Exploration of study objects on the potential of wild mushrooms growing on oil palm empty bunches for learning in the subject of IPAS project at vocational school

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ABSTRACT

The IPAS Project has a study object in the form of concrete objects and social phenomena found in nature, and it is developed based on empirical experience. This study aimed to find out various alternative study objects regarding the potential of wild mushrooms growing on oil palm empty fruit bunches (OPEFBs) piled at oil palm plantations. The research was descriptive exploratory research. Data were collected through field study, documentation, and literature study. The collected data were analyzed by using thematic analysis from Philip Marrying. The result of the field study found 12 types of wild mushrooms growing on the decayed OPEFBs. Those mushrooms were then identified based on their morphological characteristics. In this study, we found three alternative study objects towards mushrooms growing on OPEFB, which can be developed in the IPAS Project learning: (1) mushroom cultivation using OPEFB waste which includes 4 aspects (living things and their environment, substance, and their changes, earth and space, economic behavior and welfare), (2) morphological characterization for classification of mushroom including 3 aspects (living things and their environment, substance and their changes, social interaction and social dynamics), and (3) detection of chemical compounds present in mushroom, covering 3 aspects (living things and their environment, substance and their changes, economic behavior and welfare).

Keywords: object study, mushroom, dependent curriculum

INTRODUCTION

Curriculum changes since independence until 2013 are based on rapid changes in world education. The current 2013 curriculum (K-13) has been changed or refined with a new curriculum, namely the Independent Curriculum (Angga et al., 2022). The implementation of the independent curriculum has been tested on a limited basis in 2,499 educational units participating in the Program Sekolah Penggerak (PSP) and SMK Pusat Keunggulan (SMK PK) (Puskur Dikbud Ristek, 2021). Intracurricular learning in SMK in the independent curriculum is divided into 2 (two), namely general and vocational subject groups. One of the vocational group subjects in SMK is the Ilmu Pengetahuan Alam dan Sosial (IPAS) project. The IPAS project is an integration between natural sciences and social sciences which is the key to success in the learning process in the independent curriculum (Umami et al., 2021). The IPAS project subject has an object of study (project theme) in the form of concrete objects and social phenomena (non-concrete) found in nature and developed based on empirical experience, which is a real experience felt by everyone, has systematic procedures, and employs logical thinking (Umami et al., 2021)

The demands of the IPAS Project subject above, in fact, are not compatible with the actual implementation of the independent curriculum in schools. Based on the interviews with several SMK teachers in Paser district, East Kalimantan province, it is known that teachers have problems in implementing the independent curriculum in the IPAS project subject. The problems include the teacher's unfamiliarity with the implementation of the IPAS project, the teacher's knowledge of projects that can be raised in accordance with the surrounding environment, and the students' disinterest in participating in learning in non-vocational learning subjects, such as the IPAS project, because they feel that the subject is not relevant to the skill program, they are interested in. This problem is caused by the IPAS project subject teacher never developing project themes that are interesting to students.

The IPAS project has a study object with topics relevant to the local daily life, the implementation of the IPAS project should be based on local problems with scientific solutions. East Kalimantan is one of the provinces in Indonesia that ranks fifth in oil palm production with a plantation area of 1.33 million hectares and a total oil palm production of 3.94 million (Ditjenbun, 2021). The palm oil industry has produced solid waste in the form of Oil Palm Empty Fruit Bunches (OPEFBs) which is the largest waste with a very high quantity. OPEFBS waste that is left in the oil palm plantation area will decompose and become a growing medium for various types of wild fungi that can be used as food sources and medicinal ingredients and as organic compost (Mustika & Anni, 2021; Nur'aini et al., 2022; Popang et al., 2016; Riastuti et al., 2018). The potential of wild mushrooms that grow on OPEFB during decomposition into compost can be a study object in learning IPAS projects in vocational high schools located close to oil palm plantations.

The study object in the form of the potential of wild mushrooms that grow on OPEFBs has never been discussed in the IPAS project because there is no reliable information available for teachers about the potential of many types of wild mushrooms that grow on OPEFBs that can be developed as an object of study in each field of specialization. Therefore, this research will explore the study object of the potential of mushrooms growing on oil palm empty fruit bunches for learning in the IPAS project subject at vocational schools.

METHOD

This research type is descriptive exploratory research (Cresswell, 2010). The exploration carried out is in the form of a study object relating to the potential of mushrooms that grow on oil palm empty fruit bunches for learning in the subject of Natural and Social Sciences (IPAS) projects at Vocational High Schools (SMK/MAK). Data collection techniques are field studies, documentation, and literature studies. Field studies to explore various types of mushrooms that grow on OPEFBs piled on an oil palm plantation area owned by PT Tritunggal Sentra Buana, Saliki Village, Muara Badak District, Kutai Kartanegara Regency, East Kalimantan Province. The results of the field study were then documented in data collection, morphologically identifying all the mushrooms using an identification manual. After differentiate the type of mushroom by manual identification (McKnight & McKnight, 1928), the literature study stage is carried out through the literature through various scientific journals related to the potential mushrooms found in the field. The data collected was then analyzed using Phillip Mayring's thematic qualitative data analysis technique.

RESULT AND DISCUSSION

Result

To find the study objects from mushrooms growing on OPEFB for IPAS project learning, we collected all of the mushrooms growing naturally on OPEFB decayed in the oil palm plantation area. Based on the morphological characteristics including cap, stalk or stipe, lamella/gills, and annulus or ring, we found 12 different types of edible wild mushrooms, as shown in Figure 1. These mushrooms have different morphological characteristics which can be distinguished from each one another. By using a field guide to mushrooms (McKnight & McKnight, 1928), we characterized the morphology of mushrooms, including the cap shape, cap surface texture, gill or lamella, stipe or stalk, volva, and annulus or ring.

			
M1 (edible)	M2 (Edible)	M3 (Edible)	M4 (Edible)
			
M5 (Edible)	M6 (Poisonous)	M7 (Edible)	M8(Edible)
			
M9 (Edible)	M10 (Edible)	M11 (Edible)	M12 (Edible)

Figure 1. Morphological characteristics of wild mushrooms found on decayed OPEFB

We also observed the characteristics of poisonous mushrooms from the 12 types of mushroom collected based on the color of lamella, cap, and stalk, because the poisonous mushroom commonly has white lamella and red cap and stalk in color (Hall et al., 2003). The poisonous mushroom commonly also has a cap with a scale and ring in the stalk. In the present study, we found 1 type of mushroom (M6) that has darker colored spots or scales on the cap skin, and the color of the gills is white, but there was no ring in the stalk. Therefore, we considered the M6 mushroom as a poisonous mushroom. Meanwhile, another 11 types of mushrooms belong to edible mushrooms because they do not have one of the features commonly found in poisonous mushrooms. In the study, we also identified a mushroom (M1) that has similar morphological characteristics with Volvariella volvaceae due to the presence of a volva and the cap shape is umbonate/knobbed with smooth and white or brown in color. Local people commonly call this mushroom paddy straw mushroom or oil palm merang mushroom. They often collect this mushroom for eating due to its soft and chewy texture as well as savory taste. Therefore, the demand for this mushroom for consumption is quite large in the market, so the activity of collecting oil palm merang mushrooms is one of the livelihoods of the local community around the oil palm plantation area.

In addition to the Volvariella genus, other types of wild edible mushrooms found growing in OPEFB have similar morphology characteristics with the genus of *Pleurotus* (M2), *Marasmius* (M3), *Psilocybe* (M4 and M12), *Parasola* (M5), *Coprinus* (M7 and M8), *Peziza* (M9), and *Coprinellus* (M10 and M11). However, these edible mushrooms were not interested in being consumed by local people, because the fruiting body size is smaller, and the presence of a negative perception of local people that other mushrooms, except oil palm merang mushrooms, are poisonous. Based on the literature study, several mushroom species belonging to these genera have the potential as sources of medicines, foods, insecticides, dye/ink, and decolorizing agents. Hence, the scientific phenomenon relating to the growth of various mushrooms on decayed OPEFB and their potential in many fields can be mapped into several study objects for sciences and social sciences learning in the subject of the IPAS project. As shown in Figure 2, there are three study objects that can be a project topic in IPAS learning: (1) mushroom cultivation using OPEFB waste, (2) morphological characterization for distinguishing edible and poisonous mushrooms, and (3) detection of chemical compounds presents in mushroom. The three study objects can be broken down into several learning aspects according to the learning outcome of vocational school in the subject of the IPAS project, as presented in Table 1.

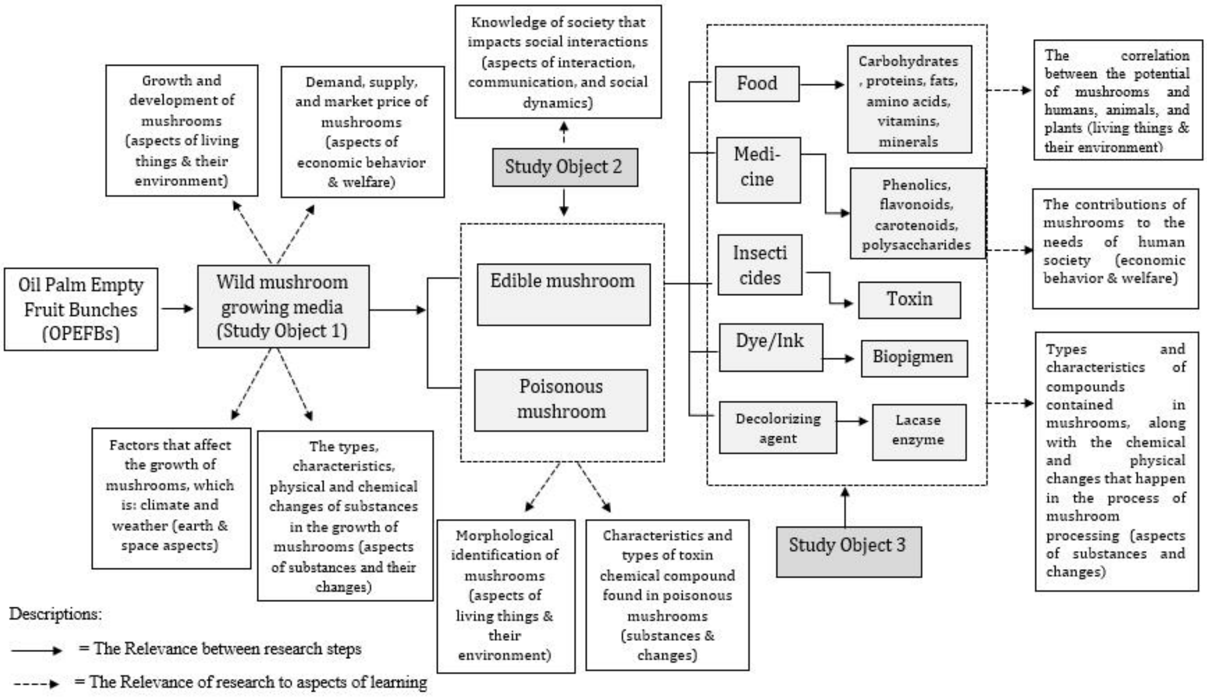

Figure 2. The Concept Mapping of Study Object for the Subject of the IPAS Project

Table 1. The learning aspects in each study object in the subject of the IPAS Project

No	Study Object	Learning aspects	Subject content
1	Mushroom Cultivation using OPEFB Waste	Living Things and Their Environment	Characteristics of living things, Living environment, Interaction between ecosystem components
		Substance and Their Changes	Material classification, Material Changes
		Earth and Space	Earth's structure
		Economic Behavior and Welfare	Supplies and shortages, Economic activity, Demand, supply, price, and markets
2	Morphological Characterization for Classification of Mushroom	Living Things and Their Environment	Characteristics of living things, Living environment
		Substance and Their Changes	Material classification, Material characteristics and measurement, Dangerous and toxic materials
		Social Interaction and Social Dynamics	Social interaction, Communication, Socialization
3	Detection of Chemical	Living Things and Their Environment	Characteristics of living things, Interaction between ecosystem components

Compounds Present in Mushroom	Substance and Their Changes	Material classification, Material characteristics and measurement, Material changes
	Economic Behavior and Welfare	Supplies and scarcity, Economic activity, Economic participants, Demand, supply, price and market, Social welfare

Discussion

The mushrooms found in oil palm plantations have different morphologies and are distinguished by the codes M1-M12 in this study. The mushrooms found were identified based on the reference field guide mushroom from McKnight & McKnight, 1928. A mushroom with the code M6 was found which has the characteristics of a poisonous mushroom. The characteristics of toxic fungi include (1) having colored rings on the stem and volva, and (2) having white lamellae, not all mushrooms with white lamellae are poisonous mushrooms, but if the type of mushroom is not known for sure, it is better not to take it, (3) the hood and stalk are light or red, not all red mushrooms are poisonous mushrooms, but many of them are poisonous, (4) mushrooms with spots or scales on the hood skin that are lighter or darker than the hood are usually poisonous mushrooms, (5) have a sharp smell like chemicals or fishy smell. Meanwhile, 11 other types of mushrooms found were classified as edible mushrooms (Hall et al., 2003; Jordan, 2000; McKnight & McKnight, 1928).

Based on literature studies, edible mushrooms have potential as a food source, medicine, insecticide, dye, and decolorizing agent. The potential that mushrooms have for food sources in the context of edible mushrooms is that they have macronutrient content (carbohydrates, protein, fat, fiber, and ash content), micronutrient content (vitamin A, vitamin B, vitamin B12, vitamin C, Calcium, Potassium, Magnesium, Phosphorus, Iron, Zinc, and Manganese), essential and non-essential amino acid content, and saturated fatty acid and unsaturated fatty acid content. Potential medicinal ingredients are owned by edible mushrooms because they contain antioxidant activity with alkaloid, phenolic, flavonoid, and β-glucan components, anticancer activity, antibacterial activity with active fraction components against several kinds of bacteria including E.coli bacteria, antitoxic activity, antiviral, antidiabetic activity from the presence of hypoglycemic effects, anti-inflammatory activity, anti-aging activity, immunomodulatory activity, as a substitute for antibiotics when treating infections, therapeutic treatment of depression, and anxiety disorders, Alzheimer's disease, and others (Akata et al., 2012; Akdogan et al., 2014; Bao et al., 2013; Chang & Miles, 2004; Kayode et al., 2016; Nosalova et al., 2001; Novakovic et al., 2016; Novaković et al., 2018; Shomali et al., 2019; Wong et al., 2020). Some types of mushrooms have natural insecticidal activity from the toxin compounds in them which makes extracts from these mushrooms potential insecticides (Park et al., 2020). Apart from being an insecticide, other types of mushrooms have potential as natural dyes because they have pigment compounds, namely the *Pleurotus ostreatus* and *Coprinus comatus* species which are also known as ink mushrooms (Mandlik & Hedawoo, 2020) as well as types of mushroom that have potential as decolorizing agents, namely the *Coprinus* species (Akdogan et al., 2014).

The results showed that there are 3 alternative study objects regarding the potential of mushrooms, which can be developed in learning IPAS project subjects at SMK in phase E., The alternative study objects can be described in Table 1. The object of study was developed based on the potential of edible mushroom species that grow in the OPEFB waste of PT TSB's oil palm plantation. Alternative project study objects in the IPAS project subject that can be developed in the learning process include the following:

1. Mushroom cultivation using OPEFB waste

   OPEFBs waste is the largest waste product of oil palm plantations, which is often left unused (Fuadi & Pranoto, 2016). Cultivating mushrooms using OPEFB waste as a substrate can relate to various aspects, such as the living beings and their environment, earth and space, substances and their changes, as well as economic behavior and well-being. Mushroom cultivation involves considering environmental factors like temperature, humidity, climate, and weather that can promote the growth of a specific mushroom species. Different mushroom species have different optimal temperature and humidity requirements (Annissa et al., 2017; Ekowati et al., 2018). This project can help students understand how climate and environmental conditions affect mushroom growth, aligning with the "Earth's Structure" content.

   OPEFB, rich in cellulose, hemicellulose, and lignin, serves as an excellent substrate for mushroom growth (Candra et al., 2014). Certain mushroom species, like *Volvariella volvaceae* and *Pleurotus ostreatus*, can degrade lignin and cellulose due to lignocellulolytic enzymes in them (Tabi et al., 2008). The project can teach students how mushrooms break down nutrients in substrates, emphasizing the aspect of substances and their changes. Mushroom cultivation projects can also have economic implications, especially considering the growing demand for mushrooms as a food source in Indonesia (Argonet.id, 2021). Students can learn about economic behavior and well-being by producing and marketing the mushrooms they cultivate as a local source of income, contributing to the local economy.

2. Morphological characterization for classification of mushroom

   Exploring and classifying edible mushrooms growing on the plantation can be developed as a project when students visit the oil palm plantation. This project can enhance students' 21st-century skills by encouraging them to observe their surroundings, think critically, and come up with creative solutions to identify different mushroom species.

Relevant aspects of learning include living beings and their environment, substances and their changes, and social interaction and dynamics. Morphological identification of mushroom species can be accurate and clear in demonstrating their relationships through molecular methods. However, molecular methods require substantial resources, whereas morphological identification is cost-effective (Joeniarti, 2012; Patantis & Fawzya, 2009). This project allows students to practice their observational and data recording skills to classify mushrooms based on physical features, contributing to the "Classifying and naming living things" content.

The presence of poisonous mushrooms, such as *Lepiota sp*., in oil palm plantations poses a substantial risk to the community. A 2014 incident in Banyuasin serves as a stark reminder of this danger, illustrating the dire consequences of insufficient knowledge regarding toxic mushrooms (Putra, 2020). It is imperative to initiate comprehensive social interactions and communication campaigns to educate the public on distinguishing between toxic and non-toxic mushroom varieties. To address these issues, a project has been conceived to foster social interaction and knowledge dissemination within the oil palm plantation communities. This project aims to empower students to engage dynamically with the community, facilitating discussions on poisonous and edible mushrooms, and imparting manual identification skills for toxic mushrooms. By doing so, the project addresses the social interaction and dynamics aspect effectively.

3. Detection of chemical compounds present in mushroom

Mushrooms play vital roles in ecosystems by acting as decomposers, mycorrhizal symbionts, and nutrient cyclers (Akdogan et al., 2014; Aung, 2005; Septiana, 2015). Investigating the ecological role of mushrooms in the oil palm plantation ecosystem aligns with various aspects of the IPAS subject, including living beings and their environment, earth and space, social interaction and dynamics, and technology and innovation. This project can explore the decomposition process facilitated by mushrooms, their interactions with other organisms, and the impact of mushrooms on nutrient cycling in the ecosystem. Students can set up experiments or observational studies to investigate these aspects, reinforcing the "Interactions within ecosystems" and "Ecological sustainability" content. To conduct this project, students would need tools for soil and environmental measurements, such as pH meters, moisture meters, and temperature sensors. They would also need basic laboratory equipment for analyzing soil samples and mushroom specimens. Teachers can provide guidance on experimental design and data analysis.

Overall, these alternative research objects can help students gain valuable knowledge and skills related to mushroom biology, environmental science, and the ecological roles of mushrooms in the oil palm plantation ecosystem. These projects also have the potential to contribute to sustainable agricultural practices by promoting the use of oil palm waste as a substrate for mushroom cultivation and increasing awareness of the ecological significance of mushrooms in plantation ecosystems.

CONCLUSION

Based on the results of the research and discussion above, it can be concluded that there are 3 (three) alternative study objects related to the potential of edible mushrooms that grow on OPEFB and can be developed for learning IPAS projects in Vocational High School, including (1) mushroom cultivation using OPEFB waste which includes 4 aspects (living things and their environment, substance and their changes, earth and space, economic behavior and welfare), (2) morphological characterization for classification of mushroom including 3 aspects (living things and their environment, substance and their changes, social interaction and social dynamics), and (3) detection of chemical compounds present in mushroom, covering 3 aspects (living things and their environment, substance and their changes, economic behavior and welfare).

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