Indogenous knowledge of macromycetes of the genus *Amanita* in Burkina Faso

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Abstract

Background: In Burkina Faso, mushrooms are used by the population for food and/or medicine. Due to accelerated population growth and anthropogenic and environmental factors, mushrooms are disappearing alarmingly. Knowledge about fungi is disappearing over time. The aim of this study is to document the state of knowledge and use of amanites by the various ethnic groups in the villages bordering the forest formations.

Methods: The study was conducted in the classified forests of Niangoloko, Kou and in the gallery forest of Dan, respectively located in the provinces of Comoé, Houet and Kénédougou between 2017 and 2019. Sampling was carried out using the opportunistic or random method, and surveys were carried out using a survey form administered to interviewees individually or in groups. Ethnomycological excavations were carried out in six villages (Orodara, Tin, Dan, Yendéré, Timperba and Nasso) and involved ten ethnic groups (Gouin, Senoufo, Karaboro, Samogo, Turka, Mossi, Bobo, Dagara, Toussian and Siamou) living around the different forests.

Results: The mycological digs resulted in the collection of 133 amanite carpophores, including 7 carpophores in Kou, 51 in Niangoloko and 75 in Dan. The survey was carried out among 133 people, 99 men and 34 women aged between 10 and 70.

Conclusion: In general, all the ethnic groups interviewed were familiar with mushrooms, although knowledge of amanites was low. Five species of amanita (*A. subviscosa*, *A. masasiensis*, *A. congolensis*, *A. strobiliformis*, *A. crassiconus*) are edible and are already consumed by the local people. However, no species of amanita has been reported in the traditional medicine.

Keywords: Surveys, Mycology, Traditions, socio-anthropology, Burkina Faso

Background

Amanita (Agaricales, Basidiomycota) is one of the most well-known genera composed of poisonous mushrooms (Cho *et al.* 2015). Species in this genus play important roles in forest ecosystems, as a large majority have a mutualistic association with plants to help effective nutrient uptake (Nara, 2006). Approximate 700 Amanita species have been described, accepted and reported worldwide (Yang *et al.* 2018; Cui *et al.* 2018). The well-known genus *Amanita* contains both poisonous and edible mushrooms (Bas, 1969). In fact, many of them are considered deadly poisonous species (Cai *et al.* 2016; Cui *et al.* 2018) but

there are valued edible species (Cui *et al.* 2018). *Amanita muscaria* (L.) Lam. is the type species of the genus (Jenkins & Petersen, 1976). Based on morphological features and chemical reaction characters of the fruit body, Amanita is divided into two subgenera, including seven sections: *Amanita* Pers. and *Lepidella* (J. E. Gilbert) Veselý emend. Corner & Bas (Weiß *et al.* 1998). While this infrageneric classification is not well supported, monophyly of each section, except *Lepidella*, is well supported (Cai *et al.* 2014). Macromycetes are widely exploited by humans for food and medicine (Gates *et al.* 2011). Indeed, edible wild mushrooms have long been a focus of different communities in different parts of the world because of their high-quality protein that can be produced with greater biological efficiency, rich in fiber, minerals and vitamins (Gregori and Pohleven, 2007). The food value of mushrooms is also often sought in their flavors, which are appreciated by gourmets (Fons *et al.* 2003). From a dietetic point of view, according to Fons et al (2018), wild edible mushrooms are rich in water (50-90%) and have a low nutritional value (20-80 kcal/100 g). Intakes are around 0.5-7% protein, 0.5-2% minerals (K, P, Se, Fe, Zn, trace elements), 2-13% carbohydrates and 0.05-2% lipids. Mushrooms are rich in B-group vitamins and fiber (Cheung, 2013) and aid transit. They are mainly used by rural African populations for food (Yorou *et al.* 2014) or as a source of income (Koné *et al.* 2013). With annual production of up to 300 kg per hectare in Sudanian open forests, the West African sub-region is home to at least 70 edible species (Yorou *et al.* 2014). The aim of this study is to document the state of knowledge and use of Amanitas by the different ethnic groups in the villages bordering the forest formations.

Materials and Methods

Study areas

Specimens were sampled in three forests in three different regions. These were the Kou classified forest, the Dan gallery forest and the Niangoloko classified forest, located in the Hauts-Bassins and Cascades regions respectively. The Niangoloko classified forest, located in the village of Yendéré in the department of Niangoloko, covers an area of 7,300 hectares between longitudes 4°50'and 4°58'W and latitudes 10°10'and 10°17'N (Figure 1). The Kou classified forest, located some fifteen kilometers west of the town of Bobo-Dioulasso, in the village of Kokorowé, covers 115 ha and is situated between latitudes 11°10'54'' and 11°11'44'' N and longitudes 04°26'00.8'' and 04°26'49'' E (Figure 1). The Dan gallery forest is located near the village of Dan, in the province of Kénédougou, in the Hauts-Bassins region. It is located on the Orodara-Banfora road between latitude 10°52'28'' North and longitude 04°50'10'' West (Figure 1). Sampling was carried out using the opportunistic method of Mueller et al (2004), and took place in groups containing ectomycorrhizal forest species such as *Berlinia grandiflora*, *Afzelia africana*, *Uapaca* sp. and *Isoberlinia doka*, hosts of Amanitas.

Ethnomycological survey

The study was carried out during survey-collection visits in order to obtain and document valuable information concerning the ethnomycological uses of Amanitas by the inhabitants of the approximate villages in the study areas. Ethnomycological data were collected using semi-structured interviews, group or individual discussions using a pre-established survey sheet and also using a dictaphone. The interviews focused on questions relating to knowledge, local names for mushrooms and their use. Additional information on the source and sharing of knowledge was also recorded. Freshly harvested carpophores and photos taken during collections and in previous years were presented to the interviewees. The surveys were carried out in the villages of Orodara, Tin and Dan in the department of Orodara, province of Kénédougou, Nasso in the department of Bobo-Dioulasso, province of Houet and Yendéré and Timperba in the department of Niangoloko, province of Comoé. The ethnic groups surveyed were Gouin, Karaboro, Samogo, Turka, Mossi, Bobo, Dagara, Toussian, Siamou and Peulh.

The proximity of these villages to the collection areas was the selection criterion. The survey was carried out randomly among people (children, young people, adults and the elderly) available during the collection periods and took place during the rainy season. All the *Amanita* carpophores collected at each site were surveyed.

Results

Diversity of Amanitas

The mycological digs, carried out between 2017 and 2019 on all three sites, resulted in the collection of 133 amanite carpophores, including 7 carpophores at Kou, 51 at Niangoloko and 75 at Dan (Figure 2). All the carpophores were divided into 2 sub-genera, 7 sections and forty-three (43) taxa (Table 1).

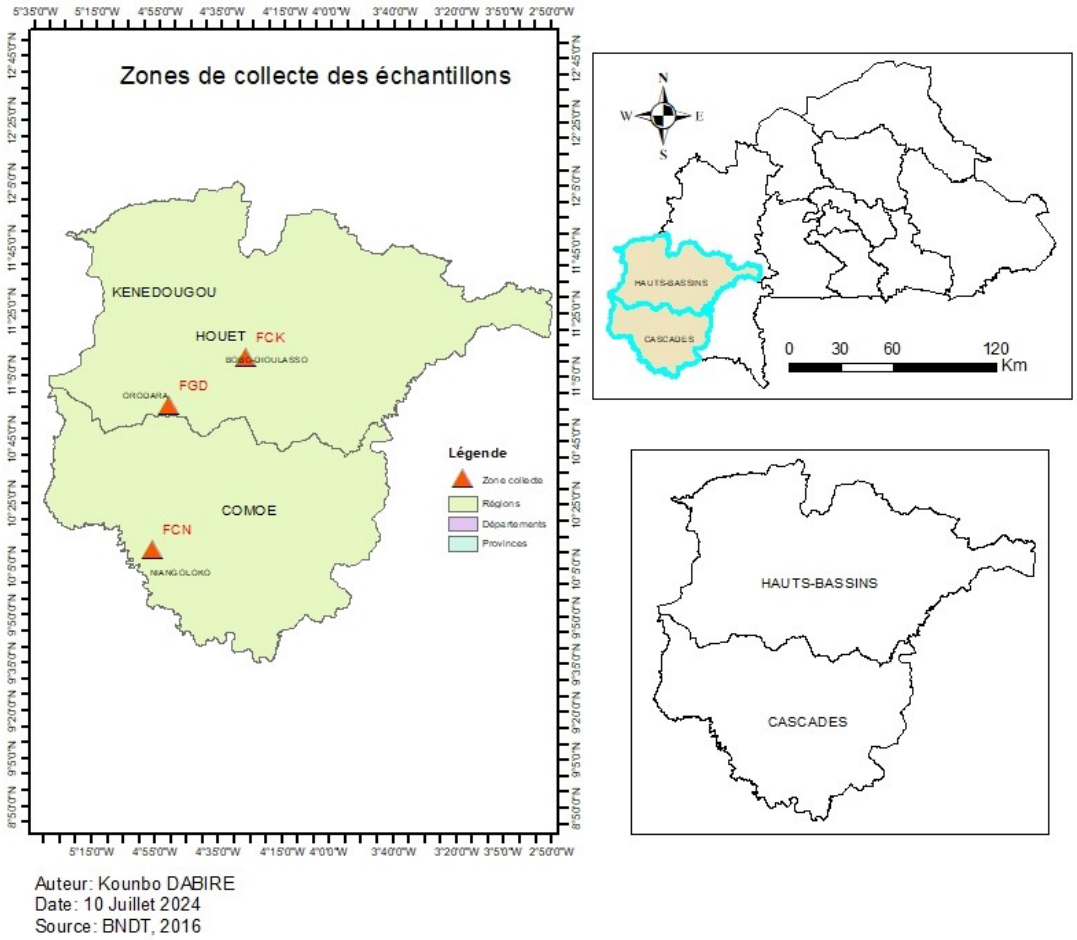

Figure 1. Location of sample collection points

Table 1. Taxonomic distribution of the amanites collected

Genus	Sub-genus	Sections	Species
Amanita	*Amanita*	*Amanita*	*A.* sp. 2
		Caesareae	*A. masasiensis* Härk. & Saarim.
		Vaginatae	*A.* aff. *griseostrobilacea* Ndolo Ebika, Yorou & Attibayeba
	Lepidella	*Lepidella*	*A. crassiconus* Bas
		Amidella	*A. subviscosa* Beeli
		Phalloideae	*A.* aff. *virosa* (Bertill.) E.-J. Gilbert
		Validae	*A. congolensis* (Beeli) Tulloss, B. E. Wolfe, K. W. Hughes, Kudzma et A. Arora

Ethnomycological knowledge of Amanitas

State of knowledge

At the end of the surveys, 133 people (99 men and 34 women aged between 10 and 70) were interviewed, depending on their availability in the field. Ethnomycological data was collected from ten ethnic groups. These were the Gouin, Peulh, Karaboro, Samogo, Turka, Mossi, Bobo, Dagara, Toussian and Siamou, with 7, 5, 2, 17, 2, 2, 9, 6, 56 and 21 people respectively. These ethnic groups come from six villages (Orodara, Tin, Dan, Yendéré, Timperba, Nasso). The results shown in Table 2 reveal that of the 133 respondents, 51 are from Dan, 43 from Tin, 13 from Yendéré and 10 from Orodara. In terms of age, 18% were aged between 10 and 30, 59% between 31 and 50 and 23% between 51 and 70.

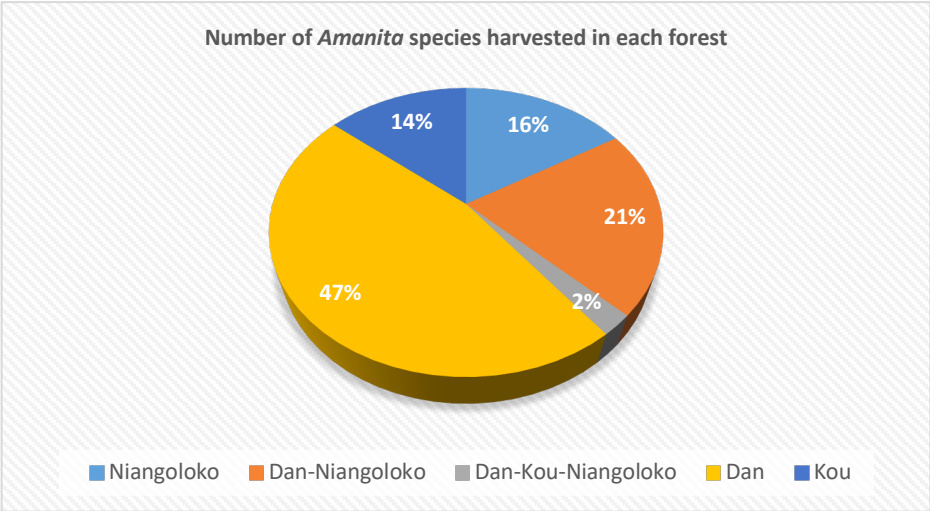

Figure 2. Number of *Amanita* species specific to or common to the three sites.

Table 2. Distribution of interviewees and percentage of amanita edibility by village.

Variables		**Orodara**			**Bobo-Dioulasso**	**Niangoloko**		**Total**
Villages		Dan	Tin	Orodara	Nasso	Yendéré	Timperba	6
Sex	H	35	33	7	8	8	8	99
	F	16	10	3	0	5	0	34
Knowledge of edible wild mushrooms (CSC)		100%	100%	100%	100%	100%	100%	-
Comestibility of amanites		23,53%			66,66%	19, 04%		-

Local or vernacular names of mushrooms

The results of this survey show that the inhabitants of the various areas surveyed have a general knowledge of mushrooms. However, knowledge of amanitas in particular is poor overall. Thus, not only does the survey reveal a plurality of names according to the different ethnic groups, but also a transversally of certain representations around which certain mushroom names take on meaning, because even if the names differ from one ethnic group to another, the reality to which they refer is very often the same. The different names are listed in Table 3. In the Siamou language, **"Kpê"** mushroom means something that "attaches itself to", something that "grafts itself onto", or something that is planted. Examples include **"Kpê Bouarè",** which means "black mushroom", **"Nandjita Kpê",** which means "mushroom of dead trees", **"Yimon Kpê",** which refers to "river mushrooms", and **"Tata Kpê"**, which is the "mushroom of termite mounds". Among the Toussians, mushrooms are called **"Vê"**, a name whose meaning remains unknown to our respondents. But like the Siamou concept, the **"Vê"** can be small **"Vê mourre",** large **"Vê m-bênè"**, or red **"Vê n'sion", "yolo Vê"** in Toussian translates as "the damp place or what grows near the marsh". Among the Bobo, we also have several names depending on the forms and social representations attached to the mushrooms. For example, **"worozouzom"** translates as "the beginning of the rains", **"soumini tangan kôrô"** means "hyena's chair", and **"Toutougo mènè"** means "the little mushroom".

Table 3. Vernacular names for edible wild mushrooms by ethnic group.

Ethnic group	**General names**	**Specific names**
Karaboro	« M'mougne »	-
Gouin	« Djoundjounou »	-
Peulh	«Kouyê»; « Pinari-bodjin»; « Dêmann-fowrou»	-
Toussian	« Vê »	« Teuvê »
Siamou	« Kpê »	« Yimon Kpê » ; « Kpê lô »
Bobo	« Toutougo »	« Vontougou » ; « Wozara »
Dagara	« Gourou »	« Gourou wêrê » « Tou-gourou »
Samogo	« Kou »	-
Turka	«Gnitiougou»	-
Mossi	«Goundou»	« Gound-pelga » « Gound-miougou

Comestibility of mushrooms

All interviewees said that mushrooms are food (i.e. they said yes to knowing about mushrooms), and are also used to treat various ailments. Mushrooms are considered a substitute for meat and are highly valued for their nutritional value, flavor and taste, especially during the fruiting seasons (rainy season). Following this survey, the mushrooms were classified into two categories: edible and medicinal. Wild edible mushrooms are an important source of food for rural communities during the rainy season. They also provide additional household income when sold at markets. It has been observed that large quantities of mushrooms are consumed in the region and are considered by many to be a healthy food and, in some cases, the equivalent of meat. The mushrooms reported to be edible and already consumed are *A. subviscosa*, *A. masasiensis*, *A. congolensis*, *A. strobiliformis* and *A. crassiconus* (Figure 3). These species were eaten in Dan and the last two in Yendéré and Timperba. However, no species has been reported in the traditional pharmacopoeia. Mushrooms have long been part of the dietary habits of local populations. Their consumption has been monitored using various techniques. Thus, the different groups interviewed had different ways of determining the edibility of mushrooms. Table 4 summarizes the criteria used by the local population to determine the edibility of a species and how it is eaten.

Table 4. Criteria for the edibility and consumption of mushrooms by the local population.

Criteria	Technical	Results	Method of consumption
Carry out a test with a domestic animal (the dog) or elderly people.	The idea was to get a dog to eat a particular species. Serve the same meal to the elderly.	Dog not sick after a certain period of observation; the species is edible. If the dog is sick or dead, the species is toxic and inedible.	All species are eaten after cooking, either fresh or dried for later use.
		No unfortunate history, the species is edible.	
Observation in the field	Sort out the species half eaten by insects or those eaten by monkeys.	All species eaten by animals or insects are considered edible.	
Color of species	The color white is a symbol of health, purity and is free from poison	All white species are considered edible.	

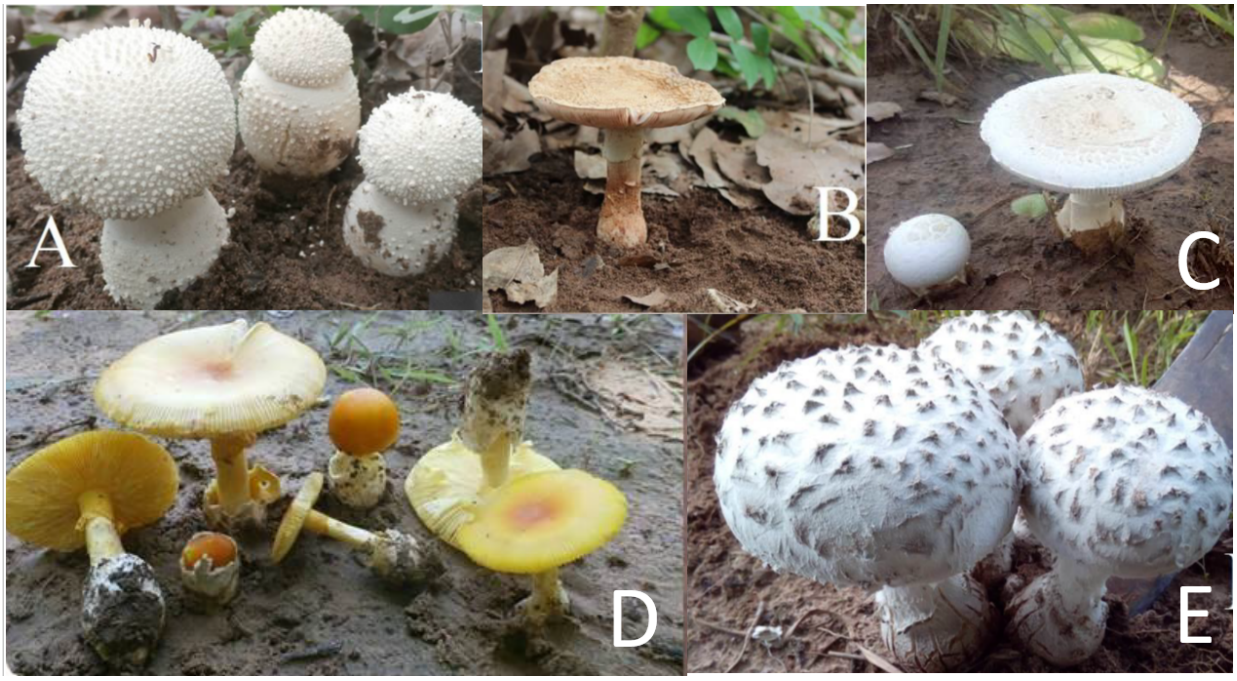

Figure 3. Species consumed by local populations in the study area.

A. *Amanita strobiliformis* ; **B.** *A. congolensis* ; **C.** *A. subviscosa ;* D. *A. masasiensis*; **E.** *A. crassiconus*

Discussion

The ethnomycological study revealed that the inhabitants of the various villages in the surveyed areas have a good general knowledge of mushrooms. Mushrooms were gathered and used as food and/or medicine and as a source of income. The ethnic groups surveyed had different ways of determining the edibility of mushrooms. The different actors in the field, depending on their diversity in terms of primogeniture, accept without having the same convictions that macroscopic mushrooms are edible. Knowledge of edibility has been passed on from parents to offspring on the basis of color and/or smell, or identified as being eaten by animals or insects, and also the places where they grow. Similar criteria based on color and smell have been reported in Cameroon (Kinge *et al.* 2011; Teke *et al.* 2018) by the Kilum-Ijim peoples and in Mexico (Alvarez-Farias *et al.* 2016) by the inhabitants of Tlayacapan, Morelos to determine the edibility of mushrooms. The men were the most numerous to be interviewed. This could be justified by the fact that the men carry out their tasks at home or close to home, whereas the women play a major role and have greater responsibility for work in the fields, obliging most of the women to go to the fields very early and not return until late in the evening. Despite the small number of women interviewed, they seemed to have a better knowledge of mushrooms than the men when it came to identifying and naming them. In Ethiopia (Giday *et al.* 2009; Kidane *et al.* 2014) and Guinea (Balde *et al.* 2015) who reported the predominance of male informants however, in ethnobotany. In reality, older people from different ethnic groups are convinced that macroscopic mushrooms are edible because they themselves have eaten them in the not too distant past. This is reflected in this passage from a testimonial: *"Young women are no longer interested in mushrooms. Otherwise, before, in August, we used to go to the marigot, where it grew a lot, to harvest and we prepared it with soumbala. But nowadays, women aren't too interested in that. They only prepare with Maggi and every time they have to buy fish, whereas in our day we used neither Maggi nor fish".* According to our respondents, it is not only the availability of food resources that explains the low consumption of mushrooms, but also climate change, which is causing the soil to dry out and under-produce organisms due to the fact that the soil is no longer fertile, making them scarcer. In addition, the level of consumption differs between the different communities surveyed. Unlike the communities surveyed in Orodara, Tin, Timperba and Yendéré, which stated that mushroom consumption was low, the Bobo people of Nasso, on the other hand, eat a lot of mushrooms and often sell them at the local Nasso market. Local people have different ways of determining the edibility of mushroom species, according to several accounts. The surveys revealed that knowledge of edibility was passed on from parents to children or by observing whether the mushroom was eaten by insects or other animals. However, this transmission seems to have been reduced during our visits in view of the answers given to us by the younger generation.

The younger generations attach little importance to eating mushrooms these days, which can be explained by the fact that there is a more varied and available food repertoire. They also accept that mushrooms are edible, even though they would not like to eat them, because they owe this belief solely to what their elders have said and not to their own eating experience. Khastini et al (2018), in Indonesia highlighted other criteria used which involved rubbing on parts of the body, particularly the arm or navel, to check for skin irritation. Skin irritation indicated that the species of fungus was not edible. These authors also mentioned another method, which involved cooking the mushroom using metal spoons. If the spoon turns black, this indicates that the species is inedible.

Our investigations also revealed that recognizing the edibility of a mushroom involved a test. This involved subjecting an animal (a dog, for example) to the consumption of this food. If after a certain length of time the product consumed did not cause the animal any discomfort, the food could be included in the repertoire of foods socially defined as edible. A second test involved serving the food to elderly people. This also explains why the consumption of certain foods is forbidden for younger people and permitted for the elderly. It is only after the food has been consumed without any unfortunate antecedents (illness, death) by the elderly consumers that it can become part of the social group's food repertoire.

Mushrooms were eaten according to their color. White carpophores were considered edible, unlike mushrooms of other colors. This thinking stems from the idea that white symbolizes health, just as red symbolizes illness and black death. The way in which macroscopic mushrooms are prepared, a factor in their edibility, already demonstrates the fear that often accompanies consumption, which explains the seriousness with which they are prepared, with a view to reducing their degree of toxicity as much as possible through repeated washing and boiling for long periods. No species is eaten raw; edible species are prepared fresh after harvesting, often sun-dried or smoked and stored in airtight containers for later use. Some edible species have been reported in other countries as edible.

Indeed, *A*. *masasiensis*, *A*. *subviscosa*, *A*. *crassiconus* and *A*. *strobiliformis* are consumed in Benin by the Nagot people in central Benin, the Mokolé and the Lopka (Yorou *et al.* 2014; Fadeyi *et al.* 2017). *A*. aff. *loosii* and *A*. *masasiensis* are very good edibles in D. R. C. (Kasongo, 2017), Burundi and Rwanda (Degreef *et al.* 2016b). *A*. *masasiensis* is a good edible in Tanzania

and Mozambique (Härkonen *et al.* 2015). A. aff. loosii is a good edible in D. R. C. (Ndolo Ebika, 2018). *A*. *subviscosa*, *A*. *strobiliformis* and *A*. aff. *xanthogala* are consumed in Niger (Yorou *et al.* 2017). *A*. *masasiensis*, *A*. *subviscosa* and *A*. *crassiconus* are consumed in Niger (Hama, 2012) and Burkina Faso (Dabiré, 2017, 2020). *A*. *congolensis* known as *A*. *rubescens* is consumed in Benin by the Nagot people in central Benin, by the Mokolé and the Lopka (Yorou *et al.* 2014; Fadeyi *et al.* 2017), in the Democratic Republic of Congo (Kasongo, 2017), Burundi and Rwanda (Degreef *et al.* 2016b), South Africa, Malawi, Zambia (De Kesel *et al.* 2017) and southern Cameroon (Onguene *et al.* 2018).

Local populations attribute specific names to certain species. The Lopka people in Benin call *A*. *crassiconus* **awoulaa** (Codja *et al.* 2002). *A*. *masasiensis* and *A*. *subviscosa* are called **osusutikpakiou** and **osusutikpa** respectively by the Nagot (Fadeyi *et al.* 2017). Other species not consumed here are consumed in other parts of the world. These are *A*. aff. *xanthogala*, A. aff. strobilaceovolvata and *A. odorata* in Benin (Fadeyi *et al.* 2017) and *A*. aff. *loosii* in D.R. Congo (Kasongo, 2017).

Conclusion

The ethnomycological digs showed that 100% of local residents knew about mushrooms in general, although little was known about Amanitas. In Yendéré, 19.04% of those interviewed, 23.53% in Dan and 66.66% in Nasso, claimed to have eaten certain species such as *A*. *subviscosa*, *A*. *masasiensis*, *A*. *congolensis*, *A*. *strobiliformis* and *A*. *crassiconus*, with the last species eaten in a putrefied state. On the other hand, no species of amanita was reported to be therapeutic or edible in the other villages. From these surveys, we can draw the conclusion that there is no great enthusiasm for eating amanitas in general. Great diversity exists across the study sites and in the associated endogenous knowledge. However, anthropogenic factors associated with the loss of indigenous knowledge and very poor conservation efforts are threatening the survival of economically and ecologically important fungi in the region. A complementary in situ and ex situ mushroom conservation strategy is therefore strongly recommended. In addition, these particular ecosystems, which are favorable for CSCs but threatened by urban development, should be taken into account in land-use planning. Much broader ethnomycological surveys should be carried out on the Amanitas of Burkina Faso, taking into account the harvesting period and the method of harvesting, cooking, preserving, etc., and in a more decentralized manner (urban populations, different ethnic groups in Burkina Faso).

Declarations

Ethics approval and consent to participate: The data were collected with confidentiality, anonymity and consent. All respondents were informed of the purpose of the study and provided prior informed consent.
Consent for publication: Not applicable.
Availability of data and materials: Data used in this article are available for any requests.
Competing interests: Authors declare no conflict of interest.
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Authors contributions: Kounbo Dabiré: primary investigator and interested party in the work, set up and monitored the trials, overseeing data collection and processing, Supervision, writing - original draft, writing - review and editing, Data conservation. Benovana Bakiono: Formal analysis, writing- revision. Andjièrèyir Kusiélé Somda: formal analysis-revision. Blaise Kabré: conceptualization, methodology, revision. Elise Sanon: methodology, conceptualization, supervision. Kuilpokpo Marie Laure Guissou: Formal analysis, Supervision. All authors have read, reviewed and approved the manuscript.

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