



Research article

Ethnomycological study of macromycetes used in the Funa district, Kinshasa, Democratic Republic of the Congo

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Abstract: The present study is a contribution to the knowledge of fungal species of food interest exploited by the population of Funa district, in Kinshasa city in the Democratic Republic of the Congo. The aim was to assess the knowledge of Funa district community in mushroom species diversity sold in the market. The mycological surveys were conducted between December 2019 and January 2020. In the study, we used survey-participation technique. A survey-participation was used as a technique, which is a non-probabilistic method where the interviewees were randomly selected. The sample size was of 81 participants. Qualitative and quantitative methods supported by ethnomycological surveys were used to collect data. Out of 81 people interviewed, 97.5% were women; food use was predominant with 93.8%; 80.2% of participants reported that mushrooms were difficult to preserve due to their perishable nature; and 96.2% of participants felt that mushrooms were only available during the dry season. The sale of sporophores in FUNA District remains the only method of supplying households and local markets. Nevertheless, mushrooms are a valued commodity in women's trading activities in Funa District. More studies are needed to have a clear view on different species consumed by the Kinshasa people and create a database of edible mushrooms consumed in DRC. Furthermore, it is required to assess the knowledge of different Congolese tribes to increase the knowledge of ethnomycology and assess their *in vitro* medicinal activities against different pathologies.

Keywords: Ethnomycology - Mushrooms - Macromycetes - Uses - Funa.

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INTRODUCTION

Currently, the problem of malnutrition is one of the major challenges facing most developing countries and continues to be a major public health concern (Muller & Krawinkel 2005, Mgbekem *et al.* 2019). Hunger and malnutrition are unacceptable in a world that has both the knowledge and the resources to end this natural disaster (Fernandes *et al.* 2021). In Central Africa, wild edible mushrooms are an important food source and they provide a supplement to the daily diet that is particularly rich in proteins, vitamins, fats, carbohydrates, amino acids, and minerals (Kamalebo 2018, El-Ramady *et al.* 2022). They are considered as a delicacy having a high nutritional and functional value, while mushrooms are also accepted as nutraceutical foods. Due to their organoleptic merit, medicinal properties, and economic significance, mushrooms are of great significance (Valverde *et al.* 2015, Mgbekem *et al.* 2019, Sande *et al.* 2019). Furthermore, they constitute important non-

timber forest products (NTFPs) that provides diverse substances and services, especially food and income for local communities from many parts of the world (Kamalebo *et al.* 2018). In poor and rural environments, this contribution is very important, especially when reserves are depleted or when crops are not yet mature (De Kesel *et al.* 2002). Edible mushrooms are macro-fungi that can be seen with the naked eye, *i.e.*, fleshy fruit bodies of many species of mushrooms, and they have already been widely used in food and medicine due to their delicious taste and diverse physiological activities (El-Ramady *et al.* 2022). To date, only 10% of mushroom species have been identified, and precisely macro fungi. It should be noted that mushrooms have been existing for centuries and have spread worldwide, and their distribution in Sub-Saharan Africa has not been completely investigated yet (Fernandes *et al.* 2021). Furthermore, they are vital and essential to humans and of high significance for the environment as global decomposers of nature organic matter and recyclers in most ecosystems. They have been used in Sub-Saharan Africa since the Paleolithic (Fernandes *et al.* 2021).

In the Democratic Republic of the Congo (DRC), mainly in rural areas, mushrooms are a good source of proteins (Kamalebo *et al.* 2018). It has been reported that only few species of mushrooms are known and consumed fresh in urban cities like Kinshasa. *Termitomyces* spp. are the only species which are sold fresh in these urban cities, mushrooms that are only found on the market during the first three weeks of the rainy season (Batubenga *et al.* 2021). Due to the scarcity of fresh mushrooms, most people are content to consume dried sporophores of a few saprotrophic species, which are sold on the local market all the year along. Most of the time, these mushrooms are poorly preserved (moldy) or badly presented (different species in the same package or bundle, lots of waste and grains of sand are found in the sporophores), with risks of consumer poisoning when a poisonous specimen is inadvertently placed in (Batubenga 2015, Batubenga *et al.* 2021). However, the seasonality of the appearance of sporophores is therefore a limiting factor for their availability, which is often random and even limited to a few weeks per year in some regions, mainly during the rainy season (Boddy *et al.* 2013, Roger *et al.* 2021).

Furthermore, only few studies have been reported on edible fungi in Africa and precisely in DRC where some preliminary inventories have been carried out by Dibaluka's team in the University of Kinshasa (Dibaluka, 2005, Batubenga *et al.* 2021, Roger *et al.* 2021). This work aimed to assess mushroom species of food interest exploited by the population of the District of Funa, in Kinshasa, DRC.

METHODOLOGY

Study area

The district of Funa, one of the four districts of Kinshasa city constitutes our study area. Kinshasa city, is located between 04° 18' and 04° 30' South latitude and between 15° 15' and 15° 22' East longitude. It is bordered to the east by Kwilu Province, to the south by Central Kongo Province, and to the north and west by the Congo River, which forms the natural border with the Republic of Congo; its average altitude is 300 m (Dibaluka 2005). Kinshasa city covers an area of 9,968 Km² and its average population density was estimated in 2016 at 12,641,463 inhabitants per km² (Nsankisa 2019).

Methodology

The biological material used is the set of specimens sold in different markets of this district. The mycological surveys were conducted between December 2019 and January 2020. In the absence of credible information to date on the population and on mushroom marketing practices in the study area, it was difficult to determine a priori the probability that each individual in the population would be selected for the survey, given the near impossibility of having a sampling frame.

Generally, non-probability methods are used when there is no sampling frame, which is partly compensated for by a set of instructions given to interviewers to limit selection bias, *i.e.* the bias introduced by the human factor in the sampling process (Diansambu 2016).

To do this, we involved the market manager to whom we first confided when we arrived in a market. After we showed him our authorization to leave and explained the reason for our visit to his market, he gave orders to his staff and the services under his authority to accompany us in order to better carry out our study. We used the survey-participation technique and randomly selected 81 participants, and they were interviewed. Using a questionnaire, socio-demographic parameters were collected (sex, gender, profile, language spoken, origin, occupation, communes of residence) and on the partw ethnomycological data were collected as well.

Data analysis

Data coding, analysis, and processing were done with SPSS version 25.0 statistical software and Microsoft Excel 2016. The bivariate analysis used tests of association or Chi-square, at 5% of significance level. The www.tropicalplantresearch.com

association was approved in case where there was a relationship between variables ($p < 0.05$, CI 95%), otherwise there was no association between variables if the p -value > 0.05 .

RESULTS

Socio-demographic characteristics

The socio-demographic characteristics of participants and the location of survey is presented in the table 1. From the analysis of table 1, it appears that the population interviewed in the communes of Kasa-Vubu, Ngiri Ngiri, Makala, Selembao and Bandalungwa was female. While in the commune of Kalamu, we observed the presence of male vendors (12.5%). Statistical analysis shows that there is no relationship between the gender of participants and the location of the survey ($\chi^2=8.331$; $df=5$; $p=0.13$; $p>0.05$).

Table 1. Gender distribution of the participants in relation to the survey location.

Investigation area	Gender of participants			
	Female		Male	
	Frequency	%	Frequency	%
Kasa_Vubu	44	100.0%	0	0.0%
Ngiri_Ngiri	14	100.0%	0	0.0%
Makala	1	100.0%	0	0.0%
Selembao	2	100.0%	0	0.0%
Kalamu	14	87.5%	2	12.5%
Bandalungwa	4	100.0%	0	0.0%
Total	79	97.5%	2	2.5%

Ethnomycological survey

The distribution of the participants gender related to the different uses of mushrooms is presented in the table 2. From the analysis of table 2, it appears that 97.4% of female and 2.6% of male use mushrooms for food use, while 100% of female use mushrooms for medicinal use and for food and medicinal use (nutraceuticals). Statistical analysis shows that there is no relationship between the respondent's gender and the use of mushrooms ($\chi^2=0.079$; $df=1$; $p=0.77$; $p>0.05$).

Table 2. Distribution of the participant's gender in relation to the uses.

Uses of mushrooms	Gender of participants			
	Female		Male	
	Number	%	Number	%
Food	74	97.4	2	2.6
Medical	2	100.0	0	0.0
Nutraceuticals	3	100.0	0	0.0
Total	79	97.5	2	2.5

Table 3 presents the distribution of the participants gender related to the conservation of mushrooms. From this table 3 it can be observed that 97.4% of female and 2.5% of male do not preserve mushrooms, while a few percentage of the participants preserve well their mushrooms (3 participants). The statistical analysis shows that there is no association between the gender of the participants and the use that can be made with mushrooms.

Table 3. Distribution of the participant's gender in relation to the conservation of mushrooms.

Conservation of mushroom	Gender of participants			
	Female		Male	
	Frequency	%	Frequency	%
No	76	97.4%	2	2.6%
Yes	3	100.0%	0	0.0%
Total	79	97.5%	2	2.5%

The distribution of the participant's gender in accordance to the family appreciation of mushrooms is presented in the table 4 below. From this table 4, it can be seen that 96.9% of female and 3.1% of male respectively believe that mushrooms are very good for the whole family, 100% of female participants believe that mushrooms are good for the whole family and mushrooms are quite good.

The availability of mushrooms in the market is presented in the table 5. From table 5, it is clear that 78 participants of all genders believe that mushrooms are available in the market during the rainy season, while 3 female participants (100%) believe that mushrooms are available in the market in all seasons (dry and rainy). Statistical analysis shows that there is an association between the gender of the participants and the availability of mushrooms in the market ($\chi^2=81$; $df=2$; $p=0.00$; $p<0.05$).

Table 4. Distribution of the participant’s gender in relation to the family appreciation of mushrooms.

Family appreciation of the mushroom	Gender of respondents			
	Female		Male	
	Frequency	%	Frequency	%
Very good	63	96.9	2	3.1
Quite good	4	100.0	0	0.0
Good	12	100.0	0	0.0
Total	79	97.5	2	2.5

Table 5. Distribution of the participant’s gender in relation to the availability of mushrooms in the market.

Availability of sporophores on the market	Gender of participants			
	Female		Male	
	Frequency	%	Frequency	%
Rainy season	76	97.4	2	2.6
Rainy season and dry season	3	100.0	0	0.0
Total	79	97.5	2	2.5

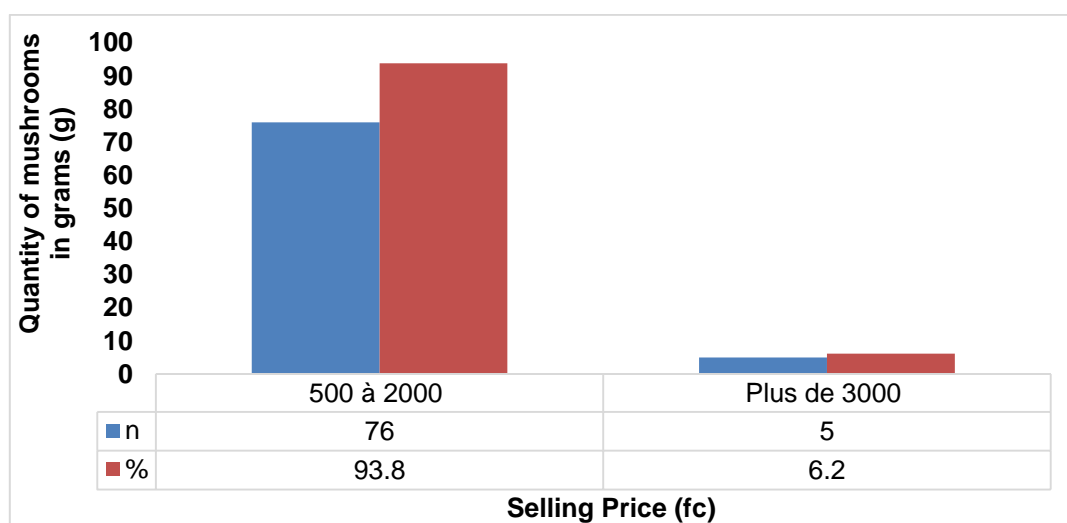


Figure 1. Distribution of quantity of mushrooms in relation to price

From this figure it can be seen that 93.8% of the people interviewed sell mushrooms at a price that varies between 500 FC and 2000 FC, 6.2% sell mushrooms at more than 3000 FC. With 50 g equivalent to 500 FC (with 1\$ = 2000FC).

DISCUSSION

The total population interviewed in our study area was 81, with the female gender dominating over the male gender, with 79 participants of the female gender against 2 participants of the male gender. This is due to the fact that the female gender lends itself more easily to listening than the male gender. Furthermore, statistical analysis shows that there is no link between the gender of the participant and the place of the survey ($\chi^2=8.331$; $dl=5$; $p=0.13$; $p>0.05$). These results corroborate those found by EyiNdong *et al.* (2011) who state that in most parts of Africa where Bantu populations live, they are preferentially harvested by women and their children.

It is important to note that 76 participants of both genders in the interviewed population use mushrooms for food use, 2 participants of the female gender use mushrooms for medicinal use and 3 participants of the female gender use mushrooms for both food and medicinal use, these results confirm those of others in this case, Kouagou *et al.* (2016) and Ndolo *et al.* (2018). The statistical analysis about the habits of mushrooms shows that there is no link between the gender of the respondent and the use that can be made with mushrooms ($\chi^2=0.079$; $dl=1$; $p=0.77$; $p>0.05$). This is justified by its gastronomic side (Batubenga *et al.* 2021).

The low rate of mushrooms in therapy is justified by the lack of specimens on the market all year round and this unavailability leads to the non-conservation. The statistical analysis in relation to conservation shows that there is no link between the gender of the participants and the use that can be made with mushrooms, and the same is true for conservation. However, 65 participants of the interviewed population consider mushrooms to be very good for the whole family, 12 participants of the female gender interviewed consider mushrooms to be good for the whole family and 4 participants interviewed consider mushrooms to be quite good for the whole

family. However, 93.8% of the interviewed population sell mushrooms at a price that varies between 500 FC (\$0.25) to 2000 FC (\$1), 6.2% sell mushrooms at more than 3000 FC (\$1.5). With 50 g equivalent to 500 FC (\$0.25). In this respect, the selling price of mushrooms remains a limiting factor for most households.

The results of our study on the sale price of mushrooms coincide with EyiNdong *et al.* (2011) who state that when mushrooms are sold in the city, their price is much higher, ranging from simple to triple or more.

CONCLUSION

The state of scientific knowledge on mushrooms sold in the Funa district of Kinshasa in the DRC is still embryonic. However, mushrooms are part of the gastronomy of the said population. They are counted among the local forest food resources known by this population.

These studies should be extended to other districts of the city to have a guide on mushrooms sold in DRC. The realization of such a study is one of the research priorities proposed for the better knowledge of the African mycoflora.

The sale of sporophores in urban areas is the only method of supplying households and local markets. The results of this study show that, nevertheless, mushrooms are a valued commodity in trading activities among women in the Funa District. Large specimens are sold in bundles of 3 to 10 feet, while small mushrooms are usually mixed in a container used as a standard of measurement.

However, this commercial activity is practiced only occasionally, because of the pronounced deforestation and the worrying regression of the wooded ecosystems that were once abundantly collected, mushrooms are becoming a scarce resource at least in terms of the quantities sold on the markets. Because of their perishable nature, 96.2% of the population interviewed do not preserve mushrooms and 80.2% of the population believes that mushrooms are good for the whole family. Hence we suggest trials of cultivation of the species most consumed in the sub-region.

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REFERENCES

- Batubenga R (2015) Inventaire des espèces fongiques du genre *Termitomyces* vendues et récoltées à Kinshasa et ses environs, (B.Sc. Thesis). University of Kinshasa, Kinshasa, Democratic Republic of the Congo
- Batubenga R, Lukoki FL, Iteku JB, Kanika DK, Mwambay EK, Bongo GN, Mukaya CB & Dibaluka SM (2021) Ethnomycological study of macromycetes used by the population of Mont-Ngafula, in Kinshasa, Democratic Republic of the Congo. *Open Access Research Journal of Science and Technology* 2(1):1–14.
- Boddy L, Buntgen U, Egli S, Gange AC, Heegaard E, Kirk PM, Mohammad A & Kauserud (2013) Climate variation effects on fungal fruiting. *Fungal Ecology* 1–14
- De Kesel A, Codjla J & Yorou N (2002) *Guide des champignons comestibles du Bénin*. Jardin Botanique National de Belgique, 274 p.
- Diansambu M (2016) Compostage de déchets organiques solides en vue de leur utilisation pour la culture de champignons comestibles. Cas de Kisantu (Kongo-Central/République Démocratique du Congo), (Ph.D. Thesis). University of Kinshasa, Kinshasa, Democratic Republic of the Congo, 310 p.
- Dibaluka M (2005) Inventaire des macromycètes de la forêt du lac de Ma Vallée (Kinshasa) et essai de mise en culture de quelques espèces comestibles, (M.Sc. Thesis). University of Kinshasa, Kinshasa, Democratic Republic of the Congo, 75 p.
- El-Ramady H, Abdalla N, Badgar K, Llanaj X, Toros G, Hadju P, Eid Y & Prokisch J (2022) Edible mushroom for sustainable and healthy human food: Nutritional and medicinal attributes. *Sustainability* 14(4941): 1–30.
- Eyi Ndong H, Degreef J & De Kesel A (2011) Champignons comestibles des forêts denses d'Afrique centrale. In: Samyn Y & Vanden Spiegel D (eds) *Taxonomie et identification*. Abc Taxa vol 10, 254 p.
- Fernandes T, Garrine C, Ferrao J, Bell V & Varzakas T (2021). Mushroom nutrition as preventative healthcare in Sub-Saharan Africa. *Applied Sciences* 11(9): 4221 [DOI: 10.3390/app11094221]
- Kamalebo HM, Seya wa Malale HN, Ndabaga CM, Degreef J & De Kesel A (2018) Uses and importance of wild fungi: traditional knowledge from the Tshopo province in the Democratic Republic of the Congo. *Journal of Ethnobiology and Ethnomedicine* 14: 13. [DOI: 10.1186/s13002-017-0203-6]
- Kouagou YR, Tsopmbeng GN & Njouonkou AL(2016) Diversité et ethnomycologie des champignons sauvages utilisés dans la préfecture de la Lobaye en République Centrafricaine. *Bulletin Scientifique sur*

- L'Environnement et la Biodiversité* 1: 30–38.
- Mgbekem M, Lukpata F, Ndukaku N, Armon M, Uka V, Udosen G & Pricilla A (2019) Knowledge and Utilization of Mushroom as a Food Supplement among Families in Selected Local Government Areas of Cross River State, Nigeria. *Food and Nutrition Sciences* 10: 1287–1299.
- Muller O & Krawinkel M (2005) Malnutrition and health in developing countries. *Canadian Medical Association Journal* 173(3): 279–286.
- Ndolo Sydney T, Codjia JEI, Yorou NS & Yeba A (2018) Les champignons sauvages comestibles et connaissances endogènes des peuples autochtones Mbènzèlè et Ngombe de la République du Congo. *Journal of Applied Biosciences* 126: 12675–12685.
- Nsankisa M (2019) Etude de l'espèce fongique *Pleurotus tuber-regium* (Rumph. ex Fr) Sing. : ethnomycologie (Mont-Amba /Kinshasa/ RDC) et mise en culture sur les inflorescences mâles et rafles du palmier à l'huile (*Elaeis guineensis* Jacq.), (M.Sc. Thesis). University of Kinshasa, Kinshasa, Democratic Republic of the Congo, 63 p.
- Roger B, Felicien LL, Gédéon BN, Jeff IB, Daddy KK, Esther MK & Simon DM (2021). Cultivation Trial of an Edible and Medicinal Mushroom Species, *Pleurotus Tuber-regium* (Rumph. ex Fr.) Singer 1951 (strain 190212) on Various Lignocellulosic Substrates. *Open Journal of Agricultural Research* 1(2): 84–93.
- Sande D, de Oliveira GP, Fidelis MMA, Martins BDA, Lima MTNS & Takahashi JA (2019) Edible mushrooms as a ubiquitous source of essential fatty acids. *Food Research International* 125: 108524 [DOI: 10.1016/j.foodres.2019.108524]
- Valverde ME, Hernandez-Perez T & Parades-Lopez O (2015) Edible mushrooms: improving human health and promoting quality life. *International Journal of Microbiology* 2015: 376–387.