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# Ethnomycological Knowledge of Three Ethnic Groups in Ethiopia

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**Abstract:** Ethnomycological information was gathered by conducting semi-structured interviews with members of the Amhara, Agew, and Sidama ethnic groups in Ethiopia. A total of 300 individuals were involved in this study. Forest excursions were also undertaken to investigate the habitat and to identify useful wild mushroom species present in the study areas. A total of 24 useful wild mushroom species were identified. Among the three ethnic groups, the Sidama have the most extensive ethnomycological knowledge and over seven vernacular names for useful fungal species were recorded for this group. Collecting mushrooms is common practice among the Sidama and usually carried out by women and children during the main rainy season from June to September. Useful mushrooms are collected in natural forests, plantation forests, grazing areas, home gardens, and swampy areas. In terms of medicinal uses, *Lycoperdon perlatum* Pers. and *Calvatia rubroflava* (Cragin) Lloyd. are well-known treatments for wounds and skin disease. Harvest storage of wild mushroom species is unknown. Respondents in the Amhara and Agew ethnic groups were similar in terms of their use and knowledge of mushrooms. Both ethnic groups reported that although wild mushroom species were consumed by their grandparents, they do not eat mushrooms themselves, which could eventually represent a loss of mycological knowledge in these two ethnic groups. Such inconsistency between ethnic groups in terms of their knowledge may also be linked to the social valuation of mushroom resources, which could easily be mitigated by raising awareness. Thus, the baseline information obtained in this study could be useful for further investigations and documentation, and to promote ethnomycological benefits to different ethnic groups in countries with similar settings.

**Keywords:** mushroom; Enguday; ethnomycology; folk taxonomy; Amhara; Agew and Sidama

## 1. Introduction

One of the world's biggest challenges is to secure sufficient food for all that is healthy, safe and of high quality, and to do so in an environmentally sustainable manner [1,2]. In this context, forest resources can play an important role as a source of food [3,4], by enhancing nutritional diversity [5,6] while maintaining diversity in natural systems [7]. Thus, in recent years, there has been growing attention focused on the sustainability of foods [4,8,9] and food systems, which has highlighted the need to conserve species diversity, mainly of foods from forest systems in many parts of the world [10,11].

Wild mushroom species are vital components of the livelihoods of rural people in different parts of the world [12,13]. Many of these mushrooms are collected because they are valuable non-timber forest products (NTFPs) [14,15], enabling people to overcome vulnerability to poverty and sustain their livelihoods through a reliable source of income [12]. This has shifted ethnomycology into a discipline in different parts of the world [14]. Globally, about 140,000 important mushroom species have been reported. In various cultures, mushrooms can serve as sources of food [14], medicine [16], enzymes and various industrial compounds [17]. They serve as also important composition of food and recipes for traditional foods and recipes [18,19]. In addition, mushrooms can serve in a recreational context and in myths and beliefs [20]. Nutritionally, mushrooms are an important source of proteins, vitamins, fats, carbohydrates, amino acids, and minerals [21,22], i.e., they are a good alternative or substitute for meat and fish [22–24].

Previous ethnomycological studies have shown that local knowledge of mushrooms varies with people's cultures and beliefs [25–27]. Within local communities, conventional knowledge is passed down from one generation to the next because this is the only way of safeguarding traditional knowledge [14,25,26]. The use of questionnaires to record traditional knowledge linked to mushrooms enables mushroom "use values" to be evaluated for a specific local community to identify cultural differences between communities [25,28,29].

In Ethiopia, mushrooms are wild edible resources and important NTFPs like that of wild edible fruits, particularly in the southern and southwestern parts of the country [30–32]. Despite poor scientific knowledge, wild mushroom utilization is a common traditional practice among different ethnic groups in Ethiopia [33,34]. Mushrooms, along with other wild edible resources, are used as a coping food during periods of food shortage in localities where they are used as food [31,35]. In some local markets, mushrooms are sold by local people to provide some income to supplement the household economy [36]. However, there are few ethnomycological reports on wild mushrooms. The available reports are scanty and contain only basic information about the existence and use of mushrooms at some community levels in the country [34,36,37]. Efforts made so far have either been of a review nature and/or cross-sectional [38,39]. This lack of documentation could make local mycological knowledge vulnerable [29]. Due to a continuing exodus of people from the countryside, local communities are gradually losing an important part of their traditional knowledge, particularly about wild mushroom species [24,26,29]. There is a genuine need to record and document local traditional knowledge and perceptions about useful wild mushrooms. Furthermore, due to their economic value, efforts are needed to integrate wild mushroom species as mainstream NTFPs in Ethiopia to ensure their conservation and enhance their value as source of nutrition to improve human welfare. Thus, assessing the various uses of wild mushroom species by local people is key to the better valorization of services provided by wild useful fungi [40]. This would also enable us to better elaborate participative management and conservation plans for these forests resources. This study has, therefore, sought to assess and document ethnomycological knowledge related to wild mushroom species of three ethnic groups from three different geographical areas in Ethiopia. Thus, our specific objectives were: (i) to identify valuable wild mushroom species in three study areas; (ii) to record the use value of wild mushroom species for each of the ethnic groups; (iii) to evaluate the status of wild mushroom species within local communities; and (iv) to identify the main threats and to assess how these threats vary across the three study areas.

## 2. Methods

### 2.1. Description of the Study Area

The study was conducted in the Amhara Region and the Southern Nations, Nationalities, and Peoples' Region (SNNPR) of Ethiopia where more than half of the ethnic groups of Ethiopia are reside and from which three ethnic groups were selected: namely, the Amhara in the Fogera Woreda, the Agew in the Banja Woreda and the Sidama in the Wondo Genet Woreda (Figure 1). These three

ethnic groups had been identified in this study with the assumption that they are having good knowledge of the identification, variability, and use of locally available NTFPs. The Amhara and Agew ethnic groups occupy the center of the northern highlands of the Amhara region. They live in the same agro- ecological zone and share the same cultures, and languages. They both are sedentary farmers who practice mixed agriculture, including crop production and livestock rearing. The crop varieties grown locally in these woredas include teff (*Eragrostis tef* (Zucc) Trotter), sorghum (*Sorghum bicolor* (L.) Moench), maize (*Zea mays* L.), finger millet (*Eleusine coracana* (L.) Gaertn.) and beans (*Phaseolus vulgaris* L.). The Sidama ethnic group is one of the largest ethnic groups in the southern highlands. The population density in Wondo Genet is higher than that of Fogera or Banja, with about seven inhabitants per $km^2$. The majority of the Sidama practice mixed agriculture, integrating cash crops, such as khat (*Catha edulis* (Vahl) Endl.) sugar cane, and Ensete (*Enset ventricosum* (Welw.) Cheesman), with livestock production, including fishing from the nearby lake.

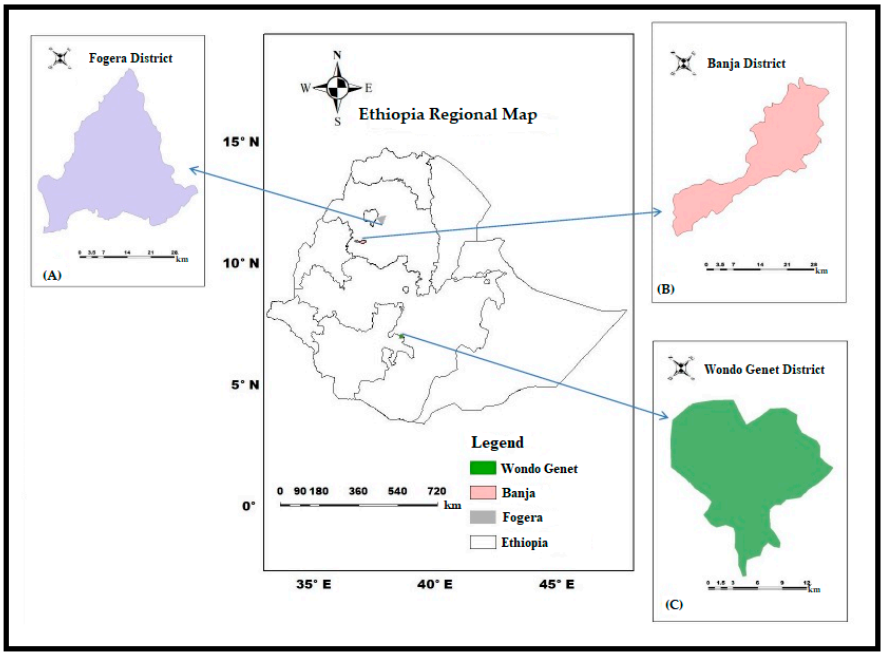


**Figure 1.** Location of the study woredas of the Amhara and Southern Nations, Nationalities, and Peoples' Region (SNNPR) in Ethiopia. (**A**) Fogera Woreda inhabited by the Amhara ethnic group; (**B**) Banja Woreda inhabited by the Agew ethnic group and (**C**) Wondo Genet Woreda inhabited by the Sidama ethnic group.

Wondo Genet, Banja and Fogera Woredas (Table 1) are characterized by high-altitude natural forests [41–44]. This high forest is dominated by Dry Afromontane forests [41,44], which are characterized by high humidity, a variable rainfall pattern and a prolonged dry season, making them complex and rich in biodiversity [45]. The main tree species found in these forests are *Juniperus procera* (Hochst. Ex Endl.), *Podocarpus falcatus* (Thubb.) Mirb.), *Hagenia abyssinica* (J.F.Gmel.), and *Olea africana* subsp. Cuspidata (Wall. & G.Don) Cif.) which are the main sources of timber in Ethiopia [46]. The Dry Afromontane forests also harbor various types of NTFPs [47], including edible fungi [38].

**Table 1.** Geographical description of the three study woredas.

| Study Woredas | Ethnic Group | Geographical Location | Altitude Range (m asl) | Mean Annual Precipitation (mm) | Mean Annual Temperature (°C) | References |
|---|---|---|---|---|---|---|
| Wondo Genet | Sidama | 7°06′ N & 38°37′ E | 1760–1920 | 1200 | 19 | [32] |
| Fogera | Amhara | 11°58′ N & 37°41′ E | 1780–2510 | 1245 | 20 | [43] |
| Banja | Agew | 11°10′ N & 36°15′ E | 1870–2570 | 1300 | 18 | [40] |

### 2.2. Socioeconomic Data Collection

This study presents three case studies as a type of ethnomycology research, each with various forms of socioeconomic data which were collected between January and August 2019. The data were collected from the primary data sources that involved the key informant interviews, focus group discussions and household interview methods. Details of the methods used followed Mekonnen et al. [48] and are described below:

The key informant interviews required people who were relatively knowledgeable about their community, local natural resources, the culture of their community, and the use of NTFPs to share their knowledge and experience with the interviewer and, therefore, suitable participants were selected for this interview. To select these key informants, a snowball method was used in which one key informant was contacted with the assistance of local administrators and community elders. Then, he/she would inform us of a second, the second would provide the name of a third and so on until a saturation number was reached [49–51]. In total, 17 elders (10 women and 7 men aged between 41 and 77 years old) from the three study areas (three from Banja, four from Fogera and the remaining 10 from Wondo Genet) served as key informants. During the study, each key informant was visited twice to verify the reliability of the data obtained. If information conveyed about a species during the first visit was not consistent with the information provided during the second visit, the information was considered unreliable and was rejected. The second visit also helped us to gather additional information from some of the participants that were not mentioned during the first interview. However, in most cases of the participants in the key informant discussion, no new information or themes were gathered during the second visit. Thus, this was a redundancy signals and the data collection was cease [50,51].

The focus group discussions were made up of representative members of the studied communities. The discussions were made up of three independent groups per kebele, the smallest administrative level in Ethiopia, and each group were consisted of ten individuals. When forming the groups, the populations in each study keble were first split into youths, women, and elders groups. Then, the overall samples consisted of some individuals from each spited groups. In each group the members are chosen randomly [49] to obtain varied knowledge and views, giving equal chances to youths, women, and elders for being selected as member of this study. The focus group discussions assessed the participants' feelings and opinions about wild mushrooms, the perceptions, beliefs, and myths attached to wild mushrooms, their marketability, knowledge of ecological niches and phenology/calendar use, as well as their opinion regarding resource degradation and the causes of degradation at the local level. At least one key informant was included in each group to triangulate information. The information collected via the key informant interviews and the focus group discussions was used to refine and compliment the information gathered via the household interviews in each of the study areas. The collected information was qualitatively interpreted and narrated in the Results and Discussion.

Household interview were conducted using a face-to-face semi-structured questionnaire interview. The households were selected purposively based on their gender and their dependence on the forest for their livelihood [49,52]. The questionnaire was constructed to obtain information relating to the objectives of the study and had been pretested with 15 randomly selected individuals from each study woredas. Based on the results of the pretest work, the questionnaires were modified as necessary. Enumerators were recruited from the study areas and the study objectives were explained to them. The enumerators were also trained in the methods of data collection and interviewing techniques. In total, 300 households from Wondo Genet, Banja, and Fogera woredas took part in the survey. The interviews were conducted in the Amharic language. In some cases, an interpreter conducted the surveys to ensure that the meaning of the questions was not changed. Interviews were conducted in a place where the informants were most comfortable. Information regarding the gathering, preparation, use, status/abundance, etc. of wild mushroom species and their marketability was also collected. Additional discussions were conducted with the households to understand the traditional use of mushrooms for medicinal purposes.

### 2.3. Wild Mushroom Species Collection

Weekly wild mushroom resource assessments were undertaken in July and August in 2016 during the major rainy season in nearby remnant Dry Afromontane forests [39]. For the purpose, we established a total of nine sample plots in each study woredas, plots were established systematically about 250 m apart. Each plot covered an area of 100 $m^2$, with a rectangular shape (2 m × 50 m) [39]. During sampling, sample fruit bodies from encountered species in the sampling plots were collected and taken to the laboratory and dried. In the field also, specimens were photographed and their ecological characteristics were noted in order to assist and facilitate taxa identification processes. Furthermore, herbaria specimens were used for mushroom species identification. Both morphological and molecular analyses were used for taxa identification. Photographs of the wild mushroom species were used during interviews and group discussions to enable the informants involved in the study to easily recognize mushroom species in their vicinity. The relative popularity of each medicinal wild mushroom was evaluated based on the informants who independently reported its medicinal use (informant consensus) in the study area.

### 2.4. Data Analysis

Descriptive statistics were used to present the basic information obtained from the questionnaires. All analyses were conducted based on the number of responses from the informants. A final list of valuable wild mushroom species used by respondents was compiled from the questionnaires and from the field collection data. All fungi were identified at genus and species level whenever possible with the aid of several keys [53–60]. The statistical significance of differences between groups was obtained by performing a chi-square test. Respondents ranked the effect of different threats on a scale of 1 to 3. Thus, a Kruskal–Wallis test was performed to identify the major causes of wild mushroom degradation based on the results of the respondents' views. Clustering was used for the 24 edible species based on their use by local communities. The cluster was based on the average linkage between groups. A binary logistic regression model was used to determine the factors that influence wild mushroom use by households [61]. Data were analyzed using STATISTICA '08 edition software (StatSoft Inc., 1984–2008, Maastricht, the Netherlands).

There are many theoretical perspectives regarding food choice decision, including social behavior, social facts, and social definition theory [61]. Each offers partial insights and makes limiting assumptions that prevents food choice decision variables being fully explained. As a result, we used a food choice process model that was developed based on constructionist social definition perspectives to examine the broadest scope of factors relevant to how individuals constructed their food choice decisions. The model included components of life course, personal food systems and influences. Thus, we selected all our explanatory variables described in Table 2.

**Table 2.** List of variables and variable descriptions used in the binary logistic regression model.

| Variables | Definition | Type of Data |
|---|---|---|
| Region | Administrative area within which the household head lives<br>1. SNNPR<br>2. Amhara | Categorical |
| Woreda | Administrative area within the region in which the household head lives expressed in years of homogeneity in terms of its ethnicity<br>1. Wondo Genet<br>2. Banja<br>3. Fogera | Categorical |
| Age | Age of the household head | Quantitative |
| Educational level | Educational level of the household head:<br>1 = illiterate<br>2 = can read and write<br>3 = primary school completed<br>4 = secondary school completed<br>5 = obtained diploma, degree or above | Categorical |

**Table 2.** *Cont.*

| Variables | Definition | Type of Data |
|---|---|---|
| Ethnicity | Ethnic groups to which the household head belongs—encompasses cultural variations between ethnic groups.<br>1. Sidama<br>2. Agew<br>3. Amhara | Categorical |
| Perceived value | Perception of mushroom consumption for food, income generation, and food security and as a medicine.<br>1. Higher<br>2. Medium<br>3. Low | Categorical |
| Taste experience | Consumption experience of an edible mushroom at least once in his/her lifetime<br>1. Yes<br>2. No | Categorical |
| Nutritional knowledge | Household head's knowledge or lack of knowledge about a mushroom's health-boosting benefits<br>1. I know<br>2. I don't know | Categorical |
| Indigenous identification knowledge | Household head's local knowledge of the identity of edible, poisonous and medicinal wild mushrooms<br>1. Yes<br>2. No | Categorical |

## 3. Results

### 3.1. Ethnotaxa of Wild Mushrooms

During the forest survey conducted in 2016, our team collected a total of 67 wild mushroom species in the Dry Afromontane forest of the study areas. Of these, 24 species belonging to 19 genera and 9 families were classified as edible. These edible mushrooms were well recognized by the local people when shown photographic images of these species. The fungi are listed in alphabetical order by species name alongside the corresponding indigenous name used by the three ethnic groups (Table 3). The families with the greatest numbers of edible species identified were the Agaricaceae (13 species) and Psathyrellaceae (three species). These two families represented 66.67% of the identified edible wild mushroom species in the study forests, whereas the remaining 33.33% of families were represented by only a single species (Table 3).

The Amhara ethnic group appeared to have limited ethnotaxa knowledge of the wild mushroom species found in the Fogera area. They classified mushrooms as 'Enguday', which in general corresponds to 'fungi' in English. All mushrooms with caps were classified as 'Yejib-tila', which means, "Shadow of the Hyena", which may indicate their cryptic nature (Table 3).

The Sidama ethnic group from the Wondo Genet area was found to be mycophiles and to have a well-developed ethnotaxa for wild mushrooms (Table 3). Some of the names given are associated with attributes of the mushroom species. For example 'Meine' is a name given to a highly valued species that is good to eat due to its taste but scarce due to high levels of collection. 'Gadifuto', which means 'Hyena's fart', is a name given to medicinal mushroom species.

Like the Sidama ethnic group, the Agew from the Banja study area also have a well-developed folk taxonomy for wild mushrooms. 'Wagi', 'Emahoyie pinchina', 'Abahoy pinchina', 'Ye Zinjero Fes', and 'Szantila' are ethnotaxa for some of the wild mushroom species (Table 3). However, for the majority of unrelated taxa, like the Amhara ethnic group, they use the collective name 'Enguday'. Remarkably, the Agew have assigned mushrooms with specific names based on the season in which the mushrooms grow. For example, those mushrooms that grow following the first rain of the season are generally called 'Gunfane', which literally means common cold. The name 'Yejib Tila' is also used by the Agew for all cap fungi.

**Table 3.** Folk taxonomy of collected wild mushroom species used by the Amhara, Agew and Sidama ethnic groups in the study woredas.

| Taxa Name | Family | Local Name of Mushroom Used by Ethnic Group | | | Edibility |
|---|---|---|---|---|---|
| | | Sidama | Agew | Amhara | |
| *Agaricus campestroides* Heinem & Gooss.-Font. | Agaricaceae | Meine/Kakea | Wagi | Enguday | E |
| *Agaricus* $sp_1$. L. | Agaricaceae | | | | |
| *Agaricus* $sp_2$. L. | Agaricaceae | - | - | - | |
| *Agaricus* $sp_3$. L. | Agaricaceae | - | - | - | |
| *Agaricus* $sp_4$. L. | Agaricaceae | - | - | - | |
| *Agaricus* $sp_5$. L. | Agaricaceae | - | - | - | |
| *Agaricus* $sp_6$. L. | Agaricaceae | - | - | - | |
| *Agaricus subedulis* Heinem. | Agaricaceae | Horoqo | Wagi | Enguday | E |
| *Agaricus trisulphuratus* Berk. | Agaricaceae | - | - | - | |
| *Agrocybe pediades* Fayod. | Strophariaceae | Shopenea | Wagi | Enguday | E |
| *Amauroderma regulicolor* Murrill. | Ganodermataceae | - | - | - | |
| *Clitocybe elegans* (Fr.) Staude | Tricholomataceae | Meine | Wagi | Enguday | E |
| *Armillaria* sp. (Fr) Staude. | Physalacriaceae | - | - | - | |
| *Calvatia rubroflava* Fr. | Agaricaceae | Gadifuto | Emahoyie pinchina | Emahoyfese | E |
| *Collybia piperata* (Beeli) Singer. | Tricholomataceae | - | - | - | E |
| *Conocybe* sp. Fayod. | Bolbitiaceae | | | | |
| *Coprinellus domesticus* (Bolton) Vilgalys, Hopple & Jacq. Johnson. | Psathyrellaceae | Feradigamea | Wagi | Enguday | E |
| *Coprinellus* sp. P.Karst. | Psathyrellaceae | - | Wagi | Enguday | E |
| *Coprinopsis nivea* (Pers.) Redhead, Vilgalys & Moncalvo | Psathyrellaceae | Shishonea | Wagi | Enguday | E |
| *Coprinopsis* $sp_1$. P.Karst. | Psathyrellaceae | - | - | - | |
| *Coprinopsis* $sp_2$. P.Karst. | Psathyrellaceae | - | - | - | |
| *Coprinus pseudoplicatilis* Pers. | Psathyrellaceae | Shishonea | Wagi | Enguday | E |
| *Coprinus* sp. Pers. | Agaricaceae | - | - | - | |
| *Crepidotus* sp. (Fr.) Staude. | Crepidotaceae | - | - | - | |
| *Cyptotrama asprata* (Berk.) Redhead & Ginns. | Physalacriaceae | - | - | - | |
| *Favolaschia calocera* R. Heim. | Mycenaceae | - | - | - | |
| *Ganoderma* sp. (Curtis) P.Karst. | Ganodermataceae | Buki bulasa | - | - | E |
| *Gerronema hungo* (Henn.) Degreef & Eyi. | Marasmiaceae | - | - | - | E |
| *Gymnopilus junonius* (Fr.) P.D. Orton. | Cortinariaceae | - | - | - | |
| *Gymnopilus pampeanus* (Speg.) Singer. | Strophariaceae | - | - | - | E |
| *Hygrophoropsis aurantiaca* (Wulfen) Maire. | Hygrophoropsidaceae | Feradigamea | Wagi | Yejib-tila | E |
| *Hymenagaricus fuscobrunneus* Heinem. | Agaricaceae | Qochiqomalea | Szantila | Yejib-tila | E |
| *Hymenagaricus* sp. Heinem. | Agaricaceae | - | - | - | |
| *Hypholoma fasciculare* (Huds.) P. Kumm. | Strophariaceae | - | - | - | |
| *Lepiota cristata* (Bolton) P.Kumm. | Agaricaceae | - | - | - | |
| *Leucoagaricus* sp. Locq. ex Singer | Agaricaceae | Meine | Szantila | Yejib-tila | E |
| *Leucoagaricus leucothites* (Vittad.) Wasser. | Agaricaceae | Kakea | Szantila | Yejib-tila | E |
| *Leucoagaricus rubrotinctus* (Peck) Singer. | Agaricaceae | Kakea | Szantila | Yejib-tila | E |
| *Leucoagaricus* $sp_1$. Locq.ex Singer. | Agaricaceae | Adulla | Szantila | Yejib-tila | E |
| *Leucoagaricus* $sp_2$. Locq.ex Singer | Agaricaceae | Silegaga | Szantila | Yejib-tila | E |
| *Leucocoprinus birnbaumii* (Corda) Singer. | Agaricaceae | Feradigamea | Szantila | Yejib-tila | E |
| *Leucocoprinus cepistipes* (Sowerby) Pat. | Agaricaceae | Feradigamea | Szantila | Yejib-tila | E |
| *Lycoperdon perlatum* Pers. | Agaricaceae | Gadifuto | Abahoy pinchina | Abahoyfese | E |
| *Lycoperdon* sp. Pers. | Agaricaceae | - | - | - | |
| *Marasmius buzungolo* Singer. | Marasmiaceae | - | - | - | |
| *Marasmius katangensis* Singer. | Marasmiaceae | - | - | - | |
| *Marasmius rotalis* Berk & Broome. | Marasmiaceae | - | - | - | |
| *Marasmius* sp. Fr. | Marasmiaceae | - | - | - | |
| *Microporus sp.P.Beauv.* | Polyporaceae | - | - | - | E |
| *Parasola* $sp_1$.Redhead, Vilgalys & Hopple. | Psathyrellaceae | - | - | - | |
| *Parasola* $sp_2$. Redhead, Vilgalys & Hopple. | Psathyrellaceae | - | - | - | |
| *Polyporus badius* (Pers.) Schwein. | Polyporaceae | - | - | - | |
| *Polyporus tuberaster* (Jacq. ex Pers.) Fr. | Polyporaceae | - | - | - | |
| *Psathyrella* $sp_1$. Fr.ex Quél. | Psathyrellaceae | - | - | - | |
| *Psathyrella* $sp_2$. Fr.ex Quél. | Psathyrellaceae | - | - | - | |
| *Psathyrella* $sp_3$. Fr.ex Quél. | Psathyrellaceae | - | - | - | |
| *Psathyrella* $sp_4$. Fr.ex Quél. | Psathyrellaceae | - | - | - | |
| *Psilocybe cyanescens* Wakef. | Hymenogastraceae | - | - | - | |
| *Psilocybe merdaria* (Fr.) Ricken. | Hymenogastraceae | - | - | - | |
| *Psilocybe* sp. (Fr.) P.Kumm. | Hymenogastraceae | - | - | - | |
| *Trametes versicolor* (L.) Lloyd. | Polyporaceae | - | - | - | |
| *Tremella mesenterica* (Schaeff.) Retz. | Tremellaceae | - | - | - | |
| Un described $sp_1$. | Undescribed | - | - | - | |
| Un described $sp_2$. | Undescribed | - | - | - | |
| Un described $sp_3$. | Undescribed | - | - | - | |
| Un described $sp_4$. | Undescribed | - | - | - | |
| *Xerula* sp. Maire. | Physalacriaceae | - | - | - | |

Note: E = edibility.

### 3.2. Wild Mushroom Collection and Habitat Type

Based on the respondents' answers, the three ethnic groups differed significantly in their knowledge of wild mushroom habitats (chi-square test; $p < 0.05$). Overall, six different habitat types were distinguished by respondents. However, the home garden and swampy areas are far less relevant

for the Amhara and Agew ethnic groups than other habitats (Figure 2). Compared with Sidama respondents, a significantly greater proportion of respondents belonging to the Amhara and Agew ethnic groups considered the natural forest to be the main mushroom habitat (Agew–Sidama = 0.001 and Amhara–Sidama = 0.001) (Figure 2). By contrast, a significantly greater proportion of Sidama respondents considered grazing areas to be a mushroom habitat compared with the Amhara and Agew respondents ($p > 0.05$). However, the proportion of Sidama and Agew respondents that considered plantations and agricultural lands to be habitats for wild mushroom species was not significantly different (Figure 2; $p > 0.05$).

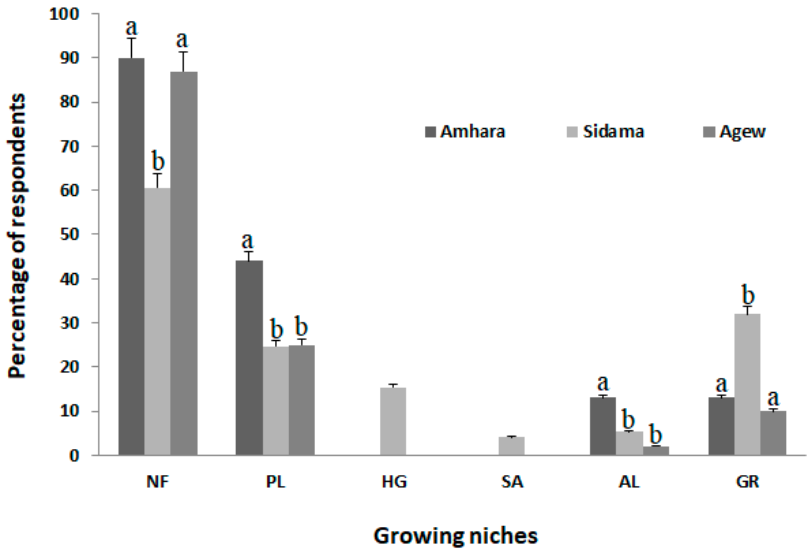


**Figure 2.** Perceptions of individuals in the three ethnic groups interviewed in the study areas about wild mushroom habitats. The data shown are mean results ± the standard error amount by five percent of the mean. Within each habitat type, values with the same letter above the bar are not significantly different. Abbreviations: NF, natural forest; PL, plantation forest; HG, home garden; SA, swampy area; AL, agricultural land; and GR, grazing area. Note: wild mushroom species are found in more than one habitat type; thus, the total percentage for all habitats is >100%.

We found significant differences in the awareness and use of wild mushroom species (chi-square test; $p < 0.05$) among the three ethnic groups. From the household survey, we realized that the Sidama ethnic group was more familiar with mushrooms than the Amhara and Agew ($p < 0.05$), whereas the Amhara and Agew were not significantly different from each other in terms of their awareness and use of wild mushroom species ($p > 0.05$).

The household interview revealed that the Sidama ethnic group collects wild mushroom species for food (93%) and medicinal (7%) purposes. About 63% of the respondents indicated that they usually collect wild mushrooms, 25% indicated that they occasionally collect wild mushroom species and 12% not collected mushrooms. The Sidama collect fungal species that have different nutritional modes. Saprotrophic fungi are preferred as food (90%) compared with other fungal types whereas *Ganoderma*, *Calvatia* and *Lycoperdon* (Table 4) are the three most commonly gathered genera for medicinal purposes. When dried, the spores of these mushroom species can be spread on skin to heal wounds and skin disease (Table 4).

Wild mushroom collection is common practice among the Sidama community: in most cases, children (22%) and women (70%) are the main collectors. This is because children are responsible for livestock keeping in the field and women are responsible for collecting firewood from the forests in the Wondo Genet area. Moreover, during the focus group discussions, the Sidama groups reported that the women in their communities know where and when wild mushroom species will be at their best. However, in some cases, men also collect mushrooms when they unintentionally find them as

they walk to or from the forest. According to the group discussion, medicinal mushroom species are usually collected by traditional herbalists; thus herbalists in the study areas are key for determining the ethnotaxa of medicinal species.

**Table 4.** Traditional use and preparation of the twelve most listed wild mushroom species by the Amhara, Agew and Sidama ethnic groups in the study areas.

| Species Scientific Name | Traditional Uses and Preparation | | | |
|---|---|---|---|---|
| | Amhara | Agew | Sidama | Local Preparation |
| *Agaricus campestroides* Heinem & Gooss.-Font. | NK | NK | F | Cooked with vegetables, oil and chili sauce |
| *Agaricus subedulis* Heinem. | NK | NK | F | Cooked with vegetables, oil and chili sauce |
| *Clitocybe elegans* (Fr.) Staude | NK | NK | F | Cooked with vegetables, oil and chili sauce |
| *Calvatia rubroflava* Fr. | NK | NK | F&M | Cooked with vegetables and oil. Also, spores/powder used to treat wounds |
| *Hymenagaricus fuscobrunneus* Heinem. | NK | NK | F | Cooked with vegetables, oil and chili sauce |
| *Leucoagaricus* sp. Locq. ex Singer | NK | NK | F | Cooked with vegetables and oil |
| *Leucoagaricus leucothites* (Vittad.) Wasser. | NK | NK | F | Cooked with vegetables and oil |
| *Leucoagaricus rubrotinctus* (Peck) Singer. | NK | NK | F | Cooked with vegetables and oil |
| *Leucoagaricus* $sp_1$. Locq.ex Singer. | NK | NK | F | Cooked with vegetables and oil |
| *Leucoagaricus* $sp_2$. Locq.ex Singer | NK | NK | F | Cooked with vegetables and oil |
| *Lycoperdon perlatum* Pers. | NK | F | F&M | Roasted or cooked with vegetables and oil<br>Also, spores/powder used to treat skin infection and wounds of both human and livestock |
| *Ganoderma* sp. (Curtis) P.Karst. | NK | NK | M | Medicinal for stomachaches and to treat wounds |

**Note:** F, species used for food; NK, species not known as food or medicine; and M, species used for medicine.

Although none of the Amhara and Agew respondents collect wild mushrooms for food or medicinal purposes, about 57% and 72% of the Amhara and Agew respondents, respectively, indicated that they do have some knowledge of the medicinal and food use value of wild mushrooms. They obtained this information from different sources as from forefathers (Amhara, 23%; Agew, 43%), elderly people belonging to other ethnic groups (Gumze) in their vicinity (Amhara, 34%; Agew, 46%), friends (Amhara, 10%; Agew, 43%), forestry expertise (Amhara, 12%; Agew, 33%), and NGOs (Amhara, 4%; Agew, 11%).

### 3.3. Seasonality/Phenology of Mushrooms

The seasonality of wild mushroom appearance was not significantly different among the three study areas (chi-square test; $p > 0.05$; Figure 3). In all three cases, wild mushroom species develop during the short (peak in March) and long (peak in July) rainy seasons (Figure 3), suggesting the importance of rainfall patterns in fungal phenology.

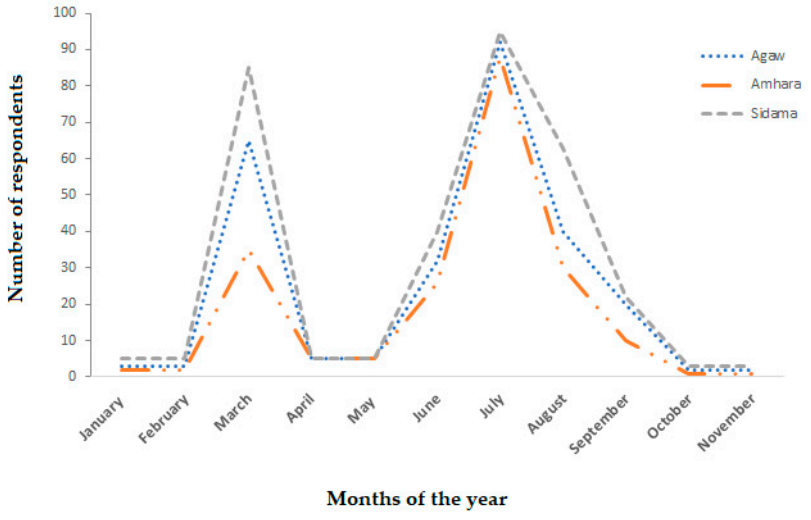


**Figure 3.** Phenology of mushrooms perceived by the three ethnic groups in the study area.

The Sidama collect wild mushroom species in Wondo Genet during the long rainy season (June to September). Mushroom availability in this area peaks between mid-July and the end of August (Figure 3). Interestingly, the majority of the respondents (97%) from Wondo Genet suggested that edible mushrooms grew during this season in well-known places and that the timing and pattern of their appearance was predictable. However, there were a few respondents (3%) from this study area who believed that some species could also be found during the dry season.

### *3.4. Wild Mushroom Use and Consumption*

The identified valuable wild mushroom species clustered in three different groups and one independent species when analyzed based on their use as food, medicine, food and medicine and unknown use (Figure 4). The respondents indicated that 12 species were not known for their use by the locals. In the second group, nine wild mushroom species were identified as edible species that were consumed by locals (Figure 4). In the third group, *Calvatia rubroflava* and *Lycoperdon perlatum* were used as food and medicine. The *Ganoderma* species, which was classified as an independent species, was used for medicinal purposes only.

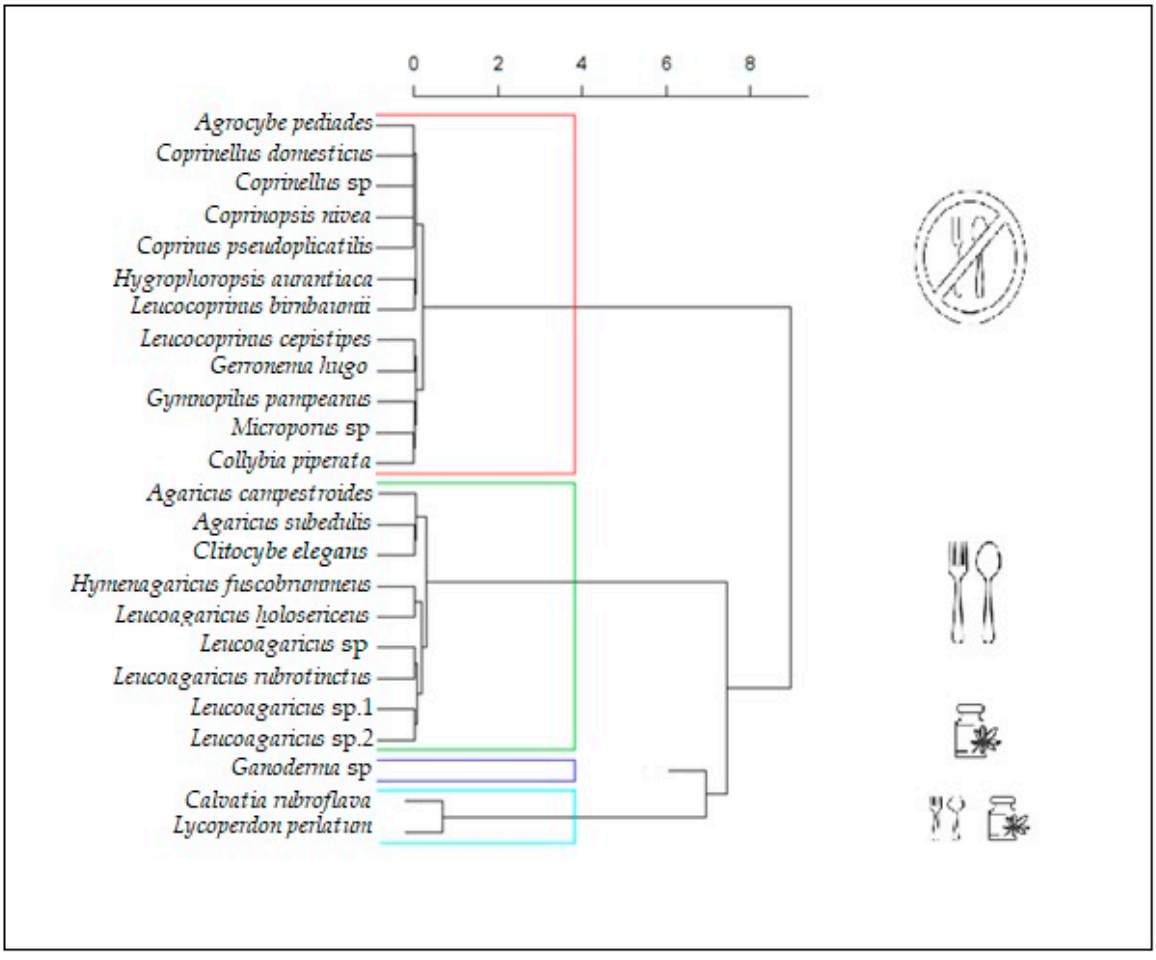


**Figure 4.** Dendrogram showing the classification of edible wild mushroom species based on their use by local communities. The horizontal axis represents the distance or dissimilarity between clusters and the vertical axis represents the species and clusters.

Wild mushroom use and consumption patterns varied among the three study areas (chi-square test; $p < 0.05$), with only the Sidama ethnic group using wild mushrooms. However, among the Sidama respondents, there was a significant difference in their perception of wild mushroom species

(chi-square test; $p < 0.001$). About 86.7% of the interviewed individuals considered mushrooms to be a substitute for meat, whereas 21.3% considered mushrooms to be a vegetable in their daily meal. The majority of the respondents consumed mushrooms by cooking them with onions, vegetables, and oil; however, some (23%) consumed mushrooms when cooked with chili sauce or when cooked with oil and salt (8%) (Table 4).

About 71% of the Sidama that were interviewed were able to distinguish between edible and poisonous wild mushrooms. Edible species were distinguished based on aroma (like that of the soil), color (usually gray), the size of the sporocarps, habitat (leaf litter) and edibility information acquired from their forefathers. Moreover, the Sidama believe that if animals feed on a mushroom species then the mushroom must be edible. The most commonly used edible species in the Wondo Genet area included *Agaricus subedulis* Heinem., *Hymenagaricus fuscobrunneus* Heinem., *Clitocybe elegans* (Fr.) Staude., *Lycoperdon perlatum* Pers., *Calvatia rubroflava* Fr., and *Leucoagaricus leucothites* (Vittad.) Wasser. The Sidama do not preserve wild mushroom species for future use because they do not have the knowhow for mushroom preservation.

The Sidama identified poisonous mushrooms by their bright colors. In addition, if, for example, a dead insect is found on a mushroom or skin itch when the mushroom touches the body, then the mushroom is considered to be poisonous. If poisoned by ingesting a mushroom in Wondo Genet, the individuals interviewed indicated that they would drink fresh goat's blood (95%), the juice of *Kocho*, which is produced from *Ensete ventricosum* (Welw.), milk (90%), or vomit (65%). Moreover, 87% of the interviewed individuals indicated that '*Gadifuto*' (both *C. rubroflava* and *L. perlatum*) were used as a powder/spores to cure skin disease and to treat human and livestock wounds.

Although wild mushroom collection by the Amhara and the Agew ethnic groups is not common practice, the group discussions in both study areas revealed that the local people were aware that mushrooms are a food resource because their descendants and neighboring communities (mainly the Gumz) used to collect and eat mushrooms from the forest. Interestingly, some Agew individuals (3%) used to eat roasted mushrooms, and they indicated that this tradition was inherited from their forefathers. People participating in the group discussion in the Banja Woreda also confirmed that their ancestors used to eat roasted and cooked young *Lycoperdon* species with vegetables and oil. Among the interviewed individuals from both ethnic groups, 91% considered the majority of wild mushroom species to be poisonous and not good for health. However, no cases of mushroom poisoning have been recorded in the Banja or Fogera study areas. Interestingly, some members of both groups (Amhara (16%) and Agew (21%)) have some knowledge of cultivated edible mushrooms and their nutritional value (i.e., *Agaricus bisporus* (J.E.Lange) Imbach, *Lentinula edodes* (Berk.) Pegler, and *Pleurotus ostreatus* (Jacq. ex Fr.) P.Kumm) because they have received training from Woreda forestry expertise.

Wild mushroom species have not been commercialized in any of the study areas. The entire mushroom harvest in Wondo Genet is used for household consumption.

### 3.5. Factors Influencing Wild Mushroom Use

According to the binary logistic model, most of the evaluated factors differed significantly in their influence on wild mushroom consumption (chi-Square, $p < 0.05$; model fit, $R^2 = 0.883$). Only age, nutritional knowledge, and indigenous identification knowledge had no influence on consumption ($p > 0.05$; Table 5). The positive elasticity in the coefficients implies that a unit addition to any of the significant parameters will have a positive influence on wild mushroom consumption by the studied ethnic groups. This also holds true for the negative significant estimated coefficients. A unit reduction to any of them will have a negative influence on wild mushroom consumption by the studied ethnic groups

**Table 5.** Factors influencing wild mushroom consumption based on a binary logistic regression model.

| Parameters | Coefficients | Standard Error | *p*-Value |
|---|---|---|---|
| Region | 0.43 | 0.51 | 0.000 ** |
| Woredas | 5.52 | 0.58 | 0.000 ** |
| Age | −0.03 | 0.02 | 0.889 |
| Education level | −1.41 | 1.05 | 0.000 ** |
| Ethnicity | 9.24 | 1.10 | 0.000 ** |
| Perceived value | −5.64 | 0.42 | 0.004 * |
| Taste experience | 7.02 | 0.65 | 0.003 * |
| Nutritional knowledge | −17.83 | 0.49 | 0.078 |
| Indigenous identification knowledge | −0.26 | 0.22 | 0.122 * |
| Constant | 0.88 | 0.34 | 0.290 |

**Note:** ** and * indicate significance at the 0.01 and 0.05 probability level, respectively.

### 3.6. Perceived Status and Threats

According to the perceived view of the respondents, the status of wild mushroom species did not differ significantly among the three ethnic groups (chi-square test; $p > 0.05$). The perception of the status of wild mushroom species was decreasing in their locality was decreasing (Figure 5). The aggregate perception also indicated that 60.67% of respondents perceived that the status of wild mushroom species had decreased compared with that in previous years, 32% perceived the status to be unchanged and 7.33% perceived the status to have increased.

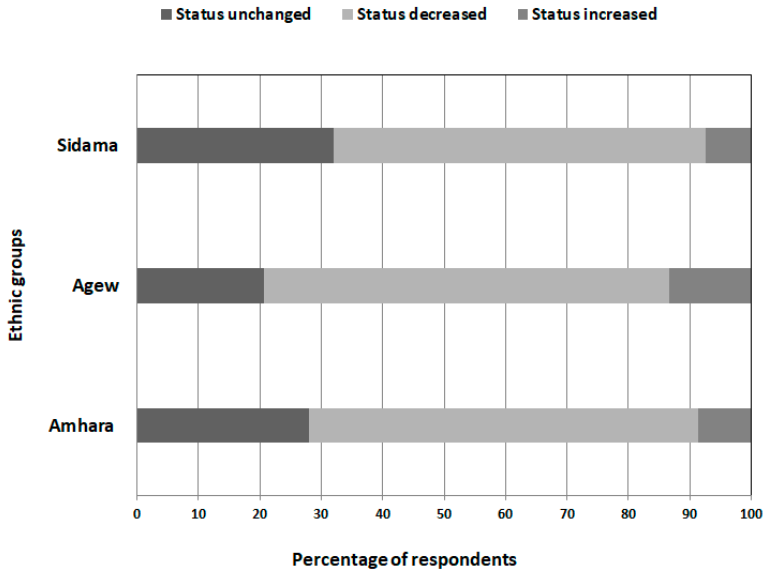


**Figure 5.** Perceived view of respondents in the Amhara, Agew and Sidama ethnic groups regarding the status of wild mushroom species in their locality.

Based on the results of the respondents' views, the major causes of wild mushroom degradation were perceived to be free grazing, agricultural expansion, settlements, fire incidence, climate change, and unknown reasons (Table 6). Among these, free grazing, agricultural expansion, settlements, and fire incidence were perceived to have a significant influence (Kruskal–Wallis test, $p < 0.05$) on the status of wild mushroom species in the three study areas.

**Table 6.** Major causes of wild mushroom degradation based on the mean risk value for each threat categorized by respondents from each ethnic group on a scale of 1 to 3. Threat: Ag, agricultural land expansion; Set, settlements; F, fire incidence in the forest; G, free grazing; CC: climate change; and UF, unknown factors.

| Ethnic Group | Ag | Set | F | G | CC | UF |
|---|---|---|---|---|---|---|
| Amhara | 2.58 | 1.74 | 2.99 | 2.22 | 1.00 | 1.00 |
| Agew | 1.85 | 1.11 | 2.24 | 1.18 | 1.00 | 1.00 |
| Sidama | 2.46 | 1.44 | 2.28 | 2.08 | 1.00 | 1.00 |
| Total mean | 2.34 | 1.43 | 2.45 | 1.90 | 1.00 | 1.00 |
| Std. deviation | 0.71 | 0.50 | 0.50 | 0.86 | 0.00 | 0.00 |
| Kruskal–Wallis test ($p$ value) | 0.000 | 0.008 | 0.000 | 0.000 | 1.00 | 1.00 |

## 4. Discussion

Previous Ethiopian ethnomycological reports have usually been based on small-scale case studies [33,34,37,62]. In this ethnomycological study, we included two regions with different ethnic compositions. The Sidama ethnic group are mycophiles and have a more extensive folk taxonomy for mushrooms than the other ethnic groups [14,27,63], indicating that the Sidama ethnic group is good at sharing ethnomycological knowledge within the ethnic group [27,29,63]. Traditional healers are key informants for the identification and characterization of medicinal species because they use different species for their traditional medicinal practices [31,62]. In addition to their use as food, *Lycoperdon perlatum* Pers. and *Calvatia rubroflava* Fr. were reported to be the most useful and important medicinal wild mushroom species because they play a key role in treating wounds and skin disease. Interestingly, *Laetiporus sulphureus* (Bull.) Murrill. sensu lato has also been reported to be a common traditional medicine for lessening pain during childbirth in Kaffa areas in the southern part of Ethiopia [36], where local people preserve powder of this species for long periods in the house. Interestingly, in this study, a *Ganoderma* species was also used for medicinal purposes by the local people. Other studies have also reported that these mushrooms are used in traditional medicine by different local communities around the world to treat stress, pain, measles and lung diseases [64–66].

In our study, the surveys revealed that the Amhara and the Agew have limited ethnomycological knowledge and do not eat mushrooms even though their parents or grandparents have consumed wild mushroom species in the past and commercial mushroom species are being cultivated artificially in their locality. The non-consumption of mushrooms will eventually represent a loss of mycological knowledge in these ethnic groups [29]. Only two of the species common to their locality have been assigned a folk taxonomy by these ethnic groups (Table 3) while the common name of the majority of wild mushroom species was reported to be Enguday or Yejibtila. Therefore, rigorous work is needed in Banja and Fogera to develop a folk taxonomy [31,39]. However, this study did provide us with an opportunity to understand how different ethnic groups in Ethiopia use their ethnomycological knowledge. This sentiment echoes expressed by Tuno [34], who reported that observing the traditional ways of mushroom utilization by the Majangir ethnic group in the southwest part of Ethiopia provided a unique opportunity for studying how people belonging to traditional tribes in Africa utilize mushroom as foods [34,39]. The findings presented in [34] suggested that communities in rural part of Ethiopia are familiar with wild mushroom species growing in their locality and prize them as subsidiary food items collected in the forest [34].

In this study, communities, particularly the Sidama, were easily able to distinguish between wild mushroom species using their own traditional protocols. Broadly, they used morphological characters, smell and habitat to identify edible mushrooms. These criteria are in line with [31,34]. The oldest accounts of this practice among tribes in developing countries have been putatively reflected by different authors [67–70]. Beside these criteria, in rural areas of Ethiopia, the local people also use the presence or absence of a strong bad smell [34] to determine the edibility of mushrooms. Thus, it could be assumed that such traditional protocols are the product of ancient experimentations and

possibly opportunistic discoveries by the indigenous people despite the confounded genealogy of their cultural uses [63]. Among the Sidama, women are generally involved in the collection and gathering of wild mushroom species and children are involved in the collection of well-known mushrooms. This is in line with [36], who reported that women are often responsible for this type of activity in the south and southwestern parts of the country, and also agrees with the findings of several other authors [27,34,39,63]. Because women are responsible for collecting firewood from the forests in the Wondo Genet area, they have become expert at distinguishing between edible and poisonous mushrooms [34,36] and are knowledgeable about the spatial distribution of mushrooms in terms of habitat and associated substrates in the forest and other niches [31,38].

Respondents also revealed that all mushrooms are collected during the rainy season (June to September) and used especially during food shortage periods. However, Dejene et al. [31] reported that the collection of some species, such as *Laetiporus* sp., could occur during the dry season [34,37]. Grain is the principal source of nutrition for communities in most parts of the country. In general, the availability of mushrooms in the rainy season coincides with periods of grain scarcity, suggesting that local communities may use wild mushroom species together with other edible wild foods during this period as a gap filler [31]. Common areas identified for wild mushroom collection were natural forests, farmlands, grazing lands, home gardens, and swampy areas. Most of these ecological niches are quite similar to those reported by [36,37] in the south and south western parts of the country. If communities are trained well, this culture of collecting wild mushroom species could be expanded to shift from subsistence use to income-generating small-scale business speculations through their commodification.

We have got determinant variables on wild mushroom consumption by the local communities in the three study woredas, implying that any of the significant variables has a positive effect on wild mushroom use the local people. For example, "taste experience" has a positive effect on wild mushroom use in the study area. This implies that those individuals who have tasted a wild mushroom species have better awareness of its use than those that have not tasted the species. This experience helps to understand the local livelihood context, the sources and nature of risks and the coping behavior of communities. This supports the findings of Lemenih et al. [71] who indicated that household experience is a commonly applied strategy for coping with shocks and is instrumental in poverty reduction. Thus, a local communities' experience of tasting a mushroom has implications for poverty reduction through emphasizing local available sources of the mushroom, enabling rural households to diversify their food sources. The same applied to the other positive coefficient variables, implying that a unit addition to any one of them will have a positive implication for wild mushroom consumption.

We evaluated different threats that affect wild mushroom species based on the perceived causes for degradation. Many of the threats related to habitat degradation are affecting wild mushroom species in Ethiopia in general. Free grazing and agricultural land expansion were considered to be the main threats in this study. This might be because rapidly growing human and livestock populations are driving an ever-increasing demand for crop and grazing land, which is aggravating the degradation of habitats in Ethiopia [32,72,73]. Such anthropogenic pressures are likely to also have an impact on useful known and unknown wild mushroom species, some of which could face extinction [73]. Moreover, this loss also limits the benefits that can be obtained from wild mushroom components of forest resources as well as the ethnomycological knowledge of different ethnic groups associated with mushroom use. Thus, the sustainable management of Ethiopian forest systems is mandatory in order to play major roles in the conservation and development of wild edible and medicinal mushrooms that cannot be economically cultivated, require very specific habitats, and are exceptionally difficult to reproduce in nurseries or laboratories. Furthermore, the importance of fungal resources has recently been brought to the forefront due to their ecological and economic importance. There have been many efforts to record their diversity at local and regional scales. Thus, product diversification is a fundamental strategy to integrate a model of sustainable forest exploitation and reverse the degradation of wild mushroom species through promoting ecosystem services such as biodiversity conservation.

## 5. Conclusions

This study has attempted to provide baseline information about the ethnomycology of three ethnic groups in Ethiopia. The Amhara and Agew ethnic groups are located in the same geographic region, are in contact with the same natural resources and have a similar knowledge of wild mushrooms. This similarity is a result of their cultural exchanges, coexistence, and shared historical events. Furthermore, parallel responses were reported in many cases, such as the consumption of wild mushroom species by their parents or grandparents even though the respondents do not eat mushrooms, which will eventually lead to the loss of mycological knowledge in these two ethnic groups. By contrast, wild mushroom consumption is an integral part of the cultural knowledge of seasonal resources among the Sidama communities in the southern part of the country. Thus, the different traditional food composition and recipes of the ethnic group should be further studied to ensure the potential value of wild mushroom species in the nutrition and food security role in the community.

Sidama women are primarily responsible for gathering and collecting valuable wild mushrooms, indicating that gender is one of the variables that influence the local knowledge of wild mushroom use and their distribution in the locality. This could also have implications for women contributing toward household food security using locally available food resources such as fungi. In other words, fungi could be a means of providing supplementary food, thereby reducing poverty and providing opportunities for women living in unfavorable areas and, hence, reducing inequality. Similarly, although most of the individuals interviewed from the Amhara and Agew ethnic groups were not familiar with the wild mushrooms, they appreciated the food value of the mushrooms when they tasted them. Thus, the experience of tasting mushrooms by local communities has implications for poverty reduction through emphasizing local available sources that enable rural households to diversify their food sources.

Although we have tried to document the traditional knowledge and uses of wild mushroom species of three ethnic groups in Ethiopia, more studies are needed to ensure that much of the potential value of wild mushroom species and the ethnomycology knowledge of local communities is not lost. Such knowledge is part of the identity of these communities: knowledge of wild mushroom uses, linguistics, and harvesting can prevent their loss as modernization proceeds due to the dominance of hegemonic culture. Documentation of this knowledge could promote a revaluation of wild mushroom species as resources and promote their conservation. The knowledge and nomenclature of useful species could also be revitalized, and their use encouraged, and in doing so, wild mushroom species could make a greater contribution to food security, especially in a country like Ethiopia where food security is a country-wide issue.

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