Ethnomycological knowledge and nutritional properties of edible mushroom Kulat Siau (*Hygrocybe conica*) in Central Kalimantan

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Abstract. Wild edible mushroom is one of the non-timber forest products that is important to the forest ecosystems. Locally known as Kulat Siau, *Hygrocybe conica* is one of the wild-edible mushrooms from the peatland ecosystem. In this study, we conducted a survey with the community about the identification, foraging activity, utilization, and economic value of *H. conica*. Proximate analysis was also carried out to determine the nutritional content of this mushroom. The results of the study show that some local people still do foraging activity to get this mushroom and sold it to the local market. Hence, this means that this non-timber forest product has economic value for the community who lives near to the forest. This mushroom is mostly harvested in secondary peat forest. As a food, *H. conica* is quite popular and can be processed into various menus. The proximate analysis result showed that the mushroom had a high dietary fibre and vegetable protein. In addition, it also contains antioxidants and vitamin C which is good for maintaining body health.

1. Introduction

By the end of 2019, the world’s population has been facing Coronavirus-2019 (COVID-19) pandemic caused by a virus which vastly spread to all countries in the world and destroys life and livelihood. The Food and Agriculture Organization of the United Nations (FAO) is very concerned about the impact of the COVID-19 attack, especially on food security. Local food materials are dependable during this disaster era [1].

Mushroom has become a solution to the world’s lack of food material and health [2]. The study on the utilization of fungi by the local community is ethnomycology. In the ethnomycology, we study the local knowledge and practice of mushroom utilization that has been implemented by communities and has developed and spread to the bigger community. Initially, ethnomycology only discussed about medicinal mushroom. However, following the development of the study, ethnomycology is also discussing edible mushrooms; that have been collected and consumed for thousands of years by the local people [3]. There are approximately 2000 mushroom species in the world that are safe for human
consumption and out of 650 species are used for medicinal purposes [4]. Wild edible mushrooms are collected for food and have economical value in almost 80 countries. Several of them even showed ecological roles as ectomycorrhiza association [5].

Central Kalimantan is rich in biodiversity including local mushrooms. Several studies have been carried out on mushrooms in tropical rain forests of Central Kalimantan, however, not specifically for food consumption. It was reported that in Tanjung Puting National Park and Sebangau National Park, there were 18 genera, 44 species, and 335 individuals of macrofungi as litter decomposer (4.13%), wood decomposer (7.91%), food material (9.46%), ectomycorrhizal which symbiosis with Dipterocarpaceae (10.41%), and as medicine for fever and heartburn (0.96%) [6]. Dayak tribe is the biggest ethnic group in Central Kalimantan who originally live in the peatland and forest that owns biodiversity of 69 ethnic plant species. These represented 45 families and 5 species of mushrooms [7]. There are 42 local vegetables and mushroom consumed by Dayak people of Central Kalimantan processed into sauteed vegetables or soup or salad, including mushroom [8]. This study aimed to add information on ethnomycology or mushroom utilization by local people including its nutrition content.

2. Methods

2.1. Fungal collection and identification
Kulat Siau (Hygrocybe conica) were collected from different traditional market of Kuala Kapuas district, Kapuas regency, Central Kalimantan province. The mushroom was identified by local people. Then, the mushroom was brought to the laboratory for further analysis including its morphological characteristics. The caps of H. conica are 2-9cm in size, red to bright orange colour, and knobbed. The gills are nearly free, close, broad and white at first, then becoming pale yellow after exposure. The stalk is 2-20cm tall, 5-15cm thick with yellow to orange colour and white on its base [9,10].

2.2. Ethnomycological study

We used in-depth interviews for several key informants in several districts which are Kapuas, Jabiren, Pulang Pisau, and Basarang of Central Kalimantan province. Moreover, the data collection was also carried out online through google forms. There were 57 respondents and they were asked on information regarding the selected mushrooms (Figure 1). The age of respondents is listed in Table 1. The information gathered including the mushroom’s local name, uses, utilization, and processing.
Table 1. Respondents information

| Variable | Categories | Number of respondents | Respondent Ratio (%) |
|----------|------------|-----------------------|----------------------|
| Age      | <20        | 11                    | 18.97                |
|          | 20-30      | 12                    | 20.69                |
|          | 31-40      | 15                    | 25.86                |
|          | 41-50      | 13                    | 22.41                |
|          | >50        | 7                     | 12.07                |
| Occupation | Student    | 13                    | 22.41                |
|          | Civil servant | 14                | 24.14                |
|          | Employee   | 6                     | 10.34                |
|          | Housewife  | 6                     | 10.34                |
|          | Enterpreneur | 11               | 18.97                |
|          | Farmer     | 8                     | 13.79                |

2.3. Nutritional analysis
The nutritional and antioxidant analysis were conducted at the Biochemistry Laboratory of Medicinal Faculty, Lambung Mangkurat University, Banjarbaru, South Kalimantan. All samples were analyzed with two-times repetition (duplo).

3. Results and Discussion

3.1. Ethnomycological knowledge
In the study, there were 58 respondents of varied ages from 19 to 61 years old. The majority of respondents had background education as senior high school (40.4%). The respondents were coming from Kapuas, Palangkaraya, and Tumbang Nusa, Central Kalimantan. Moreover, the respondent’s occupation varied including student (22.41%), civil servant (24.14), entrepreneur (18.97%), farmer (13.79%), etc. Based on the interview, Hygrocybe conica is known as Kulat Bantilung, Kulat Siau, Kulat menyala, Kulat Kudapai, and Kulat Bahandang. Moreover, the naming is adjusted to the mushroom morphological description. Kulat in Dayak language means mushroom. While Siau or Bahandang means reddish or red yellowish and the same with H. conica morphology with red fruiting body.

Most respondents said that the mushrooms were collected by themselves (61%). However, 39% said that they got them from the traditional market. According to the data, respondents with formal work (civil servant and employee) tend to buy mushroom from local market, while respondent with informal work collected and harvested fungi by themselves. This phenomenon indicated that respondents with informal work have a better understanding about the mushroom. Since they can harvest the fungi by themselves, they have better knowledge about the mushroom particularly at the mushroom’s morphological character. The mushrooms were harvested under trees in the garden, rubber trees, rambutans, bamboo, and oil palm plantations. Rainy seasons are the season for this mushroom. Fungi is likely to produce fruiting bodies at the beginning of the rainy season due to the more humid environmental condition. In general, the growth of fungi is highly influenced by various factors such as air, humidity, temperature, and light intensity. Requirements for optimal growth of this mushroom species are 20-28°C and humidity of 50-75% [11]. This mushroom was sold in the traditional market with price ranged from 8,000-30,000 rupiahs per kilogram. There was also
mushroom harvested by local people that sold directly to the buyer they found. They packed it in small plates or plastic bag (Figure 2) with price 5,000-10,000 rupiahs.

Figure 2. Local people sell mushrooms in plastic bag

Several studies showed that this mushroom has been utilized by local people in several areas in Central Kalimantan province [11,12]. Not only in Central Kalimantan, this mushroom is also used in Sarawak [13]. The kulat siau has been consumed for a long time by cooking into sauteed or soup. The mushrooms for consumption were picked and selected based on fruiting body quality, which should be free from pests. The fresher the mushroom, the tastier it gets. The mushroom needs to be boiled for 10 minutes before further processed for consumption. Several respondents suggested for boiling them until the red colour has lost. It is believed that the red colour is poisonous. Based on the interview, there was no record showing the mushroom for medical purposes.

3.2. The Nutrient Content
Each living organisms including plants have complex system containing enzymes and antioxidants, which protected them from reactive oxygen species (ROS). Antioxidant contents of certain plants had been found for non-timber forest product (NTFP) species of Central Kalimantan, especially in peatland, including H. conica [14]. The mushroom contains good nutrition (Table 2) due to its dietary fibre, mineral (iron, Na, dan K), Vitamin C (lycopene and caroten), carbohydrate, protein and Fat. In addition, H. conica can be consumed for its potential antioxidant benefit [15].

Nutrient of Na and K that contained in this mushroom play roles in maintaining the ionic balance in the cell, and also the pumping of Na-K-ATP. In addition, Iron (Zinc) in the mushroom have a important role as the main component of antioxidants enzyme (catalase) and hemoglobin which play important role in metabolism. Furthermore, Tannin, vitamin C, lycopene and carotene which can be found in the mushroom are antioxidants. Antioxidant compound work with a) scavenging H2O2 b)
metal chelating and c) radical hydroxyl scavenging. Free radical catching by antioxidant compound is able to prevent degenerative diseases such as cancer, diabetes mellitus, hypertension, etc. Kulat Sia has a lower calorie compared with other mushrooms. In addition, the vitamin C of Kulat Sia is also higher compared to other edible mushrooms (Table 2). *Hygrocybe conica* also contains lycopene. Generally, lycopene is found in orange-red fruits and vegetables. Lycopene supports liver health, cardiovascular and male fertility [16]. The complex nutrition content has made kulat sia potential as an alternative food for forest-dependent communities and society in general.

**Table 2.** Nutrition content of kulat sia (*H.conica*) compared with oyster mushroom (*Pleurotus ostreatus*) and straw mushroom (*Volvariella volvacea*)

| Analysis                  | Kulat Sia        | Oyster mushroom[17] | Straw mushroom[17] |
|---------------------------|------------------|---------------------|--------------------|
| Dietary fibre (mg)        | 26.16±8.09       | 7.5-13.3            | 7.3-8.0            |
| Vitamin C (mg/ml)         | 90.64±1.24       | Na                  | 0.3 (mg/g)         |
| Tannin (mg/ml QE)         | 1.46±0.29        | Na                  | Na                 |
| Iron (%)                  | 3.88±0.20        | Na                  | 0.7-4.0 mg/g       |
| Natrium (%)               | 0.09±0.01        | Na                  | 0.1-19.0           |
| Potassium (mg/gr)         | 1.82±0.20        | Na                  | <0.01 mg/g         |
| Lycopene (mg/ml)          | 0.21±0.00        | Na                  | Na                 |
| Carotenoid (mg/ml)        | 0.137±0.00       | Na                  | Na                 |
| Antioxidants:             |                  |                     |                    |
| Scavenging Radical Hydroxyl (inhibition %) | 41.40±1.92 | Na | Na |
| Scavenging H$_2$O$_2$ (inhibition %) | 68.72±0.69 | Na | Na |
| Scavenging chelating iron (inhibition %) | 47.39±1.56 | Na | Na |
| Ash (%)                   | 1.755±0.09       | 6.1-9.8             | 3.7-7.0            |
| Protein (%)               | 2.975±0.25       | 10.5-44             | 13.4-17.6          |
| Fat (%)                   | 1.626±0.35       | 1.1-2.4             | 4.9-9              |
| Carbohydrate (%)          | 4.2±0.21         | 50.7-81.8           | 67.5-70.7          |

na: data not available

4. Conclusion
Kulat siau is a local edible mushroom that is well known by the communities of Central Kalimantan and has been utilized as food material. It contains nutrition elements such as fibre, vitamin C and antioxidant to support a healthy society.

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