Original Research Article

ETHNOMYCOLOGICAL STUDY OF MACROFUNGI FROM MPANGA FOREST IN MPIGI DISTRICT, CENTRAL UGANDA

ABSTRACT

This study focused on the documentation of wild macrofungi species used by village communities living around Mpanga Forest in Mpigi District, Central Uganda. In order to determine the variability of knowledge and the modes of use of macrofungi by the local communities, a total of 100 people, distributed in 4 villages (Kalagala, Nakigudde, Mpambire, and Lwanga) including 25 people in each, were interviewed following a semi-structured survey. The information focused on vernacular names, different species of macrofungi used, different categories of uses (food, medicinal, commercial, mythical, and traditional beliefs), Seasonality, habitat, preservation, and preparation methods. The diversity of macrofungi was assessed by combining visits in Mpanga forest and ethnomycological surveys. Ethnomycological indices such as Total Use Value (TUV), Diversity Index (DI), Pielou Regularity Index (EI), and Sorensen's K test were calculated to analyze the use differences between the 4 village communities. To determine the influence of age, gender and literacy level on the mycological knowledge held by village communities, one-way ANOVA and t-tests were used. The field collections associated with the ethnomycological surveys made it possible to identify a total of 35 species useful for the local communities among which, 29 are edible, 14 are medicinal, 5 are used for income and 4 are used for mythical and traditional beliefs. Due to their higher total use value (TUV>1), species such as *Leucoagaricus rubrotinctus* (Ggudu), *Termitomyces sp.1* (Bubbala) and *Termitomyces sp.2* (Nakyebowa) are the most exploited by local communities. The study revealed that ethnomycological knowledge is held by a minority of respondents (IE<0.5) within each village community, a consistency homogeneity of this knowledge within this minority (DI<DImax/2), but high variability in the use of macrofungi between village communities as indicated by TUV values and Sorensen's K test. The study also shown that the distribution of mycological knowledge of local communities was significantly ($P < 0.05$) influenced by gender, age and level of education. The results of this study provided information that could, in the future, be used in the domestication of wild macrofungi species and in mycomedecine to contribute to food security and improve public health care.

Key words: Ethnomycology, useful macrofungi, variability, exploitation, village communities, Bantu people, Mpanga forest.

INTRODUCTION

Ethnomycology is a subject of growing interest in tropical Africa, it studies the contributions of people from different linguistic groups to the study of macrofungi (Eyi-Ndong, 2009), it's a term referring to the study of local knowledge of macrofungi and their uses. It popularises more the diversity of useful macrofungal species over the poisonous ones and provides insight into their sociological impacts on human behaviors, and indigenous uses (Osemwegie *et al.*, 2014). While the interaction of humans and macrofungi dated back to many millennia and peaked in the food gathering era, the documentary evidence of ethnomycological knowledge is a more recent conception. The earliest accounts of ethnomycology emerged within the century and became a migrated discipline from ethnobiology (people biota-environment interactions) and ethnobotany (cultural uses of plants) (Osemwegie *et al.*, 2014). Controversially, it also overlapped with social science-based disciplines like anthropology (study of humankind) and ethnography (empirical data on human society and culture) (Osemwegie *et al.*, 2014; De Kesel & Degreef, 2007).

Macrofungi play an important role for the local communities of tropical Africa as sources of food, medicines and substantial income (Koné *et al.*, 2013; Yorou *et al.*, 2002a, b, 2013). Over two-thirds of these communities depend on forest products, either for subsistence or as cash income derived from a wide range of non-timber forest products (NTFPs), including macrofungi (Rammeloo *et al.*, 1993). Nutritionally, they are an important source of proteins, vitamins, fats, carbohydrates, amino acids, and minerals (Adejumo & Awosanya, 2005; Degreef *et al.*, 1997), i.e., a worthy alternative or substitute for meat and fish (Eyi-Ndong *et al.*, 2014; Adejumo & Awosanya, 2005). Besides their use as food, the ethnomedical and ritual use of hallucinogenic macrofungi for divination and healing (Lampman, 2004; Treu & Adamson, 2006) among traditional peoples in various parts of the world is another important aspect of human-macrofungi interactions. Macrofungi are also known to be rich sources of various bioactive substances such as antibacterial, antifungal, antiviral, antiparasitic, antioxidant, anti-inflammatory, antiproliferative, anticancer, antitumor, cytotoxic, anti-HIV, hypocholesterolemic, antidiabetic, anticoagulant, hepatoprotectors, among others (Wasser & Weis, 1999; Ajith & Janardhanan, 2007). Despite the serious socio-economic role macrofungi play in traditional tropical Africa (Osarenkhoe *et al.*, 2014), they also play a central role in the ecological balance in the ecosystem as major decomposers (Malinowska *et al.,* 2004; Gates *et al.,* 2011). In view of all these important roles that macrofungi play, FAO (1991) promotes the sustainable use of macrofungi for forest management, biodiversity conservation and their long-term effect on income generation and food security.

There are about 2166 species of edible macrofungi recognized worldwide, including about 470 species with medicinal properties (Parveen *et al.*, 2017). In Africa, the number of recognized edible and medicinal species is low compared to the mycological potential of its tropical forests and the wealth of indigenous knowledge held by forest communities. However, nearly 300 species of wild edible macrofungi have been reported in all of sub-Saharan Africa, this number varies from one country to another, depending on the type of vegetation in the region under consideration and the quality of the inventories carried out (Rammeloo & Walleyn 1993; Walleyn & Rammeloo,1994). Boa (2004) showed in his report that countries on the continent where there are better reports of macrofungi use include South Africa, Zambia, Zimbabwe, Nigeria, Democratic Republic of Congo, Cameroon, Morocco and Kenya. However, recent studies on ethnomycology have been carried out in some countries such as Benin (Fadeyi *et al.*, 2017), Burundi (De Kesel *et al.*, 2017), Rwanda (Degreef *et al.*, 2016), DR Congo (Madamo Malasi *et al.*, 2017; Ebika *et al.*, 2018; Milenge Kamalebo & De Kesel, 2020), Ivory Coast (Kouamé *et al.*, 2018; Yian *et al.*, 2020; N'Douba *et al.*, 2021; Christine *et al.*, 2021), Togo (Kamou *et al.*, 2017b), Cameroun (Awana, *et al.*, 2018; Teke *et al*., 2018), Tanzania (Qwarse *et al.*, 2021), Zimbabwe (Lunga & Musarurwa, 2016) and Ethiopia (Sitotaw *et al.*, 2020).

In Uganda, apart from earlier publications by Pegler (1977), Rammeloo & Walleyn (1993) & Katende *et al.* (1999), those of Opige *et al.* (2006) and Nakalembe *et al.* (2009), constitute for the moment the only documentation available on ethnomycology. In studies carried by Pegler (1977); Rammeloo & Walleyn (1993); Katende *et al.* (1999), 10 species of edible macrofungi were identified while in that carried out by Nakalembe *et al.* (2009), 16 types of macrofungi have been identified, and all of them are used as a natural food and some as medicine and for cultural festivals by local communities of Mid-Western Uganda. Opige *et al.* (2006) listed 28 species of macrofungi of which 22 have been identified by the local community of Eastern Uganda as useful, food and medicine and 6 are used solely as medicine. However, no ethnomycological studies have been conducted in central Uganda, although communities living around Mpanga Forest hold traditional mycological knowledge. Hence the interest of conducting this study in order to preserve the cultural knowledge acquired from the ancients concerning macrofungi, to serve as primary information for future research in the field of nutrition and mycomedecine, and to design practices people-centred natural resource management and biodiversity conservation.

The main objective of our study is to contribute to the traditional mycological knowledge in Uganda, in particular of the communities living around Mpanga forest. The specific objectives aim to inventory the macrofungi from Mpanga forest used by the local communities living in the villages of Kalagala, Nakigudde, Mpambire and Lwanga in Mpigi district, to determine the variability in the knowledge and exploitation of macrofungi according to the different village communities and to describe their modes of use by these communities.

MATERIALS AND METHODS

Study area

Specimens were collected from Mpanga Research Forest located in Mpigi District, central Uganda **(Fig.1).** Mpanga Forest Reserve (0 ° 127 'N, 32 ° 175' E) is an area of moist semi-deciduous forest that lies between 1140 and 1200 m altitude in the Mawokota County, south of Mengo, 3 km southwest of Mpigi town, 36 km west of Kampala and 25 km north-west Entebbe, only about 20 km from the shores of Lake Victoria (Taylor *et al*., 2008). It is also located in the climatic zone of Lake Victoria (Anon, 1967), characterized by a bimodal distribution of precipitation, with the wettest periods from March to June and from September to December. The mean annual precipitation and the minimum and maximum temperatures are estimated at 1168 mm, 17.2 ° C, and 26.1 ° C, respectively with a relative humidity of 90% (Baron *et al.*, 2017). Soils in the region are generally red and yellow latosols on the peaks and crests, sandy-gray loams on the lower slopes of the hills, and gray-blue clays and silts on the lower slopes and valleys (Thomas, 1945; Langdale-Brown, 1960). Mpanga is a small expanse of natural equatorial forest of 453 hectares (SLP, 2017) which supports an impressive plant biodiversity composed of 500 species of trees and shrubs (NTEA, 2014) and dominated by *Moraceae* and *Euphorbiaceae* (Turyahabwe & Tweheyo, 2010). Some of the floristic elements are *Beilschmiedia ugandensis, Lovoa trichillioides, Budongo Mahogany, Euntumia Africana, Morus nigra, Trichilla emetica, Celtis mildbraedii, Pseudospondias macrocarpa, Celtis durandii, Albizia coliria, Albizia glaberrima, Albizia zygia, Celtis zenkeri, Antiaris toxicaria, Entandrophragma spp, Funtumia spp., Antiaris toxicara, Ficus exasperata, Ficus mucoso…*

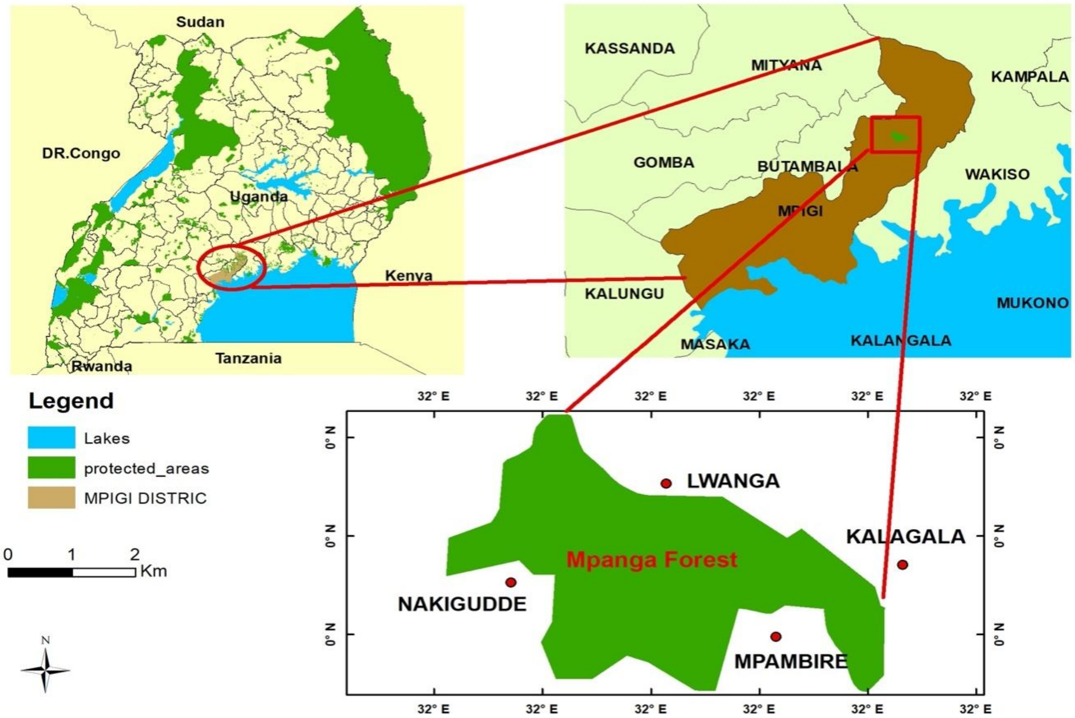

Fig.1. Location of the study area showing Mpanga forest surrounding by the four villages surveyed in Mpigi district, central Uganda

Data collection and identification of specimens

The collection of specimens was carried out in Mpanga forest, during the months of March, April and May 2020 (for the first rainy season) then of September, October, November and December 2020 (for the second rainy season) since macrofungi can't be observed all year round (Blanchard *et al.*, 2016) for most of the time. Thus, a preliminary study was carried out at the beginning of March 2020 to confirm the choice of sites which should house the plots. This study was guided by an experienced forester who has a good knowledge of the different types of forest stands in Mpanga where the macrofungi most often grow. At the end of this preliminary study, 4 sites were selected. The method that was used is plot and survey sampling recommended by Yorou *et al.* (2001). Three permanent plots of 30m x 30m have been installed in each of the 4 sites. The location of the plots was chosen at random within the sites. The distance between the plots (taken two by two) of the same site is at least 100 m. In order to facilitate the location of the plots, trees along the boundaries of the plots have been tied with a ribbon and the geographic coordinates of the plots and of each species of macrofungi harvested have been recorded using a GPS. The geographical coordinates of the plots are as follows:

Site 1 / Plot 1 (0^0 12' 33'' N - 32^0 18' 9'' E); Plot 2 (0^0 12' 33'' N - 32^0 18' 12'' E); Plot 3 (0^0 12' 29'' N - 32^0 18' 6'' E).
Site 2 / Plot 4 (0^0 12' 42'' N - 32^0 17' 27'' E); Plot 5 (0^0 12' 36'' N - 2^0 17' 27'' E); Plot 6 (0^0 12' 39'' N - 32^0 17' 31'' E).
Site 3 / Plot 7 (0^0 12' 14'' N - 32^0 17' 7'' E); Plot 8 (0^0 12' 9'' N - 32^0 17' 11'' E); Plot 9 (0^0 12' 15'' N - 32^0 17' 13'' E).
Site4 / Plot 10 (O^0 12' 11'' N - 32^0 17' 42'' E); Plot 11 (0^0 12' 9'' N - 32^0 17' 4'' E); Plot 12 (0^0 12' 6'' N - 32^0 17' 46'' E).

The collection technique used is that of Mueller *et al.* (2004). It consists of sweeping the entire plot in parallel strips of 2 m to avoid oversights. During the collection, all visible macrofungi were systematically collected and sorted by species as far as possible. This technique was supplemented by opportunistic sampling to consider the random distribution of fruiting bodies and species observed outside the plots (Mueller *et al.*, 2004).

For the in-situ photography of the samples collected, a digital camera was used to photograph each taxon encountered in order to materialize the morphological characters. Ecological features were also noted in-situ. At the end of the collection, all the samples were put in a basket and transported to the Laboratory of the Faculty of Agriculture of the Uganda Martyrs University where they were described and identified. By comparing the morphological and ecological characteristics previously described with those described in the identification manuals, the confirmation of the identification of our samples was carried out. The manuals which were used to confirm the identification are: "Iconographic flora of the mushrooms of the Congo" (Heinemann, 1958), "Illustrated flora of the mushrooms of Central Africa (Horak & Heinemann, 1978), Taxonomic and identification of edible mushrooms dense forests from central Africa (Eyi-Ndong *et al.,* 2011), and " A preliminary Agaric Flora of East Africa" (Pegler, 1977). The last one is a review of the macrofungi of tropical Africa with a focus on East Africa. For the update and the nomenclature of macrofungi, the exhaustive synonym update list available at http://www.indexfungorum.org/names/Names.asp was consulted.

Before final conservation in the herbarium, our samples were dried using a drying oven at a temperature of 50 to 65° C in order to preserve the DNA and allow its subsequent analysis. The drying time is 2 hours for non-fleshy specimens and 4 hours for fleshy or waterlogged specimens. After drying and in order to avoid any rehydration, the still hot specimens are packaged with their number in hermetic plastic bags of the "Minigrip" type which are immediately sealed.

Ethnomycological surveys

Surveys were conducted in the district of Mpigi more precisely within 4 villages (Nakigudde, Mpambire, Kalagala, and Lwanga) located around the forest of Mpanga **(Fig.1).** Mpigi District is bordered by Wakiso District to the north and east, Kalangala District to the south, Kalungu District to the southwest, Butambala District to the west, and Mityana District to the northwest **(Fig.1).** According to Uganda Bureau of Statistics (2016), in 1991, the district population was estimated at about 157,400. The next census in 2002 estimated the population of the district at about 187,800, with an annual growth rate of 1.4%. In 2012, the population of Mpigi District was estimated at approximately 215,500. The district is primarily a rural district, with only 8.4% of the population living in urban areas. In the 4 villages surveyed, the majority ethnic group is Bantu and the most spoken language is Lungada followed by Lunyankole. The main activity of the villagers is farming. The main crops are: banana, coffee, maize, groundnut, cassava, tomato... Breeding is the second activity and concerns especially poultry, goats, pigs,

cattle, sheep. Selling macrofungi is a lesser and seasonal activity. The trade concerns mainly food and craft products along the roads and at the market. The questionnaires developed by Assogbadjo *et al.* (2013) were used and readapted then inserted into the kobo tools software before being presented to the people to be interviewed, considering both the elderly and the young. A total of 100 people, including 25 in each village, were interviewed following a semi-structured sampling. The choice of respondents is based on the following criteria: sex, age, level of education and marital status. Respondents were interviewed one by one isolated way so that the answers given by one are not heard by the one who will be interviewed afterwards (Ebika *et al.*, 2018). The people interviewed are men and women living in 4 different villages (**Table 1**) and aged between 18 and 90 years old. Photos of the specimens collected were presented to people interviewed to aid in recognition but sometimes the specimens were brought by the people surveyed themselves. We were also guided by a person familiar with the local language for translation purposes. The information focused on vernacular names, different species of macrofungi used, different categories of uses (food, medicinal, commercial), seasonality, habitat, preservation and preparation methods.

Table 1. Distribution of people interviewed by village and gender

Villages / Gender	Nakigudde	Mpambire	Kalagala	Lwanga
Male	9	10	10	10
Female	16	15	15	15

Total	25	25	25	25

Data analysis

To assess the endogenous knowledge of the local communities in about the various species of macrofungi they use, the frequencies of use of each species for each category of specific use were given by each respondent. Using these frequencies, the method of Assogbadjo *et al.* (2013) was used to assign scores according to the following logic:

- The species is not used at all by the respondent: **0**
- The species is rarely used by the respondent: **0.5**
- The species is frequently used by the respondent: **1**
- The species is very frequently used by the respondent: **1.5**

These different assigned scores allowed us to calculate some ethnomycological indices:

- ***RUV:*** Reported Use Value of Gomez-Beloz (2003)

$$RUV_i = \sum_i^n Species_i$$

The total number of uses reported for a species *(e)* by the respondent *(i)*. But we will determine RUV by village community (and not by respondent) for each species.

- ***EUVek:*** ethnomycological use value for the use category *(k)* according to the respondent *(e)*. (Fandohan *et al.*, 2010):

$$RUV_{ek} = \sum_i R_{ekj}$$

R_{ekj} is the score given to the specific use (j) within the category (k) by the respondent (e).

- ***EUVk***, the ethnomycological use value of a species for a use category (k) is given by the following formula (Boni & Yorou, 2015).

$$RUV_k = \sum_e EUV_{ek} / N$$

N is the number of respondents.

- ***EUV_T,*** the total ethnomycological use value of a species *(e)* is given by following (Boni & Yorou, 2015).

$$EUV_T = \sum_k EUV_k$$

- ***DI:*** specific diversity index value of the respondent *(e)* (Byg & Balslev, 2001):

$$DI = 1 / \sum P_e$$

P_e is the number of uses cited by the respondent 'e' for a given species divided by the total of uses cited for the species (considering all respondents). ***DI*** measures how many respondents use a given species and how this knowledge is distributed among respondents. Its value varies between 0 and the number of respondents using the species **(*DI_{max}*).** In practice, this value translates the level of knowledge and use of the resource among the respondents, and therefore makes a comparison of the level of knowledge and knowledge between village communities.

- The respondent's equity index (***EI***) (Byg & Balslev, 2001):

It is the value of the diversity index (DI) divided by the maximum value of the diversity index (***DI_{max}***). It is given by the formula: ***$EI = DI / DI_{max}$*** and measures the degree of homogeneity of respondents' knowledge. It is between 0 and 1. In practice, this value reflects the degree of homogeneity of knowledge between village communities.

- **Sorensen's similarity test K= 100x 2a / (2a + b+ c)** (Assogbadjo *et al.*, 2013) was also used, which allowed us to conclude whether or not the villages taken in pairs exploit the resource in the same way. For example, if **K > 50%** the 2 village communities exploit the same resources. **a** is the number of species used by the 2 village communities, **c** is the number used by village community 1 and **b** is village community 2.

Descriptive statistics were applied to identify the number and percentage of macrofungi species used by local communities, preferred habitat of macrofungi, seasonality, preparation and preservation methods. The dynamics of indigenous knowledge on the use of macrofungi among respondents from village communities according to age, gender and literacy level were assessed statistically using a t-test and a one-way ANOVA. a 95% confidence level between the means using SPSS software. version 20.

RESULTS

Diversity and exploitation of macrofungi by local communities

Ethnomycological surveys carried out among Bantu people living around Mpanga forest revealed a diversity of 35 species of macrofungi useful including 32 vernacular names distributed by category (**Table 2**). In these categories, edible macrofungi are the majority with 29 species (83%) of which 5 are used for income and 8 are medicinal. However, 6 species (17%) are exclusively medicinal. Among the 35 macrofungi used by the local communities, the village communities of Nakigudde and Lwanga cited more species with respectively 21 and 20 species against 14 for the village community of Mpambire and 9 against that of Kalagala. Species are appreciated differently by local communities. However, species like *Leucoagaricus rubrotinctus* (Ggudu), *Termitomyces sp.1* (Bubbala), *Termitomyces sp.2* (Nakyebowa), *Termitomyces robustus* (Kkangango) and *Volvariella volvacea* (Akasukusuku) are highly appreciated by all the village communities. **Photo 1** represents some species of macrofungi used by local communities living around Mpanga forest.

Table 2. List of edible and medicinal macrofungi recognized by local communities.

N°	Scientific names	Vernacular names	E	M	IC	PA
1	*Leucoagaricus rubrotinctus* (Peck) Singer	Ggudu	+	+	+	1
2	*Termitomyces sp.1*	Bubaala	+	+	+	1
3	-	Ngomayakikere	+	-	-	4
4	*Termitomyces sp.2*	Nakyebowa	+	+	+	1
5	*Auricularia auricula-judae* (Bull.) Quél	Amaleere	+	+	-	3
6	*Volvariella volvacea* (Bull.) Singer	Akasukusuku	+	+	+	2
7	*Gymnopus ocior* (Pers.) Antonín & Noordel	Kajjanankuba	+	-	-	4
8	*Psathyrella pennata* (Fr.) A. Pearson & Dennis	Nassogorero	+	+	-	3
9	*Psathyrella leucotephra* (Berk. & Broome) P.D. Orton	Lukoota	+	-	-	2
10	-	Namulondo	+	-	-	4
11	*Termitomyces robustus* (Beeli) R. Heim	Kkangango	+	-	+	2
12	*Termitomyces sp.4*	Akatundatunda	+	-	-	3
13	*Entoloma sp.*	Akanakanaka	+	-	-	4
14	*Termitomyces sp.3*	Busejjere	+	-	-	3
15	*Gymnopus luxurians* (Peck) Murrill	Mutunduggo	+	-	-	3
16	*Gymnopus sp.*	Bunakanaka	+	-	-	4
17	-	Empeefu	+	-	-	4
18	*Coprinopsis domesticus* (Bolton) Gray	Mussukundu	+	-	-	2

19	*Psathyrella inflatocystis* A.H. Sm	Nakakanaka	+	-	-	4
20	*Termitomyces microcarpus* (Berk. & Broome) R. Heim	Akabaala	+	+	-	2
21	*Lentinus tigrinus* (Bull.) Fr	Kwaanya	+	-	-	4
22	*Polyporus grammocephalus* Berk	Bukokwe	+	+	-	4
23	*Polyporus tenuiculus* (P. Beauv.) Fr	Matawaala	-	+	-	-
24	-	Muggundu	+	-	-	4
25	*Microporus affinis* (Blume & T. Nees) Kuntze	-	-	+	-	-
26	*Polyporus varius* (Pers.) Fr	Muvawala	-	+	-	-
27	*Hexagonia tenius* (P. Beauv.) Fr	-	-	+	-	-
28	-	Kinyolwa	+	-	-	4
29	-	Mbobya	+	-	-	4
30	*Ganoderma applanatum* (Pers.) Pat	Konkomoza	-	+	-	-
31	*Amauroderma rude* (Berk.) Torrend	Munyeebwa	-	+	-	-
32	-	Akatonsa	+	-	-	4
33	-	Maatu	+	-	-	4
34	*Parasola auricoma* (Pat.) Redhead, Vilgalys & Hopple	Busukusuku	+	-	-	4
35	*Termitomyces clypeatus* R. Heim	-	+	-	-	4

Categories (E = Edible, **M** = Medicinal, **IC** = income)
PA = palatability (**1** = most delicious, **2** = delicious, **3** = good, **4** = just edible)

Photo 1. Some species of useful macrofungi for local communities: a. *Hexagonia tenius*; b. *Amauroderma rude*; c. *Psathyrella pennata*; d. *Auricularia auricula-judae*; e. *Parasola auricoma*; f. *Volvariella volvacea*; g. *Termitomyces microcarpus*; h. *Termitomyces robustus*; i. *Leucoagaricus rubrotinctus*; j. *Polyporus grammocephalus*; k. *Ganoderma applanatum*; l. *Termitomyces clypeatus*.

Variability in the recognition and exploitation of macrofungi between village communities

To assess the importance of each species of macrofungi for the different village communities, the ethnomycological use values were calculated for each species, by use category (edible, medicinal and income), and by village community (Nakigudde, Mpambire, Kalagala and Lwanga). The results are recorded in **Appendix 1**.

The results obtained showed that there are 4 categories of uses for the species *Leucoagaricus rubrotinctus* (Ggudu), *Termitomyces sp.1* (Bubaala), *Termitomyces sp.2* (Nakyebowa), and *Volvariella volvacea* (Akasukusuku); 3 categories of uses for *Auricularia auricula-judae* (Amaleere), *Psathyrella pennata* (Nassogorero); and *Termitomyces robustus* (Kkangango); and 1 category of uses for all other species. Macrofungi are mainly exploited for food by the Bantu people. The three most cited consumed species are *Leucoagaricus rubrotinctus* (Ggudu), *Termitomyces sp.1* (Bubbala), *Termitomyces sp.2* (Nakyebowa), with a total use value (TUV) higher than 1 for all the village communities. However, greater appreciation of these species was noted among the village communities of Nakigudde and Lwanga than among those of Mpambire and Kalagala. A total of 14 species are less appreciated as shown by their low total use value (TUV= 0 in at least two village communities). However, great variability exists in the exploitation and appreciation of macrofungi between village communities. Each village community specifically exploits and appreciates certain species. *Termitomyces clypeatus*, Muggundu and *Lentinus tigrinus* (Kwaanya) are specifically exploited by the village community of Nakigudde for food as well *Hexagonia tenuis*, *Polyporus varius* (Muvawala), *Microporus affinis* and *Polyporus tenuiculus* (Matawaala) in traditional medicine. Similarly, Akatonsa, Mbobya, *Psathyrella inflatocystis* (Nakakanaka), *Entoloma sp* (Akanakanaka), *Gymnopus ocior* (Kajjanankuba), *Polyporus grammocephalus* (Bukokwe), and *Termitomyces microcarpus* (Akabaala) are mentioned only by the village community of Lwanga in the diet as well as *Ganoderma applanatum* (Konkomoza), *Polyporus grammocephalus* (Bukokwe), and *Termitomyces microcarpus* (Akabaala) in traditional medicine. Species like *Parasola auricoma* (Busukusuku), Maatu and Kinyolwa are specifically exploited and used as food by the village community of Mpambire, while Ngomyakikere is the only species specifically mentioned as food by the village community of Kalagala.

Variability of ethnomycological knowledge within village communities

The values of diversity and equitability were calculated for each species and by village community in order to measure how the knowledge of the different species of macrofungi is distributed among respondents from the same village community. The results of the calculations are recorded in **Appendix 2.**

Considering the 4 village communities Nakigudde, Mpambire, Kalagala and Lwanga, the calculated DI is always less than half of DImax (DI<DImax/2) for all species. We can deduce that the diversity is relatively low, so there is a relative homogeneity of knowledge on the species of macrofungi within the respondents of these different village communities. In other words, edible, medicinal and income use for any species varies very little from one respondent to another within the same village community. We also noted that the DI of certain species is null in these village communities. However, the homogeneity is more marked in the village community of Nakigudde than in the others (Avg DI = 0.25 in the village community of Nakigudde against 0.32 in that of Lwanga, 0.35 in that of Mpambire and 0.49 in that of Kalagala). Moreover, the values of EI are all below 0.5, which means that the knowledge, although homogeneous, is held by a small group of respondents within each village community.

Difference in the exploitation of macrofungal resources between village communities

The Sorensen similarity test was carried out between village communities taken two by two. the calculated values of K are summarized in **Table 3**. The results showed that the different values of K are all lower than 50%, which testifies to the differential use of macrofungal resources between the village communities. Thus, the diversity of useful species varies according to these village communities.

Table 3. Sorensen's similarity test

	Nakigudde and Mpambire	**Nakigudde and Kalagala**	**Nakigudde and Lwanga**	**Mpambire and Kalagala**	**Lwanga and Mpambire**	**Lwanga and Kalagala**
K (%)	K = 36.36	K = 31.18	K = 33. 92	K = 34. 29	K = 37. 04	K = 32. 56
Number of species cited per village community	a = 10 b = 21 (Nakigudde) c =14	a = 7 b = 21 (Nakigudde) c = 9	a = 11 b = 21 (Nakigudde) c = 20	a = 6 b =14 (Mpambire) c = 9	a = 10 b = 20 (Lwanga) c = 14	a = 7 b = 20 (Lwanga) c = 9

	(Mpambire)	(Kalagala)	(Lwanga)	(Kalagala)	(Mpambire)	(Kalagala)

Influence of age, gender and level of education on the distribution of mycological knowledge

By comparing the average number of macrofungi reported by men (3.92 ± 1.80) and women (4.62 ± 2.53), that reported by women was higher, the difference was significant ($P<0.05$) (**Table 4**). The number of macrofungi reported by senior respondents from local village communities (>50 years old) was significantly higher ($P < 0.05$) than that reported by younger respondents (15-29 years old). A significant difference ($P < 0.05$) was also noted between the mean number of macrofungi reported by illiterate respondents and that reported by literate respondents.

Table 4. Statistical test of significance on average number of useful macrofungi reported by different village communities

Parameters	Respondent groups	N	Average ± SD	t value	P value
Gender	Male	39	3.92 ± 1.80	7.956	0.000*
	Female	61	4.62 ± 2.53		
Age	18 – 29 (young member)	16	2.75 ± 1.24	32.802	0.000*
	30 – 50 (middle age)	59	4.20 ± 2.08		
	>50 (senior members)	25	5.08 ± 2.25		
literacy level	Illiterate	2	5.50 ± 0.71	23.201	0.000*
	Primary	60	4.20 ± 2.08		
	Secondary	33	4.30 ± 2.24		
	Tertiary	5	2.80 ± 2.17		

*Significant difference ($P < 0.05$); t (0,0) (2-tailed), df = 99, N = number of respondents

Endogenous criteria for the recognition of macrofungi and the meaning of local names

Bantu people use several criteria to recognize certain species of useful macrofungi. These criteria are: habitat, color, smell, size, mode of growth and consumption by animals. For example, *Termitomyces sp.1* locally called Bubaala is recognized by its strong and pleasant smell, its small size, its white color, its growth in groups and the fact that it most often appears in the forest near termite mounds. The frequent consumption of this species by millipedes is also an indicator of edibility for local communities. However, Nakyebowa, which is another species of *Termitomyces* is easily recognized according to most respondents by a very characteristic criterion which is the length of its stalk. Other species such as

Leucoagaricus rubrotinctus (Ggudu) and *Termitomyces robustus* (Kkangango) are recognized respectively by their large size and their blackish color when mature.

40% of respondents know the meaning of local names which is most often linked to recognition criteria. In Lungada, Nakyebowa derives from Kwebowa which means a long-coiled tail while Ggudu means that the species is big and Akasukusuku that it grows in banana plantations called Lukusu. Maatu means ears because the species resembles to the ears of the human being. However, 2 meanings have been noted for Bubaala. The first is linked by its growth in abundance and the second by growing on the graves of the dead. The name Lukoota is linked to its strong taste which means that it remains in the throat when the species is boiled or poorly prepared. It has also been noted that several local names of macrofungi are derived from insect names. This is the case of Akatundatunda which grows in association with the termites called Ntunda, Busejjere with those called Nsejjere, Mbobya attached to the ant's name of the same name and Akanakakanaka which comes from the ant's name Ennaka.

Seasonality and habitat

As shown in **Table 5**, the majority of macrofungi used by local communities appear during the rainy seasons, particularly from March to May and from September to November. 80% of respondents know the period of appearance and disappearance of macrofungi and they manage to collect several times certain macrofungi like *Termitomyces sp.1* called Bubaala during the season. Respondents also have a good knowledge of the habitat of useful macrofungi. Among the 5 types of habitats (forest, garden, dump places, coffee and banana plantations) identified by the local communities, the forest dominates by sheltering 85% of the species. The substrates on which the macrofungi grow are varied, but according to the respondents, the majority of the species they use grow on soil rich in leafy litter or near termite mounds.

Table 5. Seasonality, habitat and substrate of macrofungi used by local communities

N°	Species	Months												Habitat and substrate
		J	F	M	A	M	J	J	A	S	O	N	D	
1	*Leucoagaricus rubrotinctus* (Ggudu)						*	*		*	*	*	*	Forest and garden, on soil
2	*Termitomyces sp.1* (Bubaala)			*	*	*	*		*	*	*	*	*	Forest and coffee plantation, near termite mounds

3	Ngomyakikere			*	*	*								Forest and garden, on soil
4	*Termitomyces sp.2* (Nakyebowa)									*	*	*		Forest and dump places, near termite mounds
5	*Auricularia auricula-judae* (Amaleere)									*	*	*		Forest, on tree trunk
6	*Volvariella volvacea* (Akasukusuku)				*	*								Forest and banana plantation, on dead tree trunk
7	*Gymnopus ocior* (Kajjanankuba)			*		*								Forest, on litter-rich soil and leafy
8	*Psathyrella pennata* (Nassogorero)			*		*								Forest, on litter-rich soil and leafy
9	*Psathyrella leucotephra* (Lukoota)									*	*			Forest, on litter-rich soil and leafy
10	Namulondo			*	*	*								Garden, on soil
11	*Termitomyces robustus* (Kkangango)			*	*						*		*	Forest, near termite mounds
12	*Termitomyces sp.4* (Akatundatunda)									*	*	*		Forest, near termite mounds
13	*Entoloma sp.* (Akanakanaka)									*	*	*		Forest, on litter-rich soil and leafy
14	*Termitomyces sp.3* (Busejjere)									*	*	*		Forest, near termite mounds
15	*Gymnopus luxurians* (Mutunduggo)				*	*	*			*				Forest, on litter-rich soil and leafy
16	*Gymnopus sp.* (Bunakanaka)				*	*								Forest, on litter-rich soil and leafy
17	*Empeefu*									*	*	*		Forest, on soil
18	*Coprinopsis domesticus* (Mussukundu)				*	*								Forest, on litter-rich soil and leafy
19	*Psathyrella inflatocystis* (Nakakanaka)				*	*								Forest, on litter-rich soil and leafy
20	*Termitomyces microcarpus* (Akabaala)				*	*								Forest, near termite mounds
21	*Lentinus tigrinus* (Kwaanya)			*		*								Forest, on tree trunk
22	*Polyporus grammocephalus* (Bukokwe)									*	*	*		Forest, on tree trunk

23	*Polyporus tenuiculus* (Matawaala)				*	*								Forest, on litter-rich soil and leafy
24	Muggundu			*	*	*								Coffee plantation, on soil
25	*Microporus affinis*							*	*					Forest, on a dead branch
26	*Polyporus varius* (Muvawala)				*	*	*							Forest, on twigs
27	*Hexagonia tenius*			*		*								Forest, on a tree branch
28	Kinyolwa										*	*		Garden, on soil
29	*Termitomyces sp.5* (Mbobya)			*	*	*								Forest and banana plantation, near termite mounds
30	*Ganoderma applanatum* (Konkomoza)										*	*		Forest, on tree trunk
31	*Amauroderma rude* (Munyeebwa)			*		*								Forest, on soil
32	Akatonsa				*	*								Banana and coffee plantations, on soil
33	Maatu									*	*	*		Coffee plantation, on soil
34	*Parasola auricoma* (Busukusuku)					*	*							Forest, on pieces of dead wood
35	*Termitomyces clypeatus*									*	*	*		Forest, near termite mounds

Role of macrofungi in diet, methods of preparation and preservation

Bantu people living around Mpanga forest, consume macrofungi because of their high nutritional value. This consumption is higher during the rainy season which often corresponds to a lean period. During this period, local communities use the most popular macrofungi such as *Leucoagaricus rubrotinctus* (Ggudu), *Termitomyces sp.1* (Bubaala), *Termitomyces sp.2* (Nakyebowa), and *Volvariella volvacea* (Akasukusuku) as a substitute for meat, poultry or fish.

Before consuming the macrofungi, the different village communities use roughly the same method of preparation. The preparation method most used by respondents is boiling, but big species such as *Leucoagaricus rubrotinctus* (Ggudu) are cut into small pieces before. However, some respondents prefer to fry species like *Termitomyces sp.1* called Bubaala. 90%

of respondents prefer to cook macrofungi with groundnut sauce and when consuming, most respondents associate macrofungi with cooked banana paste called "matooke", cassava or potatoes. when the macrofungi are harvested in large quantities, the excess is preserved. Sun-drying is the most common method used by respondents to preserve macrofungi. After drying, the macrofungi are tied in the banana fiber to prevent the air to moisten them, and stored on the roof of the kitchen, in a bag or in an empty dry bottle. It was also noted that some respondents prefer to boil the macrofungi before drying them in order to obtain long-term preservation.

Medicinal macrofungi and their applications

14 species of macrofungi have been reported by local communities as medicinal, of which 8 are edible. These species were recognized by most respondents, but knowledge related to the types of diseases they treat and the application process is limited to a small number of respondents, except *Termitomyces sp.1* called Bubaala whose medicinal virtues are known of all. When this species is boiled, the solution obtained is used to treat stomach pain, ulcer, hypertension, measles in babies, worms in children and facilitates deliverance in women during childbirth. By applying this solution on the umbilical cord of babies, it reduces pain and facilitates its healing by fighting against germs. Mixed with ghee, this species is also given to nursing mothers to increase breast milk. Other species like *Polyporus tenuiculus* called Matawaala and *Auricularia auricula-judae* called Amaleere are used by the village community of Nakigudde to respectively prevent scurvy and treat cancer when the species are boiled. Apart from *Termitomyces sp.1* (Bubaala), it was noted that the village community of Lwanga also uses *Volvariella volvacea* called Akasukusuku to treat hypertension in adults. Thus, after having crushed the dried species and mixed with water, the solution obtained is given to the patients.

Marketability and cultivation

Generally, the Bantu people living around Mpanga forest consume almost all of their harvests of macrofungi. Some particularly popular species of macrofungi are sold by 22% of respondents. The macrofungi are sold along the roads or at the market and the selling price varies with the level of appreciation of the species. The species sold generally belong to the *Termitomyces* genus, they are sold by heap or by kg. The sale price per heap varies from 2000 to 5000 Ugandan shillings while that per kg varies from 5000 to 10000 Ugandan shillings (1 dollar = 3765 Ugandan shillings). According to the respondents familiar with the sale of macrofungi, a person can earn 20,000 to 150,000 Ugandan shillings per day by selling macrofungi. Cultivating macrofungi is a known but impractical activity for most local communities living around Mpanga forest. According to the respondents, the lack of practice is due to the lack of skills and materials. However, 10% of respondents who cultivate macrofungi mentioned the lack of financial resources as a limiting factor.

Others uses of macrofungi

Apart from food, medicinal or commercial use, the Bantu people living around Mpanga forest use some species in their mythical and traditional beliefs. Among the 35 species of macrofungi useful for local communities, the species such as *Termitomyces sp.1* (Bubaala), *Volvariella volvacea* (Akasukusuku), *Polyporus varius* (Muvawala) and *Amauroderma rude* (Munyeebwa) are used in mythology and traditional beliefs. To chase demons, all the village communities recognized using *Termitomyces sp.1* called Bubaala. Thus, the species is boiled without salt and the soup is given to people with evil spirits. The remaining three species were only used by the village community of Nakigudde. This one use *Polyporus varius* (Muvawala) to bring a divorced man back to his wife and *Amauroderma rude* (Munyeebwa) to attract men, business and opportunities. As for *Volvariella volvacea* (Akasukusuku), it has been recognized by this village community to promote family unity by mixing it with bananas before serving it to all family members.

DISCUSSION

Our study reported a total of 35 useful species for local communities living around Mpanga forest. Among these species, 29 are edible, 14 are medicinal, 5 are used for income and 4 are used for mythical and traditional beliefs. This great diversity is probably due to the proximity of the Mpanga forest favorable to the development of macrofungi and which sheltered the majority of the species harvested. Similar studies with lower diversity have been conducted elsewhere in Uganda, such as that conducted by Nakalembe *et al.* (2009) in Mid-Western Uganda with 16 species of macrofungi, all used as natural food and some as medicine and for cultural festivals. In eastern Uganda, Opige *et al.* (2006) also listed 28 species of macrofungi of which 22 were identified by the local community as useful, food and medicinal and 6 are used only as medicine. This difference in diversity can be explained by the fact that these local communities do not live near a forest. Our results are however very similar to those obtained elsewhere in Africa such as in Tanzania where Qwarse *et al.* (2021) reported 32 species of macrofungi used by local communities living in the Selous-Niassa Corridor, in Benin where Boni & Yorou (2015) reported 35 species of macrofungi useful by local communities living around the classified forest of N'Dali, and in Cameroon where Van Dijk et al. (2003) identified 35 species of macrofungi used by local communities living around the tropical forest of southern Cameroon. The 33 local names that were identified during our survey are all different for each useful species. Similar trends have been observed in Tanzania (Tibuhwa, 2012), Nigeria (Okhuoya *et al*. 2010) and Ethiopia (Sitotaw, 2020) where local communities use almost separate names for each edible/useful species. Our results also revealed that the species most appreciated by the Bantu peoples living around Mpanga forest mostly belong to the genus *Termitomyces* because of their taste, their high nutritional value and their accessibility. The same preference was observed by Opige *et al.* (2006) among the Teso people of Eastern Uganda and by Nakalembe *et al.* (2009) among local communities living in Mid-Western Uganda. This preference also observed by Sitotaw *et al.* (2020) in Ethiopia and by Degreef *et al.*(2016) in Rwanda and in Burundi, was confirmed by De Kesel *et al.* (2002) who showed that in tropical Africa people preferred to consume species of the genus *Termitomyces.* Apart from *Termitomyces* species, local communities also appreciate species such as *Leucoagaricus rubrotinctus* (Ggudu) and *Volvariella volvacea* (Akasukusuku). The latter is highly appreciated by the Nagot, Holli and Fon peoples of Benin and takes the same place as meat, chicken or fish.

Moreover, the present study also demonstrated great differences in the recognition and exploitation of macrofungi by the different village communities living around Mpanga forest. This variability can be explained by the closer proximity villages like Nakigudde and Lwanga to the forest compared to those of Kalagala and Mpambire which are closer to the road and the town of Mpigi. Thus, the frequent access of the village communities of Nakigudde and Lwanga to the forest for agricultural and gathering activities allows them to be more in contact with macrofungi. As a result, they hold more traditional mycological knowledge than the village communities of Kalagala and Mpambire. This richness of traditional mycological knowledge of local communities living closest to the forest is supported by numerous scientists (Kakudidi, 2004). The know-how of African peoples concerning macrofungi goes back to time immemorial and is transmitted from one generation to another mainly orally (De Kesel & Malaise, 2010; Eyi-Ndong, 2011). Thus, this transmission can be eroded among the village communities of Kalagala and Mpambire because of their proximity to the town with a tendency to abandon agricultural activities especially among young people. Similar results attesting to the variability in the knowledge and exploitation of macrofungi by village communities living around forests have been found in DRC Congo (Milenge Kamalebo, 2018) and Benin (Fadeyi *et al*. 2017; Boni & Yorou, 2015; Assogbadjo *et al.*, 2013). Studies have shown that knowledge accumulated over time by a community will be transmitted to descendants within the same community, even if it erodes over time (Guissou *et al.*, 2008)). This justifies the homogeneity of traditional mycological knowledge within the same village community and the difference in the exploitation of macrofungal resources between village communities highlighted by our study.

The distribution of traditional mycological knowledge of local communities was significantly ($P < 0.05$) influenced by gender, age and level of education as shown by the results in **Table 4.** From these results it was shown that women held more traditional mycological knowledge than men. The same trends were observed in Tanzania (Qwarse *et al.*, 2021), Ethiopia (Sitotaw *et al.,* 2020) and Togo (Kamou *et al.,* 2017). This difference in knowledge can be explained on the one hand by the consequence of the roles culturally attributed to men and women and on the other hand by the division of labor due to the biological differences between men and women (Boa, 2004). Other authors like Garibay-orijel *et al*. (2012) and Montoya & Torres (2002) considered that since women were actively engaged in gathering and preparing for food and marketing, they can develop a deeper knowledge of the biology, ecology and seasonality of macrofungi.and therefore, are able to identify them more specifically. From these results, it was also shown that senior and illiterate respondents had better mycological knowledge, respectively, than young and literate respondents. These results were confirmed by those of Nakalembe *et al.,* 2009) in Mid-Western Uganda. These differences could have the same explanation because in our study area, older people are mostly illiterate and young people are most often literate. As explained by Sitotaw (2020), this difference could be due to the influence of urbanization, the shift to wage labor and the very poor way of sharing indigenous knowledge by word of mouth. According to the people surveyed, this sharing of endogenous knowledge, which was done from parents to children, has become scarce within the local community. Hence the low level of mycological knowledge recorded among the new generation.

To recognize and assign a local name to a macrofungus, local communities living around Mpanga forest often use the same criteria such as habitat, color, smell, size, mode of growth and consumption by animals. Although these criteria vary from region to region in certain African countries (Fadeyi *et al.* 2017), some of these criteria have been reported in other African countries. This is the case in Benin where it has been shown that the Nagot peoples do not eat colored macrofungi black but white colored species are commonly consumed (De Kesel *et al.,* 2002). Among the Malawians, edible macrofungi are those that are colonized by the larvae of insects (Heim, 1977) while in Nigeria, Burundi and Tanzania, the macrofungus is defined edible when accepted by animals (Oso, 1977; Buyck, 1994; Qwarse *et al.,* 2021). In Togo, Kamou *et al.* (2015) reported that some species of *Termitomyces* are locally called "Folorou" which means "dog's intestine" because they have a long pseudorhiza and “Kokossi ouro" due to their big size. The same is true for *Psathyrella tubercula* species which are small in size and are known as "kpandjoulassi; which means "small macrofungi". Local names are important parameters to describe the species useful. However, some species such as *Microporus affinis*, *Hexagonia tenius* and *Termitomyces clypeatus* do not have local names because they are less known by the Bantu people living around Mpanga forest. Similar results were observed by Kamou *et al.* (2015) with the Kotokoli people of Togo who did not assign local names to 7 species that were useful to them.

Regarding seasonality, our results shown that macrofungi appeared almost all year round, but the most favorable period is during the rainy seasons, particularly from March to May and from September to November (**Table 5**). Similar results were observed by Opige *et al.* (2006) in eastern Uganda, suggesting the importance of rainfall regime in macrofungal phenology. This importance is explained by the fact that certain macrofungi appear only at particular times of the year and are associated with particular amounts of precipitation, while others grow throughout the year provided that there is adequate humidity (Apetorgbor *et al.*, 2006). Our results also shown that forest was the dominant habitat type for macrofungi, hosting 85% of the collected species. However, anthropogenic activities such as deforestation by local communities living around Mpanga forest seriously threaten the macrofungal biodiversity of this forest. Among the elderly people interviewed, the majority declared that many macrofungi had disappeared, thus leading to the loss of this ethnomycological knowledge. Similar trends were observed in west-central Uganda by Nakalembe *et al*. (2009), in the North West region of Cameroon by Teke *et al.* (2018), in the Benshangul Gumuz region in Ethiopia by Sitotaw *et al.* (2020) and in many other countries around the world, especially in tropical regions (Ayodele *et al.*, 2011; Tibuhwa, 2012; Kik *et al.*, 2013). However, developed countries such as Europe, North America, Japan, Korea and Russia which have a tradition of eating wild edible macrofungi have come to adopt a more judicious use of these resources which has seemed to have weathered the problem encountered elsewhere (De Miriam *et al.*, 2006; Arora, and Hepard, 2008).

Like several local communities in tropical Africa, the Bantu people living around Mpanga forest use macrofungi as a food substitute for meat, poultry or fish. To consume macrofungi, the preparation method most used by local communities is boiling, but large species are cut up before cooking. This method of preparation is commonly used by rural communities in tropical Africa (Teke *et al.*, 2018; Assogbadjo *et al.*, 2013; Kamou *et al.*, 2015). However, it has been reported that in Nigeria cut pieces of cap and stipe of macrofungi are salted and hung for a short time before cooking, to kill any larvae that may be present (Oso, 1975) and this same method is also used in Niger according to Hama *et al.* (2019). During consumption, the majority of respondents declared that they preferred to associate macrofungi with groundnut sauce. This preference was observed by Teke *et al.* (2018) among forest communities of the Kilum-Ijim mountain in Cameroon while in Benin the forest communities of the commune of Pobé prefer to associate macrofungi with okra sauce (Assogbadjo *et al.,* 2013). When the harvest is successful, not all the species of macrofungi are consumed, the excess is preserved for later use. Numerous studies carried out in certain countries of tropical Africa have shown that the easiest and most widely used method of preservation is sun-drying (Codjia *et al.,* 2014; Eyi-Ndong *et al.,* 2011; Guissou *et al.,* 2005). The result of these works confirms ours, because the majority of people interviewed declared that they used sun-drying to preserve macrofungi. However, the fire-smoking method has also been reported in other tropical African countries (Eyi-Ndong *et al.,* 2011; Yorou *et al.,* 2014).

Among the 14 species of macrofungi recognized as medicinal by the local communities living around Mpanga forest, *Termitomyces sp.1* (Bubaala), *Polyporus tenuiculus* (Matawaala), *Auricularia auricula-judae* (Amaleere) and *Volvariella volvacea* (Akasukusuku) have been the only species whose modes of use are known to the respondents. Our results shown that *Volvariella volvacea* is used by local communities living around Mpanga forest to treat hypertension. The same result was reported by (Apetorgbor *et al.,* 2006) in Ghana while in Ivory Coast, apart from treating hypertension, the species is also used to treat malaria, diabetes, and other heart ailments (Yian *et al.,* 2020). Our results also revealed that *Auricularia auricula-judae* is used by the village community of Nakigudde to prevent scurvy. However, the same species is used in Ghana as a blood tonic (Apetorgbor *et al.,* 2006). This comparison shows that one species can treat the same or different diseases from one country to another. The work of Hama *et al.* (2012) and Guissou *et al.* (2008) relating to the comparison of the therapeutic species identified in Burkina Faso and Niger with respect to other African and Asian countries confirms that the treatment of a disease by a species most often varies from one country to another. The use of *Termitomyces sp.1*(Bubaala) in the treatment of cancer by local communities living around forest of Mpanga confirms that wild macrofungi can intervene in the treatment of cancer. This observation also corroborates the work of Yian *et al.* (2020), Bahl (1983), Apetorgbor *et al.* (2006) and Asemota *et al.* (2015) which has shown that wild macrofungi constitute an important resource in the fight against cancer. The species mentioned by these authors are: *Termitomyces schimperi, Ganoderma applanicum, Ganoderma lucidum, Fomitopsis pinicola, Hericium erinaceus, Trametes versicolor* and *Schizophyllum commune*.

In terms of mythical and traditional beliefs, our study shown that local communities use 4 species, including *Polyporus varius* and *Amauroderma rude*, which are used respectively to bring a divorced man back to his wife and attract opportunities (business). The same beliefs have been observed in other African countries but the species used are different. This is the case of DRC Congo where, to attract luck or opportunities, local communities living in the province of Tshopo use species such as *Cantharellus densifolius* or *Lentinus squarrosulus* (Milenge Kamalebo *et al.*, 2018). In Benin, Assogbadjo *et al.* (2013) reported that local communities living in the commune of Pobé use *Mrasmius sp.*, *Collybia sp.* or *Psathyrella tuberculata* to attract the beloved person. They also use *Collybia sp.* to attract luck or opportunities.

According to the people interviewed, the number of edible macrofungi harvested decreases significantly each year. This could explain the low rate of respondents (22%) practicing the sale of wild edible macrofungi while it is one of the main activities of local communities in other African countries. The work of Apetorgbor *et al.* (2006) showed that in Ghana, the sale of wild edible macrofungi is an important income-generating activity because the money made is used to meet the pressing needs of the family while others even build houses from it. In countries like Benin, Cameroon, Ethiopia and Gabon also, the sale of wild edible macrofungi is one of the main income-generating activities, especially for women, thus contributing to their economic independence (Van Dijk *et al.,* 2003; Eyi-Ndong, 2009; Sitotaw *et al.,* 2020).

Despite the low rate of respondents (10%) who had to practice the artificial culture of macrofungi, the local communities living around Mpanga forest showed enormous interest in this activity. Such interest of people in embracing macrofungi cultivation is in line with surveys conducted in countries like Tanzania, Cameroon, Nigeria, Japan and China, in which people have strongly accepted macrofungi cultivation for their nutritional values. and obvious medicinal (Boa, 2004; Garibay-orijel & Cifuentes, 2006; Garibay-orijel *et al.,* 2012; Kik *et al.,* 2013). Since *Volvariella volvacea* locally called Akasukusuku is one of the most appreciated species and marketed by local communities living around Mpanga forest, its cultivation could serve as an alternative by allowing them to be able to consume it all year round and increase the income of the macrofungi sellers. In some African countries such as Nigeria, Ghana, and Ivory Coast *Volvariella volvacea* has already been cultivated on various substrates, which has enabled local communities to increase their income after the sale substantially (Rammeloo & Walleyn, 1993; Bakayoko & Koné, 2022).

CONCLUSION

This preliminary study on useful macrofungi from Mpanga forest allowed a better understanding of the different uses of wild macrofungi by local communities. These local communities have facilitated the identification of useful species through ethnomycological surveys. In total, 35 useful species have been identified of which 29 are edible, 14 are medicinal, 5 are used for income, and 4 are used for mythical and traditional beliefs. Indeed, the local communities hold significant ethnobiological knowledge that should be valued at all costs. This knowledge varies from one village community to another. As for the degree of exploitation, it is very much controlled by the accessibility of macrofungi species because the village communities of Nakigudde and Lwanga use more species because of their closer proximity to the Mpanga forest. Although the local communities living around Mpanga forest have good ethnomycological knowledge, the attempt to document and conserve these valuable wild resources has been very poor. The lack of interest in research on macrofungi in the district and in the country, in general, has negatively affected the integration of this knowledge as an input into food security and mycomedicinal studies.

With the increasing Ugandan population and the growing demand for food, the domestication of indigenous varieties of macrofungi like Volvariella volvacea which is one the species highly valued by local communities can be considered as one of the alternatives to ensure food security. Given the major role played by macrofungi in traditional medicine, it becomes necessary to carry out tri-phytochemistry to identify the active principles involved in the treatment of these conditions in order to validate indigenous practices.

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Appendix 1. Ethnomycological use values according to the different village communities

Villages communities **Species**	**Nakigudde**				**Mpambire**				**Kalagala**				**Lwanga**			
	E	**M**	**IC**	**TUV**	**E**	**M**	**IC**	**TUV**	**E**	**M**	**IC**	**TUV**	**E**	**M**	**IC**	**TUV**
Leucoagaricus rubrotinctus (Ggudu)	1,32	0,3	0,36	1,98	1,2	0,2	0,35	1,75	1,2	0,13	0,2	1,65	1,02	0	0,1	1,12
Termitomyces sp.1 (Bubaala)	1,32	0,78	0,6	2,7	1,5	1,5	0,7	3,7	1,5	1,44	0,6	3,54	1,5	0,9	0,5	2,9
Ngomyakikere	0	0	0	0	0	0	0	0	0,02	0	0	0,02	0	0	0	0
Auricularia auricula-judae (Amaleere)	0,1	0,02	0	0,12	0	0	0	0	0,04	0	0	0,04	0	0	0	0
Volvariella volvacea (Akasukusuku)	0,5	0,2	0,18	0,88	0,4	0	0	0,4	0,32	0	0	0,32	0,36	0,08	0,04	0,48
Gymnopus ocior (Kajjanankuba)	0	0	0	0	0	0	0	0	0	0	0	0	0,02	0	0	0,02
Psathyrella pennata (Nassogorero)	0,1	0,02	0	0,12	0,02	0	0	0,02	0	0	0	0	0,04	0	0	0,04
Psathyrella leucotephra (Lukoota)	0,05	0	0	0,05	0,08	0	0	0.08	0,02	0	0	0,02	0,04	0	0	0,04
Namulondo	0,02	0	0	0,02	0	0	0	0	0	0	0	0	0,02	0	0	0.02
Termitomyces robustus (Kkangango)	0,5	0	0,1	0,6	0,46	0	0,2	0,62	0,36	0	0.1	0.46	0,38	0	0,04	0,42
Termitomyces sp.4 (Akatundatunda)	0,02	0	0	0,02	0,02	0	0	0,02	0	0	0	0	0,06	0	0	0,06
Entoloma sp. (Akanakanaka)	0	0	0	0	0	0	0	0	0	0	0	0	0,04	0	0	0,04
Termitomyces sp.3 (Busejjere)	0,4	0	0	0,4	0,06	0	0	0,06	0	0	0	0	0,02	0	0	0,02

Gymnopus luxurians (Mutunduggo)	0,24	0	0	0,24	0,16	0	0	0,16	0	0	0	0	0	0	0	0
Gymnopus sp. (Bunakanaka)	0	0	0	0	0,08	0	0	0,08	0	0	0	0	0,02	0	0	0,02
Empeefu	0,02	0	0	0,02	0	0	0	0	0	0	0	0	0,02	0	0	0,02
Coprinopsis domesticus (Mussukundu)	0	0	0	0	0	0	0	0	0,2	0	0	0,2	0,02	0	0	0,02
Psathyrella inflatocystis (Nakakanaka)	0	0	0	0	0	0	0	0	0	0	0	0	0,02	0	0	0,02
Termitomyces microcarpus (Akabaala)	0	0	0	0	0	0	0	0	0	0	0	0	0,2	0,04	0	0,24
Lentinus tigrinus (Kwaanya)	0,02	0	0	0,02	0	0	0	0	0	0	0	0	0	0	0	0
Polyporus grammocephalus (Bukokwe)	0	0	0	0	0	0	0	0	0	0	0	0	0,02	0,02	0	0,04
Polyporus tenuiculus (Matawaala)	0	0,02	0	0,02	0	0	0	0	0	0	0	0	0	0	0	0
Muggundu	0,02	0	0	0,02	0	0	0	0	0	0	0	0	0	0	0	0
Microporus affinis	0	0,02	0	0,02	0	0	0	0	0	0	0	0	0	0	0	0
Polyporus varius (Muvawala)	0	0,02	0	0,02	0	0	0	0	0	0	0	0	0	0	0	0
Hexagonia tenius	0	0,02	0	0,02	0	0	0	0	0	0	0	0	0	0	0	0
Kinyolwa	0	0	0	0	0,02	0	0	0,02	0	0	0	0	0	0	0	0
Termitomyces sp.5 (Mbobya)	0	0	0	0	0	0	0	0	0	0	0	0	0,02	0	0	0,02
Ganoderma applanatum (Konkomoza)	0	0	0	0	0	0	0	0	0	0	0	0	0	0,02	0	0,02

Amauroderma rude (Munyeebwa)	0	0,02	0	0,02	0	0	0	0	0	0	0	0	0	0	0	0
Akatonsa	0	0	0	0	0	0	0	0	0	0	0	0	0,02	0	0	0,02
Maatu	0	0	0	0	0,02	0	0	0,02	0	0	0	0	0	0	0	0
Parasola auricoma (Busukusuku)	0	0	0	0	0,02	0	0	0,02	0	0	0	0	0	0	0	0
Termitomyces clypeatus	0,08	0	0	0,08	0	0	0	0	0	0	0	0	0	0	0	0
Termitomyces sp.1 (Nakyebowa)	0,78	0,4	0,5	1,68	1.02	0,13	0,06	1,87	1,08	0.05	0,02	1,15	0,98	0,05	0.03	1,06

E = Edible, **M** = Medicinal, **IC** = income, **TUV** = Total ethnomycological use value

Appendix 2. Specific diversity and equitability indices

		Nakigudde	Mpambire	Kalagala	Lwanga
Leucoagaricus rubrotinctus (Ggudu)	DI	0,41269841	0,42592592	0,40579710	0,40476190
	DI max	21	18	23	14
	IE	0,01965230	0,02366255	0,01764335	0,02891156
Termitomyces sp.1 (Bubaala)	DI	0, 10392156	0,72222222	0,76000000	0,66666666
	DI max	17	24	25	25
	IE	0,00611303	0,03009259	0,03040000	0,02666666
Ngomyakikere	DI	0	0	0,50000000	0
	DI max	0	0	2	0
	IE	0	0	0,10000000	0
Auricularia auricula-judae (Amaleere)	DI	0,15000000	0	0,64285714	0
	DI max	4	0	7	0
	EI	0,0375000	0	0,09183673	0
Volvariella volvacea	DI	0,53333333	0,41666666	0,41666666	0,44444444

(Akasukusuku)	DI max	5	8	8	9
	EI	0,10666666	0,05288333	0,05288333	0,04938271
Gymnopus ocior (Kajjanankuba)	DI	0	0	0	0,33333333
	DI max	0	0	0	3
	EI	0	0	0	0,11111111
Psathyrella pennata (Nassogorero)	DI	0,13333333	0,33333333	0	0,25000000
	DI max	6	3	0	4
	EI	0,02222222	0,11111111	0	0,06150000
Psathyrella leucotephra (Lukoota)	DI	0,20000000	0,12500000	0,33333333	0,25000000
	DI max	5	8	3	4
	EI	0,04000000	0,01562500	0,11111111	0.06250000
Namulondo	DI	0,33333333	0	0	0,33333333
	DI max	3	0	0	3
	EI	0,11111111	0	0	0,11111111
Termitomyces robustus (Kkangango)	DI	0,61111110	0,59090909	0,62500000	0,55555555
	DI max	9	11	8	9
	EI	0,06790123	0,05371900	0,07812500	0,06172839
Termitomyces sp.4 (Akatundatunda)	DI	0,33333333	0,33333333	0	0,16666666
	DI max	3	3	0	6
	EI	0,11111111	0,11111111	0	0,02777777
Entoloma sp. (Akanakanaka)	DI	0	0	0	0,25000000
	DI max	0	0	0	4
	EI	0	0	0	0,06250000
Termitomyces sp.3 (Busejjere)	DI	0,14285714	0,12500000	0	0,20000000
	DI max	7	8	0	5
	EI	0,02040816	0,01562500	0	0,04000000
Gymnopus luxurians (Mutunduggo)	DI	0,16666666	0,25000000	0	0
	DI max	6	4	0	0
	EI	0,02777777	0,02500000	0	0
Gymnopus sp. (Bunakanaka)	DI	0,33333333	0	0	0
	DI max	3	0	0	0

	EI	0,11111111	0	0	0
Empeefu	DI	0,25000000	0	0	0,25000000
	DI max	4	0	0	4
	EI	0.06250000	0	0	0.06250000
Coprinopsis domesticus (Mussukundu)	DI	0	0	0,33333333	0,33333333
	DI max	0	0	3	3
	EI	0	0	0,11111111	0,11111111
Psathyrella inflatocystis (Nakakanaka)	DI	0	0	0	0,25000000
	DI max	0	0	0	4
	EI	0	0	0	0.06250000
Termitomyces microcarpus (Akabaala)	DI	0	0	0	0,20000000
	DI max	0	0	0	5
	EI	0	0	0	0,04000000
Lentinus tigrinus (Kwaanya)	DI	0,33333333	0	0	0
	DI max	3	0	0	0
	EI	0,11111111	0	0	0
Polyporus grammocephalus (Bukokwe)	DI	0	0	0	0,33333333
	DI max	0	0	0	3
	EI	0	0	0	0,11111111
Polyporus tenuiculus (Matawaala)	DI	0,25000000	0	0	0
	DI max	4	0	0	0
	EI	0.06250000	0	0	0
Muggundu	DI	0,33333333	0	0	0
	DI max	3	0	0	0
	EI	0,11111111	0	0	0
Microporus affinis	DI	0,33333333	0	0	0
	DI max	3	0	0	0
	EI	0,11111111	0	0	0
Polyporus varius (Muvawala)	DI	0,14285714	0	0	0
	DI max	7	0	0	0
	EI	0,02040816	0	0	0

Hexagonia tenius	DI	0,25000000	0	0	0
	DI max	4	0	0	0
	EI	0.06250000	0	0	0
Kinyolwa	DI	0	0,33333333	0	0
	DI max	0	3	0	0
	EI	0	0,11111111	0	0
Termitomyces sp.5 (Mbobya)	DI	0	0	0	0,33333333
	DI max	0	0	0	3
	EI	0	0	0	0,11111111
Ganoderma applanatum (Konkomoza)	DI	0	0	0	0,25000000
	DI max	0	0	0	4
	EI	0	0	0	0.06250000
Amauroderma rude (Munyeebwa)	DI	0,33333333	0	0	0
	DI max	3	0	0	0
	EI	0,11111111	0	0	0
Akatonsa	DI	0	0	0	0,25000000
	DI max	0	0	0	4
	EI	0	0	0	0.06250000
Maatu	DI	0	0,33333333	0	0
	DI max	0	3	0	0
	EI	0	0,11111111	0	0
Parasola auricoma (Busukusuku)	DI	0	0,25000000	0	0
	DI max	0	4	0	0
	EI	0	0.06250000	0	0
Termitomyces clypeatus	DI	0,12500000	0	0	0
	DI max	8	0	0	0
	EI	0,01562500	0	0	0
Termitomyces sp.2 (Nakyebowa)	DI	0,45454545	0,37499999	0,40740740	0,41025641
	DI max	11	16	18	13
	EI	0,04132223	0,02343749	0,02263374	0,03155818