



Ethnomycology of Bracket Fungi in Baduy Tribe Indonesia

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Abstract

Inhabitants of the Kendeng mountain region depend on the biodiversity of the forest resources for their livelihood. Mushrooms are important resource that provide benefits to mankind. The aim on this research was to document traditional knowledge in bracket fungi utilization to treat health problems in Baduy tribe community. The results described in this paper were obtained through the exploration and identification of bracket fungi as well as the interview to determine their cultural significance for Baduy people. Quantitative approaches were used to determine the Use Values (UV), Informant Consensus Factor (ICF) and Fidelity level (FL) values. A total of 6 species that were identified as bracket fungi were included to Basidiomycota. The Baduy community considers the main use of bracket fungi as a medicine for several ailments. The highest UV, ICF and FL value were obtained by *Ganoderma lucidum*. This study provides the information regarding bracket fungi species with the high use values that could be employed in pharmacological research and further biotechnological approaches in order to achieve an adequate revenue.

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INTRODUCTION

Indonesia is recognized as a world's megabiodiversity country among 17 "mega-diverse" countries that together contain 70 percent of the world's biodiversity (Sharma & Arya 2016), including diversity of microorganism e.g fungi. Regarding the diversity of fungi, Hawksworth and Lücking (2017) estimated their occurrence of approximately 2.2 to 3.8 million species worldwide. At present, there are approximately 3 million fungi with only 140,000 species producing fruiting bodies of sufficient size and suitable structure to be considered as mushrooms. A large variety of mushrooms is one of the important natural resources, and is utilized traditionally for food. It is estimated that there are 1,069 species of mushroom that have been reported as being used for food purposes worldwide (Boa, 2004). These wild edible mushrooms have been collected and consumed by people since thousands of years ago. Not only for food purposes, the bracket fungi can be used for the maintenance of health, as well as in the prevention and treatment of diseases. According to Wong and Cheung (2001), edible mushrooms contain a substantial amount of protein, fiber, vitamins, and minerals but low in fat. They also have various properties for health benefits and can be used to treat many human ailments such as cancer, circulatory system disorders and diabetes (Kim & Song, 2014).

Bracket fungi are one mushroom family, a member of the division Basidiomycota with a though, woody and circular fruiting body called conks. A distinguishing factor of common mushroom and Bracket fungi is the lack of a stem, only a few of them have a short stem. Otherwise, they grow directly from the wood on which they live (Fogel & Rogers, 2006). Bracket fungi are agents of root and wood destruction in the woody plants. Most are inedible and only the few of bracket fungi species are edible. People consumed these fungi because of their nutritional and medicinal properties. *Ganoderma lucidum* (W.Curt.:Fr.) P. Karst. is one of the examples of bracket fungi. Based on oriental traditions, people used it in the treatment of ailments such as therapeutic effect in the health promotion (Morris *et al.*, 2017) and boosts the immune system (Wachtel-Galor *et al.*, 2004). A wide range of biologically different active compounds was synthesized by the fungi and well documented in China and Japan (Lindequist *et al.*, 2005).

For some small rural and traditional communities, gathering and collecting wild mushrooms including Bracket fungi from the nature

as consumption goods and other purposes has been conducted over centuries. These activities are also conducted by Baduy tribe who live in the south area of Banten Province, Indonesia. They live in the remote highland jungles that is made up of mountainous plateaus as a part of Mount Kendeng valley of the river basin and the upper reaches of the river that flows to the north. The climatic condition, wide varieties of physical features and high humidity in Baduy have resulted in a diversity of ecological habitats which preserve and sustain a wide range of mushroom species including Bracket fungi. Indigenous knowledge of Baduy tribe regarding the utilization of wild mushrooms has been transmitted orally from one generation to the next. According to Davies and Kassler (2015), indigenous knowledge results from many years of experience, it constitutes a connection between the community and their natural resources. This research has been made in order to collect and documented for further investigations in future. Therefore it will prevent both loss of traditional knowledge and its destructive changes during transmission between generations.

METHODS

Description of Study Site

The study was carried out in Inner Baduy, Cibeo Hamlet, Kanekes village, sub-district of Leuwidamar, district of Lebak, Banten Province, Indonesia (Figure 1). Geographically, the village was located at 6°27'27"-6° 30' South and longitude 106°3'9"-106° 4' 5"East with an altitude ranging from 300-600 m above mean sea level. This region was located about 172 km in the west of Jakarta, Capital city of Indonesia. The average temperatures was 20° C with an average rainfall of 4,000 mm/year. Broadly, three types of soil available in the area were dark latosol, brown alluvial and andosol. The Baduy community ethnographically was the inhabitant of the 5,101.85 ha total area which consists of 2,101.85 ha residential area and 3,000 ha protected forest area. They speak the Sundanese language, the ethnic language in Indonesia.

Collection and Identification of the Bracket fungi

The Bracket fungi which was growing on the trees or on the ground were carefully picked by using a sharp sterilized knife. The collected samples that were free of infection or insect attack were then wrapped with tissue paper and stored inside a sterilized polythene bag. As the next

process, simultaneously a spore print was prepared by placing the pileus downwards in a half white and half black paper. A drop of water was added to the upper surface of pileus then the pileus was covered to maintain the humidity. After 12 hours, the pileus was lifted and the spores were observed. The sporocarps were air-dried in 50°C to make the herbaria. The herbaria then were moved into the airtight container with silica gel in it and labeled (Drábková, 2014). All herbaria were stored in the Laboratory of the Department of Biology Education, Faculty of Teacher Training and Education, University of Sultan Ageng Tirtayasa, Banten Indonesia for cross-references purpose. The Bracket fungi were then identified based on the Morphological characteristics and morphometric analysis in the laboratory (Læssøe, 2013) with the help of literature (Huffman *et al.*, 2008)

Prior to document the ethnomycology data, semi-structured interviews and focus group discussion, and personal conversations were conducted with local people and field survey (Zheng & Xing 2009) as seen in Figure 2. A total of 56 local people of Baduy tribe from the Cibeo hamlet were participated in this research. They included several *Dukun* (traditional healer) and indigenous people who were interviewed in order to record their household recipes for the preparation of Bracket fungi into traditional medicine. Detailed demographic data of respondents are provided in Table 1. The names of informants, local names of bracket fungi which linked to scientific names during the interview were recorded by showing photographic of bracket fungi. Questions were asked individually concerning the actual use of the bracket fungi in the disease treatment along with questions about how to prepare it.

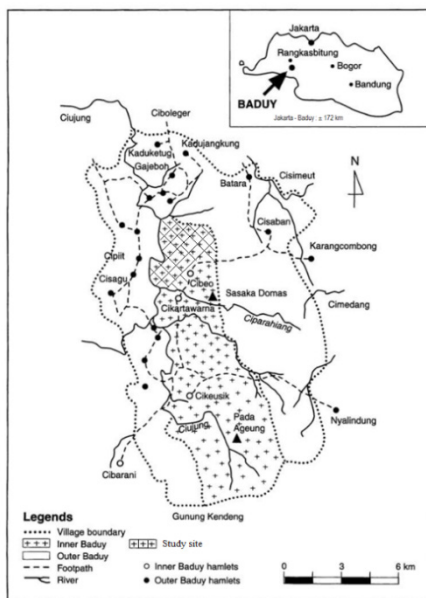


Figure 1. Study site of Baduy area in Cibeo Hamlet, Kanekes village, Leuwidamar sub-district, Lebak district, Banten province (adapted from Iskandar & Iskandar, 2017)

Data Analysis

The Use Value (UV) of a bracket fungi species was analyzed based on Phillips (1994) as follow: $UV = U/V$, where U refers to the number of mentions per species, and N means the number of informants. This value was a quantitative parameter that demonstrates the relative importance of Bracket fungi species known by local people.

Informant Consensus factor (F_{IC}) was used to identify the relative importance of bracket fungi species with the ailment categories in a particular culture which was initially developed by Trotter and Logan (1986). The value was calculated based on the following formula: $FIC = \frac{Nur - Nt}{Nur - 1}$, where Nur referred to the number of uses mentioned in each category and Nt was the number of species indicated in each category. FIC values ranged from 0 to 1 and when values were close to 1, it indicated a high proportion of informant consensus on bracket fungi species used against a disease category, while a 0 possesses an opposite sign.

Because some of bracket fungi species may be used to treat the same ailments category, it is important to determine the most preferred species

Table 1. The demographic profile of respondents in Cibeo Hamlet.

Variable	Categories	Number of Persons	Percentage (%)
Age	Youth (18-29)	13	23.21
	Adults (30-45)	18	32.14
	Elderly (>45)	25	44.64
sex	Female	7	12.50
	Male	49	87.50
Informant category	Traditional Healer (Dukun)	8	14.29
	Indigenous people	48	85.71

used in the treatment which can be done with the Fidelity Level (FL) test by Friedman *et al.* (1986). The FL value was calculated based on the following formula: $FL(\%) = (Np/N)*100$, where Np was the number of use-reports cited for a given species for a particular use category and N was the total number of use-reports cited for any given species. High FL value (near 100%) were obtained for species for which almost all use reports refer to the same way of using a given species, whereas low FLs are obtained for those that are used for many different purposes.

RESULTS AND DISCUSSION

In total, 56 informants (87.5% males and 12.5% females) with ages between 18 and 53 years were interviewed. The number of male respondents were higher than those of females. This is associated with the Baduy culture that male perform their tasks out of their homes while women play a major role and have a higher proportion of household responsibilities as mother and wife. Male informants was also more have more knowledgeable than females in identifying and naming useful bracket fungi species as they could have chances to learn the useful values of species from their daily interactions. Similarly, many kinds of research have reported the dominance of male informants in ethnomycology (Giday *et al.*, 2009; Kidane *et al.*, 2014; Balde *et al.*, 2015).

Baduy people are illiterate. School and formal education are among some of the long lists of things forbidden to the Baduy. Going to the field and staying as close as they could to nature is the way they get information for life including the knowledge of utilizing natural product for disease treatment. Related to the age characteristics of the respondent, Table 1 shows that most of the respondents were elder (Table 1). Knowledge of the medicinal uses of natural product especially fungi in Baduy older people is more than the young one. This skill is individually developed through word of mouth along family line, and was transmitted from one generation to the next with no recorded literature. The knowledge will increase when the parents involve children in daily activities so they will have the chance to observe bracket fungi directly and find out the significances for their life. These methods are similar with a cultural group in South Asia (Adhikari *et al.*, 2005), Western Asia (Ahmed 2016), Africa (Teklehaymanot 2009), America (Silva *et al.*, 2011). According to Garibay-Orijel and Valencia (2010), horizontal transfer can be an im-

portant factor in preventing the loss of traditional ethnomycological knowledge.

During the study period, a total of 6 bracket fungi species were identified to be consumed as medicine by the Baduy tribe (Table 1). The reported bracket fungi families included Ganodermataceae (3 species), Polyporaceae, Meripilaceae, and Hymenochaetaceae (1 species each). According to the respondents, the Bracket fungi species were used to treat 5 different ailments. The bracket fungi used most prevalently were Ganodermataceae. Over past decades, many studies have shown that 2 genera from family *Ganodermataceae*, *Ganoderma* and *Amauroderma* are well known medicinal mushrooms used for prevention and treatment of various human diseases, including cancer (Liu *et al.*, 2015). These species are widespread in tropical areas (Kirk *et al.*, 2008).

Bracket fungi samples were collected from logs, stumps, and snags and form single or multiple, small to large shelf-like caps. The morphology is different with the common mushroom. They have tough-fibrous, leathery, or woody in texture and usually having no stalk. Bracket fungi are highly seasonal and variable, dependent on certain kinds of ecological conditions. Only quality specimens that meet the Herbarium standards are accepted, so it is especially important to take the time and effort when collecting bracket fungi sample specimens in the field. Therefore, the sampling activity was conducted through the rainy season. Based on the occurrence of their fruiting bodies on the substrate, bracket fungi can be divided as xylosaprotrophs (growing on dead wood) and biotrophs (growing on living trees). Among the species occurred on the different type of substrates. The xylosaprotrophs (83.33%) was the most frequently substrate used. The fungi grow on dead wood and fallen substrate. It was followed by biotrophs (16.67%). This finding is in agreement of Tibuhwa (2011) that a small number of shelf and bracket fungi growth is restricted to the living tree log substrate.

The Baduy people collect the fungi from their local forest e.g. *Reuma* (immature forest) and *Leuweung kolot* (mature forest) surrounding their environment. There is about 48% land area in Baduy covered with forest which contains a high biodiversity as the source of medicinal component and still be protected under their native customary rights. Woody plants and those tree with a high economic value that grow in the Baduy forest play an important role in bracket fungi life as the substrate to grow.

Baduy tribe can distinguish and name the parts of bracket fungi species in the local langu-



Figure 2. The Sporocarp of bracket fungi species for medicinal purposes in communities of Baduy Tribe: A. *Amauroderma* sp, B. *Ganoderma lucidum*, C. *Ganoderma applanatum*, D. *Fomes fomentarius*, E. *Rigidoporus sterium*, F. *Phellinus linteus*. Scale bar = 1 cm

age-Sundanese. Traditional knowledge related to mushrooms among Baduy people and others traditional people in the world (Santiago *et al.*, 2016; Teke *et al.*, 2018) is limited to its fruit bodies, which represent the sexual stage of their life cycle. They only recognize the bracket fungi through the sporocarp shape by their local name. The sporocarp morphology can be seen in Figure 1. Local names had very precise meanings, usually corresponding to a mycological genus, and no cases of names extending beyond a genus (e.g., to name the whole family). The names designating species of bracket fungi are made up of two words, the first word *supa* means “mushroom” followed by a modifier that can be an adjective or noun. These modifiers indicate the morphology of the bracket fungi sporocarp such as color, structure or substrate used by the fungi. For instance, the diversity member of Ganodermataceae family is realized by many respondents by giving the name according to the sporocarp color.

The High Use Value was recorded for selected species, such as *Ganoderma lucidum* (0.83), *G. applanatum* (0.73), (Table 1). A High UV levels indicate high numbers of use reported by the informants for a particular species of bracket fungi. The disease categories with the highest use of bracket fungi were headache and blood circulation disorder (1.00 each), followed by cancer (0.95), immune deficiency (0.93), and fever (0.83). The Fidelity Level (FL) values in this study varied from 21.43% to 96.43%. The high-

est FL for the bracket fungi used by the Baduy tribe was recorded as *Ganoderma lucidum*. The FL of 100% for a specific mushroom indicates that all of the use-reports mentioned the same mushroom for a specific treatment (Srithi *et al.*, 2009). The FL value is used to identify most preferred species in use for treating certain ailments by key informants. It means that the informants had a tendency to rely on one specific mushroom species for treating one specific ailment than for several different ailments. *Ganoderma* species possess a much higher potential for being used in the development of remedies for specific ailments.

The informant’s consensus factor (ICF) was found to range between 0.8 and 1.00 (Table 2). A higher ICF value obtained in this study indicate a reasonably high reliability of informants in using relatively few species in the treatment of a particular ailment category. To calculate the ICF, the reported ailments were initially grouped into 5 on the basis of their use reports. Based on the result, there was no lower ICF value of bracket fungi found in the region. Therefore, no indication showed that the informants do not agree over which bracket fungi species of using a particular bracket fungi species to treat a particular ailment category (Gazzaneo *et al.*, 2005).

There are several factors that cause Baduy people to utilize bracket fungi as traditional medicines. These fungi are mainly collected from the nature that serve as a major source of primary health care for Baduy people which can be ac-

Table 2. Bracket fungi species for medicinal purposes in communities of Baduy Tribe, Indonesia

Family	Scientific Name	Local Name	UV	Medicinal uses	FL (%)
Ganodermataceae	<i>Amauroderma</i> sp.	Supa Kamanden	0.5	Analgesic	57.14
				Fever	66.07
	<i>Ganoderma lucidum</i>	Supa Tutung Bodas	0.89	Immune deficiency	89.29
				Cancer	96.43
Polyporaceae	<i>Ganoderma applanatum</i>	Supa coklat kayas	0.73	Immune deficiency	73.21
				Fever	25.00
Meripilaceae	<i>Rigidoporus stereum</i>	Supa Kayas Hideung	0.33	Immune deficiency	33.93
				Hymenochaetaceae	<i>Phellinus linteus</i>
Cancer	21.43				

Table 3. Category of ailments and their Informant Consensus Factor (ICF)

Category of ailments	Number of use reports (Nr)	Number of taxa (Nt)	ICF
Headache	1	14	1
Immune deficiency	3	30	0.93
Fever	2	7	0.83
Blood circulation disorder	1	7	1
Cancer	2	23	0.95

cessed and afford easily. The health facilities for Baduy people are actually available and provided by the Indonesian government but it takes about 4 hours from the village of Inner Baduy and with limited health facilities. The use of these species can be attributed to them possessing some properties which have been experienced by these local people to be both therapeutic (for curing) and prophylactic (for prevention) of the diseases.

Traditional medicine has a clear role to play in Baduy society. They had more confidence in folk logic treatments by themselves or the traditional healers applied. The first attempt they do when caught by diseases is to cure themselves, and if unsuccessful, they will then visit a traditional healer called *Paraji/Dukun*. They believe in the healing powers will make them healthy as well. When someone in suffers from a contagious disease for which there is no cure, such as Smallpox and Tuberculosis, he has to fight the disease with prayers and meditation.

According to the interviewed inhabitants, there are several ways to prepare bracket fungi for medicinal purposes. Even though bracket fungi are considered as edible mushroom, but they are almost impossible to eat because of their tough structure that is like leathery wood. Therefore, before ready to be consumed, preparation was needed. Usually, all parts of the sporocarps were

used. First, the sporocarps needed to be washed with water to remove the dirt, debris or adhered material. Then they were chopped into small pieces and were dried using the sunlight for removing the water content inside. The dried material can be used as a tea by slow boiling the dried material to reduce the liquid for several hours. Sometimes, the Baduy tribe use the fungi material along with other ingredients i.e. honey, and egg. Bioavailability of mushroom's active metabolite depends on the preparation technique. The most common preparation is hot water extraction technique. According to Lee *et al* (2015), water-soluble fractions for example decoctions and essences from medicinal mushrooms were used as medicine in Asia. The polysaccharide is one active compound that is synthesized by fungi that can be used as immunomodulatory agent (Lull *et al.*, 2005). Its polar molecules make hot water extraction can dissolve the molecules easily.

Several ethnomedicinal studies revealed that the use of medicinal mushroom by traditional people against several diseases such as immune deficiency and cancer is a common practice throughout the world. Many studies and investigations also revealed that medicinal mushroom used by Baduy people contain active metabolite. Chemical constituents such as Ergosterol and

polysaccharide contained in *Amauroderma* sp (Liu *et al.*, 2015; Jiao 2013) has been reported to relieve upset stomach inflammation diuretic cancer (Chan *et al.*, 2015). Polysaccharide also can be found in the species of *Ganoderma lucidum* (Menses *et al.*, 2016), *Fomes fomentarius* (Kim *et al.*, 2015) and *Rigidoporus stereum* (Cheng 2009). The substance can be used to treat human ailments as an anti-tumor, antioxidation, diuretic, alleviation of fever, and anti-inflammatory properties (Kim *et al.*, 2015). The repetitive use of these bracket fungi species by the Baduy people may serve as an indication of their effectiveness and show a high value of ethnomycology knowledge for treating a disease.

There is no previous reported ethnomycology studies that have been conducted in Baduy area. Therefore, information regarding the relative importance and indigenous knowledge of mushroom especially bracket fungi are valuable. Ethnomycological knowledge of Baduy people which is inherited over generations have a high cultural value. The knowledge has long influenced the paradigm of the people on health, and indirectly has encouraged them to conserve biodiversity of their region which consist of various tropical forest ecosystem types and serve as storage of biodiversity. Therefore, the beliefs and knowledge of traditional community developed in biodiversity utilization as medicinal compound must be protected as a heritage of traditional healing to maintain the health. This study provides the information regarding bracket fungi species with the high use values that could be employed in pharmacological research and further biotechnological approaches in order to achieve an adequate revenue.

CONCLUSIONS

Based on the study above, it is concluded that the respondent of Baduy people has recognized 6 species of Bracket fungi. It is possible that there are still a lot of species that have not been recorded yet. The indigenous knowledge about bracket fungi utilization as medicine for Baduy community was inherited over generation obtained that need to be protected and maintained its existence.

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