

Full Length Research Paper

Knowledge on utilization of wild mushrooms by the local communities in the Selous-Niassa Corridor in Ruvuma Region, Tanzania

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The present study focused on documentation of wild mushroom species used by the local communities in the Selous-Niassa corridor in Namtumbo district, Ruvuma region, Tanzania. Qualitative and quantitative data were collected by interviewing 50 local informants from different localities in the Selous-Niassa wildlife corridor in Namtumbo district. The data documented include types of wild mushroom species, taxonomical information, social-demographic information, indigenous knowledge and uses. The majority of participants in the hunting of wild mushrooms were females aged between 31 and 45 years who were literate peasants with primary education only. The knowledge about edibility of wild mushroom species was mainly transferred to others by old women whereby those eaten by insects and wild animals or do not form much foam during cooking were considered edible. A total of 32 edible and inedible wild mushroom species belonging to thirteen genera and eleven families were documented. Among the documented wild mushrooms, 34.38% were edible, 25% were medicinal and edible, 31.25% did not have known uses, 6.25% were medicinal only and 3.12% were poisonous. The fidelity level (FL) and informant consensus factor (ICF) of the 32 collected wild mushroom species ranged from 50 to 100% and 0.33 to 0.91, respectively. The documentation of wild mushroom species in communities is important for conservation, transfer of knowledge and information regarding their uses across one generation to another. This study provides information that may, in the future, be used for cultivation, pharmacological, and drug discovery studies to improve public healthcare.

Key words: Utilization, ethnomycological survey, edible mushrooms, medicinal mushrooms, indigenous knowledge, mushroom hunters.

INTRODUCTION

Traditional knowledge on mushrooms is a subject of great significance that unveils the relationships between humans and fungi in a given environment, both in the past and present (Molares et al., 2019; Sitotaw et al., 2020). These natural resources in developing countries, particularly in tropical countries, contribute to an important socioeconomic and ecological role in communities' lives, especially in rural areas. Among these resources are wild edible and medicinal mushrooms that are valuably used globally, although they are neglected in some African countries (Njouonkou et al., 2016). Rural communities in Tanzania use wild mushroom for culinary purposes, nutraceuticals (Teke et al., 2018), medicine, and other uses during the beginning of the rainy season (Härkönen et al., 2003). The existing frequency of deforestation, burning of forest or bush, and overexploitation of both timber and non timber goods (Kinge et al., 2017) are most threatening wild mushroom diversity in Tanzania (Härkönen et al., 2003).

Mushrooms are distinctive large fruiting body macrofungi, which are large enough to be seen with the naked eye and can be picked by hand mostly from *Basidiomycota* and *Agaricomycetes* phylum. Mushrooms are broadly grouped into four categories: edible, inedible, medicinal, and poisonous. Macrofungi are cosmopolitan, heterotrophic organisms that are unique in their nutritional value and ecological requirements that occupy important significance in the biodiversity of the world (Hawksworth, 2012; Vishwakarma et al., 2017). Worldwide, there are about three million fungi of which only 140,000 species are macrofungi and to-date, only 14,000 (10%) are classified as mushroom species. Among these species, about 50% (7000 species) possess varying degrees of edibility, and more than 3000 species from 31 genera are edible while less than (1%) are poisonous (Dutta and Acharya, 2014). The most edible wild mushrooms reported in Tanzania are from the genus *Cantharellus* and *Termitomyces*, while among well-known poisonous mushrooms are from the genus *Amanita* (Härkönen et al., 2003).

Traditional knowledge on the uses of mushrooms has been transmitted orally from one generation to the next across societies globally in both past times and present. This indigenous knowledge includes different uses, belief and perception on wild mushrooms (Molares et al., 2019). Romans perceived them as the "Food of the Gods". Ancient Greek beliefs suggest mushrooms have strength and life force providing capacity, particularly for the warriors when they were in battle. Ancient Chinese and

Japanese consider mushrooms as the gifts of the God Osiris and the people belonging to ancient India and Iran used mushrooms in their ritualistic performances (Dutta and Acharya, 2014).

In tropical Africa, knowledge of traditional uses of mushrooms and their diversity documentation is scarce. However, some research done on documentation of fungi in Central, East, and West Africa has shown that there is a great diversity of edible and medicinal mushrooms. The number of macrofungal species in Cameroon is estimated at 50,000 species, of which only 1,050 are known. In sub-Saharan Africa, around 300 edible mushrooms have been identified, particularly in Central and Southern Africa (Soro et al., 2019). In addition to the limited information on the macrofungi diversity in tropical regions, very little is known about their ethnomycological knowledge and its importance in Africa countries (Debnath et al., 2019; Njouonkou et al., 2016). In Tanzania, wild mushrooms are among high diversity natural resources which are not well documented. However, about 100 species of wild mushrooms are documented in different regions of Tanzania (Tibuhwa, 2013; Härkönen et al., 2003).

Mushrooms are filamentous fungi with fruiting bodies showing a huge number of pharmacological aspects in human health. They are considered one of the delicious foods and are commonly produced worldwide. These macrofungi are a rich source of nutrients and bioactive compounds such as proteins, carbohydrates, vitamins, fibers, minerals, low lipid contents, and essential amino acids. They also have huge medicinal properties including antibacterial, antiviral, antioxidant, anticancer, and hypocholesterolemic activity (Panda and Tayung, 2015; Venkatachalapathi and Paulsamy, 2016; Hussein and Tibuhwa, 2020; Kinge et al., 2020). The medicinal properties are thought to be due to the presence of diverse secondary metabolites. Mushrooms accumulate different types of secondary metabolites, including alkaloids, phenolic compounds, polyketides, terpenes, steroids, and others (Venkatachalapathi and Paulsamy, 2016; Hussein and Tibuhwa, 2020; Kinge et al., 2020).

The tropical regions in Africa have the highest diversity of macrofungi that has not been completely exploited (Kinge et al., 2017). Tanzania is among the tropical regions in Africa which have rich biodiversity but poorly unexplored. The communities in various tribes in Tanzania including the Haya, Nyamwezi, Sukuma, Hehe, Bena, Makua, and Makonde use macrofungi for various purposes including food, traditional medicines, and rituals. Some tribes such as Chagga, Maasai, and Meru lack knowledge on mushroom traditional uses (Härkönen

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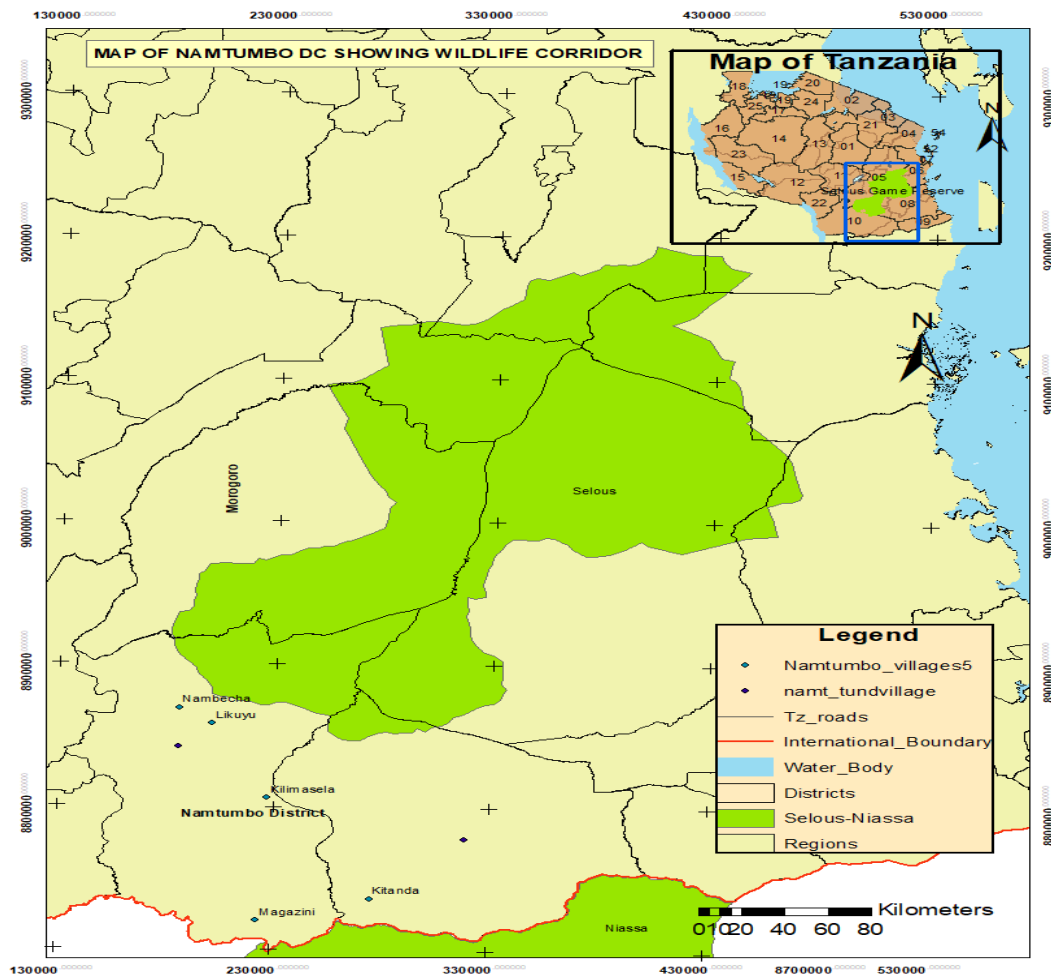


Figure 1. Map of Namtumbo district showing the study site in the Seleous-Niassa Wildlife Corridor.

et al., 2003). However, in other Tanzanian communities ethno-mycology knowledge is scarce due to a low level of documentation. There is no strong purposeful effort in Tanzania to update the wild mushrooms status. Therefore, the present study documented the edible, inedible, and medicinal mushroom species used by community groups in the Selous-Niassa corridor in Namtumbo district, Ruvuma region, Tanzania.

MATERIALS AND METHODS

Study area

The study was conducted at the Selous-Niassa corridor in Namtumbo district, located in the Ruvuma region. The region is located in the Southern part of Tanzania (Figure 1). The Selous-Niassa Wildlife corridor in the Ruvuma region of Southern Tanzania extends roughly from 10° S to 11°40' S. The corridor has a total area of about 10,000 km². The larger part of the area of the corridor is found in the Namtumbo district while the other area is found in

the east part of the Tunduru district. The corridor is bordered by Selous in the North and the Niassa in Mozambique along the Ruvuma River in the South. The collection was done in Likuyuseka, Nambecha, Kilimasera, Kitanda, and Magazini village in the Namtumbo district.

Ethnographic background and climate

According to the 2012 Population Census, the Namtumbo district human population is 201, 639 people (98,335 male and 103,304 female), whereby population density is 11 people per km² (2012 Census; URT, 2013). Mean annual rainfall is about 1230 mm. The rainfall in the corridor decreases from 1200-1300 mm in the Northern part to 800 mm per year in the Southern part along the Ruvuma River. The mean annual temperature is about 21°C (Bloesch and Mbago, 2008).

Dominant ethnic groups within the 29 villages in Namtumbo district are the Yao followed by Ndendeule who settled in the Northern part and a small group of the Ngoni tribe. The community's economy in these three ethnic groups depends on small-scale farming of crops including maize, beans, and paddy for food, with few cash crops which include cashew-nuts, sesame, and

tobacco. Livestock keeping is poorly developed but in the corridor area, livestock keeping is not completely ranched (Bloesch and Mbago, 2006, 2008).

Selection of informants and interviews

The entry point to the communities was through village government leaders, who were requested to provide information about individuals in their communities with experience in the identification and collection of wild mushrooms. Resulting from the list that was provided by the village leaders, individuals who appeared to be more knowledgeable about wild mushrooms were selected for detailed interviews. The selected interviewees signed an informed consent form before participating in detailed interviews. Two interview rounds were done, and for each round there were 25 interviewees (10 from the Ndendeule tribe, 10 from the Yao tribe, and 5 from the Ngoni tribe), making a total of 50 interviewees. The selection of respondents focused on people who, in the community, have exceptional knowledge on the use of wild mushrooms for food and medicine. The interviews were conducted in five villages in the local languages; Ngoni, Ndendeule, and Yao depending on the ethnic groups. The information which was enquired from the interviewees included; whether wild mushrooms had any importance to their livelihoods, the seasons when mushrooms are available, uses of mushrooms, and how collectors acquired knowledge about wild mushrooms. Others were: how to differentiate edible and poisonous wild mushrooms; whether they use any of the wild mushrooms for medicinal purposes; and whether there are specific people in their communities who specialized in the collection of wild mushrooms.

The collection of wild mushroom samples was done during rainy seasons in four sessions based on availability; February to March both in 2019 and 2020. The initial identification of the wild mushroom species was done in the field according to Härkönen et al. (2003), where vernacular names and putative scientific names of the wild mushroom species were documented. The collected wild mushroom species were authenticated at the Department of Molecular Biology and Biotechnology, University of Dar es Salaam. Voucher specimens were kept at the Herbarium of the Institute of Traditional Medicine, Muhimbili University of Health and Allied Sciences.

Data analysis

Wild mushrooms data were summarized using descriptive statistics to identify the number and percentage, socio-demographic information, indigenous knowledge on edibility, uses, genera, and families of wild mushrooms used in the community. Relative frequency of citation (RFC), fidelity level (FL), and informants consensus factor (ICF) were determined for quantitative data analysis.

RFC signifies the local importance of each species in a study area. The RFC was determined by:

$$RFC = \frac{FC}{N}$$

where FC is the number of informants citing a useful species and N is the total number of informants in the survey.

FL is the ratio of informants who mentioned the uses of particular species in the surveyed area. FL was determined using the formula:

$$FL = \frac{N_p}{N}$$

where 'N_p' is the number of informants that claimed the use of a particular species for a particular use and 'N' is the total number of informants citing the species for any uses.

ICF determines the homogeneity of information given by respondents. ICF was determined by:

$$ICF = \frac{Nur-Nt}{(Nur-1)}$$

where Nur is the number of use reports from informants for a particular mushroom use category and Nt is the number of taxa or species category of wild mushroom species.

Ethics approval and consent to participate

The study was awarded Ethical clearance by the Muhimbili University of Health and Allied Sciences Institutional Review Board (Ethical clearance No. Ref.No.DA.282/298/01, Dated, 26th October 2019). Permission to conduct the study in the Namtumbo district was sought from all authorities from the district to the village level. All informants gave prior informed consent before they were interviewed.

RESULTS

Documentation of mushrooms species

A total of 32 mushroom species belonging to thirteen genera and eleven families were documented (Table 1). The most represented wild mushroom families were Russulaceae (10 species) and Cantharellaceae (5 species), followed by Boletaceae (4 species), Clavulinaceae (3 species), and Agaricaceae and Auriculariaceae (2 species). The other families documented and represented by one species each include Amanitaceae, Garnodermataceae, Marasmiusmiaceae, Polyporaceae, and Suillaceae. Among the 32 documented wild mushrooms, 11 (34.38%) were edible, 10 (31.25%) inedible, 8 (25%) were both medicinal and edible species, 2 (6.25%) were medicinal only and 1 (3.12%) poisonous.

Socio-demographic information of informants

A total of 50 wild mushroom hunters and collectors including 29 (58%) women and 21 (42%) men participated as informants. Twenty were Ndendeule, twenty were Yao and ten were Ngoni. The age distribution of the wild mushroom hunters were 20-30 years 4 (8%), 31-45 years 21 (42%), 46-55 years 18 (36%), 56-65 years 4 (8%) and above 65 years 3 (6%). More than half of the respondents 31 (62%) had primary school education, while 19 (38%)

Table 1. Indigenous and conventional characterization of mushrooms.

Scientific name	Vernacular or local name (Tribe)	Family name	Morphology description	Edibility/ Medicinal application	Habitant	Fruiting period
<i>Afroboletus luteolus</i> (Heinem.)Pegler & T.W.K.Young	Nakatunu/ Nakangoma /chikoko (Yao), Mandondo and (Ngoni)	Boletaceae	Dark grey-brown globose the convex cap	Inedible	Mountains forest and miombo woodland	March
<i>Afrocantharellus platyphyllus</i> Eyssart and Buyck	Kungurukwetiti (Yao), Unguyugu uapanakate (Ndendeule) and and Karungeya (Ngoni)	Cantharellaceae	Smooth red at the centre and orange-yellow at margin cap, convex (regularly wavy and irregularly funnel-shaped). Pale to bright yellow gills.	Edible and highly valued	Miombo woodland	Late December, January, and march
<i>Afrocantharellus symoensii</i> Heinem.,Bull.Jard.bot.etat.Bruk.	Chipatwe cha njano or Kungurukweti or Upatewe (Yao), Unguyugu (Ndendeule and Karungeya a (Ngoni)	Cantharellaceae	Unevenly red and orange color mixture of a cap, Smooth, thin, depressed at Centre, convex at the margin when young, strongly funnel-shaped when matured. Light yellow or orange-yellow gills.	Edible and highly valued	Miombo woodland	Late December, January, and March
<i>Agaricus</i> spp.	Ulundi or Uhanga (Ngoni)	Agaricaceae	Smooth softy whitish brown and brown colour concentrated at the centre, convex then the flat cap. Whitish then dark white gills.	Edible and highly valued	On termites' hills	Late December, January, and March
<i>Amanita masasiensis</i> Hark. and Saarim	Kogongooro (Ndendeule), Nakajongolo Janjaro(Yao) and Ugongoro (Ngoni)	Amanitaceae	Smooth, slightly sticky yellow-orange darker at the centre, convex then flat cap. Yellow coloured gills.	Edible but not highly valued. Treatment of wound when dry	Miombo woodland	Late December, January, and March
<i>Auricularia delicate</i> (Mont.) Henn.	Mangaukau (Ngoni), Uyoga hindi (Swahili)	Auriculariaceae	Ear shaped, Pale to dark brown upper surface and whitish lower surface	Edible and highly valued. Rheumatic pain, injuries, skin inflammation, hemorrhoids, and hemoptysis.	On decaying wood mainly on mountain forest	March to April
<i>Auricularia polytricha</i> (Mount.) Sacc.	Mangaukau (Ngoni), Uyoga hindi (Swahili)	Auriculariaceae	Cup-shaped then ear-shaped or folded, Pale brown upper surface	Edible and highly valued. Rheumatic pain, Skin inflammation, and conjunctivitis	On decaying wood mainly on mountain forest	March to April
<i>Boletus Spectabilisi simus</i> Watling	Magomoyakarunga (Yao) (Madondo and (Ngoni)	Boletaceae	Rough orange-yellow or reddish yellow convex cap.	Edible but not highly valued. Alleviate cold symptoms	Degraded miombo woodland	March
<i>Boletus</i> spp.1	Maoloko (Yao),Mandondo (Ngoni)	Boletaceae	Rough greenish-brown or light greenish violent upper surface of the cap	Edible but highly valued	Miombo woodland	March

Table 1. Contd.

<i>Boletus</i> spp.2	Maoloko (Yao),Mandondo and (Ngoni)	Boletaceae	Thick, soft smooth convex to flat yellow or greenish-yellow upper and lower surface of the cap	Inedible	Miombo woodland	March
<i>Cantharellus congolensis</i> Beeli	Chipatweche, (Yao), Unguyugu kakalu (Ndendeule) and Unguyugu mtitu (Ngoni)	Cantharellaceae	Fairly thick brownish fuliginous, convex with central depression cup and brown gills	Edible but not highly valued	Miombo woodlands growing in groups	Late December, January, and March
<i>Cantharellus cf floridula</i> Heinem.	Unguyugu njano (Ndendeule) Chipatwe cha njano (Yao) and Karungeya (Ngoni)	Cantharellaceae	Very thin, Smooth funnel-shaped cap with expanded margin, intensive red at the centre, lighter and light-reddish gills	Inedible	Miombo woodland	Late December, January, and March
<i>Cantharellus isabellinus</i> Var. isabellinus Heinem.	Unguyugu upanake (Ndendeule), Upatwe or Chipatwe cha njano (Yao) Unguyugu njano (Ngoni)	Cantharellaceae	Soft brownish yellow with tiny brown and white flesh cap. Convex with slightly depressed in the middle of the cap (irregularly funnel-shaped) and pale-yellow gills	Edible and highly valued Clean liver, improve vision, regulate the breath, nourish the lung and for diuresis	Miombo woodlands	Late December, January, and March
<i>Chlorophyllum molybdites</i> (G. Mey)	Uhinda (Ndendeule)	Agaricaceae	White with pale brown scales, subglobose then flat cap. White then pale or yellowish-green coloured gills	Poisonous	Bushland vegetation	January to, March
<i>Clavulina</i> sp.1	Ndeuzyalamu like spinach (Yao)	Clavulinaceae	Pale white or cream coloured upper and lower surface	Edibility not known. Improve heartbeats and other heart conditions, treatment of cancer, relief of stomach pain	Soil with degraded woods	February to March
<i>Clavulina</i> sp.2	Ndeuzyamu (Yao)	Clavulinaceae	Soft thick pale white or cream when young and black at edge surface when matured	Edibility not known. Improved heart condition, treatment of cancer, relief of stomach pain	Soil with degraded woods	February to March
<i>Clavulina wisoli</i> R.H,Peterson	Ndeuzyalamu (Yao)	Clavulinaceae	Smooth coloured with a faint pinkish-grey tint. Brush like	Edible. Improve heartbeats and other heart condition, relieve stomach pain, skin infection	Degraded Brachystegia species	February to March
<i>Gastromycetes</i> spp.	Uyoga mayai	Arachniaceae	Yellow or greenish with small brown scales globose with 2-4cm diameter attached to the ground by a thick mass of mycelial strands.	Edible and highly valued	Growing partly buried in soil under different tree species	March

Table 1. Contd.

<i>Humphreya eminni</i>	Not known	Garnodermataceae	Cream, ochraceous to orange-brown upper surface cap	Inedible	Miombo woodland	March
<i>Lactarius densifolius</i> Verbeken and Karhula	Upowa (Ndendeule), Nakazoku (Yao) and Upowa (Ngoni)	Russulaceae	Smooth cream or pale brown convex with a slight central depression cap. Very thin pale cream coloured gills	Edible and highly valued Strengthen weak body condition, condition stomach condition, relieve pain, nourish lungs regulate breath and used in the treatment of cancer	Miombo wood	Late December to March
<i>Lactarius tanzanicus</i> Karhula and Verbeken	Unguyugu nakakuru (Ndendeule), Uyoga mchenga or Upatwe (Yao)	Russulaceae	Bright orange convex then uplifted cap. Dark with brown spots	Inedible	Miombo woodland	Late December to March
<i>Lactarius denigricans</i> Verbeken and Karhula	Kancheke or Likangandunda (Ndendeule) and Upowa (Ngoni)	Russulaceae	Smooth white with black spots or brownish black which convex slightly depressed cap. White with black gills	Edible	Miombo woodlands	Late December to March
<i>Lactarius edulis</i> Verbeken and Buyck	Uboa (Yao) and Nakahuko (Ndendeule)	Russulaceae	Rough with cracks whitish brown or ochraceous cream, darker at the centre with convex then uplifted cap. Ochraceous cream gills	Edible and highly valued	Miombo woodland	Late December to March
<i>Lactarius heimi</i> Verbeken	Kikawa (poison) (Ndendeule)	Russulaceae	Smooth pale brownish-orange convex with central depression which then uplifted cap. Yellowish white gills	Inedible	Miombo woodland	Late December to March
<i>Lactarius Kabansus</i> Regler	Kambalakata/ Umbulakata (Ndendeule), Nakambalakata/ Kungulokwetiti (Yao) and Kambarakata (Ngoni)	Russulaceae	Smooth blackish-brown convex with central depression which then uplifted cap. Dark buff-yellow-white gills.	Edible but not highly valued	Miombo woodland	Late December to March
<i>Lactarius medusae</i> Verbeken	Not known to Ndendeule, Yao, and Ngoni	Russulaceae	Tall, applanation to slightly depressed pale greyish purple to a brown cap. Pale cream coloured gills	Edible but not highly valued	Mimbo woodland	Late December to March
<i>Lactarius pumilus</i> Verbeken	Unguyugu kachoko (Ndendeule) and Upatwe (Yao)	Russulaceae	Golden yellow to an orange-yellow convex then slightly depressed cap. Pale orange gills.	Inedible	Miombo woodland	Late December to March
<i>Lactarius xerampelinus</i> Karhula and Verbeken	Chitutazanga (Yao) and not known (Ndendeule)	Russulaceae	Dark red-brown convex with central depression then depressed to funnel shape cap. Pale cream gills	Edible highly valued	Miombo woodland	Late December to March

Table 1. Contd.

<i>Marasmius bekolacongoli</i> Beeli,	Not known	Marasmiusmiaceae	White with dull lilac-colored depression, central rough and greyish lilac, edge wavy thin like a paper upper cap. Sordid cream white lower side.	Inedible	On ground debris in different types of forest	February to March
<i>Polyporus moluccensis</i> (Mont.) Ryvardeen	Ngaha (Ngoni)	Polyporaceae	Convex to a flat brownish upper surface	Edible and. Skin treatment highly valued	Decaying wood during moist period	March
<i>Russula aff. roseovelata</i> Quél.	Upoa (Ndendeule),	Russulaceae	Rough greyish-brown or white with brown spots, convex becoming applanate with shallow depression cap. White gills.	Inedible	Miombo woodland	January to March
<i>Suillus</i> spp.	Dito (Ndendeule)	Suillaceae	Smooth purple convex cap	Inedible	Miombo woodland	March

were uneducated.

Indigenous knowledge on wild mushrooms

All the informants recognized wild mushrooms as a source of low-cost food, but only 16 (32.32%) recognized wild mushrooms as a source of medicines and 1 (2%) reported that some of the wild mushrooms are used for recreational and ritual functions. Knowledge on wild mushrooms is transmitted from generation to generation by elderly people and mushroom hunters. Three criteria are used for wild mushroom identification; wild mushrooms that are eaten by insects and wild animals are recognized as edible wild mushrooms; wild mushrooms, which foam during cooking, or those which produce latex are classified as inedible. Some are out rightly recognized as poisonous wild mushrooms.

Harvested wild mushrooms are either consumed immediately or preserved for future use. Preservation of wild mushrooms for long-term use

is done by drying in the sun, smoking, and salting. The wild mushrooms are also boiled followed by drying in the sun as an alternative preservation method.

Relative frequency of citation (RFC) and fidelity level (FL)

The FL of the 32 collected wild mushroom species ranged from 50 to 100% (Table 2). The wild mushroom species with high FL were *Agaricus* species, *Cantharellus isabelinus*, *Afrocantharellus platyphyllus*, *Afrocantharellus symoensii*, *Lactarius denigricans*, *Lactarius edulis*, *Lactarius pumilus*, *Lactarius tanzanicus*, *Amanita masasiensis*, *Gastromyces* species, *Auricularia delicata*, and *Auricularia polytricha*. The RFC index authenticates the frequency of citation of wild mushroom species for various uses. RFC of reported species ranged from 22 to 100% (Table 2).

The species with high RFC were *Agaricus* spp.,

C. isabelinus, *A. symoensii*, *Lactarius kabansus*, *Lactarius medusa*, *L. tanzanicus*, *A. masasiensis*, *Clavulina wisoli*, *Gastromyces* spp., *A. delicata*, and *A. polytricha*.

Informant consensus factor (ICF)

The ICF value for selected Tanzanian wild mushrooms ranged between 0.33 and 0.91 (Table 3). A higher ICF value found in this study showed practically high reliability of informants in using relatively few species in a particular use category. ICF were categorized into five groups on the basis of the use of informants' reports: edible, medicinal, inedible, both edible and medicinal as well as poisonous.

DISCUSSION

In this study, it has been established that wild edible mushroom species are significant non-timber natural resources of food supplements in the Namtumbo district, and this was found to be a

Table 2. Relative frequency citation (RFC) and fidelity level (FL).

Scientific name	RFC (%)	Major use	FL (%)
<i>Afroboletus luteolus</i>	66	Inedible	97.00
<i>Afrocantharellus platyphyllus</i>	84	Edible	97.60
<i>Afrocantharellus symoensii</i>	100	Edible	100.00
<i>Agaricus</i> spp.	100	Edible	95.70
<i>Amanita masasiensis</i>	92	Edible	95.70
<i>Auricularia delicata</i>	88	Edible	97.70
<i>Auricularia polytricha</i>	94	Edible	95.50
<i>Boletus Spectabilis imus</i>	34	Inedible	58.80
<i>Boletus</i> sp.1	22	Inedible	81.80
<i>Boletus</i> sp.2	54	Inedible	59.30
<i>Cantharellus cf floridula</i>	6	Inedible	46.00
<i>Cantharellus congolensis</i>	68	Inedible	76.50
<i>Cantharellus isabelinus</i>	96	Edible	100.00
<i>Chlorophyllum molybdites</i>	48	Poison	75.00
<i>Clavulina</i> spp.1	22	Inedible	100.00
<i>Clavulina</i> spp.2	26	Inedible	100.00
<i>Clavulina wisoli</i>	92	Edible	73.90
<i>Gastromycetes</i> spp.	90	Edible	86.00
<i>Humphreya eminni</i>	28	Inedible	100.00
<i>Lactarius densifolius</i>	24	Inedible	83.30
<i>Lactarius tanzanicus</i>	94	Inedible	100.00
<i>Lactarius denigricans</i>	84	Inedible	100.00
<i>Lactarius edulis</i>	80	Edible	92.50
<i>Lactarius heimi</i>	46	Inedible	56.50
<i>Lactarius Kabansus</i>	96	Edible	85.40
<i>Lactarius medusae</i>	92	Inedible	85.40
<i>Lactarius pumilus</i>	64	Inedible	100.00
<i>Lactarius xerampelinus</i>	86	Edible	86.10
<i>Marasmius bekolacongoli</i>	24	Inedible	83.30
<i>Polyporus moluccensis</i>	34	Edible	50.00
<i>Russula aff. roseovelata</i>	32	Inedible	93.80
<i>Suillus</i> spp.	28	Inedible	100.00

Table 3. Informant consensus factor (ICF).

User category	Citations		Species		IFC
	User citation	% of user citation	Number of species	% species	
Food	132	73.33	11	34.38	0.91
Inedible	24	13.37	10	31.25	0.61
Medicinal	03	1.67	02	6.25	0.33
Food/Medicinal	18	10.00	08	25.00	0.58
Poisonous	03	1.67	01	6.25	0.33

common feature among the three tribes living in the district.

According to the literature, this is a common phenomenon for rural communities in developing and

developed countries who use mushrooms to maintain health and increase longevity since ancient times (Panda and Tayung, 2015). Ethnic groups in other parts of Tanzania also use wild mushrooms for food including the

Coast, Iringa, Mara, Morogoro, Ruvuma, Shinyanga, Tabora, and Tanga regions (Tibuhwa, 2018). Some ethnics in Tanzania use mushroom species to promote healthy recovery of mothers after childbirth, malnutrition in children and elders, treatment of stomach pain as well as management of heart conditions (Haärkönen et al., 2003). In the Namtumbo district, wild mushrooms of the genus *Cantharellus* are the most eaten wild mushrooms followed by the genus *Lactarius*. The genus *Cantharellus* is the most consumed species in most ethnic groups in Africa including Burundi, Cameroon, and Congo (Kamalebo and Kesel, 2020). Most edible wild mushrooms in India are of the genus *Lactarius* and *Cantherallus* (Kumar et al., 2017).

Wild mushrooms are collected during the rainy season by different ethnic groups in the Selous- Niassa wildlife corridor in Namtumbo district since this is when wild mushrooms grow and they disappear shortly after the rainy season in mid-December to late January and late February to early April. The same practice has been observed among other tribes in Tanzania including Bena, Makua, Hehe, Ngoni, Nyamwezi, Nyika, and Sambia (Haärkönen et al., 2003). The collected wild mushrooms are used as food for about 2 to 3 weeks, after which period most of these tribes preserve wild mushrooms for food by drying them while still raw or they boil the wild mushrooms and dry them in the sun. The present study has established that the Yao, Ndendeule, and Ngoni tribes in the Namtumbo district use the same methods for wild mushroom preservation.

Wild mushrooms gathering or hunting by other Tanzanian ethnic groups are gender-oriented particularly by women for food and commercial purposes (Tibuhwa, 2013, 2018). Wild mushroom activities including collection, selling, processing, and preservation are dominated by women, in Njombe and Mufindi (Chelela et al., 2014). The same was observed in the Namtumbo district; where women are the main wild mushroom collectors and hunters. This seems to be the trend in many societies (Garibay-Orijel et al., 2012). Women worldwide especially in developing countries are the main collectors, traders, and possess knowledge of wild mushroom use such as for food, medicines, and recreational purposes (Haärkönen et al., 2003; Garibay-Orijel et al., 2012; De Leon et al., 2016; Fui et al., 2018). In Mexico (Ruan-Soto, 2006), Nigeria and Brazil (Oso, 1975; Prance, 1984; Teke et al., 2018), and the Philippines (Tantengco and Rragio, 2018) most wild mushroom sellers and gatherers or hunters are women above 40 years of age.

In this study, it was observed that knowledge about wild mushrooms is transferred to younger generations by the women collectors, and elderly women constitute a big knowledge resource that is important for the transfer of this knowledge to young generations. Knowledge on the identification of wild mushrooms, folk taxonomy, habitat,

phenology, and preparation methods are transferred orally in the Namtumbo district and, in other indigenous communities in Tanzania. This shows that if efforts are not made to document knowledge on these wild mushrooms, knowledge will eventually disappear with time and the embedded economic potential may not be realized. The role of elders, especially women (mothers), in transferring this knowledge from one generation to another has been previously underscored (Sitotaw et al., 2020). Tanzanian children are taken by their mothers to identify edible from inedible and pick edible wild mushrooms for food. This knowledge is not taught in schools in rural areas where these wild mushrooms grow (Härkönen et al., 2003).

The tribes in the Namtumbo district determine the edibility of wild mushrooms by morphological charters, growth habitats, and whether eaten by wild animals or insects through observation. Similar methods of edibility identification have been reported in other tribes of Tanzania (Tibuhwa, 2018) and elsewhere in the developing countries (Basumatary and Gogoi, 2016; Teke et al., 2018; Mérida Ponce et al., 2019). Wild mushrooms with mild tastes, thick flesh, and eaten by tortoise or rodents are edible (Fui et al., 2018). The wild mushrooms changing color to red during cooking, yellowish or blackish after touching or cutting, and give a burning sensation on the tongue when tasted raw are considered inedible (Fui et al., 2018; Sitotaw et al., 2020). The three tribes living in the Selous- Niassa wildlife corridor use the related methods for inedibility identification of wild mushrooms.

High values of FL validate potential traditional mushrooms for specific use while low FL values indicate a wide range of uses with the disagreement of a particular use of some specific species (Jamil and Tanweer, 2016; Dapar et al., 2020). A score of 100% FL for a specific mushroom species indicates that all of the use-reports mention the same mushroom for specific use in the study area (Khastini et al., 2018). In Namtumbo district *Agaricus* spp., *C. isabelinus*, *A. masasiensis*, *L. denigricans*, *L. pumulis*, *Suillus*, and *Clavulina* species had 100% FL for edibility. This FL value information reveals that the three communities in the Namtumbo district rely on specific mushroom species for food (Kim and Song, 2014).

The ICF for the species was determined to know the agreement among the informants living in the Selous-Niassa Corridor in Namtumbo district for indigenous knowledge on wild mushrooms edibility, inedibility, and medicinal uses. The ICF reflected homogeneity, reliability, and the extent of informants' knowledge in the use of wild mushroom species for food, medicinal purposes, and those that are considered inedible in the communities (Uddin and Hassan, 2014). The high ICF value for edible wild mushrooms indicates that wild mushrooms are a valuable traditionally used macrofungi

for three ethics in the Namtumbo district as previously suggested in other studies. The low ICF value for inedible wild mushroom species as recorded in the study could be due to a lack of indigenous knowledge on the identification and toxicity determination (Uddin and Hassan, 2014; Tibuhwa, 2018). This is supported by the fact that some of the wild mushrooms that are not eaten in the Namtumbo district are not all poisonous and they are taken as food in other regions in Tanzania (Tibuhwa, 2012, 2013, 2018). Wild mushroom species with high informant consensus factor and fidelity level are interesting for research and as suggested by other previous researchers they should be given priority to carry out bioassay and toxicity studies (Khastini et al., 2018).

Research highlights

- (1) The present study exposes the rich ethnomycological practices of wild mushroom species use and indigenous knowledge of Ndendeule, Yao, and Ngoni ethnic groups of the Namtumbo district.
- (2) Exchange of information among the local communities in Namtumbo district was observed among three tribes; however, the younger generation has a potential decline of interest due to modern lifestyles and modern medicines.
- (3) Novel medicinal use, nutritional use of edible and inedible wild mushroom species were reported in this study.
- (4) The consolidated data of this qualitative and quantitative ethnomycology study contributes knowledge on the indigenous use of wild mushrooms that should be taken up by scientists, physicians, and experts such as phytochemists, botanists, pharmacists, taxonomists, and environmentalists for value addition and products development.

CONCLUSION AND FUTURE ASPECTS

Indigenous communities in the Namtumbo district are rich custodians of traditional knowledge and practice in the utilization of wild mushroom species for food and medicine. They have the ability to identify edible wild mushrooms from inedible and poisonous mushrooms. Further work in scientific identification of edible and medicinal mushroom species, nutritional proximate analyses, and bioactivity assays are needed to support the economic exploitation of this resource.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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