

Inventaritation and Potential Utilization of Macroscopic Mushroom in TPKh Tenjo KPH Bogor

Zalfa Alfatinnisa¹, Wahyu Aji Mahardhika^{2*}, Arina Tri Lunggani¹, Ivan Permana Putra³

¹Department of Biology, Diponegoro University Semarang, Jl. Prof. H. Soedarto, SH, Tembalang, Semarang, Central Java, Indonesia – 50275

²Microbiology Study Program, Postgraduate School, Bogor Agricultural Institute, Jalan Agatis, Dramaga Campus of IPB, Bogor, Indonesia – 16680

³Mycology Division, Department of Biology, Bogor Agricultural Institute, Jalan Agatis Dramaga Campus IPB Bogor, Indonesia – 16680, Tel./Fax. +62-251-862283

*Corresponding Author: mahardhikaaji@gmail.com

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Abstract. The TPKh Tenjo KPH Bogor is a production forest wood collection area and becomes a production forest for the *Acacia mangium* wood species. Timber harvesting activities leave a lot of tree stumps, twigs, or piles of wood that do not pass production. Environmental conditions with a lot of harvested wood residue and supported by relatively cool air temperatures and high humidity, it is suspected this area has a diversity of macroscopic fungi with various unknown potentials. This study aims to obtain data on the types of macroscopic fungi and their potential uses. The research method includes the stages of exploration, identification and literature study to obtain the potential of the macroscopic fungi found. The research succeeded in finding 8 types of macroscopic fungi classified into the phylum Basidiomycota, 3 orders, 5 families, and 7 genera. The macroscopic fungi include *Coprinellus* sp., *Lentinus* sp., *Panus* sp., *Schizophyllum commune*, *Pycnoporus* sp., *Fomitopsis* sp. 1, *Fomitopsis* sp. 2, and *Lycoperdon* sp. Based on the results of the literature study, the potential uses of macroscopic fungi were found are as food, medicine, natural pigment producer, and enzyme producer. This data report can be used as basic information on the use of macroscopic mushrooms by communities around the area to be used as food or medicinal ingredients. Further utilization of this data is the development of the potential of macroscopic fungi that produce enzymes, pigments or drugs to be produced on a large scale. Research on the development of potential mushroom conservation strategies can also be carried out for sustainable use.

Keywords: diversity; macroscopic mushroom; potential utilization; TPKh Tenjo

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INTRODUCTION

Fungi are saprophytic organisms known as decomposer biotic agents. In the decomposition process, the decomposition of lignocellulose, cellulose, or other complex compounds occurs. Fungi with a strong decomposition effect are generally fungi with fruit bodies or are classified as macroscopic fungi (Dossa et al., 2021). In forest ecosystems, fungi will play a role in ensuring forest health by carrying out the function of material degradation, so that the material cycle can take place and provide material in the soil as nutrients for plant germination and growth (Nur et al., 2021). Many macroscopic fungi are found growing in habitats such as weathered wood, litter, and soil surfaces (Susan & Retnowati, 2016). The use of macroscopic fungi for humans has been known for a long time. For centuries, the Japanese

and Chinese dynasties used mushrooms as a food ingredient that is rich in nutrients and provides medicinal therapeutic effects. According to history, King Pharaoh of the Kingdom of Egypt consumed mushrooms as food for nobles and royal troops to increase the body's immunity and prolong life (Arini et al., 2019).

Kawasan Tempat Penimbunan Kayu Hutan (TPKh) is one of the production forest timber collection areas from the Kesatuan Pemangku Hutan (KPH) Bogor (Perhutani, 2015). In addition to being a forest wood collection area, this area has land that is used as a production forest with *Acacia mangium* wood species. During harvesting, primary wood products are produced by logging the trees. This activity will leave parts in the form of tree stumps, twigs, or piles of wood that do not pass the product selection. The Tenjo TPKh area has a temperature range of 18°C - 26°C and an

average annual rainfall of 3,000 mm/year (Perhutani, 2015). The number of rain days will be directly proportional to the humidity level of an area (Denson et al., 2020). The environmental conditions of the Tenjo TPKh area with a lot of harvested wood residue, and relatively cool air temperatures accompanied by high rainfall and humidity will greatly support the growth of macroscopic fungi in the area. Until now, information on the existence of fungi in the TPKh Tenjo area is minimal even though the area has conditions that support the growth of macroscopic fungi. Therefore, it is necessary to study macroscopic mushroom cover in the TPKh Tenjo area which is suspected of having various unknown potential uses. The purpose of this study was to obtain data on the types and potential uses of macroscopic fungi found in the TPKh Tenjo KPH Bogor area.

METHODS

The research was conducted in October 2021 in the TPKh Tenjo KPH Bogor area, Tenjo District, Bogor Regency, West Java. The tools used during the research included camera, GPS (Global Positioning System), knives, soil shovels, brushes, field notebooks, rulers, stationery, masks, gloves, and macroscopic mushroom identification books. The materials used in this study were samples of macroscopic fungi found and specimen bags.

The method used in this research is the exploring method. The search was carried out in three different areas in the TPKh area, namely areas composed of tree stumps left over from logging, areas with young vegetation components, and areas with mature vegetation as shown in Figure 2. The sampling method of mushrooms was carried out by purposive sampling or only samples that met the criteria to be taken as data (Bella et al., 2022; Mahardhika et al., 2021). At the time of sampling it is necessary to record the characteristics of the mushrooms found. Characteristics recorded include the shape of the fruiting body, the color of the fruiting body, the size of the fruiting body, the surface of the cap, the type of hymenophore, and the type of substrate (Putra, 2021). The recording of morphological characters during exploration was carried out in order to avoid changes in mushroom characters

that had not yet been observed in the field. In addition, the fruit bodies of mushrooms that live in nature and are found during sampling are documented especially in the identification key character section to facilitate the identification process. Furthermore, the mushroom fruit bodies were collected by taking samples of the mushroom fruit bodies from the substrate, cleaned of various impurities, and then stored in a specimen bag for further observation. Mushroom specimen bags should be made of paper or aluminum foil to avoid spoilage due to fungal respiration (Putra, 2021). The macroscopic fungi that were found were then identified based on character descriptions and then compared with reference to the book of *The Books of Fungi* (Roberts and Evans, 2014), *Mushrooms: How to Identify and Gather Wild Mushroom and Other Fungi* (Laæssøe, 2013), and research articles (Han et al., 2016). The potential utilization of macroscopic fungi that have been identified was obtained from secondary data collected from various reference sources, both national and international journals.

RESULTS AND DISCUSSION

Based on the research that has been done, macroscopic fungi have been found in several locations (Figure 1a). The number of fungi found in the study area is supported by environmental conditions such as the amount of wood left over from cuttings and part of the tree stump left over from logging which can be a substrate for the growth of macroscopic fungi (Figure 1b). In addition, other supporting factors such as the temperature and humidity which reached 28.5°C and 76.5%, respectively were very suitable for the growth of macroscopic fungi.

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(a)

Figure 1. (a) Environmental conditions in the TPKh Tenjo KPH Bogor area**Table 1.** Species of macroscopic fungi found in the TPKh Tenjo KPH Bogor area

Dead wood	Soil	Genus	Family	Ordo	Phylum
<i>Coprinellus</i> sp.	-	<i>Coprinellus</i>	Psathyrellaceae	Agaricales	Basidiomycota
<i>Lentinus</i> sp.	-	<i>Lentinus</i>	Polyporaceae	Agaricales	Basidiomycota
<i>Panus</i> sp.	-	<i>Panus</i>	Polyporaceae	Polyporales	Basidiomycota
<i>Schizophyllum commune</i>	-	<i>Schizophyllum</i>	Schizopylaxaceae	Polyporales	Basidiomycota
<i>Fomitopsis</i> sp. 1	-	<i>Fomitopsis</i>	Fomitopsidaceae	Polyporales	Basidiomycota
<i>Fomitopsis</i> sp. 2	-	<i>Fomitopsis</i>	Fomitopsidaceae	Polyporales	Basidiomycota
<i>Pycnoporus</i> sp.	-	<i>Pycnoporus</i>	Polyporaceae	Polyporales	Basidiomycota
-	<i>Lycoperdon</i> sp.	<i>Lycoperdon</i>	Lycoperdaceae	Lycoperdales	Basidiomycota

The total macroscopic fungal species found were 8 species from 7 genera, 5 families, 3 orders, and 1 phylum, namely Basidiomycota (Table 1). Based on where it was found, the macroscopic fungi in the TPKh area dominated found on rotten wood. This is related to the condition of the TPKh Tenjo KPH Bogor area which is dominated by the rest of Perhutani's wood cuttings. This is also supported by the percentage of the order Polyporales as the most commonly found order in this region. Desjardin et al., (2015), order Polyporales is a saprophytic fungus that is classified as a wood rot fungus. Members of the order Polyporales play a major role in breaking down dead trees and play an important role in the carbon cycle in forest ecosystems.

Coprinellus sp.

Coprinellus sp. was found growing solitary on

rotting wood (Figure 2a). The pileus of this mushroom is convex-shaped, the edges are flat, white with a brownish center, and 1 cm in diameter. The pileus surface is smooth (Fig. 2b). Gills-type hymenophores. The stipe is white with a length of 1.2 cm (Figure 2c). The fruiting body of this mushroom is very fragile.

Members of the genus *Coprinellus* sp. such as *Coprinellus micaceus* are included in edible mushrooms (Khayati & Warsito, 2018). Tersoo et al., (2019) reported on *C. micaceus* mixed with millet as the basic ingredient for making Ibyer, a typical Nigerian cereal. The mixture of *C. micaceus* in Ibyer has the potential as a nutrient enricher because it contains high levels of amino acids, micronutrients, and bioactive components. Nurhayat et al., (2021) stated that one of the bioactive components in *C. micaceus* is a phenolic component that acts as an antioxidant.

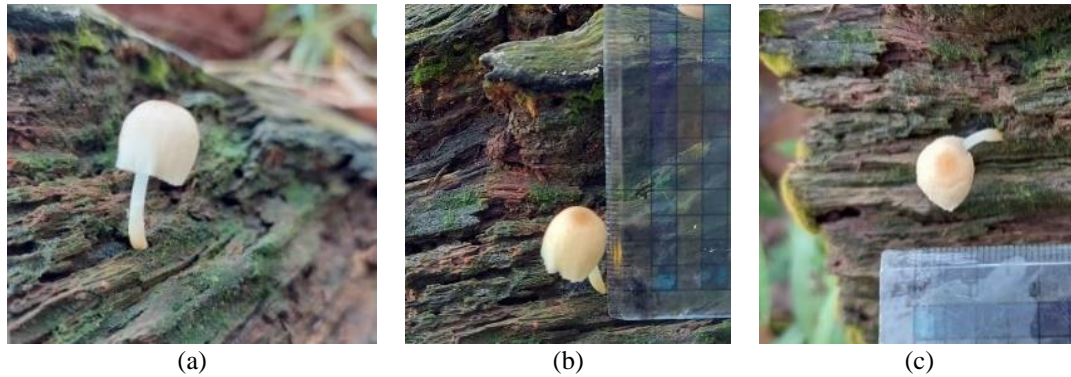


Figure 2. *Coprinellus* sp., (a) and (b) Fruiting body, (c) Pileus top view

***Lentinus* sp.**

Lentinus sp. 1 grew solitary on wood cuttings (Figure 3a). The pileus is depressed, the edges are flat, yellowish white, and 1-2 cm in diameter. The surface of the pileus is downy (Fig. 3b). Hymenophore gills type with a fairly tight spacing between gills. Hymenophore attachment with decurrent type stipe. The stipe is white with a length of 1 cm (Figure 3c).

Lentinus is a fungus with a dead wood habitat. *Lentinus* sp. contains good nutrients such as fat, carbohydrates, protein, minerals, fiber, and vitamins. Its good content causes several types of *Lentinus* except those with hard fruiting bodies to be widely consumed by the public, such as *L. subnudus*, *L. squarrosulus*, *L. lepideus*, *L. tuberregium*, and *L. polychrous* Lev. (Sulistiany et al., 2015).

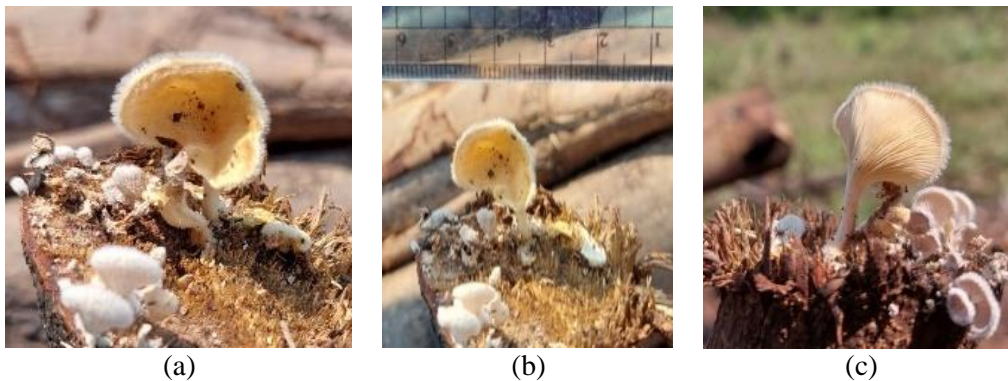


Figure 3. *Lentinus* sp., (a) and (b) Fruiting body, (c) Hymenophore

***Panus* sp.**

Panus sp. was found in the remains of the wood chips (Figure 4a). The pileus is depressed, the edges are flat, brownish, and 1.5 cm in diameter. The surface of the pileus is downy (Fig. 4b). Gills-type hymenophores. Hymenophore attachment with decurrent type. The stipe is attached to the pileus laterally. The stipe is brownish and 0.8 cm long (Fig. 4c).

Panus sp. is included in the wild mushrooms that can be consumed. This is because based on the results of the toxicity test conducted by Debnath et al., (2018), the fungus *Panus* sp. has proven to be free from the toxins amanitin and phalloidin which

are the main toxins in macroscopic fungi. In addition, *Panus* sp. has a positive result of screening for laccase enzyme testing so it can be a potential source of laccase enzyme for industrial-scale production. In addition, the fungus *Panus* sp. is known to produce bioactive compounds such as naematolin, naematolone, panepoxydone, and panotorulone. Member of the genus *Panus* sp. such as *P. conchatus* and *P. rudis* can produce panepoxydone which can inhibit signal transduction mediated by NF- κ B in animal cells so that it has the potential to cure pathological diseases such as cancer (Luangharn et al., 2019).

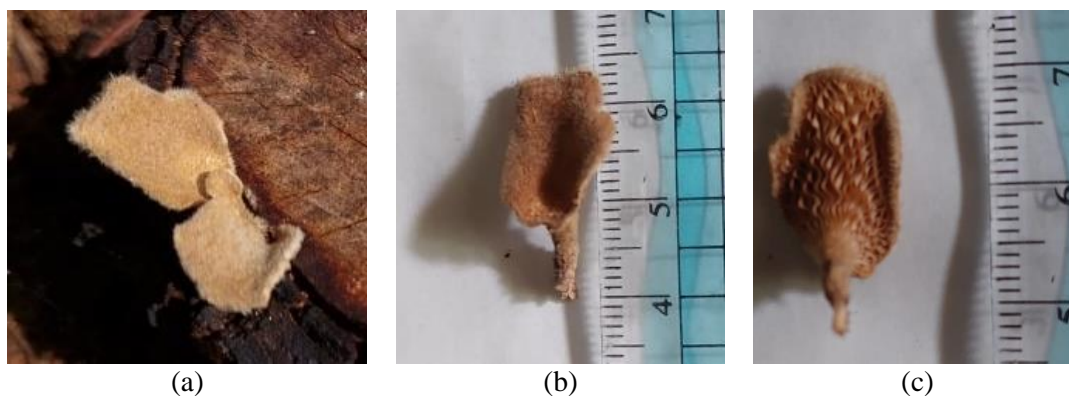


Figure 4. *Panus* sp., (a) Pileus top view, (b) Fruiting body, (c) Hymenophore

Schizophyllum commune

Schizophyllum commune was found in the remaining wood chips (Figure 5a). Pileus fan-shaped, lobed periphery, whitish brown, and measures 0.5x1 cm. The pileus surface is dry with a rough texture (Fig. 5b). Hymenophore gills type grooved to narrow stipe as attachment points with dead wood as habitat. Gills are whitish brown (Fig. 5c).

S. commune mushrooms are widely used as food ingredients, especially in Asian countries

(Kurnia et al., 2020). *S. commune* can be found in several regions in Indonesia under different local names. *S. commune* in Java is known as "jamur gigit" while in West Papua it is known as "jamur gerigit". *S. commune* mushrooms as food mushrooms contain high levels of β -carotene and vitamin E, namely tocopherols. In addition, this mushroom also contains minerals such as magnesium, zinc, and potassium (Nurlita et al., 2021).

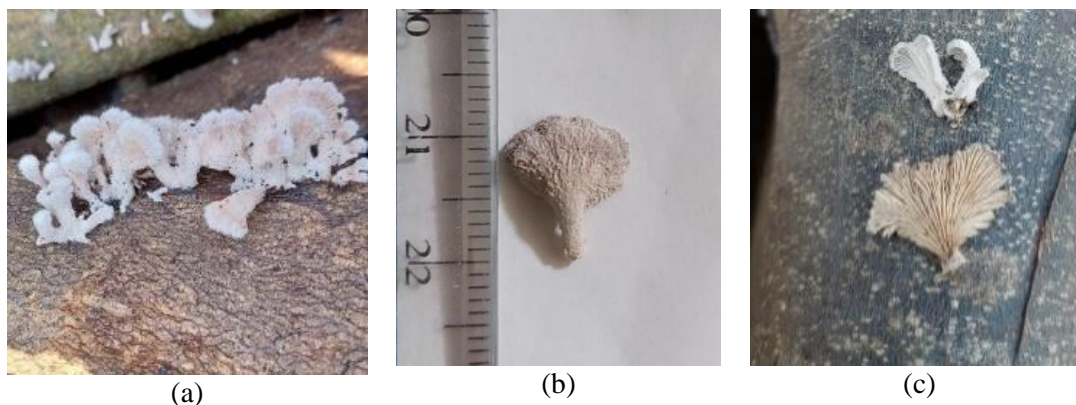


Figure 5. *Schizophyllum commune*, (a) *Schizophyllum commune* colony, (b) Fruiting body, (c) Hymenophore

Pycnoporus sp.

Pycnoporus sp. was found growing on wood stumps (Figure 6a). This mushroom has a hard and dry fruiting body. The pileus is fan-shaped to rounded, the margins are lobed, orange to reddish, and 3-4 cm in diameter. The pileus surface was dry and smooth (Fig. 6b). The hymenophores are porous and orange in color (Fig. 6c). This mushroom has no stipe.

The genus *Pycnoporus* sp. has great potential to be developed in the biotechnology industry because it has the ability to produce laccase enzymes (Christita et al., 2017). Production of laccase enzymes by *Pycnoporus* sp. has been

widely used for the delignification step of polysaccharides into biopolymers in the agro-industry, bioremediation of polycyclic aromatic hydrocarbons, and applied to the pulp and paper industry (Susan et al., 2021). Another potential of *Pycnoporus* sp. is found in the fruiting body that produces a reddish-orange color. Zhang et al., (2019) reported that the color produced by *Pycnoporus sanguineus* was caused by the metabolism of the pigment cinnabarine synthesis. This pigment has good stability in various conditions so it has the potential to be developed as a natural pigment production.

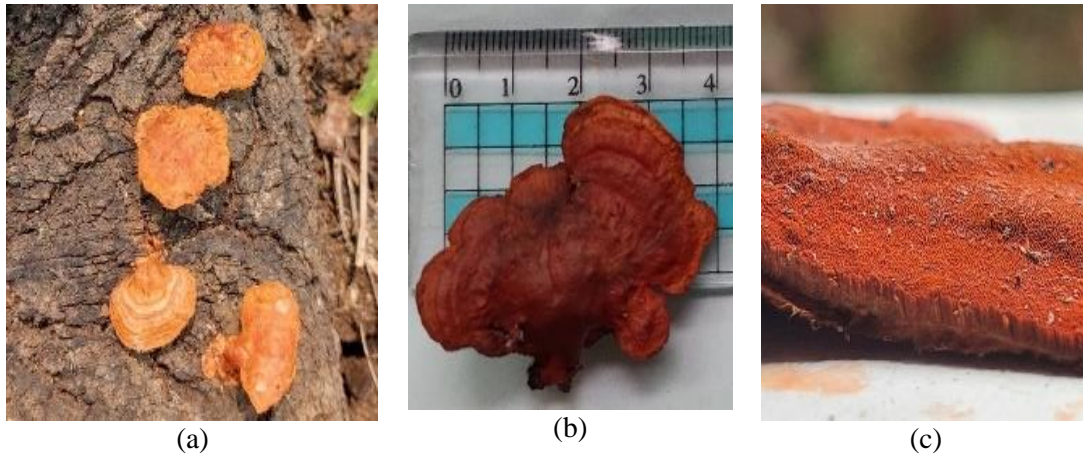


Figure 6. *Pycnoporus* sp., (a) and (b) Fruiting body, (c) Hymenophore

***Lycoperdon* sp.**

The habitat of *Lycoperdon* sp. is in the soil and close to plant roots (Figure 7a). The fruiting body is fleshy, round in shape, and measures 0.5x0.5x0.5 cm. This mushroom has a smooth fruiting body surface. The fruiting body of this mushroom is white with brown dots (Figure 7b). There is a mycelium for attaching the fungus to the soil (Fig. 7c). The fruiting bodies of *Lycoperdon* sp. found at the study site have not yet reached the

adult phase. This can be seen from the fruit body which has solid white flesh.

Fungi of the genus *Lycoperdon* sp., *L. pyriforme* is reported to produce -glucosidase with enzyme characteristics that are resistant to several metal ions such as Na⁺, Li⁺, Mg²⁺, Zn²⁺, Co²⁺, Ca²⁺, and Cu²⁺; chemicals such as sodium dodecyl sulfate (SDS) and ethanol. This makes *L. pyriforme* mushrooms potential to be applied in the industrial (Alkatin, 2013).

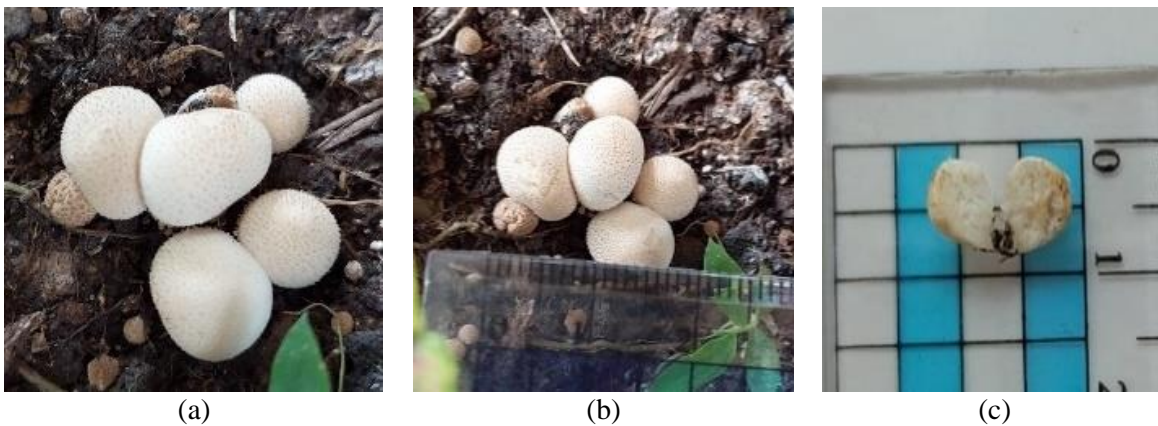


Figure 7. *Lycoperdon* sp., (a) and (b) Fruitig body, (c) Cross section of fruitig body

***Fomitopsis* sp. 1**

Fomitopsis sp. 1 is found in decaying wood. The fruiting bodies are sessile attached and hard woody (Fig. 8a). The pileus shape is like a semicircle or fan. The surface of the pileus is light

brown when young and turns dark brown with age (Fig. 8a;b). The surface of the pileus also appears with concentric lines. The pileus measures 6.5 x 4 cm (Figure 8c). The hymenophore is pore type. The pore surface is pink (Fig. 8d). There is no stipe.

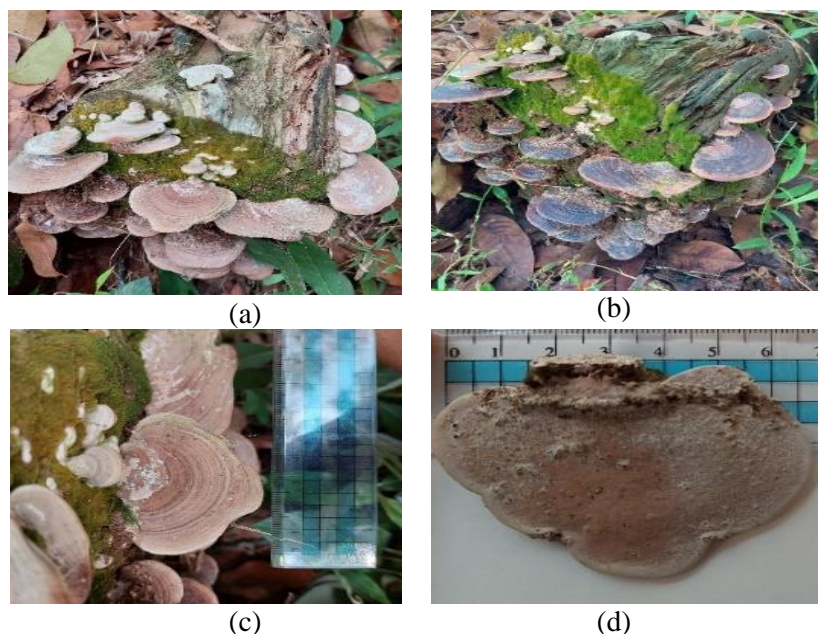


Figure 8. *Fomitopsis* sp. 1, (a) young fruiting bodies, (b) mature fruiting bodies, (c) fruiting bodies, and (d) hymenophores

Fomitopsis sp. 2

Fomitopsis sp. 2 is found in decaying wood. The fruiting bodies attach sessile. The fruiting body when young is hard, woody, and creamy to light brown colors at the edges of the hood. When ripe, the fruiting body changes color to black with red edges (Fig. 9a;b). The pileus is shaped like a semicircle or fan. The pileus measures 3.7x1.5 cm

(Figure 9c). The hymenophore is pore type. The pore surface is pink (Fig. 9d;e). There is no stipe.

Fungi belonging to the genus *Fomitopsis* sp. such as *Fomitopsis pinicola* was reported to have potential as an antidiabetic therapeutic agent. The ethanol extract of *Fomitopsis pinicola* can show antidiabetic activity in streptozotocin-induced rats by increasing insulin secretion (Zahid et al., 2020).

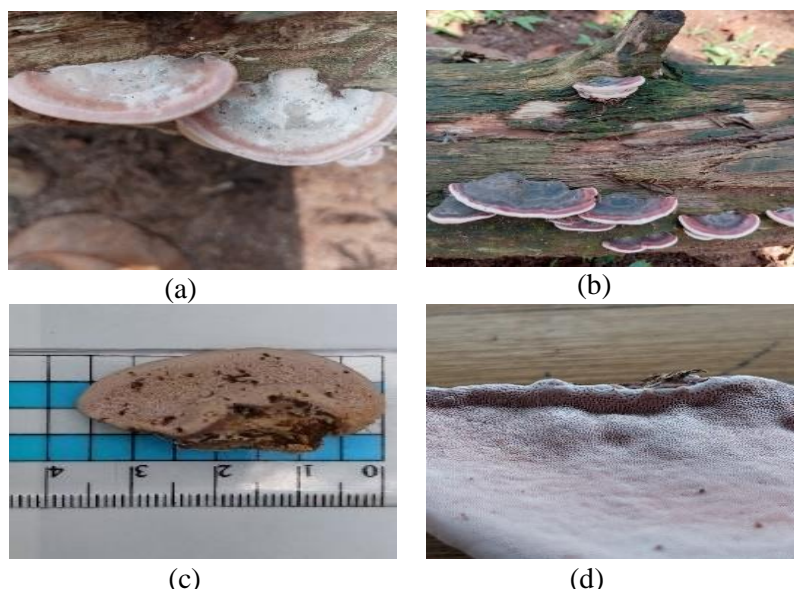


Figure 9. *Fomitopsis* sp. 2, (a) young fruiting bodies, (b) mature fruiting bodies, (c) hymenophores, and (d) pores

Macroscopic mushrooms found in addition to having ecological benefits have also been reported to have many other potential benefits. Some are useful as food ingredients which are characterized

by the texture of the mushroom fruiting body which is soft, it has a pleasant aroma and taste. Not only that, the high nutritional content such as carbohydrates, protein, fat, fiber, vitamins,

minerals, and water make these macroscopic mushrooms a source of nutrition (Wati et al., 2019; Noverita & Ilmi, 2020). Examples of macroscopic fungi found and have the potential to become food ingredients are *Lentinus* sp., *Panus* sp., *Coprinellus* sp., and *S. commune*. The utilization of these four types of mushrooms as food is still quite low compared to other types of mushrooms that are known to the public and commercially such as *Pleurotus ostreatus*, *Volvariella volvacea*, *Agaricus bisporus*, and *Auricularia auricular* (Kumar et al., 2021). While macroscopic mushrooms with potential as medicinal ingredients generally have fruit bodies with a hard texture and contain bioactive compounds that can treat disease (Noverita & Ilmi, 2020). An example of this fungus is *Ganoderma* sp. and *Cordyceps* sp. (Liu et al., 2016; Fitriani et al., 2018). The types of fungi that were found to have potential as medicinal ingredients were *Fomitopsis* sp.

Another potential benefit of the mushrooms found is that they have a great opportunity to be developed in the industrial world as environmentally friendly materials because they come from nature. This study found *Panus* sp., *Pycnoporus* sp., *Lycoperdon* sp. which can be a source of enzymes, and other potential uses, namely *Pycnoporus* sp. as a pigment producer. An example of a fungus that has been empirically proven to be useful in the pulp industry and batik industry for deodorizing batik liquid waste is *P. ostreatus*. This is due to its ability to produce extracellular enzymes, namely lignin peroxidase (LiP), manganese peroxidase (Mn-P) and Laccase (Lac) which can increase the catalytic activity of the degradation of various types of substrates. In addition, the fungus *P. ostreatus* is also commonly found in nature, especially on wood substrates to help the weathering process by degrading lignin into simpler compounds (Al Wahid & Rahayu, 2017).

CONCLUSION

Based on research that has been conducted in the TPKh Tenjo KPH area, Bogor, it is known that the area has a variety of macroscopic fungi. The macroscopic fungi found were *Coprinellus* sp., *Lentinus* sp. 1, *Lentinus* sp. 2, *Scyzophyllum commune*, *Fomitopsis* sp. 1, *Fomitopsis* sp. 2, *Pycnoporus* sp. and *Calvatia* sp. The diversity of fungi in this area has great potential for ecological and socio-economic benefits such as medicinal, food, enzyme-producing, and pigments.

This study has some limitations on the duration of field exploration and laboratory observations. In future studies, it is hoped that macroscopic mushroom sampling activities can be carried out in a long duration, even across seasons. It is possible to grow the macroscopic fungi for further identification microscopically and molecularly in order to get a full inventory of the fungi.

REFERENCES

- Akatin, M. Y. (2013). Characterization of a β -Glucosidase from an Edible Mushroom, *Lycoperdon Pyriform*. *International Journal of Food Properties*, 16(7), 1565-1577.
- Al Wahid, H. Z., Rahayu, T. (2017). Pertumbuhan Miselium Jamur Pelapuk Putih Isolat dari *Edupark* Universitas Muhammadiyah Surakarta. *Seminar Nasional Pendidikan Biologi dan Saintek II*, 36-40.
- Arini, D. I. D., Christita, M., Kinho, J. (2019). The Macrofungi Diversity and Their Potential Utilization in Tangale Nature Reserve Gorontalo Province. *Berita Biologi*, 18(1), 109-115.
- Bella, I., Rondonuwu, S., Tangapo, A. M. (2022). Inventarisasi Jamur Makroskopis di Perkebunan Kelapa Tengatuel Desa Tokin Baru Kecamatan Motoling Timur. *Journal of Biotechnology and Conservation in Wallacea*, 2(1), 16-28.
- Christita, M., Arini, D. I. D., Kinho, J., Halawane, J. E., Diwi, M. S. (2017). Keragaman dan Potensi Makrofungi di Obyek Ekowisata Kaki Dian, Gunung Klabat-Minahasa Utara. *Jurnal Mikologi Indonesia*, 1(2), 82-95.
- Debnath, G., Das, P., Saha, A. K. (2018). Screening of Toxicity Test and Extracellular Laccase Enzyme of Some Wild Edible Mushrooms of Tripura Northeast India. *Life Science Informatics Publications*, 4(4), 586-593.
- Denson, E., Wasko, C., Peel, M. C. (2021). Decreases in Relative Humidity Across Australia. *Environmental Research Letters*, 16(7).
- Desjardin, D. E., Wood, M. G., Stevens, F. A. (2015). *California Mushrooms: The Comprehensive Identification Guide*. Timber Press, London.
- Dossa, G. G. O., Yang, Y. Q., Hu, W., Paudel, E., Schaefer, D., Yang, Y., Cao, K., Xu, J., Bushley, K. E., Harrison, R. D. (2021). Fungal Succession in Decomposing Woody Debris Across A Tropical Forest Disturbance Gradient. *Soil Biology and Biochemistry*, 155(108142).

- Fitriani, L., Krisnawati, Y., Anorda, M. O. R., Lanjarini, K. (2018). Jenis-Jenis dan Potensi Jamur Makroskopis yang Terdapat di PT Perkebunan Hasil Musi Lestari dan PT Djuanda Sawit Kabupaten Musi Rawas. *Jurnal BIOSILAMPARI: Jurnal Biologi*, 1(1), 21-28.
- Han, M., Chen, Y., Shen, L., Song, J., Vlasak, J., Dai, Y., Cui, B. (2016). Taxonomy and Phylogeny of The Brown-Rot Fungi: *Fomitopsis* and Its Related Genera. *Fungal Diversity*, 80, 343-373.
- Kumar, K., Mehra, R., Guine, R. P. F., Lima, M. J., Kumar, N., Kaushik, R., Ahmed, N., Yadav, A. N., Kumar, H. (2021). Edible Mushrooms: A Comprehensive Review on Bioactive Compounds with Health Benefits and Processing Aspects. *Foods*, 10(12).
- Kurnia, F., Periadnadi, Nurmiati. (2020). Isolation of *Schizophyllum commune* From Rubberwood. *Int.J.Curr.Micobiol.App.Sci.*, 9(12), 1202-1207.
- Laessøe, T. (2013). *Mushrooms: How to Identify and Gather Wild Mushrooms and Other Fungi*. New York: Dorling Kindersley Limited DK.
- Liu, C., Song, J., Teng, M., Zheng, X., Li, X., Tian, Y., Pan, M., Li, Y., Lee, R. J., Wang, D. (2016). Antidiabetic and Antineprithic Activities of Aqueous Extract of *Cordyceps militaris* Fruit Body in Diet-Streptozotocin-Induced Diabetic Sprague Dawley Rats. *Oxid Med Cell Longev*, 9685257.
- Luangham, Y., Karunarathna, S. C., Mortimer, P. E., Hyde, K. D., Xu, J. (2019). Morphological and Molecular Identification of *Panus conchatus* (Polyporaceae, Polyporales) From Yunnan Province, China. *Studies in Fungi*, 4(1), 253-262.
- Mahardhika, W. A., Sibero, M. T., Hanafi, L., Putra, I. P. (2021). Keragaman Makrofungi di Lingkungan Universitas Diponegoro dan Potensi Pemanfaatannya. *Prosiding Biologi Achieving the Sustainable Development Goals with Biodiversity in Confronting Climate Change*, 260-275.
- Noverita, Ilmi, F. (2020). Inventarisasi dan Potensi Jamur Makro di Kawasan Taman Nasional Ujung Kulon Banten. *AL-KAUNIYAH: Jurnal Biologi*, 13(1), 63-75.
- Nur, I. F., Sihombing, A. D., Fazriati, N., Az-Zahra, R., Utami, A. W. A., Ristanto, R. H. (2021). Keanekaragaman Makrofungi di Hutan Kota Srengsreng dan Pesanggrahan Sangga Buana Jakarta. *Proceeding of Biology Education*, 4(1), 89-108.
- Nurhayat, O. D., Putra, I. P., Anita, S. H., Yanto, D. H. Y. (2021). Notes Some Macro Fungi From Taman Eden 100, Kawasan Toba, Sumatera Utara Indonesia: Description and Its Potency. *BIOEDUSCIENCE*, 5(1), 30-39.
- Nurlita, A. I., Putra, I. P., Ikhsan, M. (2021). Catatan Pemanfaatan *Schizophyllum commune* di Kampung Udapi Hilir, Papua. *Integrated Lab Journal*, 9(1), 18-28.
- Perhutani. (2015). KPH Bogor. <https://www.perhutani.co.id/tentang-kami/struktur-organisasi-perum-perhutani/divisi-regional/janten/kph-bogor/>. Diakses pada 11 Desember 2021.
- Putra, I. P. (2021). Panduan Karakterisasi Jamur Makroskopik di Indonesia: Bagian 1-Deskripsi Ciri Makroskopis. *Jurnal Penelitian Kehutanan Wallacea*, 10(1), 25-37.
- Roberts, P., & Evans, S. (2014). *The book of fungi: a life-size guide to six hundred species from around the world*. University of Chicago Press.
- Sulistiany, H., Sudirman, L. I. (2015). Pertumbuhan dan Produksi Jamur *Lentinus sajor-caju* Isolat LSC9 pada Media Serbuk Gergajian Kayu Sengon (*Paraserianthes falcataria*) dan Tandan Kosong Kelapa Sawit. *Jurnal Sumberdaya HAYATI*, 1(2), 41-46.
- Susan, D., Fastantanti, F. S., Sutikno, Supriyanti, Y., Robiah, Y., Ariasari, N. (2021). The Genus *Pycnoporus* in Indonesia. *Floribunda*, 6(7), 248-256.
- Susan, D., Retnowati, A. (2016). Catatan Beberapa Jamur Makro dari Pulau Enggano: Diversitas dan Potensinya. *Berita Biologi*, 16(3), 243-256.
- Tersoo-Abiem, E. M., Gbaa, S. T., Sule, S. (2019). Effect of Mushroom (*Coprinellus micaceus*) Flour Addition on the Quality Characteristics of Millet-Based *Ibyer*. *Research Journal of Food and Nutrition*, 3(4), 1-5.
- Wati, R., Noverita, Setia, T. M. (2019). Keanekaragaman Jamur Makroskopis di Beberapa Habitat Kawasan Nasional Baluran. *Al-Kauniyah: Jurnal Biologi*, 12(2), 171-180.
- Zahid, M. T., Idrees, M., Abdullah, I., Ying, W., Zaki, A.H., Bao, H. (2020). Antidiabetic Properties of the Red Belt Conk Medicinal Mushroom *Fomitopsis pinicola* (Agaricomycetes) Extracts on Streptozotocin-Induced Diabetic Rats. *Int J Med Mushrooms*, 22(8), 731-741.
- Zhang, H., Gao, X., Guo, X., Kurakov, A., Song, F. (2019). Stability Study of The Pigment Extract from A Wild *Pycnoporus sanguineus*. *International Journal of Microbiology and Biotechnology*, 4(4), 121-127.