The Diversity of Indigenous Mushrooms Grow on Decomposed Oil Palm Empty Fruits Bunch at Palm Oil Plantation in Paser Regency, Indonesia

Masitah[1,2], Krishna Purnawan Candra[1,3(✉)], Muhammad Amir Masruhim[1,2], and Pintaka Kusumaningtyas[1,2]

[1] Environmental Science Graduate Program of Mulawarman University, Jl. Sambaliung, Kampus Gunung Kelua, Samarinda 75119, Indonesia
candra@faperta.unmul.ac.id
[2] Departement Biology Education of Mulawarman University, Jl. Muara Pahu, Kampus Gunung Kelua, Samarinda 75119, Indonesia
[3] Departement Agricultural Product Technology, Mulawarman University, Jl. Tanah Grogot, Kampus Gunung Kelua, Samarinda 75119, Indonesia

Abstract. The community nearby palm oil plantations have benefited from the indigenous mushroom growing on decomposed oil palm empty fruit bunches (OPEFB). Some mushrooms are edible, but others are known as non-edible due to their toxicity. There is limited scientific information about the biodiversity of indigenous mushrooms growing on the decomposed OPEFB. Therefore, an explorative study was conducted in March 2021 to determine the level of the indigenous mushrooms during the one to six months of decompose period of the OPEFB at a palm oil plantation in Paser Regency, Indonesia. Purposive plot sampling on decomposed OPEFB pile was carried out to collect the mushrooms. A deep interview questioner was used to find out the utilization of the mushrooms using census method on respondents living nearby the plantation area. The diversity characteristics of the mushrooms growing on OPEFB were determined by morphological identification based on the reference of Watling (2017) "Identification of the Larger Fungi" and using mushrooms identification application of "mushroom identificator" for Android. This research identifies five types of indigenous mushrooms growing on OPEFB: *Auricularia polytricha*, *Volvariella volvaceae*, and *Pleurotus ostreatus*, which are edible mushrooms. At the same time, *due to their toxicity, Collytoybe decembris and Coprinus comatus belong to non-edible mushrooms*. The biodiversity characteristics of indigenous mushrooms growing on OPEFB are low for diversity index (0.460), dominance index (0.428), and wealth index/species richness (0.517), while the evenness index is classified as moderate (0.660). These results show that decomposed OPEFB has bioeconomic potential due to the various indigenous mushrooms, which then be developed as functional food sources or medicinal plants.

Keywords: Biodiversity · Indigenous mushrooms · Decomposition · Oil palm empty fruit bunch

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1 Introduction

Indonesia is the most extensive palm oil plantations in the world. Two considerable wastes from the palm oil plantations are Oil Palm Empty Fruit Bunch (OPEFB) and Palm Oil Mill Effluent (POME) [1, 2]. However, the OPEFB remains a constraint for the palm oil industry due to not being optimally utilized yet. On the other hand, the decomposed OPEFB shows a potential growing media for indigenous mushrooms, which are already advantaged by the community nearby the plantation area [3].

Currently, mushrooms have been widely used as functional food ingredients because of their high antioxidant content [4] as well as physical properties [5], such as being used as an ingredient in frozen foods such as meatballs, nuggets, and dim sum [6]. On average, mushrooms have 19–35% higher protein than rice and wheat. There are about 9 of the 20 known essential amino acids found in mushrooms. In addition, mushrooms have a lower fat content than meat. Mushrooms also have a higher protein content than other food ingredients derived from plants. The nutrients in mushrooms include carbohydrates, minerals such as calcium, potassium, phosphorus, iron, and vitamins B1, B2, B12, C, and D [7].

Indigenous mushroom diversity in palm oil plantations and its various potentials has not been fully explored and is still in the stage of science for science. Lack of human resources and unavailability of research funds for basic research are problems that must be solved together. There are few mushroom taxonomic researchers in Indonesia compared to the number of higher plant taxonomic researchers. Indonesia has a mushroom diversity of 13.33% (200,000 species) of the world's mushroom diversity, estimated at 1.5 million. Only 4.6% (69 thousand) species of the mushrooms have been identified [8].

Recent studies on the decomposing OPEFB are limited to accelerating the decompose rate [9, 10] and their use as fertilizer [11]. Some reports on the nutritional content of indigenous mushrooms growing on OPEFB are available [3]. However, exploration of their diversity has not been thoroughly studied.

This research aimed to explore the diversity of indigenous mushrooms growing on decomposed OPEFB and the surrounding mushroom growing locus's environmental condition. The bioeconomic potential of the determined mushrooms was also examined. This study will give a new insight into the advantage of the potent of OPEFB as a growth medium of the indigenous mushroom. The findings are important as the essential information for developing the indigenous mushrooms as functional food or medicinal plant sources, which now have become a new commodity among the community living around the palm oil plantations [12].

2 Materials and Methods

This research was conducted in March 2021 at a location nearby the "Long Pinang" oil palm plant of a state-owned enterprise palm oil plantation PT. Perkebunan Nusantara XIII, located in Olong Pinang Village, Pasir Belengkong Sub-district (116° 12'29.19" E, 01° 57'22.7" S), Paser District, East Kalimantan Province, Indonesia. In the Pasir Belengkong sub-district, the palm oil plantation area is 27,716.42 ha, and the "Long Pinang" oil palm plant is located at the center of the plantation area [13, 14].

An explorative survey was applied to determine the diversity of "Indigenous Mushrooms Growing on Decomposed OPEFB" (IMDO) at oil palm plantation areas. The purposive plot sampling selected three experimental plots (each of 1 × 1 m) replicating each decomposition age of the OPEFB pile, i.e., 1, 2, 3, and 6 months. In each plot, measurements of abiotic environmental conditions, i.e., pH, humidity, temperature, and altitude, were carried out.

The decomposed OPEFB pH was determined by E.M. System Soil Tester (Demetra PAT 193478, Japan), the humidity and temperature were determined by Humidity Temperature Meter (Mastech MS6505, USA), while the altitude was measured by GPS device (Garmin Gpsmap 64s, USA). The growing mushrooms were morphologically identified using the Watling manual [15] and the "mushroom identificator" app for Android. The parameters observed in this study were the abundance of IMDO diversity [16], including diversity index, wealth species index/species richness, evenness index, density index, and dominance index.

Whether consumed or sold, the mushrooms' usefulness was questioned using the census method of the plantation workers and nearby community at the location study. The number of respondents asked was five.

3 Results and Discussion

Physicochemical environmental characteristics, e.g., pH, humidity, and temperature, are the critical factors in growing mushrooms. Table 1 shows the changing physicochemical ecological characteristics of the OPEFB pile during decomposition. The pH of decomposed OPEFB (dOPEFB) for 1–6 months is relatively stable at 6.9. However, there was a slight change in humidity and temperature. The humidity of the dOPEFB increased as the age increased. As a result, the increase in IMDO species varieties is noted. Five mushroom types found at research locus were identified: *Auricularia polytricha*, *Volvariella volvaceae*, *Pleurotus ostreatus*, *Collytoybe decembris*, and *Coprinus comatus* (Table 2a).

Table 1. Physicochemical environmental characteristics of OPEFB pile

Characteristics	Age of OPEFB pile (months)			
	1	2	3	6
pH	6.9 ± 0.1	6.9 ± 0.1	6.9 ± 0.1	6.9 ± 0.1
Max humidity (%)	88.6 ± 5.7	86.9 ± 2.6	93.7 ± 2.3	96.2 ± 1.2
Min humidity (%)	84.0 ± 5.4	81.3 ± 2.7	89.2 ± 2.1	95.2 ± 0.1
Temperature (^{o}C)	28.5 ± 0.8	29.9 ± 0.6	27.7 ± 0.2	27.0 ± 0.6
AMSL (m)	14 ± 1	15 ± 4	16 ± 8	24 ± 12
Species grow*	2, 4, 5	2, 4, 5	2, 3, 4, 5	1, 2, 3, 4, 5

Note: *) Species of mushrooms grow on the three piles, i.e., 1 = *Auricularia polytricha*, 2 = *Volvariella volvaceae*, 3 = *Pleurotus ostreatus*, 4 = *Collytoybe decembris*, 5 = *Coprinus comatus*. AMSL = Above mean sea level.

Table 2. Density and diversity characteristics of indigenous mushrooms grow on decomposed OPEFB at 1–6 months of age

a. Density characteristic		
Mushroom	Total number of candies	Density (%)
Edible (3)		
Auricularia polytricha	10	0.43
Volvariella volvaceae	102	4.43
Pleurotus ostreatus	488	21.22
Non-edible (2)		
Collytoybe decembris	315	13.70
Coprinus comatus	1,384	62.90
AMOUNT	2,299	100.00
b. Diversity characteristics		
Characteristics	Value	Category
Species diversity index	0.460	Low
Wealth Index / Species Richness	0.517	Low
Evenness Index	0.660	Medium
Dominance Index	0.428	Low

Note: Five types of different mushrooms were found in the study location.

Based on the in-depth interviews with the people living nearby the study locus, it was agreed that *Volvariella volvaceae*, *A. polytricha,* and *Pleurotus ostreatus* belong to the edible mushroom type. Furthermore, Marlina et al. [17] also reported that *V. volvaceae* grow on decomposed OPEFB, while Fitria et al. [18] wrote for *P. ostreatus.*

The edible mushrooms are found only on the dOPEFB with the age of above one month. This fact shows that the OPEFB could be used as a growth medium for the mushroom after decomposing for at least one month.

Among the three edible mushrooms, only *V. volvaceae,* known as *"kulat sawit"* by the local community, is the potent mushroom for the commercial market due to its good taste and relatively big morphological form (the density is 4.43%). On the other hand, other edible mushroom types, i.e., *A. polytricha* has no commercial value because they only grow in a small quantity (the density is 0.43%). The *C. comatus,* on the other hand, has no retail value due to its tiny morphological form and even shows a higher density of about 62.90%. An advanced study is still going on to explore the potential of the mushrooms for functional food and medicinal plants source.

This study found two non-edible IMDO, i.e., *Collytoibe decembris* and *Coprinus comatus.* The number of the growing *C. comatus* is higher than *C. decembris.* This fact is also described by Fitriani et al. [19], who studied in palm oil plantation area in Musi Rawas District, South Sumatera Province.

The density and diversity analysis of the IMDO were presented in Table 2b. *C. comatus* shows the most considerable density of about 62.90%, while the *A. polytricha* shows the lowest one of about 0.43%. Each type of mushroom can be found on almost all the dOPEFB plots observed. No single mushroom type dominates the entire kind of mushrooms found on the dOPEFB. For example, the dominance of indigenous mushrooms in oil palm plantations is 0.428 with a low category, meaning that no species dominates [20].

The number of mushroom types growing on the decomposed OPEFB increase as the decomposing age of OPEFB increases. Three types of mushrooms (*Volvariella volvaceae*, *Collytoybe decembris*, and *Coprinus comatus*) were found on the decomposed OPEFB at 1–2 months while on decomposed OPEFB at the age of 6 months grow, two more mushroom types, i.e., *Auricularia polytricha* and *Pleurotus ostreatus.* The diversity characteristics of the mushroom's community show a low category for species diversity index (H = 0.460), wealth index/species richness (R = 0.517), and dominance (0.428), while the evenness (e = 0.660) is classified as moderate. Three of the five mushroom types are edible, i.e., *V. volvaceae*, *C. comatus,* and *A. polytricha*; however, only *V. volvaceae* has a potential market value.

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Authors' Contributions. M conceived the original idea and research aim, collected and generated data, getting initial data processing, data analysis, and writing the initial manuscript. KPC conceived the original idea, refining the research aim, constructed the research design, advance data processing and analysis, and finishing writing the manuscript. MAM and PK reviewed the experimental design, analysis method, and reviewing the manuscript. All authors read and approved the final manuscript.

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