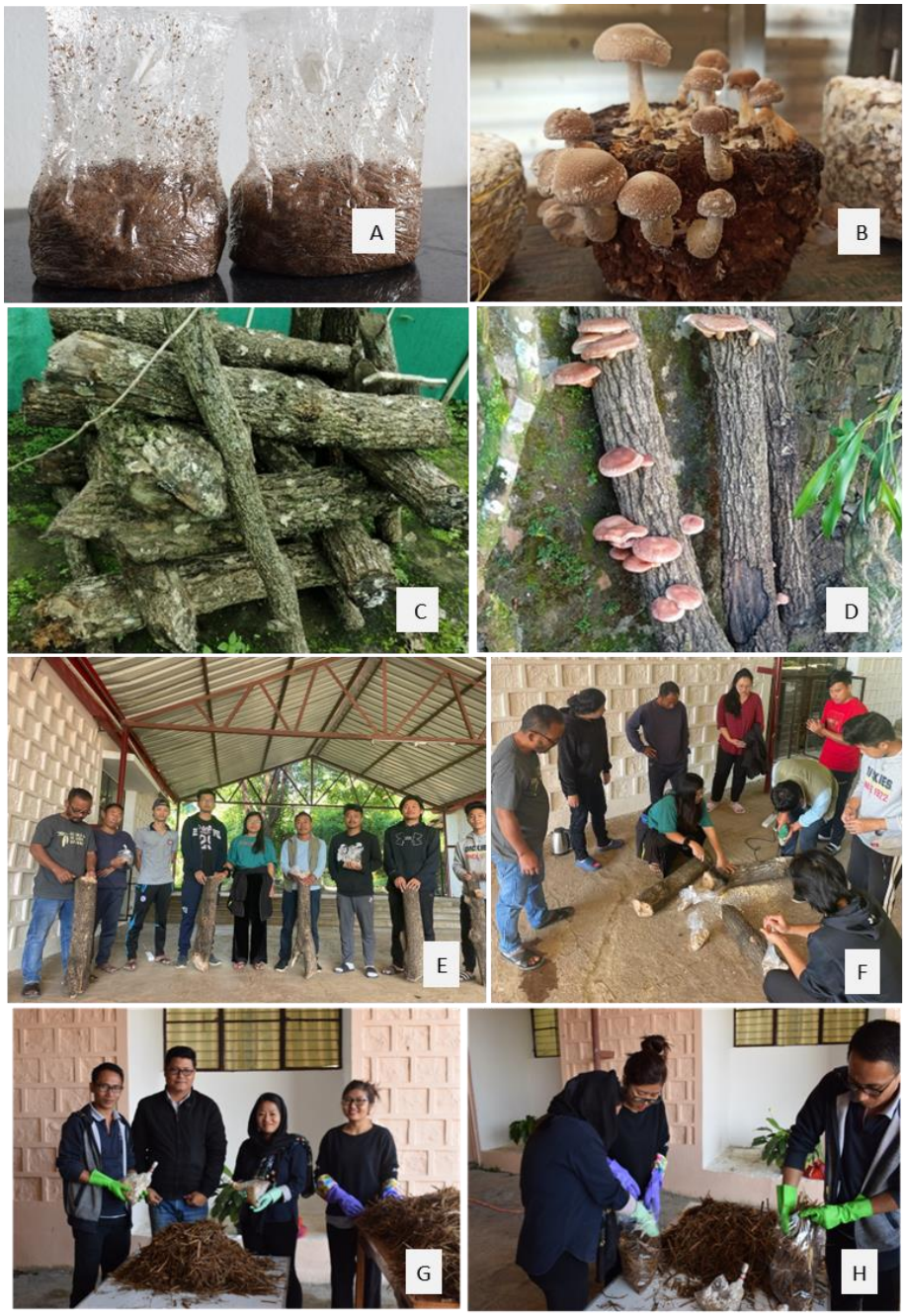

Figure 4.14 (A)Inoculated mycelium in saw dust substrate (B) Fruiting of *Lentinula edodes* on saw dust substrate (C) Inoculated logs with bamboo plugs (D) Fruiting of *L. edodes* on the log of *Quercus serrata* (E-H) Short term hands-on-training conducted in the Department of Botany, Nagaland University on Shiitake mushroom cultivation as well as Oyster mushroom cultivation.

Given the circumstance that the indigenous population solely relies on forest-derived mushrooms as their dietary staple, it is incumbent upon us to establish an alternative means of meeting their nutritional needs. Failure to do so will inevitably result in the overexploitation of the environment and the eventual extinction of the species. The gradual loss of immensely diverse and important groups of organisms is being attributed to a combination of natural and anthropogenic factors.

Therefore, given the current situation, the only way to satisfy the need is via the production of mushrooms. So, after researching the scientific data showing how these mushrooms may aid an organism in battling and preventing a number of disorders, the process of educating and sharing knowledge on mushroom farming was initiated.

4.5.2 Comparative nutritional assessment

Table 4.16 shows the comparative data of the nutritional components of the wild and cultivated mushrooms on log and saw dust. In this study, it was observed that the results achieved by *Lentinula edodes* that were grown on sawdust gave better result and had more nutritional value as compared to the wild variety and the other that was grown on logs with 85.33% moisture content, which was followed by 84.65% from the log and finally 84.335 from the wild. The fruit from saw dust harvested reported highest with the value of 6.5g/100 for reducing sugar, 58.3 g/100g for carbohydrate content, 5.67 g/100g for crude protein 2.98% for crude fat with and 6.84% for total ash content. Higher content of mushroom in the cultivated strain were also observed by other workers (Fasidi & Kadiri, 2016; Manjunathan et al., 2011). Except for the crude fiber and dry matter where the highest content was observed in the wild variety with 5.67%

and 15.66g/100g respectively which is also supported by other authors (Beluhan & Ranogajec, 2011; Chye et al., 2008).

According to Manzi et al., (1999) the growth compost can impact the composition of chemicals and nutritional value of cultivated mushrooms. The quality of mushrooms can be affected by various factors, including the developmental stage of the mushrooms as well as the conditions before and after harvesting. Various interfering factors account for the observed variability in the composition data reported by different authors, even when working with the same groups of fungi(Manzi et al., 1999).

Table 4.16 Composition of wild edible species in a dry weight (d.w.) basis

Mushroom species	Moisture (%)	Dry matter (%)	Reducing sugar (g/100g)	Crude Protein (g/100g)	Carbohydrate (g/100g)	Crude fiber (%)	Crude Fat (%)	Ash (%)
Lentinula edodes (Wild)	84.335±0.03	15.665±0.03	4.53±0.39	.04±0.01	37±0.03	5.67±0.02	1.028±0.01	4.93±0.03
Lentinula edodes (log)	84.65±0.01	15.35±0.01	2.8±0.01	4.68±0.00	33.3±0.09	5.18±0.01	1.18±0.01	4.15±0.02
Lentinula edodes (Saw dust)	85.33±0.5	14.67±0.5	6.5±0.03	5.67±0.03	58.3±0.01	4±0.1	2.98±0.03	6.84±0.00

Each value is expressed as Mean ± Standard deviation (SD) (n=3)

4.5.3 Antioxidant and phytochemical assessment

The results of the comparative analysis of the cultivated and wild variety of Lentinula edodes which were extracted by various solvents viz, Ethyl acetate, Methanol and

water are discussed below.

4.5.4 DPPH free radial scavenging activity

Table 4.17 shows the IC50 values of various extracts of the wild and cultivated mushrooms for their antioxidant properties. Among the three solvent extracts, methanolic extracts gave the lowest IC50 value signifying it to be a better solvent for extraction. Among the mushrooms studied, methanolic extract of fruiting body from the log showed the lowest IC50 with 0.35 mg/ml followed by IC50 of 1.7 mg/ml of water extract and the least was observed from ethyl acetate extract with IC50 of 2.49±0.09mg/ml. The wild variety of *Lentinula edodes* was reported the least potent among them with IC50 value of 0.65, 2.19, and 4.27mg/ml for methanol, ethyl acetate and water extract respectively.

4.5.4.1 ABTS free radical scavenging ability

Table 4.18. shows the ABTS free radical scavenging activity of various extracts. Among the three extracts, the highest ABTS free radical scavenging activity was found in the methanolic extract of *Lentinula edodes* (Wild) with IC50 0.52 mg/ml followed by the ethyl acetate extract with IC50 of 1.62±0.0 mg/ml and least was observed in the water extract with IC50 of 74 mg/ml. followed by *Russula griseocarnosa* (IC50 0.28 mg/ml). Similar results were also achieved by other authors as well (Sudha et al., 2012). In comparison, the aqueous extracts exhibited superior ABTS free radical scavenging efficacy in contrast to the ethyl acetate extracts. The findings suggest that the methanolic extracts possess the capability to scavenge neutral and cation free radicals..

4.5.4.2 **Metal chelating activity**

Table 4.19 shows the chelating effects of the various extract of the wild and cultivated edible mushroom species. The methanolic extract by far gave the best result for the antioxidant potential followed by the water extract. Chelating effect was highest for methanolic extract in *Lentinula edodes* (Saw dust) with IC50 of 0.53 mg/ml followed by water extract with IC50 1.4 mg/ml and the least was recorded with IC50 value of 2.17 mg/ml. The data obtained reveals that various extracts demonstrate an effective capacity for iron binding, suggesting its action as peroxidation inhibitor that may be related to its iron-binding capacity.

Table 4.17: IC50 values of various extracts for DPPH free radical scavenging **ability**

Mushroom species	**DPPH**		
	Extract		
	IC50(mg/ml)		
	Methanol	**Ethyl acetate**	**Water**
Lentinula edodes (Wild)	0.6595±0.04	2.1996±0.07	4.2777±0.07
Lentinula edodes (Log)	0.3501±0.01	2.49±0.09	1.7021±0.03
Lentinula edodes (Saw dust)	0.6345±0.00	1.4518±0.02	1.6006±0.03

Each value is expressed as Mean ± Standard deviation (SD) (n=3)

Table 4.18: IC50 values of various extracts from for ABTS free radical scavenging ability

Mushroom species	ABTS		
	IC_{50} (mg/ml)		
	Extract		
	Methanol	Ethyl acetate	Water
Lentinula edodes (Wild)	0.52±0.01	1.62±0.0	1.74±0.0
Lentinula edodes (Log)	0.84±0.01	2.04±0.06	0.71±0.00
Lentinula edodes (Saw dust)	0.67±0.00	1.04±0.00	0.81±0.00

Each value is expressed as Mean ± Standard deviation (SD) (n=3)

Table 4.19: IC50 values of various extracts for Metal chelating activity

Each value is expressed as Mean ± Standard deviation (SD) (n=3)

Mushroom species	Chelating activity		
	Extract		
	IC50(mg/ml)		
	Methanol	Ethyl acetate	Water
Lentinula edodes (Wild)	0.59±0.00	3.09±0.17	1.2±0.10
Lentinula edodes (Log)	0.62±0.03	1.08±0.01	0.64±0.03
Lentinula edodes (Saw dust)	0.53±0.016	2.17±0.03	1.4±0.01

4.5.4.3 Total Phenolic content

Table 4.20 shows the content of the phenolic contents of various solvent extracts of the mushrooms. The results revealed that the methanolic extraction procedure showed higher efficiency than water and ethyl acetate solvents for all mushroom

species. The highest extractable phenolic content was found in the menthanolic extract of *Lentinula edodes* (Saw dust) with the value of 43.19mg GAE/g DW, followed by the water extract (9.97 mg GAE/g DW) and the ethyl acetate extract (8.45 mg GAE/g DW). Among the extracts the least effective was observed in the ethyl acetate extract. The findings suggest a correlation between total phenolics and antioxidant activity, as the samples with the lowest antioxidant activity also exhibited the lowest phenolic content, and vice versa. The findings suggest that the choice of solvent during the extraction process may have an impact on the phenolic contents that can be extracted.

4.5.4.4 Total flavonoid content

Table 4.22 shows the results of flavonoid content of the wild and cultivated mushrooms of *Lentinula edodes*. The highest content of flavonoid compounds was found in ethyl acetate extract of wild *Lentinula edodes* with 30.9 mg QE/g DW. It was followed by water extract with 12 mg QE/g DW and finally the least was observed in the methanolic extract with 4.3 mg QE/g DW. Among the extracts the least value was recorded in the methanolic extract of all the three varieties. The findings of our study indicate that the utilisation of solvents with varying polarities yielded distinct profiles of the primary bioactive constituents found in various mushroom taxa. Hence, it is crucial to contemplate the correlation between both flavonoid and phenolic compounds and the diverse biological activities present in different extracts of wild edible mushrooms.

4.5.4.5 **Total tannin content**

In this study, all of the mushroom species were evaluated for their tannin content. Table 4.21 shows tannin content of mushroom species of the various extracts. The highest tannin content was observed from the ethyl acetate extract of log cultivated *Lentinula edodes* with 85.93 mg CE/g followed by the value of 28.52 mg CE/g of water extract and lastly by the value of 8.07 mg CE/g of methanolic extract. The least content of tannin was recorded from both water and ethyl acetate extract of *Lentinula edodes* (Saw dust) with 18.94 mg CE/g each. The tannin content was also recorded to be highest for Wild *Lentinula edodes* with 77.92 CE/g from methanolic extract.

Table 4.20 Total Phenol content of various extracts of *Lentinula edodes*

Mushroom species	**Total Phenol Content (mg GAE/g)**		
		Extract	
	Methanol	**Ethyl acetate**	**Water**
Lentinula edodes (Wild)	28.60±0.05	6.35±0.01	9.58±0.02
Lentinula edodes (Log)	11.20±0.05	3.80±0.01	4.92±0.02
Lentinula edodes (Saw dust)	43.19±0.32	8.45±0.00	9.97±0.02

Each value is expressed as Mean ± Standard deviation (SD) (n=3)

Table 4.21 Total Tannin Content of various extracts of *Lentinula edodes*

Mushroom species	Total Tannins (mg CE/g)		
		Extract	
	Methanol	Ethyl acetate	Water
Lentinula edodes (Wild)	77.92±0.23	25.13±0.02	13.53±0.02
Lentinula edodes (Log)	8.07±0.01	85.93±0.11	28.52±0.05
Lentinula edodes (Saw dust)	21.23±0.02	18.94±0.00	18.94±0.00

Each value is expressed as Mean ± Standard deviation (SD) (n=3)

Table 4.22 Total Flavonoid Content of various extracts of *Lentinula edodes*

Mushroom species	Total flavonoids (mg QE/g)		
	Extract		
	Methanol	Ethyl acetate	Water
Lentinula edodes (Wild)	5.9±0.00	30.9±0.17	12±0.10
Lentinula edodes (Log)	6.2±0.03	10.8±0.01	6.4±0.03
Lentinula edodes (Saw dust)	0.53±0.016	21.7±0.03	14±0.01

Each value is expressed as Mean ± Standard deviation (SD) (n=3)

Based on the findings, it can be inferred that *Lentinula edodes* cultivated on formulated substrates possess greater nutritional value and antioxidant properties. The study demonstrates that the utilisation of sawdust in combination with wheat bran is a suitable medium for the cultivation of *Lentinula edodes*. Furthermore, diverse combinations of the aforementioned substrates significantly influenced the nutritional composition of the mushrooms.

The results of the study indicate that it is possible to alter the substrate in order to achieve the desired nutritional composition of mushrooms. The addition of wheat bran to the substrate resulted in the most favourable proximate composition and nutritional profile. Wheat bran and other similar components are suggested as viable supplements for augmenting value-added expansion, particularly with regards to nutritional benefits.

The diversion of agricultural waste into mushroom production can be facilitated by various stakeholders in the food supply chain, including the government, food scientists, and nutritionists. This initiative has the potential to contribute to economic growth, environmental conservation, and serve as a valuable source of nutrition for the population.

The current study provides further evidence for the consumption of edible mushrooms as a source of highly nutritious food. Moreover, they can serve as a repository for numerous antioxidant components, such as phenols, flavonoids, and tannins, which play a crucial role in the treatment of various degenerative ailments, particularly among rural and tribal communities.

CHAPTER - 5

SUMMARY AND CONCLUSIONS

Nagaland is home to a diverse array of macrofungi due to its favourable environment and climate. It has a rich biological diversity, but has been one of the most neglected areas of exploration. The present study is an integral step towards assessing the macrofungal diversity in Nagaland. This work entails a comprehensive database of 376 diverse wild mushrooms of Nagaland wherein 135 species were new records for Nagaland. At the same time, this study also reports 73 species of wild mushrooms to be edible wherein 38 are new reports. The outcome of this study is expected to be highly beneficial in meeting the objectives of the National Biodiversity Action Plan.

While conventional fungal taxonomy serves as a useful tool for distinguishing between various mushroom species, there exist certain ambiguities that cannot be resolved through this approach. Because of this, the sequences of the eleven significant wild edible mushrooms underwent molecular identification and were subsequently deposited into the NCBI GenBank database. viz., *Lentinus badius* (MZ389889), *Lentinula edodes* (OM717957), *Phaeotremella* sp. (OM884055), *Suillus luteus* (OM714489), *Daldinia vernicosa* (OM744414), *Lyophyllum fumosum (*OM760490), *Pleurotus giganteus* (OM717958), *Pleurotus tuber-regium* (OM721745), *Ramaria*

thindii (OM760492) *Russula griseocarnosa (*OM760493) and *Boletus reticulatus* (OM728307).

Nutritional assessment of twenty-eight wild edible mushrooms and two cultivated mushrooms also suggested its high nutritional content in terms of their reducing sugar, crude proteins, carbohydrates, crude fiber and ash content. Carbohydrate content was recorded the highest in *Lentinula edodes* cultivated in saw dust substrate with 58.3±0.01 g/100g d.w); protein content was recorded the highest in *Lentinus sajor-caju* (6.45±0.45 g/100g d.w); *Fistulina hepatica* recorded the highest reducing sugar (13.5±0.01 g/100g d.w); crude fiber was highest in *Favolus* sp. 2 (10.3±0.29 %); *Amanita vaginata* recorded the highest crude fat content (9.90±0.07 %), whereas *Turbinellus floccosus* recorded the highest in ash content(10.5±0.01 %).

Frequent consumption of foods that are naturally rich in antioxidants has the potential to decrease the likelihood of developing chronic illnesses. The heightened attention towards natural antioxidants is attributed to their potential to mitigate the incidence of chronic ailments and the dietary prohibition of synthetic antioxidants. The study on thirty mushrooms revealed that all extracts demonstrated significant antioxidant activity. The methanolic extract demonstrated superior efficacy in terms of its ability to scavenge free radicals, as compared to the other extracts. *Lentinus squarrosulus* (IC50 0.163 mg/ml) exhibited the highest free radical scavenging activity. Chelating effect was highest for methanolic extract in *Cantherellus lateritius* with IC50 of 0.38 mg/ml. The highest ABTS free radical scavenging activity was found in the methanolic extract of *Lentinus squarrosulus* (IC50 0.163 mg/ml). The highest

extractable phenolic content was found in the menthanolic extract of *Boletus reticulatus* (116.41 mg GAE/g DW). The highest content of flavonoid compounds was found in ethyl acetate extract of *Russula griseocarnosa* with 38.5 mg QE/g DW. The highest tannin content was observed from the ethyl acetate extract of log cultivated *Lentinula edodes* with 85.93 mg CE/g. The findings suggest that the selectivity of solvents utilised during the extraction process may have an impact on the levels of extractable antioxidants. This study's findings suggest that the methanol extraction method is adequate for extracting wild edible mushrooms.

This study aimed to develop a cost-effective and sustainable alternative to wood for producing plugs used in log inoculation. The focus was on utilising bamboo as a replacement material, which has the potential to offer both economic and environmental benefits. The study revealed that Lentinula edodes cultivated on sawdust exhibited superior outcomes and higher nutritional content in comparison to the wild variety and the log-grown counterpart. with 85.33% moisture content, 6.5g/100 for reducing sugar, 58.3 g/100g for carbohydrate content, 5.67 g/100g for crude protein 2.98% for crude fat with and 6.84% for total ash content.

However, the radical scavenging activity of the fruiting body's methanolic extract obtained from the log was found to be the highest, with an IC50 value of 0.35 mg/ml. The highest ABTS free radical scavenging activity was found in the methanolic extract *of Lentinula edodes* (Wild) with IC50 0.52 mg/ml, Chelating effect was highest for methanolic extract in *Lentinula edodes* (Saw dust) with IC50 of 0.53 mg/ml. The

highest extractable phenolic content was found in the menthanolic extract of *Lentinula edodes* (Saw dust) with the value of 43.19mg GAE/g DW.

The highest content of flavonoid compounds was found in ethyl acetate extract of wild *Lentinula edodes* with 30.9 mg QE/g DW. The highest tannin content was observed from the ethyl acetate extract of log cultivated *Lentinula edodes* with 85.93 mg CE/g.

The implementation of the techniques of cultivation and hands-on training proved to be beneficial, particularly for the indigenous population, and has the potential to contribute significantly to their utilisation and management practises in the future. Thus, this research has contributed to attaining both practical and academic significance. Moreover, there is a need to address the enhancement of the production of current cultivated species, which encompasses the year-round cultivation of seasonal species and the implementation of superior quality control measures.

In the current decade, there appears to be a decline in the transmission of traditional knowledge regarding the edibility of wild mushrooms, particularly among younger generations. As such, it is imperative to implement robust measures and awareness campaigns aimed at preserving and managing these natural resources by targeting this particular group of organisms among the general populace.

The current study was conducted to examine various aspects of mushrooms in relation to their potential benefits for human health, as well as to address the nutritional needs of future generations in order to address issues of food supply, scarcity, and quality. This study has additionally established a pathway for bilateral collaborations

in research to further enhance the endeavour of investigating this promising research domain.

However, there are still additional obstacles to overcome, and it is necessary to make collaborative endeavours in domains such as the cultivation of novel consumable and therapeutic varieties. Additional research is required to examine the antioxidant properties both enzymatic and non-enzymatic of these substances in order to render them suitable for use in food fortification initiatives and the creation of nutraceuticals and therapeutic agents.

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Nyenthang, G., Kichu, A., Yeptho, L., & Ajungla, T. (2019b). *Fistulina hepatica* (Schaeff.) With. Belonging to the family Fistulinaceae in Nagaland, India. *Current Science*, 117, 1433–1434.

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Nyenthang, G., & Ajungla, T. (2022).Diversity, Database Documentation and Cultivation of Wild Edible Mushrooms of Nagaland

Nyenthang, G., & Ajungla, T. (2023) Exploration on the nutritional composition of two wild edible mushrooms from Nagaland. Conference proceedings on International Conference on 'Bioresources & Bioeconomy' (ICBB-2022) Nagaland University, Lumami, Nagaland, India in Collaboration with NFMP, Govt. of Nagaland, India.

Nyenthang, G., & Ajungla, T. (2023) Nineteen new species report of wild edible macrofungi from Nagaland, India: A data based on hereditary knowledge. *Current Science*

Paper Presented

Nyenthang, G., Ajungla, T. & Chaturvedi (2019). "Ethnomycological documentation of wild edible mushrooms from Nagaland, India." The 9th Conference on Taxonomy and Systematics in Thailand (TST9) Chiang Mai, Thailand, October 2-4, 2019.

Nyenthang, G., & Ajungla, T. (2020). Indigenous knowledge on wild edible

mushroom and its potent efficacy as bioresource and sustainable livelihood in Nagaland, India. National e-conference on “Bioresources and sustainable livelihood of rural India”, September 28-28, 2020 organised by department of Botany, Nagaland University, Lumami-798627, Nagaland.

Nyenthang, G., & Ajungla, T. (2022). “Radical scavenging and antioxidant activities of methanolic extracts from two wild Lentinus species in Nagaland, India.” International e-conference on “Novel approaches in Life sciences” organized by Dept. of Botany in collaboration with IQAC, G. N. Khalsa College, Mumbai 19

Nyenthang, G., & Ajungla, T. (2022). Antioxidant and phytochemical analysis of various extracts from wild *Lentinula edodes* (Berk.) Pegler of Nagaland, India International Conference on ‘Bioresources & Bioeconomy’ (ICBB-2022) Nagaland University, Lumami, Nagaland, India in Collaboration with NFMP, Govt. of Nagaland, India

Poster Presented

Nyenthang, G., & Ajungla, T. (2019). Some wild edible mushroom of Nagaland. National Conference of Stakeholders on Conservation, Cultivation, Resource Development and Sustainable Utilization of Medicinal Plants of North-Eastern India, Nagaland University, Lumami 6-7 March 2019

Training and workshop

“Short-Term Skill Development Training Program in Biotechnology for Students of

North-East India". Held during 16th November-15th December, 2017. Jointly organized Biotech Park, Lucknow and Institutional Biotech Hub, Nagaland University.

Hands on training on " Genomics and Gene Expression Anaysis". Organised by Department of Biotechnology, Govt. Of India Sponsored. Advanced Level Institutional Biotech Hub, Nagaland University, Lumami 798627, Nagaland. July 18-23, 2018.

"Skill and Entrepreneurial Development of the Tribal Youth". Held during July 25th-28th, 2018. Jointly organized by biotech park, Lucknow and Institutional biotech hub, Department of Botany, Nagaland University.

"Skill building training on Scientific Paper Writing and Statistical Analysis using R" organized at the Institute Headquarters, Kosi-Katarmal, Almora, during September 10-15, 2019

"Research Ethics, Paper Writing & IPR" Organised & Sponsored by UGC-SAP(DRS-III), Department of Botany & Department of Biotechnology, Govt. of India sponsored. Advanced Level Institutional Biotech Hub, Nagaland University, Lumami. November 14-15, 2019

"Mapping the Changemakers of North-East Region 2020" under the PhD/ Post Doctoral category organized by BIRAC Regional Techno-Entrepreneurship Promotion Centre (BRTC) at KIIT-TBI BioNEST supported by BIRAC, DBT, Govt. of India.

National Level Online Faculty Development Programme on " Effective Teaching Techniques and Skills for Career Advancement " held from 23rd to 28th June 2021, organized by Faculties of Science Stream, Sao Chang College, Tuensang; Nagaland.

E-photography Competition on "The World of Fungi" by Department of Botany in collaboration with Shri Shivaji Science College Amravati and Mycological Society of India on the occasion of World Fungus Day. 27th Sept- 2nd Oct 2021.

"Role of Botanists in Quality Control Measures of Ayurvedic/ Herbal Medicines" organized by Post Graduate Department of Botany, Mahatma Gandhi. Govt. Arts College, Mahe on 22-07-2020.

"Recent Developments in Plant Science" organised by IQAC and Department of Botany, JSS College for Women (Autonomous), Saraswathipuram, Mysuru-09. 6 August 2020

"Trends in biomedicine and life sciences publishing and nuances and tools of scientific publishing of a webinar series on All about scientific publishing- Trends, nuances, tools, ethics, etc!" organised by Springer Nature in collaboration with DeLCON, DBT e-library consortium on September 2, 2020.