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Assessment of Wild Mushroom Species in Lantapan, Bukidnon, Philippines

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Abstract Bukidnon's mountain ranges and relatively cool and humid climates serve as a habitat and a thriving location for different flora and fauna. It is presumed that many different kinds of mushrooms in the province's wilderness still have not yet been discovered or used to their full potential. The study assessed wild mushroom species in Purok-3, Baclayon, Lantapan, Bukidnon. Specifically, this aimed to collect and identify all species of wild mushrooms in the area and their present conservation status, identify wild mushroom species that are edible and with medicinal value according to literature and studies, and determine how diverse wild mushrooms are present in the study site. The study focused on identifying wild mushroom species and harnessing their full potential before becoming extinct in the area. A transect walk within 300 m and 100 m from the roadside was used. A total of 12 individual species belonging to 9 different families and 9 genera were identified. Five wild mushrooms were edible and with medicinal properties (*Lycoperdon* sp., *Cantharellus* sp., *Coprinellus* sp., *Auricularia auricula-judae, and Termitomyces* sp.). Four wild mushrooms were inedible but with medical properties (*Trametes cinnabarina, Ganoderma applanatum, Daedalea* sp., *Trametes* sp.). One wild mushroom was inedible (*Panaeolus* sp.). Currently, the following species are not included in the IUCN Red List and DENR DAO. This entails that the species are generally not disturbed or threatened. Moreover, more studies about these wild mushrooms are required to determine their conservation status further and implement measures to protect them. The diversity of wild mushroom species in the study site was assessed using the Shannon-Wiener's Diversity Index (2.09), which represents low diversity, and Margalef's Richness Index (3.219), which represents medium species richness of wild mushrooms. Disturbance of the area and the different microhabitats affect the diversity of wild mushrooms. Furthermore, improved investigation should be done, and more sampling plots in the other parts of Lantapan, Bukidnon, Philippines to fully discover all the wild mushroom species found in the area, harness their full potential, and promote conservation.

Keywords: *biodiversity, conservation, edible mushrooms, wild mushrooms*

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1. Introduction

Mushrooms are seasonal macrofungi occupying various niches in the forest environment [1]. They are most common during the rainy season, especially in forests where the dense tree canopy shadow creates a wet environment favorable for the germination and growth of mushrooms [2].

The Philippines is a mega-biodiverse country with high humidity, temperature, and precipitation, making it an ideal place for the growth of mushrooms. *Schizophyllum commune*, *Ganoderma lucidum*, *G. applanatum*, *Auricularia polytricha*, and *Microporus xanthopus* were the most reported species of wild mushrooms in the Philippines [3].

In the Philippines, ten different kinds of edible and therapeutic mushrooms are produced, such as paddy straw mushrooms, oyster mushrooms, shiitake mushrooms, button mushrooms, ear fungi mushrooms, milky mushrooms, yellowish oyster mushrooms, reishi mushrooms, lion's mane mushrooms, and king tuber oyster mushrooms [4]. A new record for a successfully domesticated Philippine basidiomycetous mushroom is *Lentinus swartzii*, which has antioxidant and anti-diabetic activities [5].

With the growing focus placed on mushrooms due to their profound pharmacological and nutritional effects, there is a need to evaluate macrofungal diversity, particularly in Visayas and Mindanao, since biodiversity assessments of wild mushrooms were mainly in the province of Luzon and very few in the regions of Visayas and Mindanao. It is presumed that there are still many different kinds of mushrooms in the Philippine wilderness that have yet to be discovered or used to their full potential also, before they become extinct because of the

noticeable changes in the forest ecosystem brought on by the growing Filipino population, for conservation, and future research into their different applications [3].

One of the mountain ranges in Bukidnon, Mt. Kilakiron, is shown to be the habitat of abundant decomposer bracket fungi [6]. The province's high altitude is the reason for the relatively cool and humid climate throughout the year, which has been an excellent thriving location for mushrooms.

With the benefits mentioned earlier derived from fungal species, it was timely to perform an assessment study of wild mushroom species present in some forest ecosystems within our locality. One of the most accessible and safe places to conduct this study was in Lantapan, Bukidnon, situated between one of the highest peaks in the country, which has climatic conditions that are relatively cool and humid by Philippine standards. Specifically in Purok-3, Baclayon, one of the remote areas in Lantapan, Bukidnon, where some growing wild mushrooms were used as excellent substitutes for food, but knowledge about wild mushrooms still needed to be improved. This qualitative research aimed to determine all the common wild mushroom species in P-3, Baclayon, and their present conservation status, determine the edible and medically essential species in the study site according to literature and studies and evaluate how diverse the wild mushroom species in the area are.

2. Methods

2.1. Research Design

This study employed a descriptive research design to assess the wild mushroom species in P-3, Baclayon, Lantapan, Bukidnon. The researchers systematically observed the study site, noting the species encountered during a transect walk. This approach aimed to provide a comprehensive and detailed account of the mushroom species present without preconceived theories or assumptions. The transect walk method facilitated a better understanding of the mushrooms' distribution, abundance, and characteristics in P-3, Baclayon. Although different from traditional qualitative research genres, the descriptive research design was considered appropriate for achieving the study's objectives by directly observing and experiencing the wild mushroom species in the area.

2.2. Entry Protocol

Before conducting the study, the researchers drafted a letter requesting permission for the proposed site. To ensure ethical information gathering, researchers gathered consent for a permit secured from the locality, including the Barangay Captain and landowner. Moreover, a letter was sent to the Department of Environment and Natural Resources, requesting permission to conduct a study that complied with regulations.

2.3. Locale of the Study

The researchers assessed wild mushroom species in P-3, Baclayon, Lantapan, Bukidnon. The area was situated at an estimated altitude of 700 meters above sea level (masl). The temperature varied from 67 °F to 87 °F throughout the year, while the average humidity ranged from 60 % to 86 %. The area is primarily agricultural land with most crops, such as coffee, corn, and banana, and some portions of forest.

2.4. Establishment of the Study

The researchers employed a transect walk method to collect wild mushroom samples, starting from a point approximately 100 meters away from the roadside, following an adapted procedure [7,8]. The endpoint of the transect walk was set at a distance of about 300 meters from the starting point. All mushroom species encountered along the identified transect line were carefully collected and stored in appropriately labeled paper bags and salad cups.

2.5. Preparation and Collection of Wild Mushrooms

Procedures for collecting samples were conducted based on the guidelines suggested by the mycology expert. Mushrooms that were found growing directly on the soil were meticulously dug out using a bolo similar to the procedure followed by Perpetua et al. [8]. For fruiting structures that were observed on tree bark, a scissor was used to cut them carefully. Fragile and fleshy mushrooms were immediately placed in salad cups containing ethanol for preservation, while woody mushrooms were air-dried without delay.

2.6. Identification of Wild Mushrooms

Based on the characters described in the Workbook in Tropical Fungi by [11] and other references, the collected samples were pre-identified before submission to the Department of Plant Pathology, College of Agriculture, Central Mindanao University, for validation and confirmation of the identified wild mushroom species. The specimens underwent a thorough assessment based on their macroscopic and microscopic characteristics. A mycology expert was consulted to ensure correct mushroom species identification and classification.

2.7. Documentation

The mushrooms were documented in their actual natural environment, capturing them undisturbed. These documents were compiled as visual records of the wild mushrooms within their natural habitat.

2.8. Ethical Considerations

The data collected during the study were treated with the highest respect and care. Safety precautions were strictly followed to prevent the contraction of any potential ailments and to minimize the risk of bodily harm during the actual field visit. There is no conflict of interest among the researchers.

3. Results and Discussion

Wild Mushroom Species

The assessment of wild mushroom species in P-3, Baclayon, Lantapan, Bukidnon revealed a total of 12 individual species collected, shown in Figure 1 below.

Figure 1. Collected wild mushroom species. **A.** *Lycoperdon* sp. **B.** *Cantharellus* sp. **C.** *Cantharellus* sp. **D.** *Panaeolus* sp. **E.** *Coprinellus* sp. **F.** *A. auricula-judae* **G.** *Termitomyces* sp. **H.** *Cantharellus* sp. **I.** *T. cinnabarina* **J.** *G. applanatum* **K.** *Daedalea* sp. **L.** *Trametes* sp.

Table 1. List of Collected Species

FAMILY	GENERA	SPECIES	CONSERVATION STATUS
Agaricaceae	Lycoperdon	*Lycoperdon sp.*	Insufficient data
Cantharellaceae	Cantharellus	*Cantharellus sp.*	Insufficient data
Bolbitiaceae	Panaeolus	*Panaeolus sp.*	Insufficient data
Psathyrellaceae	Coprinellus	*Coprinellus sp.*	Insufficient data
Auriculariaceae	Auricularia	*A. auricula-judae*	Insufficient data
Lyophyllaceae	Termitomyces	*Termitomyces sp.*	Insufficient data
Polyporaceae	Trametes	*T. cinnabarina Trametes sp.*	Insufficient data
Ganodermataceae	Ganoderma	*G. applanatum*	Insufficient data
Fomitopsidaceae	Daedalea	*Daedalea sp.*	Insufficient data

Conservation status source: IUCN Red List & DENR DAO 2017-11

The various types of wild mushrooms found in P-3 Baclayon, Lantapan, Bukidnon are listed in Table 1 above. There are twelve (12) species overall, belonging to nine (9) families and nine (9) genera. The family Agaricaceae has one (1) species, *Lycoperdon* sp. Cantharellaceae has three (3) species, all belonging to *Cantharellus* sp. The family Bolbitiaceae has one (1) species, *Panaeolus* sp. The family Psathyrellaceae also has one (1) species, *Coprinellus* sp. The family Auriculariaceae is represented by *A. auricula-judae*. Lyophyllaceae has one (1) species, *Termitomyces* sp. Polyporaceae has two (2) species, *T. cinnabarina* and *Trametes* sp. The family Ganodermataceae has one (1) species, *G. applanatum*. The family Fomitopsidaceae also has one (1) species, *Daedalea* sp.

At present, the following species are not included in the IUCN Red List [9] and DENR DAO [10]. This entails that the species are generally not disturbed or threatened. Moreover, more studies about these wild mushrooms are required to determine their conservation status further and implement measures to protect them.

The species were identified based on morphological characteristics outlined in Quimio's Workbook in Tropical Fungi (2001) [11] and confirmed with the assistance of an expert from Central Mindanao University. The reported wild mushroom species in this study are also cited in the Records of Wild Mushrooms in the Philippines [3] and the macrofungi checklist of the Philippines [12], which includes 376 verified macrofungal species across 66 families and 130 genera. Most of these species belong to the Ascomycota and Basidiomycota classes, with notable families such as Agaricaceae, Lycoperdaceae, and Polyporaceae. Previous studies [6,7] [13,14] also reported the presence of species like *Coprinellus* sp. and *Trametes* sp. in various locations in the Philippine wilderness.

Fleshy mushrooms were primarily found on forest humus, while hard woody mushrooms grew on tree bark as parasites or saprophytes, consistent with Aminuzzaman et al. [15] study on mushroom biodiversity in Bangladesh. The mushrooms exhibited various colors: yellow, orange, brown, ash, and predominantly white. Their shapes typically featured convex caps with grooved edges. Ganoderma species were commonly attached to tree bark via pseudostems, while fleshy mushrooms often had a stipe. Mushrooms attached to trees lacked hymenophores, whereas fleshy fungi growing in soil or humus had white gills underneath the cap or pileus, which served as hymenophores [16]. These findings align with the [17] assessment of wild mushrooms in San Antonio, Northern Samar, which highlighted the species' occurrence in various habitats, such as dead wood, soil, and tree branches.

The study also revealed that the macrofungi found in the site exhibited ectomycorrhizal, parasitic, saprotrophic, and predominantly saprobic characteristics, contributing to decomposition, nutrient cycling, soil fertility, and ecological balance. This suggests the presence of enriched soil quality and the maintenance of forest health [3].

Edible and with Medicinal Value, Wild Mushroom Species

Five wild mushrooms have been found to be edible (*Lycoperdon* sp., *Cantharellus* sp., *Coprinellus* sp., *A. auricula-judae*, *Termitomyces* sp.), all of which have medicinal properties. Four wild mushrooms found were inedible but had medical properties (*T. cinnabarina*, *G. applanatum*, *Daedalea* sp., *Trametes* sp.). One wild mushroom found was inedible and potentially toxic (*Panaeolus* sp.).

***Lycoperdon* sp.** *Lycoperdon* sp. is a species of edible puffball mushrooms only when young and the interior

flesh is still white [18]. It has soluble phenolic compounds that may be effective anti-tumor, antibacterial, antioxidant, and antiviral agents [19]. It is also used traditionally by tribal tribes in Northern and Central India for controlling bleeding and wound care [20].

***Cantharellus* sp**. Chanterelle mushrooms are popular edible mushrooms that grow in soil and most commonly during hot and humid times of the year [21]. They contain high levels of vitamins B and C, carbohydrates and proteins, and low fat, phenolic compounds, and organic acids [22]. In the study of [23], it has been reported to display various biological properties, including antimicrobial, cytotoxicity, antioxidant, antihypoxic, antihyperglycemic, wound healing, anti-inflammatory, and iron-chelation activity.

***Panaeolus* sp**. Panaeolus is a genus of small, black-spored, saprotrophic agarics that contain psilocybin and its active metabolite psilocin, which can cause ataxia, hyperkinesis, and hallucinations [24]. Reports of toxicity associated with these mushrooms have increased due to their popularity as hallucinogens [25]. No members of Panaeolus are used for food—one of the most studied Philippine mushrooms.

***Coprinellus* sp.** In the study of [26], aqueous extracts from Coprinellus species were identified as anti-proliferative in human estrogen receptor-negative (MDA-MB-231, BT-20) and estrogen receptor-positive (MCF-7) breast cancer cells.

***A. auricula-judae* (Jelly ear)**. Jelly ear is a popular ingredient in Asian cuisine and one of the most studied Philippine mushrooms. It has a low level of fat and high levels of melanin, carbohydrates, fiber, protein, amino acids, ergosterol, and ascorbic acids. Studies have shown that it has antioxidant properties, balances blood sugar and lipid levels, stimulates macrophages and inflammatory cytokines, has anti-cancer properties, and prevents gut microbial dysbiosis [27]. In the study with Ayta communities, it is utilized as food and alternative medicine for cough, weakness, common colds, and poor eyesight [28]. Used as food by the Bugkalot indigenous community [29]. It is also among the ten kinds of mushrooms the Philippines produces that are edible and therapeutic [4].

***Termitomyces* sp.** Termitomyces is a genus of edible mushrooms commonly consumed in Africa and Asia. These mushrooms grow symbiotically in termite nests and produce enzymes that aid in termite digestion. Various ethnic groups use them for their medicinal properties, and their bioactive components have shown potential as antioxidants, immunomodulators, anti-tumors, antimicrobials, and treatments for neurodegenerative disorders [30]. *Termitomyces* and *A. auricula-judae* are utilized as food and alternative medicine in Ayta communities in the Philippines [28]. It is also one of the country's most extensively studied mushroom species.

T. cinnabarina. *T. cinnabarina* is inedible, but has found medicinal purposes and is used for mycelial growth and antibacterial metabolite production [31]. It produces bright red pigments, which are deposited in fruiting bodies and have been studied for their bioactive properties, including antibacterial activity. Cinnabarinic acid, cinnabarina, tramesanguine, and other phenoxazinone derivatives have been identified as bioactive metabolites of *T. cinnabarina* and *T. sanguinea* [32].

***G. applanatum*.** This fungus has been used in Chinese medicine to treat rheumatic tuberculosis and esophageal carcinoma. It has also been used more commonly to resolve indigestion and relieve pain [33]. It also includes anti-tumor, anti-oxidation, and as a regulatory for body immunity [34]. The Bugkalot indigenous community in Alfonso Castaneda, Nueva Vizcaya, utilized it as medicine treatment for gastric ulcers, ground and boiled to drink the broth [29]. One of the most studied Philippine mushrooms and among the most reported species of wild mushrooms [3].

***Daedalea* sp.** Commonly known as maze polypores, they are generally not considered edible. They have a tough and woody texture, making them unsuitable for culinary purposes [35]. Daedalea has different biological activities such as antioxidant, antimicrobial, and anti-cancer [36].

***Trametes* sp.** *Trametes sp*. is used by indigenous people in Ifugao Province for stomach aches, headaches, and body cleansing [37]. *Trametes versicolor* (turkey tail) is a widely studied edible species known for its medicinal properties, used in traditional Chinese medicine [38]. It is considered useful for removing toxins, strengthening, increasing energy, improving liver and spleen function, and enhancing the immune response, especially when it is dried, ground, and prepared into tea [39]. It is believed to have benefits such as toxin removal, immune response enhancement, and treatment of various cancers, hepatitis, and infections. Polysaccharopeptides from *T. versicolor* show antiviral effects and *Trametes* spp. fruiting body extracts have significant antioxidant activity. These effects are attributed to the production of the polysaccharide krestin (PSK) and polysaccharide-peptide complexes that reduce cancer metastases and stimulate interleukin-1 production [39].

Diversity of Mushroom Species

Table 2. Species Diversity of Wild Mushroom in P-3 Baclayon

Transect no.	No. of Species	No. of Individuals	Shannon W's Index	Margalef's Index
1	9	12	2.09	3.219

Legend:

The classification scheme for the Shannon Diversity Index (Fernando et al. 1998).

Relative values	Shannon-Wiener diversity Index (H')
Very High	3.50 and above
High	3.00- 3.49
Moderate	2.50- 2.99
Low	2.0-2.49
Very Low	1.99 and below

Criteria for Margalef's Richness Index values (Latumahina et al. 2020)

Index Value	Category
R < 2,5	Low species richness
2,5 > R < 4	Medium species richness
R > 4	High species richness

The diversity of wild mushroom species in the study site was assessed using the Shannon-Wiener's Diversity Index (2.09) and Margalef's Richness Index (3.219) shown in Table 2 above. The low diversity and medium species richness of wild mushrooms can be attributed to the disturbance of the area, as noted by previous studies [40]. P-3 Baclayon is a semi-disturbed area because even if there are uncultivated areas, a small number of people are already settling and cultivating some areas into farmlands. Unlike the study of [8] in Dansolihon, Cagayan de Oro City, higher altitudes in the study area did not correlate with increased species richness and diversity, likely due to disturbances. Similar to the finding of [41], macrofungi diversity and species richness were high in restricted population forest sites with few disturbances compared to the community forest. In the first 30 m, the researchers were able to get a variety of wild mushrooms as it is a rarely disturbed area with adequate moisture and tree canopy. The researchers then collected another variety of species after 200 m, where the area was not frequently disturbed, with less tree canopy and many dead logs. Most species collected were found in dead woods. This implies that other factors that might contribute to the distribution of bracket fungi are the abundance of logs, dead wood, and decaying materials found in the study area [42]. Also, the entire collected mushroom was found on different substrates. These findings align with the report of [43] that mushrooms vary widely in their habitats. Furthermore, sporocarp-environment relations differed among microhabitats defined by topography, understory light availability, and plant community [16].

4. Conclusions and Recommendations

The results revealed a total of nine (9) species overall taken from 12 samples that differ under nine (9) families and nine (9) genera. The species are *Lycoperdon* sp., *Cantharellus* sp., *Panaeolus* sp., *Coprinellus* sp., *Auricularia auricula-judae, Termitocytes* sp., *T. cinnabarina, Trametes* sp., *G. applanatum* and *Daedalea* sp. The identified species were not found in the IUCN Red List and DENR-DAO. This entails that the species are generally not disturbed or threatened or are still to be studied. All wild mushrooms found are on the records of wild mushrooms in the Philippines, implying that those are the species that commonly grow in the Philippine wilderness; no new species have been found. Most wild mushrooms near farming lands are decomposers, suggesting a nutrient-rich soil that maintains forest health.

Among these, five wild mushrooms are edible and have medicinal properties. Four wild mushrooms were found to be inedible but had medical properties. One wild mushroom found was inedible and potentially toxic. This implies that the mushrooms in the area were not just wild mushrooms but had great potential to enhance human health and the community, which needs to be paid more attention. Given the benefits these wild mushrooms growing in the area provide, conservation should be promoted to utilize the full potential of these wild mushroom species and serve as a source of nutritious food and alternative medicine, as the location of this remote area makes it challenging to access these basic needs.

The diversity of wild mushrooms was low, but species richness was classified as medium. The disturbance of the area affects the diversity and richness of species, so extra care must be taken to keep the environment suitable for wild mushrooms with great potential to grow.

Furthermore, it is recommended to establish a more extended transect area in different parts of Lantapan, Bukidnon, Philippines of at least 2 kilometers and explore more appropriate sampling techniques following the standards set by DENR-BMB (2016). A larger and more diverse sample size will contribute to a more representative analysis of wild mushroom populations and their ecological roles. Conduct further study regarding the different species found to validate and update their conservation status for further conservation and management of these wild mushrooms. Furthermore, consideration should be given to factors that affect the distribution and diversity of wild mushrooms to ensure a comprehensive understanding of the ecosystem. These will help discover all the wild mushroom species in the area, harness their full potential and medicinal and nutritional potentials, and promote conservation.

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