Exploration of potential wild medicinal mushrooms from Pocut Meurah Intan forest park, Aceh, Indonesia

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Abstract. Mushroom is one of living things with abundant diversity and has various beneficial potentials; one of them is as medicine. The use of mushrooms as medicine has long been known primarily as traditionally made herbs and the knowledge has been passed down for generations. The Pocut Meurah Intan Forest Park as a conservation forest, stores a variety of mushrooms in it. Data about the type of mushroom that has medicinal potential existed in the forest park has never been published so it is important to do so. This study aims to record the types of mushrooms that have benefits as medicines. The method used is an exploratory survey through a trail or tracking path then identified as a medicinal mushroom base on literature studies. The results of the study found 15 species of mushrooms that have potential as medicine, namely Cookeina tricholoma, Sarcoscypha coccinea, Tremella fuciformis, Auricularia auricula-judae, Flammulina velutipes, Schizophyllum commune, Scleroderma citrinum, Boletus edulis, Trametes versicolor, Lentinus tigrinus, Lentinus squarosulus, Ganoderma applanatum, Ganoderma resinaceum, Thelephora ganbajun and Lycoperdon echinatum. This shows that Pocut Meurah Intan Forest Park has great resources and potential that can be utilized for the benefit of the surrounding community, and it needs to be preserved so that diversity is maintained and can be used by future generations.

Keywords: Potency of Mushrooms, Medicinal, Wild Macrofungi

INTRODUCTION

A fungus is an important factor that has many functions in the forest ecosystem including decomposition, nutrient cycle, biological relationships with plants, biological control of other fungi, and as a causative agent of diseases in plants and animals. Macroscopic fungi or macrofungi are one of the potential biodiversity that has been developed for various purposes such as food, medicine, waste biodegradation, and the development of plantations and agriculture [1].

History shows, various species of mushrooms have been consumed by the community as a source of nutrition and as natural medicines [2]. Mushrooms are considered to be rich in benefits because of their contents and the function of the nutrients they contain. Recent years indicate that mushroom consumption has increased and the focus is on health, nutrition, and prevention of disease [3]. Previous studies have shown that mushrooms contain various ingredients that are useful as medicines such as antioxidants, antimicrobials, DNA protectors, analgesics, anti-inflammatory, antiviral, Cytotoxic, anti-cancer, anti-parasitic, Immunomodulation effects and Hepatoprotective activity [4][5].

Identifying mushrooms that have potential as drugs is a significant step to identify natural sources of medicine to fight disease. Pocut Meurah Intan Forest Park, located in Saree, Aceh Besar is a conservation area with vegetation composed of various types of plants ranging from woody trees to shrubs and grasses. The ecosystem balance in the area has created optimal habitat conditions for fungal development. The surface of the soil in this area is generally covered with leaf litter and weathered twigs. These environmental conditions are very suitable in supporting the growth and development of mushrooms, due to the availability of optimal growing substrate and suitable environmental conditions. Therefore, it is possible for the high diversity of
fungus species, especially those that have the potential as medicines in the Pocut Meurah Intan Forest Park area.

The purpose of this study is to identify and provide information about mushrooms that have potential as medicines in the Pocut Meurah Intan Forest Park area, Saree Aceh Besar District for food researchers, pharmaceuticals, nutritionists and public, in general.

**METHODOLOGY**

The mushrooms were collected from October 2018 to February 2019 from the Pocut Meurah Intan Forest Park, Saree Aceh Besar District. Morphological characteristics (shape, color, and size) and ecological characters are recorded in the field. Samples were preserved in 70% alcohol and taken to the Biology Laboratory of Faculty of Mathematics and Natural Sciences, Syiah Kuala University to observe their microscopic characteristics. Specimens were identified morphologically by using the following references: Mushrooms of the Pacific Northwest [6], Mushrooms for Trees and people [7], The Great Encyclopedia of Mushrooms [8], Mushrooms & Other Fungi [9], and The Book of Fungi [10] and subsequently mushrooms which have the potential as drugs are identified by using books from Miles & Chang [5], Groves [11], Pohleven [12] and Hall [13].

**RESULTS AND DISCUSSION**

The use of mushrooms as medicines has been recorded for a long time. Information regarding the cultivation of mushrooms as medicines comes from China even since 600 BC. However, the use of mushrooms for medicinal purposes continues to develop over time [5].

The ability of fungi in treating various diseases is due to the presence of active compounds in the form of vitamins, minerals, Beta-D-glucans, Triterpenoids, Sterols, Statins, Nucleosides, and secondary metabolites such as alkaloids, inotodiol, trametolonic acid and betulinic acid that have been scientifically proven has a broad spectrum of pharmacological activities [12].

Found naturally growing wild, a total of 15 mushrooms that have potential as medicines were successfully identified from the Pocut Meurah Intan Forest Park, belongs to 13 genera, 11 families. Detailed information on scientific names, family, habitat, medicinal uses, and references are shown in Table 1. Based on the number of species, the family Polyporaceae is the most dominant with the most number of species found, namely 3 species, this is also reported is the most potential fungus found and used by the Irula tribe in India [14]. Followed by Sarcoscyphaceae and Ganodermataceae families respectively 2 species each. While other families such as Tremellaceae, Auriculariaceae, Psathyrellaceae, Schizophyllaceae, Sclerodermaeae, Boletaceae, Thelephoraceae, Agaricaceae 1 species each.

Generally, the mushrooms found in the Pocut Meurah Intan Forest Park, such as Cookeina tricholoma, Sarcoscypha coccinea, Tremella fuciformis, Schizophyllum commune, Trametes versicolor, Ganoderma aplanatum, and Ganoderma resniaceum have efficacy as immunomodulators. Immunomodulators are substances that can affect the immune system, both those that have a suppressing effect (called immunosuppressants), have the effect of increasing (called immunostimulant) immune responses, or cause the tissue to become unresponsive to an antigen so that it is quite prospective in the treatment of a disease [15].

These fungi also have properties as antitumor and anti-cancer. According to Wasser (2002) this ability is because in the fungus there is a content of biologically active polysaccharides. Antitumor action of this polysaccharide works by activating the immune response in the host organism, so it is also known as a biological response modifier which means that (1) does not cause danger and does not cause additional stress on the body; (2) helps the body adapt to various environmental and biological stresses; and (3) exerting actions that are not specific to the body, supporting some or all of the major systems, including the nervous, hormonal and immune systems, and the regulatory system [16].

Some of the mushrooms found in Pocut Meurah Intan Forest Park have the ability as Neuroprotective or maintain the ability of nerve cells so they do not degenerate, one example is Alzheimer. Alzheimer's disease (AD) is a progressive neurodegenerative disorder related to age. This is the most common form of dementia which affects about 5% of adults over 65 years. Tremella fuciformis and Cookeina tricholoma are known to have this ability [17].
Antioxidants are molecules that can slow down or prevent the oxidation process of other molecules. Oxidation is a chemical reaction that can produce free radicals, thus triggering a chain reaction that can damage cells. Antioxidants found in mushrooms are phenolic, flavonoids, ascorbic acid, tocopherols, carotenoids. Besides containing antioxidants, *Lentinus squarrosulus* is also useful as an anti-ulcer. Research conducted by Abdullah (2011) shows that the ulceration healing rate of rats undergoing ulceration after 24, 48, and 72 hours of treatment is 82%, 90%, and 100%, respectively, with treatment using antioxidants extracted from *L. squarrosulus* [29].

*Boletus edulis* is also commonly consumed. This fungus produces polysaccharides that show a variety of biological activities, including anti-tumor, immune stimulation, and anti-oxidation. According to research conducted by Wu et al (2016), *B. edulis* polysaccharide reduces the pro-inflammatory response and enhances the anti-inflammatory response in mouse models that are induced by asthma [25]. Generally, the way people get mushrooms used as medicine is by collecting from the forest. Its use is usually traditional, either by cooking with food or using it directly. Many studies have shown that regular consumption of certain mushroom species either as ordinary food or as extracted compounds (nutriceuticals) is ideal dietary ingredients for the prevention of atherosclerosis because of their high fiber, protein, microelements, and low-fat content. *Auricularia auricula* is known to have a strong hypocholesterolemic effect in plasma. Research shows that the administration of *Auricularia auricula* reduces plasma triglycerides, total cholesterol, low-density lipoprotein cholesterol while increasing high cholesterol levels of lipoprotein in hyperlipidemic rats. Regular consumption of mushrooms with hypolipidemic substances can also reduce blood pressure for people with hypertension [32].

Table 1. Potentially medicinal macrofungi found in Pocut Meurah Intan Forest Park, Aceh Besar District.

| Scientific Name            | Family               | Habitat                      | Medicinal uses                                      | Ref.  |
|----------------------------|----------------------|------------------------------|-----------------------------------------------------|-------|
| Cookeina tricholoma        | Sarcoscyphaeae       | Broken dead tree covered in soil | Antinociceptive, immunomodulator                      | [18]  |
| Sarcoscypha coccinea       | Sarcoscyphaeae       | Manured soil                 | Antinociceptive, immunomodulator                      | [19]  |
| Tremella fuciformis         | Tremellaceae         | Dead branch                  | Neuroprotective, skin protection, immunomodulator     | [17]  |
| Auricularia auricula        | Auriculariaceae      | Dead branch                  | Anti-tumor, anti-cancer, hypolipidemic effect         | [20][12] |
| Flammulina velutipes        | Psathyrellaceae      | Tree stumps                  | Anti-tumor, anti-hepatitis, antiviral                 | [21]  |
| Schizophyllum commune       | Schizophyllaceae     | Dead Branch                  | Antimicrobial, immunomodulator                        | [22]  |
| Scleroderma citrinum        | Sclerodermataceae    | Soil surface                 | Skin diseases and wound Healing.                     | [23]  |
| Boletus edulis              | Boletaceae           | Leaf-littered soil surface   | Antioxidant, anti-inflammatory, Antimicrobial         | [24][25] |
| Trametes versicolor         | Polyporaceae         | Dead tree                    | Increase immune system and Depression.               | [26][27] |
| Lentinus tigrinus           | Polyporaceae         | Dead Tree                    | Antioxidant, anti-microbe                            | [28]  |
| Lentinus squarrosulus       | Polyporaceae         | Dead Tree                    | Antioxidant, Anti-ulcer                              | [29]  |
| Ganoderma applanatum        | Ganodermataceae      | Dead Tree                    | Improve immune system, liver protection, lower blood pressure and Inhibits cholesterol synthesis. | [30]  |
| Ganoderma resinaceum        | Ganodermataceae      | Dead Tree                    | Improve immune system, liver protection, lower blood pressure and inhibits cholesterol synthesis. | [30]  |
| Thelephora ganbajan         | Thelephoraceae        | Leaf-littered soil surface   | Antioxidant, antitumor, Antimicrobial                 | [31]  |
| Lycoperdon echinatum        | Agaricaceae          | Rotten branches litter       | Wound Healing                                       | [5]    |

*Auricularia auricula* is an edible fungus known as edible mushroom and has been widely consumed by the public. Edible mushrooms are ideal dietary ingredients for the prevention of atherosclerosis because of their high fiber, protein, microelements, and low-fat content. *Auricularia auricula* is known to have a strong hypocholesterolemic effect in plasma. Research shows that the administration of *Auricularia auricula* reduces plasma triglycerides, total cholesterol, low-density lipoprotein cholesterol while increasing high cholesterol levels of lipoprotein in hyperlipidemic rats. Regular consumption of mushrooms with hypolipidemic substances can also reduce blood pressure for people with hypertension [32].

*Flammulina velutipes, Schizophyllum commune*, and *Lentinus tigrinus* are popular edible fungi in Southeast Asia. This fungus is consumed as highly nutritious food and has been cultivated. They are known to have efficacy as anti-virus, anti-microbial fungus, and also useful as an immune system enhancer and have high levels of antioxidants. Almost all mushrooms found have the antioxidant ability. Antioxidants are molecules that can slow down or prevent the oxidation process of other molecules. Oxidation is a
effective in preventing and treating certain diseases, especially through immunopotentiation and antioxidant activity. Therefore, the intake of mushrooms and extractable bioactive compounds seems to be effective in cancer prevention and growth inhibition. Another important fact is that mushroom extract, compared to other drugs, shows very low toxicity when consumed regularly, even in high doses [33].

Figure 1. Potentially medicinal macrofungi found in Pocut Meurah Intan Forest Park, Aceh Besar District. (A). Cookeina tricholoma, (B). Sarcoscypha coccinea, (C). Tremella fuciformis, (D). Auricularia auricula-judae, (E). Flammulina velutipes, (F). Schizophyllum commune, (G). Scleroderma citrinum, (H). Boletus edulis, (I). Trametes versicolor.

The following is a morphological description of 15 potential mushrooms as medicines found in the Pocut Meurah Intan Forest Park, Saree, Aceh Besar District.

1) Cookeina tricholoma
Fruit body or Apothecia shaped cup chipped with curved edges, 1-2 cm in diameter, with slender stipes whose height is 1-3 cm. Apothecia hood, pink to bright red, has striking fine hair; stiff hair such as bristle bristles, and usually 2-3 mm long (Figure 1A). C. tricholoma is a saprophyte, the typical habitat is in wood such as twigs and branches of rotten trees, at low altitudes (usually below 1000 m), in the tropics.

2) Sarcoscypha coccinea
Fruit body with a width of 1-5 cm, height 0.5-2 cm, the edge of the fruit body is slightly wavy slightly curled, the color of the body is the interior of the fruit (the part that contains spores) is bright red, whitish edge color, while the exterior color is more fade to vaginal discharge, irregular fruit body (tomentose); has no stipe or if there is a very short shape with a slightly tapered down (Figure 1B). It grows in groups on wood branches that fall or are buried in the ground.

3) Tremella fuciformis
The fruit body is gelatinous but hard enough; it consists of graceful lobes; transparent to whitish consisting of thin but upright leaves, such as seaweed, branching, often cracking at the edges. It is measured up to about 7 cm and 4 cm high. The surface of the fruit body is smooth and shiny (Figure 1C).

4) Auricularia auricula-judae
The fruiting body of A. auricula-judae is usually 3-8 cm in size. The shape is typical,
usually reminiscent of flexible ears, although the fruit body is also cup-shaped. Fruit bodies are usually attached to the substrate laterally and sometimes with very short stems. This species has an elastic texture that is chewy when fresh, thin flesh-like gelatinous rubber, but hard and brittle when dry. The outer surface is reddish-brown and light brown, often covered with fine gray hairs. It has Smooth fruiting bodies, in younger specimens, or wavy with folds and wrinkles. The color becomes darker with age. The inner surface is grayish gray and smooth. Sometimes wrinkles, with creases and wrinkles, and may have "veins", make them look more like ears (Figure 1D). *A. auricular-judae* is Saprobe on rotting wood, wood trunks, and tree stumps.

5) *Flammulina velutipes*

The generic name *Flammulina* is a reference to the orange hat, which shines like 'little fire' in the sun. The hood is 2 to 10 cm in size and is often distorted due to neighboring closures in clusters; the bright orange lid of *Flammulina velutipes* is generally rather dark towards the center. The adnate type Lamella and its distance is rather close-sparse, the white Velvet Shank Lamella mushroom initially turns pale yellow when the fruit's body is ripe. The stem is hard and covered with velvety smooth down. Usually pale near the lid, the trunk often turns brown toward the base (Figure 1E). Velvet Shank mushroom is saprobe on stumps and dead hardwood tree trunks, and sometimes on living trees that are sick.

6) *Schizophyllum commune*

Saprobiac on dead wood or sometimes parasites on living wood; growing alone or more often clustered; growing on decayed wood and rotting logs (even on boards and boards), the fruit body lasts all year long (survives by shrinking and waiting for more moisture). Fruit body width 1-5 cm, fan-shaped when attached to the wooden side, irregularly shaped like a shell when mounted above or below, upper surface covered with small hair, dry, grayish-white or brown, below the surface consisting of folds such as lamella which is split in the middle (split gill), whitish to grayish, without the stem, hard, rough, pale flesh (Figure 1F). White Spore Print.

7) *Scleroderma citrinum*

The fruit body has a width of 2.5-10 cm and a height of 2-4 cm. The fruit's body is almost round to slightly flattened pale brown to brownish-yellow and covered with large, rough, and flat warts. When ripe open irregularly at the top to expose spores. When young, the inner flesh (gleba) is hard and white but soon becomes marble and purplish-black to black and hard until it is ripe, the mass of spores in the form of blackish-brown powder. Sectioning (surgery) reveals a white outer wall that is thick up to 4 mm or more (Figure 1G). Edibility: Toxic. Grow solitary or in groups on hardened soil, acting as a saprophyte.

8) *Boletus edulis*

The cap measured 7-30 cm, the surface is moist slightly sticky, convex when young and evenly distributed with age. The color is generally reddish-brown fading to white in the area near margin and continues to darken when ripe. The stem is 8-25 cm high and 7 cm thick — quite large compared to the lid, shaped club and located in the middle. Under the surface porous hood, spore production site, they are 1 to 2 cm (0.4 to 0.8 in) deep, and are whitish when young, but mature with greenish-yellow. The angular pores, which are not stained when bruised, are small - about 2 to 3 pores per millimeter. In youth, the pores are white and look like they are filled with cotton; as we get older it turns yellow and then browns. Spore molds in olive-brown. The flesh of the fruit body is white, thick and tight when young, but becomes rather chewy with age. When bruised or cut, the color does not change, or change to very light brown or bright red (Figure 1H).

9) *Trametes versicolor*

*Trametes versicolor* has a hood measuring 2-8 cm, thickness of 1-2 mm; plano-convex to flat, fan-shaped, semicircular, circular, or kidney-shaped, often integrates with the hood of other individuals, flexible when fresh, hairy or velvety solid, often with alternating texture zones, with concentric zones of white, gray, brown, cinnamon, orange, and reddish-brown (colors vary greatly including blue, green, and orange). Pore surface whitish to pale brown, not bruised, with 3-6 or more small pores per mm. Traces of vaginal discharge (Figure 1I). Usually grows on twigs or wood that rot in large quantities.
Figure 2. Potentially medicinal macrofungi found in Pocut Meurah Intan Forest Park, Aceh Besar District, (A). Lentinus tigrinus, (B). Lentinus squarosulus, (C). Ganoderma applanatum, (D). Ganoderma resinaceum, (E). Thelephora ganbajun dan (F). Lycoperdon echinatum.

10) Lentinus tigrinus
When fully grown, sporocarp L. fasciatus is pale brown to purplish brown, usually depressed or funnel shaped and up to 20-70 cm in diameter with lots of pale and downy hair which forms the long edge of the margins on the surface of the cap. The stems are sturdy cylindrical, with blond hair and soft, dark in color matching with a hood or darker. The meat is hard and white (Figure 2A). Saprobe grows on twigs or dead wood. It can be eaten while sporocarp is still young.

11) Lentinus squarosulus
Sporocarp of L. squarlosulus reaches up to 2-7 cm in diameter and its surface is milky white or pink. The shape of the hood is usually convex to slightly flat (depressed). Lamella flows in the stem, crowded, the edges are slightly jagged, frequent short gills white to beige. Stems have a length of 2-4 cm, 2–5 mm wide, the same size from the base, or slightly pointed toward the base, dry, scaly with fine brown scales such as those on the lid when fresh and young, but often lose scales quickly and appear fibrillose or even bald (Figure 2C).

12) Ganoderma applanatum
Hoods measuring 10–30 cm x 8–14 cm; the shape is approximately half a circle in outline, or irregular; surfaces with foaming outer skin that are not too hard, often shrinking in “zones”, brownish to grayish-brown, slippery. Pore surface grayish-white or pale brown, yellow to brownish bruises if scratched or injured. As age pores change from dark brown to dirty brown; small 4-6 circular pores per mm. Stems are usually absent; if any, lateral and very fat (Figure 2B). Saprobe or parasite, growing solitary or scattered or in overlapping clusters on rotting wood (rarely coniferous), sometimes living trees; fruit body can last all year.

13) Ganoderma resinaceum
The woody basidiocarp is approximately half a circle measuring 14–16 cm x 4–9 cm, slightly bent, eccentric, stipe up to 5 cm. The upper surface is wine colored to brownish, slightly curved, zones, glabrous when fresh, often covered with brownish basidiospore powder. It margins 1 to 1.5 mm, sterile, creamy-white, thin, rather sharp. Yellowish-brown pore surface. Angular pores, 3-4 per mm. Tube 3 mm brown. 5 mm flesh, light brown, slightly zoning (Figure 2D). G.resinaceum is saprophytic or parasitic in woody plants.

14) Thelephora ganbajun
The body of the fruit is coarse, usually brown when ripe, and varies in shape from coral-like tufts to having a different hood, rather like a rose with a middle stem. The hood is irregularly rounded, often with an additional partial hood. The surface is smooth to slightly hairy, jagged, in shades of brown. In young specimens the margin is whitish, and may be hairy. The lower surface is smooth and purplish brown, the trunk is narrow and whitish to purple brown (Figure 2E). T. ganbajun is an ectomycorrhizal species, especially with living tree roots. Found under bamboo groves. T. ganbajun is edible and it tastes good.
15) *Lycoperdon echinatum*

Fruit bodies are usually 2.5 to 5 cm long, height 3 to 7 cm, thorn length is usually 4 to 5 mm. The fruit body is shaped vertically flat on a short stem, initially white, soon becomes reddish-brown with age. Soft spines are in groups of three (or sometimes groups of four) that gather at the end. As the maturity of the thorn falls away leaving a net-like pattern on the fruit's skin leaving brownish marks, the fruit's body finally breaks at the top to release the spores. It does not have a stem or a very short stem (Figure 2F). *L. echinatum* is saprobic.

**CONCLUSION**

Tahura Pocut Meurah Intan has an extraordinary forest wealth. This study shows as many as 15 wild mushroom species from the research area of mushroom diversity that can be used as medicine or food, not to mention several mushroom species that types and benefits have not yet been identified. Specific research is needed regarding the benefits of mushrooms for their treatment and application. It is also expected to be used as reference material for herbal treatment methods. The cultivation process is also needed to increase the economic resources of the community around the forest.

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