



Notes Some Macro Fungi From Taman Eden 100, Kawasan Toba, Sumatera Utara, Indonesia: Description and Its Potency

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ABSTRACT

Background: The record and research on macrofungi from Taman Eden 100, Toba-Samosir Regency, North Sumatra, Indonesia, was conducted to provide some information about their current status and potential use in the future. **Methods:** This research was divided into three steps: exploration, identification, and literature studies of the potential use from the identified macrofungi. **Results:** The research had successfully identified 14 macrofungi that were classified into 4 orders and 9 families. All the macrofungi found were Basidiomycota, namely *Gymnopilus* sp., *Marasmiellus* sp.1, *Marasmiellus* sp.2, *Marasmius* sp., *Favolaschia* sp., *Coprinellus* sp., *Coprinopsis* sp., *Auricularia* sp.1, *Auricularia* sp.2, *Auricularia* sp.3, *Auricularia* sp.4, *Tylopilus* sp., *Suillus* sp., and *Russula* sp. The identified macrofungi are potentially used as food supplements, medicine, bio-fertilisers, bioherbicides, and bioremediation agents based on the literature. **Conclusions:** Taman Eden 100 has a unique fungal diversity of macrofungi and has never been published in a scientific journal. Further investigations are needed to determine the fungal diversity and potential use of macrofungi in other places in Taman Eden 100.

Catatan Beberapa Jamur Makro Dari Taman Eden 100, Kawasan Toba, Sumatera Utara, Indonesia: Deskripsi dan Potensinya

ABSTRAK

Background: Pencatatan dan penelitian jamur makro dari Taman Eden 100, Kawasan Toba, Sumatera Utara, Indonesia dilakukan dengan tujuan menyediakan informasi status dan mengungkap potensi pemanfaatannya pada masa depan. **Metode:** Penelitian pencatatan jamur dibagi menjadi tiga tahap kegiatan yaitu eksplorasi, identifikasi, dan studi literatur potensi jamur yang berhasil diidentifikasi. **Hasil:** Penelitian berhasil mengidentifikasi 14 jamur makro yang diklasifikasikan ke dalam 4 ordo dan 9 famili. Seluruh jamur merupakan filum Basidiomycota yaitu: *Gymnopilus* sp., *Marasmiellus* sp.1, *Marasmiellus* sp.2, *Marasmius* sp., *Favolaschia* sp., *Coprinellus* sp., *Coprinopsis* sp., *Auricularia* sp.1, *Auricularia* sp.2, *Auricularia* sp.3, *Auricularia* sp.4, *Tylopilus* sp., *Suillus* sp., dan *Russula* sp. Berdasarkan studi literatur diperoleh bahwa potensi jamur makro yang ditemukan dapat digunakan sebagai bahan alternatif makanan, suplemen, obat, pupuk hayati, bioherbisida, dan agen bioremediasi. **Kesimpulan:** Taman Eden 100 memiliki keragaman jamur makro yang unik dan belum pernah dipublikasikan dalam jurnal ilmiah. Penelitian lebih lanjut diperlukan untuk mengetahui keragaman dan potensi pemanfaatan jamur yang ada di tempat lain di Taman Eden 100.

Kata kunci:

Jamur makro

Keragaman jamur

Potensi makrofungi

Taman Eden 100



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Introduction

Fungi are organisms that play an essential role in the ecosystem due to their ability as decomposers to break down cellulose and lignin compounds in the nutrient cycle

process in nature to maintain soil fertility. Some species of fungi also form a mutualistic symbiosis with plant roots and form mycorrhiza structures (Pointing et al., 2005; Lehto & Zwiazek, 2011; Lenoir et al., 2016; Guerrero-galán et al., 2019). Besides, several species of fungi are also

applied for biotechnology purposes, and the results of its applications are developed extensively in several industries areas such as food, agriculture, textile, medicine, and wastewater treatment (Sing et al., 2017; Anita et al., 2019; Hyde et al., 2019). As a eukaryotes organism, fungi can be found in both macroscopic and microscopic forms. This is because their characteristics can be seen with the naked eye with different shapes and colours between groups.

As a tropical country, Indonesia has many forests with high biodiversity, including its macrofungi species. Based on the report of Darajati et al. (2016), there are only 16.000 macrofungi species that have been identified, and most of them are reported from Java. As an archipelago country, Indonesia has a diverse of natural or tourist forests that are home to various species of fungi. However, several researchers have attempted to record species of macrofungi in natural, conservation, and artificial forests in Indonesia. (Retnowati, 2004, 2007, 2015; Wahyudi & P, 2016; Putra et al., 2017; Susan Dewi, 2017; Putra, Amelya, et al., 2019; Putra, Nasrullah, et al., 2019; Putra, 2020b, 2020a)

Macrofungi are generally groups of Basidiomycota and Ascomycota. Several groups of Basidiomycota fungi are characterised by spores production in the lamella and pore systems under their cap. The characteristics of the member of macrofungi have various structures from the cap shape, lamella, stipe, texture, and dominant colour of sporocarps. The Basidiomycota fungi are well known to have several edible species, even though some of them consist of deadly toxins compounds (Retnowati, 2004; Gull-e-Laala et al., 2019).

Taman Eden 100 is one of the tropical tourist park in Toba Regency, Samosir, North Sumatera Province, Indonesia, and is located at an altitude of 1100-1750 above sea level. Tropical forest conditions in Taman Eden 100 are natural and provide a wide range of biodiversity both flora and fauna including conservation activities of several species of orchids (Pemerintah Kabupaten Toba Samosir, 2014).

There is no scientific report that studies on macrofungi in Taman Eden 100. Thus, as an initial step to optimise the application of macrofungi in Indonesia, exploration and identification of macrofungi are necessary to give the distribution of macrofungi in Sumatera. This research aimed to provide potency and diversity information of macrofungi in Taman Eden 100.

Methods

The study was conducted in Taman Eden 100, Toba region, Samosir, North Sumatera, Indonesia, in March 2018 at three location sampling: Park entrance post area, air terjun dua tingkat, and Rumah tarzan (Figure 1). The ambient temperature of the sampling location was 19-22 °C. Macrofungi were collected by an opportunistic sampling method (O'Dell et al. 2004). Macrofungi identification to genus level was carried out using loupe and stereo microscope based on macroscopic structure, referring to Putra et al. (2018) with modification. Macroscopic identification characteristics including the information of fungi: Growth habit, sporocarp shape, cap colour, the upper shape of the cap, cap surface, cap edge, cap margin, wetness level, and hymenophore type (lamella, pore, teeth). Besides, the other characteristics such as the shape of the stipe, stipe colour, stipe surface, the position of stipe attachment to the cap, stipe attachment to substrate, partial veil and universal veil (tudung universal), sporocarp texture were observed. The information of utilisation as a food source (edible or non-edible) was conducted through interviews with key person and literature review to obtain reliable data. Furthermore, macrofungi samples were identified using several identification references, including Largent (1977), Arora (1986), Rokuya, I., Yoshio, O., Tsugia, (2011) dan Desjardin et al., (2015).

Results

A total of 14 macrofungi were described and identified in this study. The observed macrofungi were distinct into 4 orders and 9 Families (Table 1). All macrofungi found in

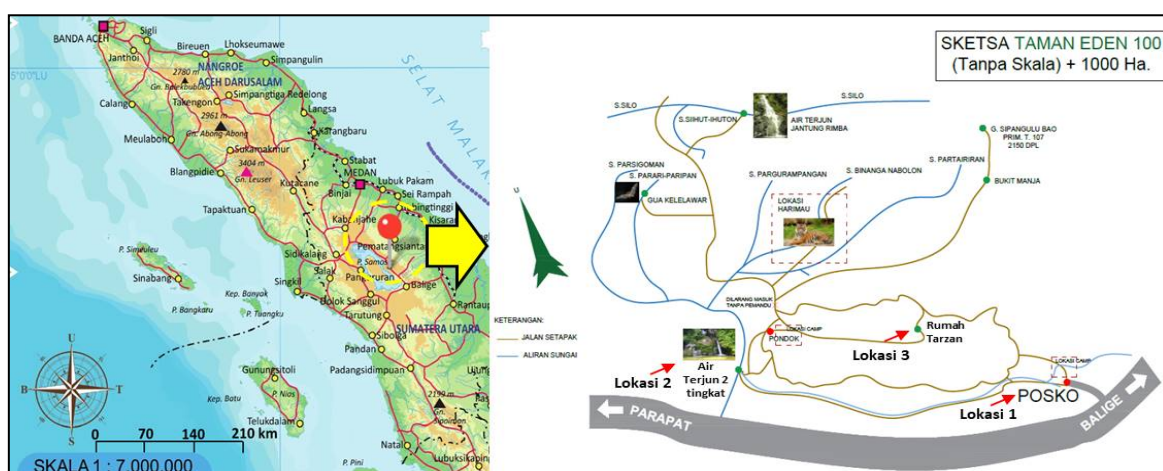


Figure 1. Sampling location

this study were divided into phylum of Basidiomycota. The identification results confirmed 14 Basidiomycota, namely: *Gymnopilus* sp., *Marasmiellus* sp.1, *Marasmiellus* sp.2, *Marasmius* sp., *Favolaschia* sp., *Coprinellus* sp., *Coprinopsis* sp., *Auricularia* sp.1, *Auricularia* sp.2, *Auricularia* sp.3, *Auricularia* sp.4, *Tylophilus* sp., *Suillus* sp., and *Russula* sp. Each of those macrofungi has different characteristics. The following results were the list of identified macrofungi and their potential application in the future.

Discussions

***Gymnopilus* sp.**

This fungus is found solitary on the deadwood (Figure 2a). This fungus has a sporocarp shape in the form of a cap, and hymenophore is cream-yellowish lamellae with adnate type.

The dominant colour of the cap is bright reddish-brown with good spots on the top. The cap is plane when observed from above, and the lower shape is ovoid. The shape of the cap surface is rough with flat edges. The stipe has a bright reddish-brown, smooth surface, the position of stipe attachment in the middle (central), but slightly towards the edge of the cap, and the style of attachment to the substrate is inserted (Figure 2b). Some of the species *Gymnopilus* have antioxidant and antibacterial activity. Lee et al. (2008) reported the extract of *Gymnopilus spectabilis* sporocarp contains bisnoryangonin had potent as an antioxidant compound. Moreover, the chemical compound extraction from *Gymnopilus* penetrans fruiting bodies has antibacterial and antioxidant activities (Nowacka et al., 2015).

***Marasmiellus* sp.1**

This fungus was found grow in small colonies on the

deadwood (Figure 3). The sporocarp has a cap, hymenophore as lamella with a short stipe (Figure 3a). The thin cap dominant color is white dominan putih dan tipis (Figure 3b). The cap shape is convex when observed from above and its lower shape is ovoid. The cap has a smooth surface with flat edges. The space type between lamella is distant with a decurrent type of attachment to the stipe. The stipe color is white-colored, curved in shape. easy to break, with a smooth surface. The position stipe on the cap is central and the type of attachment on the substrate is inserted.

***Marasmiellus* sp.2**

Generally, *Marasmiellus* sp. 2 features were similar with *Marasmiellus* sp. 1 but in macroscopic character was distinguished in the cap texture is thicker, a more dense white colour, and an absence of light brown colour in the centre (Figure 4).

Food and agriculture organisation (FAO) data source describes several species of *Marasmiellus* are edible and has high mineral content (Boa, 2004). Fitria et al. (2020) reported *Marasmiellus ramealis* could be used as an alternative food that has a high protein content with low fat. Furthermore, in the process of remediation of the polluted environment, *Marasmiellus palmivorus* has the potential to remove textile wastewater and crude oil contamination because of its ability to produce laccase enzymes (Chenthamarakshan et al., 2017).

Table 1. Taxonomy position of macrofungi at Taman Eden 100

Phylum	Class	Orders	Family	Species
Basidiomycota	Agaricomycetes	Agaricales	Hymenogastraceae	<i>Gymnopilus</i> sp.
			Omphalotaceae	<i>Marasmiellus</i> sp.1
				<i>Marasmiellus</i> sp.2
			Marasmiaceae	<i>Marasmius</i> sp.
			Mycenaceae	<i>Favolaschia</i> sp.
			Physalacriaceae	<i>Coprinellus</i> sp.
				<i>Coprinopsis</i> sp.
		Auriculariales	Auriculariaceae	<i>Auricularia</i> sp.1
				<i>Auricularia</i> sp.2
				<i>Auricularia</i> sp.3
				<i>Auricularia</i> sp.4
		Boletales	Boletaceae	<i>Tylophilus</i> sp.
				Suillaceae
Russulales	Russulaceae	<i>Russula</i> sp.		

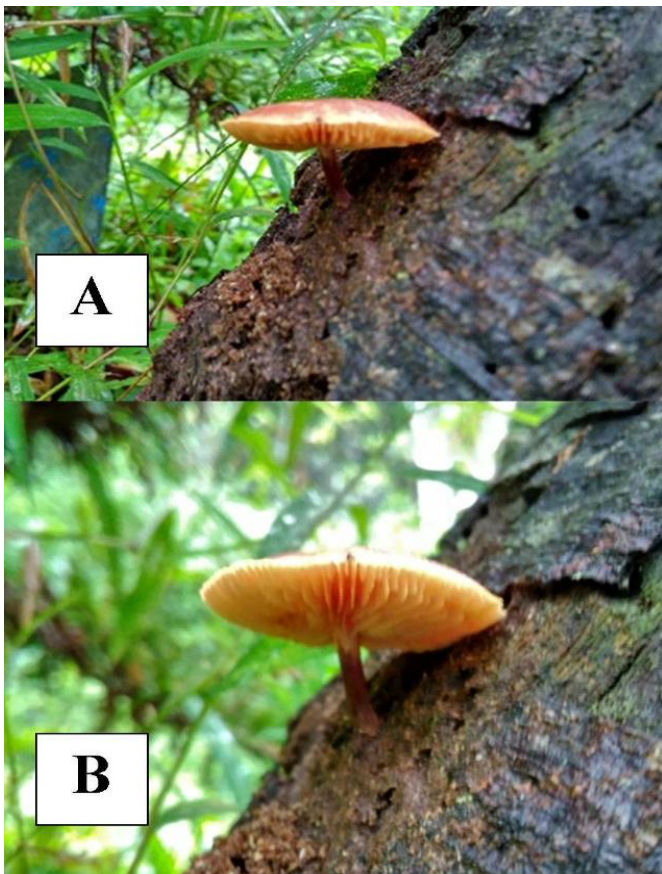


Figure 2. Characteristics of macroscopic identification of *Gymnopilus* sp. A) solitary grow, B) stipe characteristic



Figure 3. Characteristics of macroscopic identification of *Marasmiellus* sp. 1. A) Sporocarp characteristic, B) cap characteristic



Figure 4. Characteristics of macroscopic identification of *Marasmiellus* sp. 2

Marasmius sp. grew in groups close to each other with different basal origins (Figure 5). The cap colour is cream to brown, convex in shape on the top while the bottom is ovoid. The cap has a smooth texture, smooth edges, and plane margins. The rows of lamella have a distant type and adnate to the stipe. Stipe is straight and easy to broken, reddish-brown in colour, smooth, central attachment to the cap, and has rhizoid type when found on the substrate.



Figure 5. Characteristics of macroscopic identification of *Marasmius* sp.

The decolourisation studies of anthraquinone dyes by *Marasmius cladophyllus* were demonstrated by Sing et al. (2017). In their study, *Marasmius cladophyllus* produced a laccase enzyme that able to degraded those recalcitrant dyes. *Marasmius palmivorus* can be applied as

bioherbicidal to pathogen fungi on the plant (Tamur et al., 2019). Moreover, Ranadive et al. (2013) reported that the extract from *Marasmius* species has antibacterial activity.

Favolaschia sp.

The sporocarp of this species gregarious on rotten wood and grow from the same basal. The basidiocarp shape of this fungi has a cap, and hymenophores shape are pores with fleshy texture (Figure 6) and frail stipe. The colour of the cap is white. The convex shape was observed from the top, while the ovoid shape at the bottom. On the top of the cap, the small umbo was observed. The surface of the pileus is smooth with flat edges. *Favolaschia* sp. has a straight type, white colour with soft powdery. The position of stipe attachment on the pileus is central, the mass of hyphae directly embedded in the growth substrate. (basal tomentum). Based on the macroscopic characteristics, this fungus has similar features with *Favolaschia* cf. *manipularis*.

Kornsakulkarn et al. (2019) reported that *Favolaschia* sp. BCC 1868 and *F. Calocera* BCC 36684 isolates have 9-methoxystrobilurins G,K compounds as antimalarial drugs. which have potential as yang berpotensi sebagai obat antimalaria. The species of *Favolaschia* also consist of antibacterial activity obtained from the mycelia and sporocarp extraction (Ranadive et al., 2013; Sum et al., 2019). Moreover, these fungi also can be used as a food source by some mycologists in Indonesia.



Figure 6. Characteristics of macroscopic identification of *Favolaschia* sp.

Coprinellus sp.

This fungus was found growing on dead wood in colonies. The basidiocarp is also observed in numbers, that grow assembly together from different basal (gregarious)

(Figure 7a). This fungus has fruiting bodies with conical cap type, hymenophore in the form of the lamella, and a brittle stipe. The pileus colour is cream, ovoid shape at the bottom, while a radial line pattern is observed on the top of the cap. The cap surface is smooth and powdery with plane edges. The stipe is straight, white in colour, powdery and smooth texture on its surface. The position of the stipe adhered to the pileus is central, and the attachment to the substrate was basal tomentum (Figure 7b).

Many of the *Coprinellus* species may have the potency to produce an antioxidant compound. Tesanovic et al. (2017), in their study, reported that *Coprinellus truncorum* has a phenolic compound that is a potent antioxidant. Besides, Nguyen et al. (2015) reported that the extract of *Coprinellus micaceus* basidiocarp contains several beneficial compounds for medical purposes.

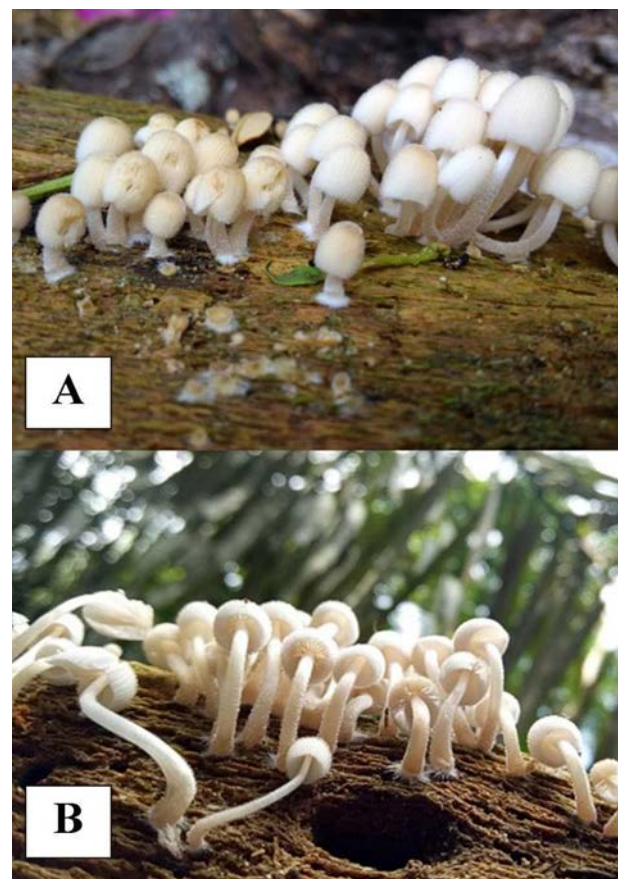


Figure 7. Characteristics of macroscopic identification of *Coprinellus* sp. A) gregarious growth B) stipe characteristics

Coprinopsis sp.

Coprinopsis sp. were found growing in groups in limited numbers on the substrate of dead palm stems (Figure 8). This fungus has a cap, lamella, and stipe. The cap colour is brown with slightly uneven edges. The cap shape is conical when viewed from above and ovoid at the bottom. The surface texture of the cap is smooth with a line in the form of a radial line to the edge of the cap with the entire type. The stipe has a similar shape, brown colour, the surface

texture slightly powdery, the attachment to pileus is central, and the type of attachment to the substrate is basal tomentum. The texture of the fruit body is cartilaginous.

Kombrink et al. (2019) reported that protein extracted from *Coprinopiscinerea*, namely cysteine stabilised by $\alpha\beta$ -defensins (Cs $\alpha\beta$ -defensins) and Lysozyme type GH24-have gram-positive and negative antibacterial activities. Furthermore, Banks et al. (2020) studied antibacterial compound that isolated from *Coprinopsis strossmayeri* are dimeric sesquiterpenes, bovistol B (1) dan D (2), and monomeric sesquiterpene, strossmayerin (7)



Figure 8. Characteristics of macroscopic identification of *Coprinopsis* sp.

Auricularia spp.

All *Auricularia* is found growing in groups of varying numbers with gregarious fruiting bodies on the fallen tree trunks. This fungus has a gelatinous basidiocarp texture. The cap color varies from light brown (Figure 9), dark brown (Figure 10), cream (Figure 11), purplish (Figure 12). On the top of the cap is a flat shape and a semi-ovoid at the bottom. The surface of the pileus is smooth and slick with a variety of strokes in each species that was found. The type of cap edges is undulated. *Auricularia* species has a type development of basidiocarp is always open all the time gymnocarpus with a jelly texture.

Auricularia mushrooms have been widely consumed by Indonesian people as food. Jamur *Auricularia* telah banyak dikonsumsi oleh masyarakat di Indonesia sebagai makanan. Anti-quorum sensing compound from *Auricularia auricular* extract is reported by Zhu et al. (2011). Furthermore, the compound from that fungus induced the growth of *Vigna radiata* plumules and radicle compared to

another wild mushroom extract (Putra, 2020a). this fungus also has potential as a nutritional supplement. Liu et al, (2019) reported that their team succeeded in characterising a new iron compound that bound to the polysaccharide (Polysaccharide-Iron (III) (AAPS-iron III) from *Auricularia auricular*. This compound has high antioxidant activity with high stability, and water solubility activity to assist the treatment of iron deficiency anemia.



Figure 9. Characteristics of macroscopic identification of *Auricularia* sp.1



Figure 10. Characteristics of macroscopic identification of *Auricularia* sp.2



Figure 11. Characteristics of macroscopic identification of *Auricularia* sp.3



Figure 12. Characteristics of macroscopic identification of *Auricularia* sp.4

***Tylopilus* sp.**

The growth habit of this fungus is solitary when found around the root system of the plants. This species has a cap, the hymenophore in pore shape, and a stipe. The cap color is red to brown with a slightly wavy edge shape. The Cap shape is a convex, smooth surface, and has a wrinkle line on the entire cap. The stipe has a large size and bulging

towards the base, red to purplish, and has a fine net on its surface that distinct it from *Boletus* or *Suillus* groups (Figure 13). The position stipe attachment on pileus is central and attachment to the substrate has basal tomentum type. The sporocarp texture is solid and fleshy.

Tylopilus species have potency as anticancer and anti-allergic properties. Šušaničková et al. (2018) reported that the compounds extracted from *Tylopilus felleus* showed cytotoxic reaction against MCF-7 cancer cells. Moreover, Nguyen et al. (2015) reported that the basidiocarp extract from *Tylopilus neofelleus* inhibited 51,6% of lipoxygenase that caused asthma, inflammation, and psoriasis from allergic reactions in the body.



Figure 13. Characteristics of macroscopic identification of *Tylopilus* sp.

***Suillus* sp.**

Suillus sp. when was found is solitary grow on the litter mixed with soil around the root system of plants. The sporocarp of this fungus consists of a cap, the pore shape hymenophore, and stipe. The cap shape is convex, light brown, flat edges, smooth surface with gelatine substances (Figure 14a). The stipe has a large size at the top, and a small size at the bottom, yellowish-brown, attached to the cap in a central position, and the type of attachment to the substrate is basal tomentum (Figure 14b). Basidiocarp texture is fleshy, and the connection of rhizomorph to the stipe at the bottom was observed.

Suillus species have a mutualistic symbiotic with forest plants and form ectomycorrhiza. Kipfer et al. (2012) described how *Suillus granulatus* could affect the growth of

Pinus sylvestris seeds. Thus, it can be applied as a bio-fertiliser for forestry plants.

Suillus species are also known to be used for medical purposes. Liu et al. (2009) reported *Suillus placidus* was extracted to obtain Cuillin, which can be used for liver cancer therapy.



Figure 14. Characteristics of macroscopic identification of *Suillus* sp. A) cap characteristics, B) stipe characteristics

Russula sp.

This species was found growing solitary on the soil mixed with litter around the root system of plants. This

fungus has a cap, pores, hymenophores, and stipe. The cap colour is pink with a mixture of white on the edges, and the margins of the cap are flat. The cap is almost flat with a smooth surface. The stipe shape like chalk, consistent in size from top to bottom, white, attached to the cap in a central position, and the type of attachment to the substrate is the basal tomentum (Figure 15). The texture of the basidiocarp is fleshy with fistulose characteristics.

The role of this fungus can form an ectomycorrhizal symbiotic that helps the absorption of nutrients in the soil and transfer them to plant roots so that it has great potential to be developed as a bio-fertiliser (Hyde et al., 2019). The studied Khatua et al. (2015) reported that *Russula sinensis* extract had antimicrobial and antioxidant activity.



Figure 15. Characteristics of macroscopic identification of *Russula* sp.

Conclusion

A total of 14 macroscopic fungi were identified and described morphologically in this study. These fungi are divided into 4 orders and 9 families. All fungi are groups of the Basidiomycota, namely: *Gymnopilus* sp., *Marasmiellus* sp.1, *Marasmiellus* sp.2, *Marasmius* sp., *Favolaschia* sp., *Coprinellus* sp., *Coprinopsis* sp., *Auricularia* sp.1, *Auricularia* sp.2, *Auricularia* sp.3, *Auricularia* sp.4, *Tylophilus* sp., *Suillus* sp., and *Russula* sp. The fungi that found to be potentially used as antioxidant (*Gymnopilus* sp., *Coprinellus* sp., *Auricularia* sp., *Russula* sp.), antibacterial (*Gymnopilus* sp., *Favolaschia* sp., *Coprinopsis* sp., *Auricularia* sp., and *Russula* sp.), bioremediation (*Marasmiellus* sp., *Marasmius* sp.), bioherbicides (*Marasmius* sp.), bio-fertilisers (*Suillus* sp., and *Russula* sp.), and medicine (*Tylophilus* sp., *Suillus* sp.,

Favolaschia sp., *Coprinellus* sp., *Auricularia* sp.). However, to confirm and validate, advanced studies and research need to be carried out in the future.

Declaration statement

The authors reported no potential conflict of interest.

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