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High altitude deep forest mushrooms in Lagawe, Ifugao, Cordillera Autonomous Region, Northern Philippines

Ramelo B. Ramirez Jr*[1], Julius T. Capili[2]

[1]*Natural Product Research and Innovation Center, Cagayan State University, Andrews Campus, Tuguegarao City, Cagayan North, Northern Philippines*

[2]*College of Allied Health Sciences, Cagayan State University, Andrews Campus, Tuguegarao City, Cagayan North, Northern Philippines*

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Abstract

The researchers documented the edible and medicinal mushrooms located in high altitude and deep forest areas of Lagawe, Ifugao, Cordillera Autonomous Region. Specifically, the study aimed to: (1) conduct a survey of mushrooms naturally growing in Lagawe; (2) conduct taxonomic identification of collected species; and (3) determine their food and medicinal potentials. The collection of specimen was conducted in preparation for taxonomic classification which was done through morphological assessment and photographs and authenticated by the Museum of Natural History and interview of residents was done to determine if the mushrooms are edible and/or medicinal. Results of the study showed that there are five orders of mushrooms, namely, Polyporales (10 families & 2 unidentified), Agaricales (7 families & 3 unidentified), Rusulales (4 families), Auriculiales (2 famiies) and Cantharellales (1 family). of the 29 mushrooms, 7 samples are both edible and medicinal, 13 are edible, 7 are medicinal and 2 are both inedible and non – medicinal. The researchers recommend that the unidentified mushrooms be subjected to barcoding for taxonomic identification, phytochemical analysis, cytotoxicity tests, acute toxicity assays, bioactivity assays, test for contaminants, etc. They further suggest the development of (1) functional food products from the mushrooms which are both edible and medicinal; (2) the mushrooms which are edible only be cultivated for food purposes; & (3) the mushrooms which are medicinal only be developed in herbal formulations.

***Corresponding Author:** Ramelo B. Ramirez Jr., ✉ rameloramirez@csu,edu,ph

Introduction

Fungi are ubiquitous and worldwide in distribution and about 1.5 million fungi have been projected on earth surface of these, approximately 5-7% of the fungi are described till now (Dwivedi et. al., April 2017). Only about 6.7% of the 1.5 million species of fungi estimated in the world have been described and these are mostly in temperate regions and the tropical region which has the highest fungal diversity has not been fully exploited (Kinge *et al.,* 2017). Fungi are one of the most species-rich and diverse groups of organisms on Earth, with forests ecosystems being the main habitats for macro-fungi (Teke *et al.,* 2017). Macrofungi are important economically due to their importance in food, medicine, bio-control, chemical, biological and other industries (Dwivedi *et al.,* December 2017). Macro-fungi include fungi distinguished by having fruiting bodies visible to the unaided eye commonly referred to as mushrooms (Teke *et al.,* 2017). Mushrooms are seasonal macro fungi; occupy diverse niches in nature in the forest ecosystem; form macroscopic fruiting bodies such as agarics, boletes, jelly fungi, coral fungi, stinkhorns, bracket fungi, puffballs and bird's nest fungi; and they maybe fleshy, sub-fleshy, leathery or woody and bear their fertile surface either on lamellae or lining the tubes, opening out by means of pores (Ao et. al, 2016). Mushrooms are seasonal fungi, which occupy additional lists appeared in between culminating with the diverse niches in nature in the forest ecosystem and their habitat and climate are major factors that indicate their biodiversity (Rashid *et al.,* 2017).

Mushroom have high nutritional value along with high proteins, vitamins, minerals, fibers, trace elements content and even low or more or less no calories and cholesterol contents making them ideal food items (Rumainul, Aminuzzaman, and Chowdhury, 2015). They are low in fat, high in complex carbohydrates and protein and they also lack cholesterol and are good sources of vitamins and minerals (Abantenh & Gizaw, 2018). Nowadays, many edible mushrooms have been scientifically tested in order to search for their bioactive compounds as free radical antioxidants (Benchawattananon, 2016). They are the sources of various bioactive substances like, antibacterial, antifungal, antiviral, anti-parasitic, antioxidant, anti-inflammatory, anti-proliferative, anticancer, anti-tumor, cytotoxic, DNA damaging, anti-HIV, hypo- cholesterolemic, anti-diabetic, anticoagulant, hepato-protective, insecticidal properties and an efficient tool for recycling of organic wastes (Rumainul, Aminuzzaman, and Chowdhury, 2015).

Biodiversity studies have been conducted mostly on forest areas like the study of Karun and Sridhar (2017) and knowledge of indigenous people have been harnessed like in the study of Adeniyi, Odeyemi and Odeyemi (2018). Only about 6.7% of the 1.5 million species of fungi estimated in the world have been described and these are mostly in temperate regions and the tropical region which has the highest fungal diversity has not been fully exploited (Kinge, *et al.,* 2017). The researchers conducted this study in the high altitude deep forest of Ifugao which is suitable areas for the study on wild edible and medicinal mushrooms in the area.

Material and methods

Survey

The researchers interviewed the residents in the collection area about the presence of edible and medicinal mushrooms and its traditional therapeutic effects, if any.

Documentation with Photographs

Photographs were taken using a digital camera. It was used to document the physical characteristics of the mushroom including its color, size, shape and appearance, respectively. Photographs include the following: the specimen growing in its natural habitat, a display of the specimen which shows the gills or pores, any unusual, distinctive or interesting features of the mushroom, and the range of variation within the taxon.

Collection

A pocket-knife was used to extract specimens from the substrate to collect the whole specimen including the base. Mushrooms found from the soil were dug out to remove the whole specimen that often

possesses anatomical characters which are taxonomically diagnostic. Mushrooms having black spores were wrapped with a clean white band paper while clean black colored paper were used for mushrooms having white spores. It was done to protect the mushrooms and for moisture retention. The wrapped mushrooms were put inside a clear plastic bag and sealed with a scotch tape before putting it in a sturdy basket in order to avoid contamination.

Transportation

Wooden baskets were used to keep the mushrooms safe and well-preserved before transporting it to the research institute for its taxonomic identification.

Experimental Procedures and Design

Preservation

The collected mushrooms were dried up quickly to prevent the onset of microorganism and mold attack. Drying oven was used and the temperature was set at 50 degrees Celsius for about 8-12 hours depending on the size of samples. After drying, specimens were packed on a ziploc bags.

Identification

Prior to preservation, the mushrooms were identified based on their morphological, macroscopic, physiological and ecological features according to a previously published guide and further identification was based on their structure, substratum they were attached to, spore growth, colour, shape, and mycology textbooks (Protocol adapted from Bankole & Adekunle, 2012 with slight modifications). Features like spores were also annotated. Photographs and dried samples were sent to Museum of Natural History, University of the Philippines Los Banos, Laguna for confirmation of their taxonomic identification.

Result and discussion

Identification of the Mushrooms

As shown in Table 1, out of the thirty samples collected, 10 belong to the Order Agaricales, 2 belong to Order Auriculariales, one belongs to Order Cantharellales, 12 belongs to Order Polyporales, 4 belong to Order Rusulales, and one is not a mushroom but a foliose lichen. The mushrooms in the Order Agacariles belong to the following families: Marasmiaceae, Mycenaceae, Pleurotaceae, Pleuteaceae, Psathyrellaceae, and Schizophyllaceae with 3 unidentified mushrooms. The mushrooms of the Order Auriculariales belong to Family Auriculariaceae. The family Cantharellaceae belongs to Order Cantharellas. The mushrooms in the Order Polyporales belong to the following families: Meruliaceae, Ganodermataceae, and Polyporaceae with two unidentified mushrooms. All mushrooms of the Order Russulales belong to the family Stereaceae. The mushrooms surveyed belonged to five orders, twelve families, and twenty four species with five unidentified mushroom species.

Table 1. Taxonomic identification of the mushroom samples.

Sample	Order	Family	Scientific Name
2	Agaricales	Marasmiaceae	*Favolaschia* sp.
3	Agaricales		(Unidentified)
8	Agaricales	Marasmiaceae	*Marasmius* sp.
9	Agaricales		(Unidentified)
13, 20, 21 & 31	Agaricales	Schizophyllaceae	*Schizophyllum commune* Fr.
16	Agaricales	Pleurotaceae	*Pleurotus* sp.
18	Agaricales		(Unidentified)
19	Agaricales	Pleuteaceae	*Volvariella volvacea* (Bull.) Singer
25	Agaricales	Mycenaceae	*Mycena* sp.
33	Agaricales	Psathyrellaceae	*Coprinellus disseminates* (Pers.) J.E Lange
6	Auriculariales	Auriculariaceae	*Auricularia polytricha* (Mont.) Sacc.
26	Auriculariales	Auriculariaceae	*Auricularia auricular* (L.) Underw.
35	Cantharellales	Cantharellaceae	*Cantharellus sp.* (Juss.)
1	Polyporales	Meruliaceae	*Cymatoderma* sp.
4, 24 & 37	Polyporales	Ganodermataceae	*Ganoderma applanatum* (Pers.) Pat
5	Polyporales	Polyporaceae	*Trametes* sp.
7	Polyporales	Meruliaceae	*Cymatoderma* sp.
12 & 27	Polyporales	Ganodermataceae	*Ganoderma* sp.
17	Polyporales		(Unidentified)

Sample	Order	Family	Scientific Name
22	Polyporales		(Unidentified)
28	Polyporales	Polyporaceae	*Lentinus tigrinus* (Bull.)Fr.
29	Polyporales	Polyporaceae	*Lenzites elegans* (Spreng.)Pat.
30	Polyporales	Polyporaceae	*Pycnoporus sanguine* (L.) Murill
32	Polyporales	Polyporaceae	*Trametes versicolor* (L.) Lloyd
36	Polyporales	Polyporaceae	*Panus conchatus* (Bull.) Fr.
10 & 34	Rusulales	Stereaceae	*Stereum ostrea* (Blume& T. Nees) Fr.
14	Rusulales	Stereaceae	*Stereum complicatum* (Fr.) Fr.
15	Rusulales	Stereaceae	*Stereum hirsitum* (Wild.) Pers.
23	Rusulales	Stereaceae	*Xylobolus* sp.
11			Foliose lichen

The species diversity of fungi and their natural beauty occupy prime place in the biological world. The scope is limitless and this is high time to survey, collect, conserve, record and identifying the biodiversity, habitat and morphology in general and fungal diversity in particular as no one knows when and how some these valuable forms might be lost for forever. (Rashid *et al.,* 2017)

Classification of Mushrooms as Edible and/or Medicinal

Mushrooms are known to everyone as an edible form and their utilization as food is closely related with the history of mankind & edible as well as medicinal properties of mushrooms were known in many of the ancient civilizations (Dwivedi *et al.,* December 2017). They have been under cultivation from time immortal on substrates representing various categories of agriculture waste from nutritional supplements in our daily food material. The edible mushrooms thus provide very efficient methods of recycling renewable organic and agricultural waste. (Dwivedi *et al.,* December 2017).

Among the 29 samples, 20 are edible and 9 are inedible and 14 are medicinal and 15 are non – medicinal. Furthermore 7 samples are both edible and medicinal, 13 are edible only, 7 are medicinal only, and 2 are both inedible and non – medicinal as seen in Table 2. Edible mushrooms constitute alternative source of food against plant- or animal-derived food sources and wild edible mushrooms are the major concern in food security of ethnic and tribal population (Karun and Sridhar, 2017). Humans have consumed fungi for sustenance, medicine, and culinary delight since ancient times Rashid, *et al.,* 2017). They also stated that some fungi are purposely cultivated, but most edible fungi are gathered from the wild. They also said that the Romans and Greeks treated mushrooms as a special kind of food. Of the mushrooms in the Order Agacariles, all are edible and only two are medicinal. The mushrooms under the Order Auriculariales, both are edible but one only is medicinal. The mushroom of the Order Cantharallales is both edible and medicinal. Of the twelve mushrooms of the Order Polyporales, 5 are edible and 6 are medicinal.

Table 2. Classification of the mushroom samples as to its being medicinal and/or edible

Sample No.	Edible	Medicinal	Scientific Name
2	Yes	Yes	*Favolaschia* sp.
3	Yes	No	(Unknown)
8	Yes	No	*Marasmius* sp.2e
9	Yes	No	(Unknown)
13, 20, 21 & 31	Yes	Yes	*Schizophyllum commune* Fr.
16	Yes	No	*Pleurotus* sp.
18	Yes	No	(unknown)
19	Yes	No	*Volvariella volvacea* (Bull.) Singer
25	Yes	No	*Mycena* sp.
33	Yes	No	*Coprinellus disseminates* (Pers.) J.E Lange
6	Yes	No	*Auricularia polytricha* (Mont.) Sacc.
26	Yes	Yes	*Auricularia auricular* (L.) Underw.
35	Yes	Yes	*Cantharellus sp.* (Juss.)
1	Yes	Yes	*Cymatoderma* sp.
4, 24 & 37	No	Yes	*Ganoderma applanatum* (Pers.) Pat

Sample No.	Edible	Medicinal	Scientific Name
5	No	Yes	*Trametes* sp.
7	No	No	*Cymatoderma* sp.
12 & 27	No	Yes	*Ganoderma* sp.
17	Yes	No	(Unknown)
22	No	No	(Unknown)
28	Yes	No	*Lentinus tigrinus* (Bull.)Fr.
29	No	Yes	*Lenzites elegans* (Spreng.)Pat.
30	No	Yes	*Pycnoporus sanguine* (L.) Murill
32	Yes	Yes	*Trametes versicolor* (L.) Lloyd
36	Yes	No	*Panus conchatus* (Bull.) Fr.
10 & 34	No	Yes	*Stereum ostrea* (Blume& T. Nees) Fr.
14	Yes	No	*Stereum complicatum* (Fr.) Fr.
15	No	Yes	*Stereum hirsitum* (Wild.) Pers.
23	Yes	Yes	*Xylobolus* sp.
11	No	No	Foliose lichen

There are two mushrooms of the family Meruliaceae, both of ther Cymatoderma sp but one is both edible and medicinal but the other is non – edible and non – medicinal. They must be two different plant species. Of the four mushrooms under the Order Russulales, two are edible and three are medicinal.

Conclusion

The results showed that there are twenty – four identified d five unidentified mushrooms in seven orders of mushrooms and twelve families in the collection area. Among the 29 samples, 20 are edible and 9 are inedible and 14 are medicinal and 15 are non – medicinal. Furthermore 7 samples are both edible and medicinal, 13 are edible only, 7 are medicinal only, and 2 are both inedible and non – medicinal.

Recommendation(S)

The researchers recommend that the unidentified mushrooms be subjected to barcoding for taxonomic identification, phytochemical analysis, cytotoxicity tests, acute toxicity assays, bioactivity assays, test for contaminants, etc. They further suggest the development of (1) functional food products from the mushrooms which are both edible and medicinal; (2) the mushrooms which are edible only be cultivated for food purposes; & (3) the mushrooms which are medicinal only be developed in herbal formulations.

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