Co-management of the Katavi – Ugalla corridor forests

Wild mushrooms of Mulele Hills Forest Reserve. Use and marketing potential

(24 February – 10 March 2021)

Adansonia-Consulting, Dr. Urs Bloesch, 9 May 2021

Front page photograph: Mushroom picking near Mlima Isegenezya, Rungwa River Forest Reserve

Content

Acknowledgement

I sincerely thank ADAP Geneva for entrusting me with this wild mushroom study of the villages bordering Mulele Hills Forest Reserve in Western Tanzania. I am very grateful to Mr. Shabani Halfani, project supervisor, and Twinzi Henrico, Technical Assistant Community Development, for their frank collaboration and great support for conducting successfully this mission. My special thanks go to Mr. Valentine Msusa, TFS zonal manager western Tanzania, for his advice and for supporting the mission and to Abas Gwambaye Ngalagale, TFS forest officer Mlele for joining the field mission and his engagement in the mission.

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Abbreviations

ADAP	Association for the Development of Protected Areas
BKZ	Beekeping Zone
FR	Forest Reserve
GCA	Game Controlled Area
GEF	Global Environment Facility
GTZ-IS	Deutsche Gesellschaft für Technische Zusammenarbeit, International Services
IBA	Inyonga Beekeeping Association
JFM	Joint Forest Management
NWFP	Non-wood forest products
SIDO	Small Industries Development Organisation
SME	Small and medium-sized enterprises
TBS	Tanzania Bureau of Standards
TCCIA	Tanzania Chamber of Commerce, Industry and Agriculture
TFDA	Tanzania Food and Drugs Authority
TFS	Tanzania Forest Service Agency
UNDP	United Nations Development Programme
VEO	Village Executive Officer
VGS	Village Game Scout
WEO	Ward Executive Officer

Executive summary

This second mushroom study was carried out from 24 February to 10 March 2021 in the eight villages bordering Mulele Hills Forest Reserve of the project entitled *Co-management of the Katavi – Ugalla corridor forests* in Mlele district (Katavi region). The field survey focussed on the inventory of edible mushrooms and the current use of mushrooms by local communities thereby complementing the first study carried out in the Rungwa corridor project in March 2020. Moreover, a rather brief market survey was carried out in Tabora, Sikonge and Inyonga markets.

In total 263 villagers from the eight villages participated in the socio-economic group discussion. 69 villagers, whereof 17 men and 52 women, were interviewed on the recognition and use of wild mushrooms including amongst others vernacular name, fructification period, edibility, medicinal uses, mushroom habitat, consumption pattern, preserving techniques, and marketing. 22 vendors were interviewed in the market survey focussing mainly on species sold, source of supply, purchase and selling price.

This second survey allowed to expand the species list to include 40 new species resulting in a total of 100 species. Most people of the project villages pick mushrooms in the nearby protected areas. TFS should consider the amendment of the current rules to have a legal framework which is more practicable and in support of the promotion and marketing of wild edible mushrooms.

Almost 80% of the interviewees are picking at least once a week mushrooms during the rainy season. Out of the 69 interviewees, 49 villagers are collecting mushrooms for food only while 19 villagers are picking mushrooms for both, own consumption and for sale. The one-way walking distances for picking mushrooms in the forest vary mostly from a quarter of an hour up to two hours. Traditional mushroom knowledge is transferred mainly from mothers and grandparents to the young generation. Mainly women are gathering mushrooms.

51 species are eaten by people. Most preferred species are *Amanita loosei* (*Ulelema*), *Cantharellus afrocibarius* (*Wange*), C. *isabellinus* (*Ungukwe*)*, C. platyphyllus* (*Wange*), *C. rufopunctatus* (*Ungukwe*), *C. symoensii* (*Wange*), *Lactarius kabansus* (*Umpalala*), and *Termitomyces microcarpus* (*Kansolele*). 40% of the interviewees are eating at least three to four times a week fresh mushrooms, while 77% of the interviewees are consuming at least once a week mushrooms. 34% of the interviewees are consuming at least once a week dried mushrooms in the off-season.

Almost 30% of interviewed people are selling mushrooms to retailers who act as middlemen and resell them to the vendors. Ten out of 22 vendors are selling mushrooms all year round. The demand for fresh and dried mushrooms is high and more mushrooms could be sold if more regularly available. The greatest demand is for chanterelles (*Ungukwe and Wange*).

Quality and minimal hygiene standards have to be respected for successfully marketing wild edible mushrooms and severeal criteria have to be respected for harvest, transport, preservation and packaging of mushrooms. We suggest using solar dryers leading to better quality dried products and possibly better market prices. Only fresh and undamaged mushrooms or properly dried mushrooms free of dirt should be sold at the market.

On-the-spot trainings will be organised in December 2021 for a) mushroom pickers in properly handling mushrooms and in the use of solar dryers and b) vendors in species identification and properly preserving and stocking mushrooms. A well-illustrated leaflet with the most important edible mushrooms of the two districts will be elaborated and will serve for the promotion and marketing of mushrooms and will be used for the training of mushroom

pickers and vendors. It is suggested to carry out a workshop with key stakeholders to define a market strategy for wild edible mushrooms for Katavi-Ugalla and Rungwa corridors following a market systems development approach.

1) Introduction

The Association for the Development of Protected Areas (ADAP) is implementing the project entitled *Co-management of the Katavi – Ugalla corridor forests* in Mlele district (Katavi region) in western Tanzania (April 2020 - March 2022). The project aims to support and accompany eight villages bordering Mulele Hills Forest Reserve (FR) in establishing together with the Tanzania Forest Service Agency (TFS) a co-management for the entire reserve. A memorandum of understanding is currently under discussion with the TFS.

This Joint Forest Management (JFM) encourages forest adjacent communities to play a role in forest management through forest protection. In return for these efforts, they receive a range of concrete benefits, such as rights to harvest forest products, share revenue from forest harvesting, retain fines as well as confiscated materials/produce, use local water sources and so on (Forestry and Beekeeping Division, 2007, 2013).

Sustainable community-based forest management will improve the livelihoods and resilience of the local communities through the development of income generating activities based on non-wood forest products (NWFP) thereby inciting the local population for the conservation of the miombo forest ecosystems. In addition to the promotion of honey, wild edible mushrooms have been identified as another promising added-value chain.

ADAP in collaboration with UNDP/GEF/GTZ-IS formerly mandated two mushroom studies in the Selous-Niassa Wildlife Corridor in Ruvuma region in Southern Tanzania (Bloesch & Mbago 2008, 2009a). These studies clearly demonstrated the high potential of wild edible mushroom in the miombo woodlands and their importance for the diet of the local communities during the rainy season. The studies showed also the high interest of the locals to be involved in the commercialisation of this highly priced food. In addition, a mushroom flyer with coloured photographs of the most important edible mushrooms of the Selous-Niassa Wildlife Corridor was elaborated for supporting the promotion of wild edible mushrooms (Bloesch 2009b).

Large parts of the Mlele and Sikonge districts are covered with extensive miombo woodlands well known for their abundance of edible mushrooms (Bloesch & Mbago 2008, 2009a). In addition, mushrooms growing on termite mounds and agarics are frequent on cultivated lands and within settlements.

The socio-economic baseline survey (Mwakimata 2018) revealed that mushrooms are the second most important NWFP after beekeeping in the Rungwa corridor. 40.5% of interviewees were engaged in gathering wild edible mushrooms whereof 91% of the households were picking mushrooms for food purpose only while 9% of the households were using the mushrooms for self-consumption and for sale.

This ethnomycological study complements a first mushroom survey conducted in in Sikonge District from 9 to 22 March 2020 (Bloesch 2020). Being rich in proteins and vitamins, mushrooms are a potentially valuable source of proteins, particularly for the poor section of the population (Kivaisi 2007).

For this study ADAP has mandated Adansonia-Consulting to assess the use and marketing potential of wild mushrooms in Miombo woodlands of Mulele Hills FR and ajacent areas (see terms of reference in Annexe A):

1) Conducting the discussions / interviews with mushroom gatherers in the eight project villages in Mlele District based on a updated and amended questionnaire from the March 2020 survey;

2) Complete the inventory of edible mushrooms and the description of their habitat (through questionnaires and field observations);
3) Assess the current use of mushrooms by local communities (species, harvesting and conditioning practices, patterns of consumption and preferences, sales on markets…);
4) Make a preliminary evaluation of the marketing potential of the edible mushrooms in the local market of Inyonga and the regional market of Tabora;
5) Provide direction and guidance to project staff for the implementation of the market study at regional level;
6) Design a field guide (leaflet) in Swahili and English for the identification and promotion of prominent wild edible mushrooms from western Tanzania.

In addition to the eight project villages bordering Mulele Hills FR (Masigo, Mgombe, Mtakuja, Nsenkwa, Kanoge, Kaulolo, Utende, and Wachawaseme) the two villages of Ilunde and Isegenezya bordering Rungwa River FR were sampled as well since they could not be visited during the first survey in March 2020 due to extensive flooding of the area.

The organisation of the consultancy was quite a challenge due to current situation of the Covid-19 pandemic and the testing requirement for travelling. The mission was finally carried out from 24 February to 10 March 2021 and the field team was composed of Dr. Urs Bloesch, Adansonia-Consulting, Twinzi Henrico, ADAP technical assistant community development, Abas Gwambaye Ngalagale, TFS forest officer Mlele, Dicksoni Malembeka, VGS (Village Game Scout), Peter Amando, VGS, and Yahya Ally, ADAP driver (see mission programme in Annexe B and organisations and people met in Annexe C).

While access was very difficult or even impossible during the mushroom survey in March 2020, the situation was quite different this year and only the road conditions to Ilunde and Isegenezya were challenging due to heavy rains (see Fig.1). On the other hand, some locations were even exposed to a dry spell and mushrooms were not very abundant.

This report includes the data and preliminary findings from the first mushroom survey in March 2020 and makes recommandations for developing an added-value chain for the marketing of wild mushrooms in Western Tanzania.

Fig. 1. Road under water between Inyonga and Ilunde.

2) Study area

Since several years ADAP has supported a community-based management in the Beekeeping Zone (BKZ) covering 850 km^2 within Mulele Hills FR to address the alarming degradation of the miombo ecosystems caused by deforestation and poaching mainly. With the new project *Co-management of the Katavi – Ugalla corridor forests* in Mlele district ADAP has extended its support to the entire area of Mulele Hills FR of 2,350 km^2.

Mulele Hills FR was gazetted in 1953 (TFS 2014) and is located in the west of Inyonga township surrounded by a dense network of protected areas in Katavi Region (see Fig. 2). The altitude ranges from 1200 to 1500 m a.s.l. along the escarpment which crosses the protected area from northwest to southeast.

Miombo woodlands are the predominating vegetation type of Mulele Hills FR covering more than 90% of the area (see also Bloesch 2019). The average annual rainfall is estimated to oscillate between 1000 and 1200 mm. The miombo type is transitional between “drier” and “wetter” miombo. The seasonally waterlogged mbugas are mainly covered with grasslands and occasionally with few trees and shrubs (wooded grasslands). Narrow riverine forests occur along the permanent and seasonal streams and some evergreen forest patches exist on deeper soils in depressions (south of Ngaramira area and at Masigo according to Kayombo et al. 2013).

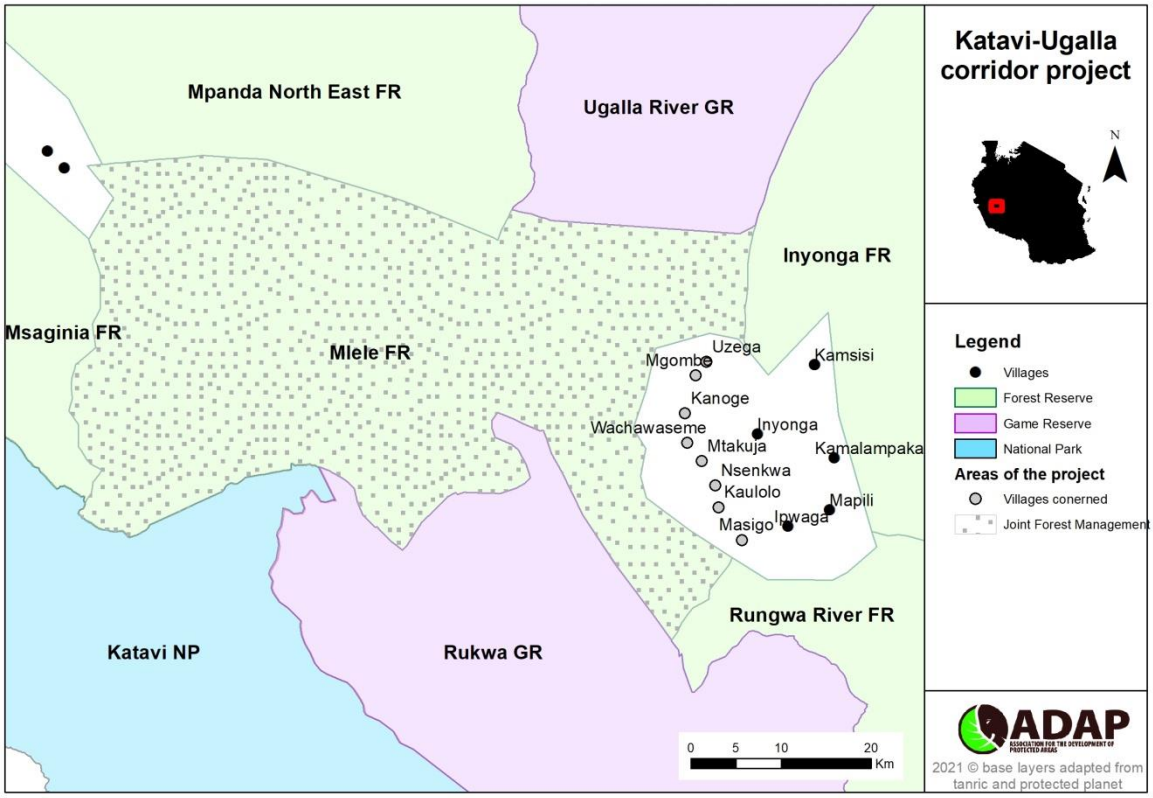

Fig. 2. Location of the project area.

3) Methodology

All eight project villages bordering Mulele Hills FR including Masigo, Mgombe, Mtakuja, Nsenkwa, Kanoge, Kaulolo, Utende, and Wachawaseme as well as the two villages of Ilunde and Isegenezya bordering Rungwa River FR were sampled.

For the individual face-to-face interviews we reviewed and adapted the field questionnaire which was used for the first mushroom survey in the Rungwa corridor in March 2020 (see English questionnaire for villagers in Annexe D). Prior to the interviews / discussions we introduced ourselves to the village authorities. The villagers were informed about the meeting on the previous day what allowed their mobilisation on time. In total, 263 villagers participated in the survey (see table 1).

The interviews were led by Twinzi Henrico, Abas Gwambaye Ngalagale and Dicksoni Malembeka (see Fig. 3). The field questionnaire contains 25 questions and focusses on the recognition and use of wild mushrooms including folk taxonomy, fructification period, edibility, medicinal uses, mushroom habitat, consumption pattern, preserving techniques, and marketing (see Annexe D). In addition, demographic features about the interviewee are recorded. 69 villagers with good knowledge about mushrooms, whereof 17 men and 52 women, were selected for the interviews.

Fig. 3. Twinzi Henrico leading an interview with a woman from Isegenezya.

While the interviews were being held, a semi-structured discussion was animated by the team leader including *open-ended-questions* with villagers not busy with the interviews (see Fig. 4). We used the colour photographs in the book from Härkönen et al. (2003) to obtain the vernacular names and people's knowledge about a particular mushroom species. These group discussions allowed us to verify and complete some of the information received during the face-to-face interviews. Table 1 below summarises the number of participants and interviews led per village (gender-disaggregated).

Table 1. Number of participants and face-to-face interviews conducted

Village	FR	Participants	Interviewees	
			Male	Female
Masigo	Mulele Hills	32	3	7
Mgombe	Mulele Hills	31	1	7
Mtakuja	Mulele Hills	17	1	5
Nsenkwa	Mulele Hills	34	2	4
Kanoge	Mulele Hills	34	4	7
Kaulolo	Mulele Hills	34	2	4
Utende	Mulele Hills	17	3	6
Wachawaseme	Mulele Hills	16	-	4
Ilunde / Isegenezya	Rungwa River	48	1	8
Total		**263**	**17**	**52**

Fig. 4. Common determination of mushrooms at Mgombe with the help of the book of Härkönen et al. (2003).

After the interviews/group discussions some key informants brought us to some of their usual mushroom picking sites near the villages (see Fig. 5). No mushroom foray was realised in Nsenkwa and Kaulolo because of heavy rains. Representative fruit bodies of mushrooms were systematically photographed in the field and labelled. In addition, we took notes about important taxonomic characteristics including substrate, consistency, smell and taste, colour changes, latex (colour and possible colour changes) and spore print.

Fig. 5. Mushroom foray of milk caps (*Lactarius xerampelinus*) at Masigo-Kamagogo, Mulele Hills FR.

Several literature sources were used for the species identification including AGCD (1994), Härkönen et al. (2003, 2015), and Ndong et al. (2011). The nomenclature follows the Index Fungorum (http://www.indexfungorum.org/names/Names.asp).

The edibility of each eatable mushroom was evaluated by the locals in comparison with other mushrooms. For the edibility rating we followed Härkönen et al. (2003):

* = edible species
** = good edible species
*** = edible, delicious

All mushrooms mentioned by the locals during the discussions and / or found in the field were recorded with their vernacular names (mainly Kinyamwezi, Kikonongo, and Swahili and few other local languages) and their edibility what allowed to complement the mushroom list from March 2020 from the Rungwa corridor to get an overall species list for Mlele and Sikonge districts (see table 3). The locality for each mushroom species is mentioned and comprises mainly the three project areas: Kululu forest (Mkola, Mwitikio, Majojoro), Rungwa River FR (Ilunde and Isegenezya) and Mulele Hills FR (Masigo, Mgombe, Mtakuja, Nsenkwa, Kanoge, Kaulolo, Utende, and Wachawaseme) and the name of the market if applicable. The growing habitat is miombo woodland if not otherwise stipulated. In addition, all species with their collection purposes cited by the interviewees are given with their vernacular names in Annexe F.

For facilitating the identification of unknown species at later stage we produced eight exsiccates. We cut thin slices along the cross section from good specimens which we immediately put in a small hermetic plastic bag. We added silica gel with moisture indicator (silicagel red, Districhimie Art.14191) in an approximate proportion of 10 grams silica per one gram of mushroom. Samples dried within a few hours and were periodically checked for re-hydration (if necessary more silica gel was added). At the moment two exsiccates were examined microscopically and thereby *Cantharellus rufopunctatus* and *Lactarius xerampelinus* could be confirmed.

For the market study we reviewed and adapted the questionnaire for villagers which was used for the first mushroom survey in the Rungwa corridor in March 2020 (see English questionnaire for market in Annexe E). The questionnaire including 18 questions focusses mainly on the species sold, source of supply, purchase and selling price. In addition, demographic features about the interviewee are recorded. To initiate the market survey two interviews with mushroom sellers were conducted jointly with Twinzi Henrico at Inyonga and Tabora markets, who afterwards completed the face-to-face interviews in Tabora, Sikonge and Inyonga townships (see table 2 below). At Ipole market no mushrooms were sold at the day of the survey. Out of the 22 interviewees 21 were females. 14 interviewees were selling mushrooms in established markets, seven interviewees were selling alongside the road at Tabora township and one interviewee was just passing in a street of Tabora township with mushrooms for selling (see Fig. 8). Only one of them is harvester and vendor at the same time.

Table 2. Market face-to-face interviews

Market	Interviewee	
	Male	**Female**
Tabora (different markets)	-	12
Sikonge	-	3
Inyonga	1	6
Total	**1**	**21**

4) Results

4.1 Species inventory

All mushroom species mentioned by the locals during the discussions and/or found in the field (markets) from the March 2020 survey and from this survey are listed in table 3 below. Out of 100 species recorded, 64 could be identified at species level, 31 at genus level only and 5 species could not yet be identified. In addition, 39 species were mentioned with their vernacular names during the face-to-face interviewees (see Annexe F).

The **most common families** are as follows:

***Amanitaceae*:** A striking characteristic is the sac-like volva at the stipe base, which surrounds the developing fruit body. Nine species of *Amanita* have been identified whereof seven could be named scientifically. This genus is ectomycorrhizal living symbiotically with trees.

***Boletaceae*:** Usually boletes have a robust appearance with a hemispherical cap, and a well-developed stipe. Typical of boletes is that instead of gills they have tubes. Many species are bright-coloured, and often bruised pore surface and exposed flesh show rapid and bright

colour changes. Most bolete species are associated with trees in an ectomycorrhizal relationship.

***Cantharellaceae*:** Fruit bodies are fleshy but firm, small to medium sized, often trumpet- or funnel-shaped (see Fig. 6). Chanterelles are the prominent species of the miombo woodlands and are also very abundant in the project are with an impressive diversity of 13 species whereof eight species could be named scientifically. Most of them are eaten and are among the most valued edible mushrooms and they can be preserved fresh for several days. All chanterelles are ectomycorrhizal.

***Russulaceae*:** The flesh is brittle, not fibrous, breaking equally in all directions when crushed. This family is the most speciose including 16 *Lactarius* species (milk caps) exuding white, watery or coloured milk latex when cut or broken and 11 *Russula* species. Many of them are edible although some species are only eaten by some peoples while others reject them. All of them are ectomycorrhizal.

***Tricholomataceae*:** This tropical genus is typified by its symbiotic life together with termites. Termites cultivate the mycelium in their nests and fruit bodies can be seen arising on or near the mounds. A typical characteristic is the stipe which is prolonged downwards into a long, thin, root-like extension called a pseudorrhiza ("false root") connecting the fruit body with the underground termite nest. Seven *Termitomyces* species have been recognised whereof only two species including the popular *Termitomyces microcarpus* (Kansolele) were found in the field due to their predominant fructification period in the early rainy season.

Fig. 6. Highly cherished yellow chanterelles (*Cantharellus afrocibarius*) at Kaliagulu, Nyonga FR.

Table 3. Recorded mushroom species in Mlele and Sikonge districts (from forays and discussions of two surveys)

Mushroom species	Kinyamwezi	Kikonongo	Swahili	Edibility	Locality; remarks
Agaricaceae					
Agaricus aff. *arvensis*	*Lolemilwa ng'ombe, Umtegeta*	*Umtegeta*, *Umande*	*Ulimi wa ng'ombe*	* d	Kululu forest area, Rungwa River FR, Mulele Hills FR; cultivated land on dung
Agaricus bingensis	*Wasefu, Utapa*	*Unvamiti*, *Unyang'ombe*		* d	Rungwa River FR, Mulele Hills FR; on termitaria in forest and agricultural fields
Chlorohyllum molybdites		*Unyang'ombe*		* d[5]	Mulele Hills FR
Coprinus cinereus sensu lato	*Umpumwe*	*Utapa?*		* d	Kululu forest area, Mulele Hills FR
Lepiota sp. 1				not eaten	Mulele Hills FR (slit in der outer wall of a house)
Macrolepiota dolichaula	*Kaumwenda*			not eaten	Rungwa River FR, Mulele Hills FR
Volvariella volvacea		*Unjwa ng'ombe*		* d	Mulele Hills FR
Amanitaceae					
Amanita afrospinosa?	Ukivuu			not eaten	Rungwa River FR
Amanita loosei	Ulelema	Ulelema		*** d	Market Tabora, Kululu forest area, Rungwa River FR, Mulele Hills FR; beginning rainy season
Amanita mafingensis	*Umgongolo*[1a], *Wisani*	*Umgongolo*[1a]		* d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR; early rainy season
Amanita masasiensis	*Umgongolo*[1a]	*Umgongolo*[1a], *Umafuta*		* d[5]	Kululu forest area, Mulele Hills FR
Amanita miomboensis				not eaten	Kululu forest area
Amanita aff.rubescens?				not eaten	Wembele hunting camp
Amanita tanzanica	*Umgongolo*[1a]	*Umgongolo*[1a]		* d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR; early rainy season
Amanita sp. 1	Umpunda			* only d	Rungwa River FR
Amanita sp. 2				not eaten	Mulele Hills FR

Boletaceae					
Afroboletus luteolus				not eaten	Kululu forest area, Rungwa River FR, Mulele Hills FR
Boletus pallidissimus				not eaten	Kululu forest area, Rungwa River FR, Mulele Hills FR
Boletus spectabilissimus[3]		*Ndui*		not eaten	Kululu forest area, Rungwa River FR, Mulele Hills FR
Suillus granulatus	*Ikikuku*[1c]	*Ikikuku*[1c]		not eaten	Wembele hunting camp, Mulele Hills FR
Suillus sp. 1				not eaten	Mulele Hills FR
Boletus sp. 1				not eaten	Kululu forest area
Boletus sp. 2				not eaten	Kululu forest area
Boletus sp. 3				not eaten	Rungwa River FR, Mulele Hills FR; context and tubes turn quickly blue when exposed
Boletus sp. 4				not eaten	Mulele Hills FR
Boletus sp. 5		Ndui		not eaten	Mulele Hills FR
Boletus sp. 6				not eaten	Mulele Hills FR
Boletus sp. 7				not eaten	Mulele Hills FR
Boletus sp. 8				not eaten	Mulele Hills FR
Boletus sp. 9				not eaten	Rungwa River FR
Cantharellaceae					
Cantharellus addaiensis	Wijogoro (nyekundu) Kakungulumee	Kakungulumee, Umgongo	Wange nyekundu	* d[5]	Wembele hunting camp, Kululu forest area, Rungwa River FR, Mulele Hills FR
Cantharellus afrocibarius			Wange njano	*** d	Rungwa River FR, Mulele Hills FR (fleshy species like C. isabellinus, clumped)
Cantharellus congolensis	*Utowa*, *Wikese*	*Utowa*, *Ungukwe*		** d[5]	Tabora market, Kululu forest area, Rungwa River FR, Mulele Hills FR
Cantharellus isabellinus	Ungukwe, Wikese	Ungukwe, Wange wapee	Wange mweupe	*** b?&d	Market Tabora, Kululu forest area, Rungwa River FR, Mulele Hills FR
Cantharellus platyphyllus	Wijogoro (nyekundu) Kakungulumee	Kakungulumee, Wange wazaa	Wange nyekundu	*** d	Wembele hunting camp, Kululu forest area, Rungwa River FR
Cantharellus pseudocibarius	Wijogoro (njano)		Wange njano	**	Wembele hunting camp (small cap, slender stipe, like C. addaiensis but yellow; former Cantharellus sp. 1)
Cantharellus rufopunctatus	Ungukwe			***	Mulele Hills FR, Tabora market
Cantharellus symoensii	Wijogoro Wikese? Kakungulumee	Kakungulumee, Wange wazaa / wanjano	Wange nyekundu	***	Wembele hunting camp, Kululu forest area, Rungwa River FR, Mulele Hills FR
Cantharellus sp. 2				?	Rungwa River FR (caramel colour)

Cantharellus sp. 3			Wange nyekundu	?	Mulele Hills FR (bright red cap and bright yellow stipe)
Cantharellus sp. 4			Wange njano	**	Mulele Hills FR (slender stipe, caps not clumped)
Cantharellus sp. 5					Mulele Hills FR (brownish)
Cantharellus sp. 6		Umgongo		**	Mulele Hills FR (yellow / red, small)
Coriolaceae					
Cyclomyces tabacinus[2]				not eaten	Kululu forest area
Funalia polyzona[2,7]	*Mavikuku*	*Mavikoko*		not eaten	Kululu forest area, Mulele Hills FR
Pycnoporus sanguineus				not eaten	Wembele hunting camp, Kululu forest area, Rungwa River FR, Mulele Hills FR; on dead wood
Trametes sp. 1[2]	*Vikukoa*	*Vikukoa*		not eaten	Mkola; on dead wood
Trametes sp.2[2]	Ikikuku[1c]	Ikikuku[1c]		not eaten	Mkola; on dead wood
Clavulinaceae					
Clavulina albiramea	Ukalezuu	Umwenda	Kilezu chamwa guku, Ulim wa ng'ombe	** d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR; whitish creamy (formerly C. wisoli)
Clavulina sp. 1	Mandevu, Umwenda			*	Rungwa River FR; pinkish orange
Ganodermataceae					
Humphreya eminii				not eaten	Wembele hunting camp, Kululu forest area
Hygrophoraceae					
Hygrocybe aff. persistens				not eaten	Mulele Hills FR
Hymenochaetaceae					
Phellinus rimosus[2]	Chikukuu	Nduvi		not eaten	Rungwa River FR, Mulele Hills FR
Phellinus sp. 1				not eaten	Mulele Hills FR
Pluteaceae					
Volvariella volvacea				*	Kululu forest area
Pleurotaceae					
Pleurotus tuber-regium				not eaten	Mulele Hills FR
Polyporaceae					
Hexagonia sp.				not eaten	Rungwa River FR (dry sample)
Polyporus sp. 1				not eaten	Rungwa River FR

Russulaceae					
Lactarius denigricans	*Uskowha, Ukikova*[1d]	*Uskowha, Usikobha*[6], *Utovaa*[6]	*Umpalala wa dume*	* d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR
Lactarius densifolius	*Uskowha, Utovaa*[6]	*Uskowha, Vikova, Ungusu, Ukikova*[1d]		** d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR
Lactarius edulis	*Uskowha*	*Uskowha, Utovaa*[6], *Vikova Ungusu Ukikova*[1d], *Machikova*		** d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR
Lactarius heimii	Uskowha	Uskowha, Usensuka		* d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR
Lactarius kabansus[4]	Umpalala	Umpalala		*** b?&d	Wembele hunting camp, Kululu forest area, Rungwa River FR, Mulele Hills FR
Lactarius luteopus	Makanga lutova	*Usekese*, *Kamkungulu*		* d	Kululu forest area, Rungwa River FR, Mulele Hills FR
Lactarius pumilus			Umulandula[8]	* d[5]	Rungwa River FR, Mulele Hills FR
Lactarius medusae	*Uskowha*	*Uskowha, Usensuka*		* d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR
Lactarius tanzanicus	Ulimba, Usensuka	Usensuka	Molalile[8]	* d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR
Lactarius volemoides	Usensuka, Ukakeku			* d[5]	Wembele hunting camp, Rungwa River FR, Mulele Hills FR
Lactarius xerampelinus	Ukikova[1d] Usikobha[6]	Ukikova[1d]		** d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR, Tabora market
Lactarius sp. 1				not eaten	Mulele Hills FR
Lactarius sp. 2		Usekese		not eaten	Mulele Hills FR
Lactarius sp. 3		Ukikova[1d]		not eaten	Mulele Hills FR; fishy smell
Lactarius sp. 4		Umkusu		not eaten	Mulele Hills FR
Lactarius sp. 5				not eaten	Mulele Hills FR (clear viscid milk)
Russula albofloccosa				not eaten	Wembele hunting camp, Rungwa River FR, Mulele Hills FR
Russula cellulata	Utyelele			* d[5]	Rungwa River FR, Mulele Hills FR
Russula ciliata		Umaharage, Umgongo		* b&d	Rungwa River FR, Mulele Hills FR
Russula compressa		*Umaharage*		* d	Kululu forest area, Rungwa River FR, Mulele Hills FR
Russula harkoneniana				not eaten	Rungwa River FR, Mulele Hills FR

Russula congoana	Umpotya	Umaharage		* d[5]	Kululu forest area, Mulele Hills FR
Russula hiemisilvae		Iliminya ng'ombe		* d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR
Russula aff. roseovelata		*Lolemilwa ng'ombe*, *Umsuzi*		* d[5]	Rungwa River FR, Mulele Hills FR; on pastures
Russula roseoviolacea	*Ukakuva*	*Ukakuva, Iliminya ng'ombe*		* d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR
Russula sejuncta				*	Rungwa River FR
Russula sp. 1	Uyungwe ng'ombe	Uyungwe ng'ombe		***	Wembele hunting camp, Kululu forest area
Schizophyllaceae					
Schizophyllum commune		*Makikuku*		not eaten[2]	Kululu forest area, Rungwa River FR, Mulele Hills FR
Sclerodermataceae					
Scleroderma verrucosum				not eaten	Kululu forest area, Rungwa River FR
Tricholomataceae					Termitomyces on termitaria mainly on cultivated land
Termitomyces aurantiacus	*Untele, Utyelele,Umtuli*	*Utyelele, Umtuli, Umswale*		** d	Kululu forest area, Rungwa River FR, Mulele Hills FR
Termitomyces clypeatus	*Utyelele*	*Utyelele, Ufumapatali, Umtuli*, *Uvumbu*		** d	Kululu forest area, Rungwa River FR, Mulele Hills FR
Termitomyces eurrhizus		*Ufumapatali, Uswale*, *Uvumbu*[1b]		** d	Rungwa River FR, Mulele Hills FR
Termitomyces letestui	*Uhima, Ufumapatali*	*Uhima,Uswale Ufumapatali Uvumbu*[1b]		** d	Market Tabora, Kululu forest area, Rungwa River FR, Mulele Hills FR
Termitomyces microcarpus	Kansolele	Kansolele		*** d	Tabora, Sikonge markets, Kululu forest area, Rungwa River FR, Mulele Hills FR
Termitomyces singidensis	*Uvumbu*[1b]	*Vusenge*		** d[5]	Kululu forest area, Rungwa River FR, Mulele Hills FR
Termitomyces tyleranus			*Umtuli*, *Utapa*	** d	Kululu forest area

Termitomyces sp. 1					Tabora town along foot path
Family not known	*Kibamila mbanga*	*Kibamila mbanga*			Kululu forest area
	Ukema wifulele			?	Kululu forest area
			Def ya babu	?	Kululu forest area
			Kidevu cha babu	?	Kululu forest area
		Utapa		** d	Mulele Hills FR (growing on rotten woods / roots)

100 species in total whereof 61 recorded in the field; 51 edible species

Legend:
Locality: miombo woodlands when not otherwise specified;
Mushrooms written in *italic*: not seen in the field / market;
b = edible after parboiling; d = also eaten dried
1a) Mgongolo = Umgongolo; plural Wigongolo; 1b) Plural Mavumbu; 1c) Plural Makikuku; 1d) Ukikova / Ukikoba: plural Makikova; 1e) Ungukwe = Ukukwe / plural Mkukwe
2) Powder used against cough;
3) When touching this mushroom the person will be lost in the forest;
4) Can be eaten raw.
5) Eaten in some villages, but not in others
6) Utovaa = Utobha?; Usikobha = Usikova
7) For treating pancreas sickness
8) Kiha language

The key findings from the face-to-face interviews regarding the use of mushrooms by the local communities are presented in the following chapters.

4.2 Mushroom picking and collection purposes

Almost 80% of the interviewees are picking at least once a week mushrooms during the rainy season. The most collected mushrooms are presented in table 4 below.

Table 4. The ten most collected mushrooms

Mushroom species	**Frequency of mentioning**
Wange (*Cantharellus afrocibarius, C. isabellinus, C. pseudocibarius, C. symoensii, C.* sp. 3 and 4)	55 out of 69
Umpalala (*Lactarius kabansus*)	31 out of 69
Kansolele (*Termitomyces microcarpus*)	28 out of 69
Utapa	12 out of 69
Umkwilima	9 out of 69
Uhima (*Termitomyces letestui*)	7 out of 69
Utobha (*Lactarius denigricans, L. densifolius, L. edulis*)	6 out of 69
Usensuka (*Lactarius heimii, L. medusae, L. tanzanicus, L. volemoides*)	6 out of 69
Umgongolo (*Amanita mafingensis, A. masasiensis, A. tanzanica*)	5 out of 69
Ulelema (*Amanita loosei*)	5 out of 69

Out of the 69 interviewees, 49 villagers are collecting mushrooms for food only while 19 villagers are picking mushrooms for both, own consumption and for sale (see Annexe F). Mainly women are gathering mushrooms.

When people collect mushrooms for food they identify them with methods similar to those used in the north, i.e. after picking the mushroom they break the stipe to see if the flesh is brittle or tough (fibrous), they smell and taste it.

The walking distances (one way) for picking mushrooms in the forest vary mostly from a quarter of an hour up to two hours. Usually the mushroom pickers are using bucket of 20 liters to transport the fungi. Over 85% are collecting one to two buckets per foray in average. Traditional mushroom knowledge is transferred mainly from mothers and grandparents to the young generation.

4.3 Edibility

All interviewed people valued mushrooms as food very highly. 51 species out of 100 species (not counting the mushrooms mentioned in the interviews) are eaten by people (see table 3). Most of the edible species are from the genus *Amanita, Cantharellus* (chanterelles), *Lactarius* and *Termitomyces* (termite mushrooms). Most preferred species are *Amanita loosei* (*Ulelema*), *Cantharellus afrocibarius* (*Wange*), C. *isabellinus* (*Ungukwe*), *C. platyphyllus* (*Wange*), *C. rufopunctatus* (*Ungukwe*), *C. symoensii* (*Wange*), *Lactarius kabansus* (*Umpalala*), and *Termitomyces microcarpus* (*Kansolele*). *Boletaceae* are not eaten in Africa in general and also in the study area none of the 14 recorded boletes is eaten by the locals although some might be edible. In Europe many boletes are eaten, and some belong to the most esteemed edible fungi.

For differentiating edible from poisonous species many people considering mushrooms which are eaten by insects or animals as edible what is scientifically not true. Especially insects also attack poisonous fungi. Many poisonous species have no specific name and are all called *sumu* (in Swahili). Some poisonous mushrooms with an own vernacular name were mentioned during the interview are given in table 5 below.

Table 5. Poisonous mushrooms with an own vernacular name

Mushroom species	Local language
Kibamila mbanga (from March 2020)	Kinyamwezi+Kikonongo
Kangalutobhab	Kinyamwezi+Kikonongo
Linkangalutobha	Kinyamwezi+Kikonongo
Makozyakozya	Kinyamwezi+Kikonongo
Makikuku	Kikonongo
Mdende	Kiha
Mzaziukasasi	Kipimbwe
Ndubhi	Kikonongo
Ndui	Kikonongo
Umsegese	Kikonongo
Unduvaluva	Kinyamwezi+Kikonongo

4.4 Consumption, shelf time and preserving techniques

40% of the interviewees are eating at least three to four times a week fresh mushrooms, while 77% of the interviewees are consuming at least once a week mushrooms. The shelf life of fresh edible mushrooms varies between one to four days. Five common mushrooms with the longest respectively shortest shelf life according to the interviewees are given in table 6 and 7 below.

Table 6. Five common fresh mushrooms with the longest shelf life

Mushroom species	Frequency of mentioning	Average shelf life in days
Usensuka (*Lactarius heimii, L. medusae, L. tanzanicus, L. volemoides*)	10 out of 69	3.7
Wange (*Cantharellus afrocibarius, C. isabellinus, C. pseudocibarius, C. symoensii, C.* sp. 3 and 4)	39 out of 69	2.6
Usikobha (*Lactarius denigricans, L. xerampelinus*)	12 out of 69	2.4
Umpalala (*Lactarius kabansus*)	27 out of 69	1.5
Ungurume	5 out of 69	1.5

Table 7. Five common fresh mushrooms with the shortest shelf life

Mushroom species	Frequency of mentioning	Average shelf life in days
Umkwilima	13 out of 69	1.0
Umgongolo (*Amanita mafingensis, A. masasiensis, A. tanzanica*)	4 out of 69	1.0
Utobha (*Lactarius denigricans, L. densifolius, L. edulis*)	2 out of 69	1.0
Kansolele (*Termitomyces microcarpus*)	23 out of 69	1.2
Umaharage (*Russula ciliata, R. compressa, R. congoana*)	4 out of 69	1.3

Almost all people are drying the surplus of the mushroom harvest for the consumption during the dry season. Most of the species are frequently dried. Some people first boil the mushrooms before sun-drying them on a mat. Due to the pre-boiling the mushrooms become very hard and have to be soaked before cooking. Properly dried and stored mushrooms have a shelf life of at least one year. 34% of the interviewees are consuming at least once a week dried mushrooms in the off-season.

4.5 Medicinal uses

Several polypores are used for treating cough including such as *Phellinus rimosus* (the taxonomic identification of the species has to be confirmed). The mushrooms are first burnt and then grinded to powder and eaten with salt (maize flour). Only one interviewee is collecting mushrooms also for medicinal use.

4.6 Marketing

Almost 30% of interviewed people are gathering mushrooms also for selling. All 19 villagers who are doing business with mushrooms are selling the collected fungi to retailers. The average selling price of the five most sold mushrooms is shown in table 8 below.

Table 8. Average mushroom selling price of mushroom pickers for the five most sold mushrooms (fresh and dried)

Mushroom species	Frequency of mentioning	Price per bucket of 20 litres (TSh)
Wange (*Cantharellus afrocibarius, C. isabellinus, C. pseudocibarius, C. symoensii, C.* sp. 3 and 4)	15 out of 19	25,000
Umpalala (*Lactarius kabansus*)	15 out of 19	25,000
Kansolele (*Termitomyces microcarpus*)	14 out of 19	25,000
Utobha (*Lactarius denigricans, L. densifolius, L. edulis*)	7 out of 19	20,000
Ulelema (*Amanita loosei*)	6 out of 19	20,000

Most interviewed market vendors purchase mushrooms from retailers. Few vendors were getting mushrooms directly from pickers from the villagers who transport the mushrooms to the market places.

Fresh and dried mushrooms with their buying and selling price in towns are listed in table 9 and 10, respectively. All market venders are selling fresh mushrooms while less than half of them are also selling dried mushrooms (see Fig. 7). The mushrooms prices received during the interviews are not consistent what does not surprise as financial data are sensitive (see table 8 – 10). For example the selling price given by mushroom pickers (see table 8) is considerably higher than the buying price at the vendors level although pickers and retailers are not necessary from the same market chain. Ten out of 22 vendors are selling mushrooms all year round. The demand for chanterelles (*Ungukwe and Wange*) is greatest.

Table 9. Buying and selling prices of fresh mushrooms at market place

Mushroom species	Mention frequency	Average buying price (TSh)	Average selling price (TSh)
Ungukwe (*Cantharellus isabellinus, C. rufopunctatus*)	11 out of 22	13,900	20,400
Wange (*Cantharellus afrocibarius, C. isabellinus, C. pseudocibarius, C. symoensii, C.* sp. 3 and 4)	10 out of 22	14,500	17,700
Usikobha (*Lactarius denigricans, L. xerampelinus*)	8 out of 22	8,000	11,100
Umpalala (*Lactarius kabansus*)	6 out of 22	9,900	15,000
Kansolele (*Termitomyces microcarpus*)	4 out of 22	13,000	19,500
Uhima (*Termitomyces letestui*)	4 out of 22	10,000	16,700
Utobha (*Lactarius denigricans, L. densifolius, L. edulis*)	3 out of 22	10,300	15,000

Table 10. Buying and selling prices of dried mushrooms at market place

Mushroom species	Mention frequency	Average buying price (TSh)	Average selling price (TSh)
Kansolele (*Termitomyces microcarpus*)	4 out of 22	32,000	73,000
Usikobha (*Lactarius denigricans, L. xerampelinus*)	3 out of 22	15,000	41,700
Utobha (*Lactarius denigricans, L. densifolius, L. edulis*)	3 out of 22	15,000	40,000
Umpalala (*Lactarius kabansus*)	2 out of 22	16,700	40,000
Ungukwe (*Cantharellus isabellinus, C. rufopunctatus*)	2 out of 22	20,000	30,000
Wange (*Cantharellus afrocibarius, C. isabellinus, C. pseudocibarius, C. symoensii, C.* sp. 3 and 4)	2 out of 22	10,000	15,000
Uhima (*Termitomyces letestui*)	1 out of 22	30,000	45,000

Fig. 7. Selling of *Lactarius xerampelinus* at Tabora market.

The mushrooms that cannot be sold in due time are sun-dried in an open space on an underlay (tray, canvas or mat, see Fig. 9).

Fig. 8. Interview with vendor at Tabora market; foreground *Cantharellus rufopunctatus*.

5) Discussion

The local communities are interested to develop a mushroom value chain. Wild edible mushrooms are recognised by TFS as an important NWFP of miombo woodlands and they are interested to support the sustainable harvesting of mushrooms for the benefit of the conservation of the miombo ecosystems.

263 people participated in the discussions whereof 52 women and 17 men were interviewed. Since every participant received TSh 3,000 for attending the meeting their motivation is difficult to assess. Nevertheless most people were very interested in the topic and participated actively in the survey. We have to be cautious for not extrapolating the socio-economic findings of the survey to the whole population since the participating villagers interested in the mushroom topic may not be representative for the whole population, e.g.

their average frequency of picking and consuming mushrooms may differ from the rest of the community.

This second survey allowed to greatly amend the species list despite a short dry spell for some locations where mushrooms were not very abundant. 40 new mushroom species could be recorded resulting now in a total of 100 species mentioned by the locals and/or recorded in the field.

The two mushroom surveys confirmed the high abundance of wild edible mushrooms in miombo woodlands (Bloesch & Mbago 2008, 2009a, Mlambo & Maphosa 2017) with 51 edible species recorded. Chelela et al. (2014) reported 45 wild edible mushrooms collected by Benna and Hehe communities in Njombe and Iringa regions in the Southern Highlands of Tanzania. The findings of the two surveys will be discussed in more detail compared to other studies in the planned publication of a scientific article.

Several species from the genera *Amanita, Lactarius, and Russula* were eaten in some villages, but not in others. Some people are lacking the knowledge to differentiate between edible and poisonous mushrooms with certainty. The fact that a fungus is attacked by insects does not confirm its edibility. *Amanita* species should be picked for food always from miombo woodlands and never from the plantations of exotic trees to avoid confusion with the poisonous Death cap (*Amanita phalloides*) or the Red fly agaric (*Amanita muscaria*).

64 species could be determined at species level despite the still existing challenges in species identification. The taxonomy of Tanzanian mushrooms is still incomplete although many new species to science have been described in the last decades. A comprehensive field book including species identification keys is still missing. Usually, edible mushrooms have vernacular names but often several species have the same local name and sometimes people confuse the vernacular names what further complicates the species determination. Further additional assessments are necessary for confirmation and amendment of the species list. Most of the interviewees in Kululu forest area and Rungwa River FR are Wanyamwezi while the dominant language near Mulele Hills FR is Kikonongo. Vernacular names in other languages were also recorded including Swahili, Kiha, and Kipimbwe (see table 3 and list of vernacular names from the face-to-face interviews in Annexe F).

The survey confirmed the strong seasonality of many mushroom species (Härkönen et al. 2015). Since both mushroom surveys were organised towards the end of the rainy season most of the termite mushroom species and some other species such as e.g., *Amanita tanzanica* which grow only in the early rainy season, were no more available. Therefore, the training mission planned for December 2021 will certainly allow recording some of these fungi in the field.

Many people in the Mlele and Sikonge districts are frequently picking mushrooms during the rainy season. Both fresh and dried mushrooms are a valued food. We assume that most people of the project villages pick mushrooms in the nearby protected areas. Officially they should get a permit from TFS for gathering mushrooms in the forest reserve including an entry fee of TSh 3000 and the payment of TSh 200 per kg collected mushrooms. Furthermore, a TFS officer should accompany the mushroom picker what is unrealistic regarding the limited number of officers available in both districts. In reality, no mushroom picking permit has been issued so far by TFS in Mlele and Sikonge districts. While beekeeping is a prominent NWFP in Tanzania and promoted by TFS the marketing of wild edible mushrooms has been widely neglected. TFS should consider the amendment of the current rules to have a legal framework which is more practicable and in support of the promotion and marketing of wild edible mushrooms. It should be possible for mushroom groups in future to get a single permit for all members.

Many common and edible fungi from the families *Amanitaceae, Cantharellaceae*, and *Russulaceae* are ectomycorrhizal living in symbiosis with certain tree species. The miombo woodlands are mainly composed of ectomycorrhizal trees of the *Caesalpinioideae* subfamily including the genera *Afzelia*, *Bauhinia*, *Berlinia*, *Brachystegia*, *Cassia*, *Erythrophleum*, *Isoberlinia*, and *Julbernardia*. This explains the high abundance and diversity of macro fungi in these ecosystems. The common tree species may alter from one area to another thereby also changing the occurrence of mycorrhizal mushroom species. This is why the inherited wisdom of mushrooms is very local (Härkönen et al 2003).

Many mushroom pickers and vendors are drying mushrooms but basic quality and hygienic standards during the drying process are barely met. Mushrooms are usually sun-dried in an open space thereby exposed to dust and insects which may feed and/or lay eggs in the mushrooms (see Fig. 9). Furthermore, not fully dried mushrooms are decaying rapidly due to mould fungi infestation. Equally important is the appropriate storage of dried mushrooms in clean and hermitically sealed containers.

Fig. 9. Sun-drying of unsold mushrooms on a canvas at Inyonga market exposed to dust and insects which may feed and/or lay eggs in the mushrooms.

Properly dried and stored mushrooms have a longer shelf life what will enhance the self-consumption of this highly nutritional diet during the off-season in benefit of the food and nutrition security of the local communities (see also Chelela et al. 2014).

5.1 Marketing strategy

The Rungwa corridor project started to organise the interested people in village mushroom groups. The *Co-management of the Katavi – Ugalla corridor forests* project should start as well to organise the interested mushroom pickers from the eight adjacent villages of Mulele Hills FR in village groups.

Quality and minimal hygiene standards have to be respected for successfully marketing wild edible mushrooms and severeal criteria have to be respected for the harvest, transport, preservation and packaging of mushrooms (Annexe G). Only fresh and undamaged mushrooms or properly dried mushrooms free of dirt / dust (and properly packaged if applicable) should be sold at the market.

However, the current practice of open-air drying of mushrooms does barely meet minimal hygienic standards (see Fig. 9). Therefore, we suggest using solar dryers leading to better quality dried products and possibly better market prices (GTZ-GATE 2001). They generally allow more complete drying and therefore longer storage and reduce losses and contamination from insects, other animals and dust. Only clean, properly dried and packed mushrooms considering hygenic aspects will meet the quality requirements. The market demand will be assessed for this quality project supported by a market promotion campaign.

During a practical formation in December 2021 mushroom group members will be trained in properly picking, transporting, preserving and stocking mushrooms and in the correct handling of solar dryers and packaging of dried mushrooms. Most of the urban mushroom consumers are not able to distinguish with certainty the different mushroom species sold at the market. Therefore, vendors should be able to differentiate edible from and inedible or even poisonous mushrooms and it is foreseen to give them training in December 2021.

Although the walking distances in some villages may reach several hours one way the mushroom business could be interesting for the mushroom pickers provided that market access is facilitated. The demand for mushrooms in town is high and often the vendors cannot meet the demand and more mushrooms could be sold if regularly available.

It seems that the return for the sellers is good although the financial data received during the survey are sensitive (see table 9 and 10). Chanterelles and *Kansolele* (*Termitomyces microcarpus*) achieve the highest sales price of fresh mushrooms (see table 9). On the other, termite mushrooms (*Termitomyces letestui and especially T. microcarpus*) which are light and uncongested when fresh are sold at much higher price when dried than other mushrooms which are more fleshy and compact such as Chanterelles (see table 10).

According to Chelela et al. (2014) mushroom collectors from the Southern Highlands of Tanzania were able to earn US$ 500 to 650 US$ per season while the retailers gained US$ 750 to US$ 1000 per season {see also similar study from Mlambo & Maphosa (2017) from Zimbabwe}.

This survey focussing on mushroom pickers and vendors in Tabora Region revealed the important role of retailers for understanding the functioning of the market chain. It seems that many of the retailers are coming from the steadily increasing Wasukuma who are well known for their interest in business. Their active involvement in the development of a mushroom market chain could be also beneficial for conservation issues. The information gathered on the retailers qui act as middlemen should be further deepened.

Some mushroom consumers are coming from big cities to purchase mushrooms such one famous lady dealer known as Mama Juma Nsansa coming from Dar es Salaam to buy

mushrooms at Tabora farmers' market. Potentially larger scale buyers such as supermarkets, stores, restaurants or hotels will be contacted to assess their interest for high quality mushrooms (fresh or properly dried). In future, also more distant urban centres will be evaluated at later stage considering also additional preservation technics (curing, vinegar, canning…).

As recommended in the first mushroom report (Bloesch 2020) we suggest following a Market Systems Development (MSD) approach to design a value chain for promoting and marketing wild edible mushrooms from the miombo ecosystem (DCED 2020, 6 April). Contrary to traditional project approaches, in which implementing agencies provide services directly to the poor, an agency applying *Making Markets Work for the Poor* (M4P) acts as a facilitator to align key players and functions of a market system to produce sustainable results. The ADAP projects should therefore only facilitate / advise key players in the marketing of wild edible mushrooms but not taking the lead role (direct implementation).

A realistic vision should be developed, e.g., *the steadily increased market demand for quality wild mushrooms is met by regular supply of mushrooms from the Rungwa corridor leading to higher income and better nutrition of the local communities during the dry season*. The core problem(s) for the marketing of mushrooms should be clearly identified. The supporting functions (e.g. proper mushroom drying technics or media campaign), the relevant rules (e.g. hygienic standards) and the role of the key players should be well understood. The development of a comprehensive marketing strategy can profit from the large experience of the beekeeping value chain established with the support of ADAP in Mlele District. We suggest setting up a mushroom association for mushroom groups from both districts for better supporting the interest of the mushroom groups and for taking the lead in the marketing of wild edible mushrooms.

The small Industries Development Organisation (SIDO) is a parastatal organisation under the Ministry of Trade, Industry and Investment. It is a leading institution in promoting the development of small and medium-sized enterprises (SMEs) for sustainable industrialisation in Tanzania. Their experience in the organisation of agricultural producers, traceability of products, private sector involvement and their technical advice for the drying process and packaging of mushrooms will be very beneficial for elaborating the marketing strategy. Other key partners are the Tanzania Food and Drugs Authority (TFDA) and the Tanzania Bureau of Standards (TBS) for the marketing of wild edible mushrooms respecting relevant food safety and quality regulations and standards. Further important stakeholders to involve in the elaboration of a marketing strategy are in general the private sector and the Tanzania Chamber of Commerce, Industry and Agriculture.

5.2 Mushroom leaflet

As discussed, a well-illustrated leaflet with the most important edible mushrooms of the two districts will be elaborated. The well-elaborated mushroom leaflet from the former ADAP Namtumbo project in Songea Region serves as a template (Bloesch 2009b). The leaflet will support the promotion and marketing of mushrooms and will be used for the training of mushroom pickers and vendors. It includes a brief presentation of the project and provides guidance regarding mushroom identification, recommended picking techniques, appropriate containers for the foray and transport, and proper drying techniques.

The English version of the leaflet will target the English spoken audience (authorities, technical services, private sector, hotels, developing agencies, donors...). The English version will be translated in easy Swahili for the local communities who will be the main beneficiaries of the promotion and marketing of wild edible mushrooms.

6) Conclusions

This second mushroom survey further confirmed the high abundance and rich diversity of macro fungi in miombo woodlands and the widely unused potential of this NWFP in Tanzania. The sustainable and proper use of wild edible mushrooms can enhance the livelihoods of the local communities for both personal consumption and income.

The demand for mushrooms in Tabora, Sikonge and Inyonga markets often exceeds the supply. A better organisation of the market chain will reduce current access and transport constraints. Improved stocking and preservation techniques will contribute to a more regular supply of mushrooms.

The information gathered during the two surveys form a solid basis for developing a market strategy considering the principles of a market systems development approach. It is suggested to organise a workshop for defining a common strategy for the two projects just after the training of mushroom pickers and vendors foreseen for December 2021. The template of a well-illustrated leaflet for some prominent edible mushrooms of the region should be ready for print for the English and Swahili version in June and August 2021, respectively.

7) Recommendations

The following **recommendations are aimed at both ADAP projects** and cover the period up to end of the next mushroom season in April 2022. The corresponding activities and their timeline are shown in table 11. The planned workshop for defining a market strategy will further refine some of the activities.

1) Present TFS the key findings of the two mushroom survey and the next steps for elaboration a market strategy.
2) Elaborate a mushroom leaflet in English and Swahili with the most important edible mushrooms of the two districts for the promotion and marketing of mushrooms as well as for the training of mushroom pickers and vendors.
3) Write a scientific article for an ethno-mycological journal focussing on the species inventory and the two surveys.
4) Contact the Botanic Garden in Meise in Belgium for the determination of unknown fungi.
5) Clarify the requirements for picking permits for mushroom groups with TFS.
6) Evaluate different solar dryers, select an appropriate type and order at least 2 units for each project.
7) Form village mushroom groups in Mlele and Sikonge (consolidation).
8) Discuss challenges and role of different stakeholders related to the establishment of an added-value for wild edible mushrooms with key institutions including SIDO office Tabora, Tanzania Chamber of Commerce, Industry and Agriculture (TCCIA) office Tabora and private sector representatives.
9) Discuss relevant food safety and quality regulations and standards with Tanzania Food and Drugs Authority (TFDA) and Tanzania Bureau of Standards (TBS) for selling wild edible mushrooms.
10) On-the-spot training of mushroom pickers in properly picking, transporting, preserving and stocking mushrooms and in the correct handling of solar dryers and packaging of dried mushrooms.

11) Train mushroom vendors in species identification and in properly preserving and stocking mushrooms.
12) Carry out a workshop with key stakeholders to define a market strategy for wild edible mushrooms for Katavi-Ugalla and Rungwa corridors.
13) Map the mushroom retailers and their purchase and selling contacts.
14) Conduct preservation tests (shelf life) of fresh mushrooms with interested mushroom pickers.
15) On-site testing, experimentation and adjustments of solar dryers with mushroom pickers.
16) Organise market media campaign (radio, newspaper) and market sale booth (with posters, distribution of leaflets…) for promoting the consumption of wild edible mushrooms.
17) Testing the market demand for properly dried and packed mushrooms supported by a market promotion campaign.
18) Assess the demand for quality mushrooms at supermarkets, stores, restaurants and hotels in Tabora (and possibly other cities).
19) Support the creation and functioning of a mushroom marketing association for facilitating the organisation of an added-value chain (e.g. mushroom depots, transport, regular exchange mushroom pickers, retailers, and vendors).
20) Elaborate and implement a monitoring system for the value chain (quantities of mushrooms harvested, consumed and sold by members of mushroom groups.

Table 11. Tentative timetable for promoting and marketing activities of wild edible mushrooms for both ADAP projects

Activity	Mushroom season											
	Off-season 2021			Season 2021/22			Off-season 2022			Season 2022/23		
	M/J	J/A	S/O	N/D	J/F	M/A	M/J	J/A	S/O	N/D	J/F	M/A
1) Brief presentation of key findings and next steps for a market strategy to TFS												
2a) Mushroom leaflet template ready for print In English												
2b) Mushroom leaflet template ready for print In English												
3) Writing an article for an ethno-mycological scientific journal												
4) Determination of unknown fungi Meise Botanic Garden, Belgium												
5) Clarification picking permits for mushroom groups with TFS												
6) Procurement of 4 solar dryers (2 for each project)												
7) Formation of mushroom groups (consolidation in Sikonge)												
8) Discussion of added-value chain with SIDO,												

TTCCI and private sector												
9) Discussion of food safety and quality regulations and standards with TFDA, TBS												
10) Training of mushroom pickers in handling mushrooms (incl. dryer)												
11) Training of vendors in species knowledge and handling of mushrooms												
12) Market strategy workshop with key stakeholders and development of strategy												
13) Mapping of retailers and their purchase and selling contacts												
14) Preservation tests (shelf life) of fresh mushrooms (different species)												
15) On-site testing of solar dryers												
16) Organise market media campaign and market booth												
17) Testing market demand for properly dried and packed mushrooms												
18) Assessment of demand of supermarkets, stores, restaurants, and hotels												
19) Support creation and functioning of mushroom marketing association												
20a) Elaboration monitoring system of value chain												
20b) Implementation monitoring system of value chain												

Urs Bloesch is in charge of the brief presentation to TFS (recommendation 1), the elaboration of the template for the mushroom leaflet (2), the writing of a scientific article in collaboration with project staff and ADAP Geneva (3), and the determination of unknown fungi together with the Botanic Garden in Meise, Belgium (4). Furthermore, he will contribute to the training of mushroom pickers and vendors (10, 11) and the market strategy workshop (12).

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Annexe A: Terms of Reference

Study on wild mushroom species and their potential marketing

Background information
The Katavi-Ugalla corridor project aims to support and accompany eight villages bordering the Mlele Forest Reserve in establishing co-management of the entire reserve in order to secure their rights to the reserve, its management and the income generated from it. The project will be developed along two lines, the first aiming to facilitate the establishment of village institutional structures for the management of the reserve, the second to support the development of income-generating activities for the benefit of the neighboring communities by focusing on two sectors: honey and wild edible mushrooms.
The present terms of reference concern the first steps for developing an added-value chain for wild mushrooms including species inventory, assessment and analysis of the current uses of wild mushrooms and their market potential. This first step is necessary to pave the way for a tailored to the needs training in appropriate mushroom picking, transport, storage and conditioning adapted to the socio-economic and cultural context of the project villages. The training will be organised at the beginning of the next rainy season in December 2021 / January 2022 and will be subject to separate ToR. In addition the data collected during this mission will be used to frame the content and illustrations of a leaflet in English and Swahili, which will be an important support for the training and the promotion and marketing of mushrooms.
Adansonia-Consulting, reprensented by Dr Urs Bloesch, was selected for this consultancy for his proven expertise in miombo woodlands mushroom species identification and the development of added-value chains in Tanzania.

Objectives
The mushroom study undertaken by an external consultant should:

- Together with project staff, conducting the discussions / interviews with mushroom gatherers of the 8 project villages in Mlele District based on a updated and amended questionnaire ;
- Complete the inventory of edible mushrooms and the description of their habitat (through questionnaires and field data collection);
- Assess the current use of mushrooms by local communities (species, harvesting and conditioning practices, patterns of consumption and preferences, sales on markets…);
- Make a preliminary evaluation of the marketing potential of the edible mushrooms in local market of Inyonga and regional market of Tabora;
- Provide direction and guidance to the project staff for the implementation of the market study at regional level;
- Design a field guide (leaflet) in Swahili and English for the identification and promotion of prominent wild edible mushrooms from western Tanzania.

Implementation of the study
Timeframe of field work: 15 days
Reporting requirement: short verbal debriefing to the project team and TFS officer or District Forest Officer after accomplishing the field work.
Report: The consultant will present the findings, conclusions and recommendations in a report in English language before May 2021. The report will establish a time frame for the forthcoming steps to support. In addition the consultant will create a database of pictures per species for the leaflet.

Leaflet : PDF documents ready to print in English and Swahili (introduction, description of key species; pictures of mushrooms in high resolution).
Means of work in the field: the car of the project or motorbikes will be at the disposal of the consultant for his field work; Village Game Scouts and technical assistance staff of the project will be available to support the data collection. In addition, the project will ensure the participation of TFS officer to the field visit in Mlele.

Study area
For mushroom identification: Mlele Forest Reserve and patches of forests nearby villages
For discussions / questionnaires: villages of Utende, Mgombe, Kanoge, Wachawaseme, Mtakuja, Kaulolo, Nsenkwa and Masigo (Mlele FR)
For market survey: Inyonga and Tabora

Budget

3.58	Design of a promotional leaflet on mushrooms of Miombo woodlands in Western Tanzania (Swahili and English)	2000 CHF
3.32	Mushroom study (consultancy fee and allowances)	4500 CHF
2.32	Refundable costs (flight tickets and visa)	750 CHF
	TOTAL	7250 CHF

Annexe B: Mission Programme

Date	Programme
23/2/2021	Travelling from Evilard to Geneva by train
24/2/2021	Flight Geneva – Dar es Salaam
25/2/2021	Flight Dar es Salaam – Tabora; meeting with TFS; Tabora – Inyonga by car
26/2/2021	Briefing ADAP team and discussion programme; visit Mlele District authorities and immigration office; reviewing field questionnaire
27/2/2021	Discussion mushroom pickers from Isegenezya and Ilunde at Isegenezya and mushroom picking at Mlima Isegenezya; mushroom identification in the office
28/2/2021	Mushroom identification in the office; visit market at Inyonga
1/3/2021	Discussion mushroom pickers at Mgombe and mushroom picking in Mulele Hills FR
2/3/2021	Discussion mushroom pickers at Utende and mushroom picking in Nyonga FR
3/3/2021	Discussion mushroom pickers at Kanoge and mushroom picking at Ulaya in BKZ of Mulele Hills FR
4/3/2021	Discussion mushroom pickers at Wachawaseme and Mtakuja and mushroom picking within settlement
5/3/2021	Reviewing market questionnaire; discussion mushroom pickers at Nsenkwa and Kaulolo; visit market at Inyonga
6/3/2021	Discussion mushroom pickers at Masigo and nearby mushroom picking in Mulele Hills FR; briefing ADAP project supervisor at Inyonga and departure by road to Tabora
7/3/2021	Organisation return back to Switzerland (corona testing)
8/3/2021	Visit markets at Tabora; organisation return back to Switzerland (corona testing)
9/3/2021	Flight Tabora – Dar es Salaam
10/3/2021	Flight Dar es Salaam – Geneva; travelling Geneva – Evilard (train, cable car)

Annexe C: Organisations / people met

Organisation	People met
ADAP Headquarters Geneva	Yves Hausser, head of operation
ADAP Mlele	Shabani Halfani, project supervisor Twinzi Henrico, technical assistant community development Yahya Ally, driver
IBA	Ernest Kanumba, manager
Local authorities and technical services	Lincoln B. Tamba, District Administrative Secretary Victor Subira, district immigration officer Mlele Bahati Neberi Mwenisongole, WEO Utende Joyce Anthony Shekika, WEO Nsenkwa Andrew Damian Mwinjira, VEO Itesengenezya Robina Nestance William, VEO Mgombe Evelina Tumaini Robert, VEO Kanoge Amosi Aliseni Ngozi, VEO Wachawaseme Mathew Edward Juakali, VEO Mtakuja Grace Joachim Mambwe, VEO Nsenkwa
TFS	Valentine Msusa, zonal manager western Tanzania Thomas Wambura, assistant manager forest development, western Tanzania Nuru Kasim Tengeza, assistant manager beekeeping development, western Tanzania Abas Gwambaye Ngalagale, forest officer Mlele Paulo Rugola, forest officer Mlele
VGS	Dicksoni Malembeka Peter Amando

Annexe D: Village questionnaire

This questionanaire is about mushroom availability, uses and potential marketing for the villages bordering Mulele Hills and Rungwa River Forest Reserves

<u>Section One</u> : Introduction

1. **Name ……..**
   2. **Sex**
      Male ( )
      Female ( )
   3. **Age**
      15-29 ( )
      30-44 ( )
      45-54 ( )
      55-64 ( )
      65-74 ( )
      75-84 ( )
      85-94 ( )
   4. **What is your occupation ?**
      a) **Main occupation……..**
      b) **Additional occupation (if any)……**
   5. **Settlement Places**
      a) **Sub-Village ……..**
      b) **Village ……..**
      c) **Ward ……..**
      d) **Division ……**

<u>Section Two</u> : Mushrooms information

6. **Mushrooms collection purposes?**
   a) Food ( )
   b) Medicine ( )
   c) Business ( )

7. Mention names of mushrooms and their collection purposes

	Mushrooms species	Collection purposes (a, b, c); in case of b specify the kind of treatment.
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

8. Name three names of mushrooms that you prefer to collect most?

……
……
……

9. Who taught you to identify and collect mushrooms?

. ……
……

10. Who is picking mushrooms in your village?

	Group	Part of group participating
1	Women	
2	Men	
3	Children	

11. How can you differentiate edible from inedible mushrooms?

……
……
……

12. What are the names of poisonous mushrooms you know?

……
……
……

13. Mention places where mushrooms are found and their walking distances. (give time for one way)

	Name of place where mushrooms are found	One-way walking time
1		
2		
3		
4		
5		

14. Specify the sites or trees where five types of mushrooms are growing.

	Mushroom species	Site/tree
1		
2		
3		
4		
5		

15. How many times per week or month are you collecting mushrooms?

.....

16. How much in terms of bucket do you collect mushrooms per trip (specify bucket)?

.....

17. Do you preserve mushrooms to avoid being decayed? And if yes how?

……

18. What is the shelf time of five common mushrooms?

	Mushroom species	Shelf time (days)
1		
2		
3		
4		
5		

19. Mention names of mushrooms and their months of availability.

	Mushroom species	Month or months of their availability
1		
2		
3		
4		
5		

20. How many times per week or month do you consume mushrooms at your house hold during the rain season?

.....

21. **How many times per week or month do you consume mushrooms at your house hold during the off- season?**
    ……..

22. **Do you sell part of the collected mushrooms? If yes, how much are you selling (half of it, quarter or very small)?**
    ……...
    ……..

23. **What are the mushroom species you are selling and what is their price?**

	Mushroom species	**Price (per bucket)**
1		
2		
3		
4		
5		

24. **For what purposes do you use the income from mushrooms selling?**
    ……

25. **Are there any problems you experienced in selling mushrooms? If yes, specify the problems**
    ……
    ……
    ……

Annexe E: Market questionnaire

This questionnaire is about assessment of mushroom markets

First Section: Introduction

1. Name ……

2. Sex
Male ( )
Female ( )

3. Age
15-29 ( )
30-44 ( )
45-54 ( )
55-64 ( )
65-74 ( )
75-84 ( )
85-94 ( )

4. What is your occupation?

a) **Your main occupation……..**
b) **Additional occupation (if any)……**

5. Contacts?.....

6. Location of the business (market, shop, alongside the road, any other places).
…….

Second Section: Mushroom Information

7. What are the mushroom species you are selling?
…….
…….
…….

8. Where do you get the mushrooms and from whom?
……
……

9. How much mushrooms are you selling per day and per species?

No	Fresh mushrooms	quantity
1		
2		
3		

No	Dry mushrooms	quantity
1		
2		
3		

10. In which month (s) are you selling mushrooms?

……..

11. What is the buying and selling price per species and selling unit (fresh/dry)?

Mushroom species	Price	Rain Season		Dry Season
		Fresh mushroom	Dried Mushroom	Dried mushrooms
	Buying price			
	Selling price			
	Buying price			
	Selling price			
	Buying price			
	Selling price			
	Buying price			
	Selling price			

12. Where are the customers?

……

13. What are you doing with not sold fresh mushrooms?

……

……

14. What is the shelf time of fresh and dried mushrooms?

No	Mushroom species	Shelf time	
		Fresh	Dried
1			
2			
3			
4			
5			

15. In which month (s) mushrooms are highly demanded?

……

16. What are the mushroom species with high demand?

……
……
……

17. What are the problems you are facing in that mushroom business?

……
……

18. How mushrooms business could be better promoted?

……
……

Annexe F: Vernacular names of mushrooms and their collection purposes (from interviews)

Ranking 39 species	Mushroom species	Local language	Frequency of mentioning (out of 69)	Collection purposes
1	Wange	Kikonongo+Knyamwezi	59	Food and business
2	Umpalala	Konongo+Knyamwezi	52	Food and business
3	Kansolele	Kikonongo+Knyamwezi	51	Food and business
4	Ulelema	Kikonongo+Kinyamwezi	30	Food and business
5	Umgongolo	Kikonongo	25	Food and business
6	Umkwilima	Kikonongo	22	Food and business
6	Utobha	Kikonongo+Kinyamwezi	22	Food and business
8	Utapa	Kikonongo+Utapa	21	Food and business
8	Uvumbu	Kikonongo+Kinyamwezi	21	Food ad business
10	Ufumapatali	Kikonongo+Kinyamwezi	20	Food and business
11	Usikobha	Kikonongo+Kinyamwezi	19	Food and medicine
11	Unyang'ombe	Kikonongo+Kinyamwezi	19	Food and business
13	Umwenda	Kikonongo+Kinyamwezi	17	Food and business
14	Umaharage	Kikonongo	13	Food and business
15	Umtuli	Kikonongo	12	Food and business
16	Uhima	Kikonongo+Kinyamwezi	11	Food and business
16	Usensuka	Kikonongo+Kinyamwezi	11	Food and business
16	Uhima	Kikonongo+Kinyamwezi	11	Food and business
19	Uyungwe	Kikonongo+Kinyamwezi	7	Food and business
20	Mtegeta	Kikonongo	6	Food and business
21	Umande	Kikonongo	5	Food and business
22	Umsuzi	Kikonongo+Kinyamwezi	4	Food and business
23	Usiwe	Kipimbwe	3	Food and business
24	Uswale	Kipimbwe	2	Food
24	Mkukwe	Kikonongo+Kinyamwezi	2	Food and medicine
24	Utelele	Kiha	2	Food and business
24	Wikese	Kikonongo+Kinyamwezi	2	Food and business
24	Ugela	Kiha	2	Food and business
24	Ukanchekeche	Kikonongo	2	Food
30	Umkusu	Kikonongo	1	Food and business
30	Mapalale	Kipimbwe	1	Food and business
30	Ukase	Kipimbwe	1	Food
30	Umaziwa	Kikonongo+Kinyamwezi	1	Food and business
30	Ulungula	Kikonongo	1	Food
30	Uyole	Kipimbwe	1	Food and business
30	Umagazi	Kikonongo	1	Food and business
30	Umiti	Kikonongo	1	Food and business
30	Mamkulangu	Kikonongo+Kinyamwezi	1	Food
30	Mampuke	Kikonongo	1	Food

Annexe G: Principles for proper picking and handling mushrooms

The following principles should be respected in the proper picking and handling of mushrooms:

***Mushroom foray*:** Careful picking is very important to meet high quality and hygiene standards for a successful marketing of mushrooms. Only fresh and undamaged mushrooms should be collected. Mushrooms should be cut off near the ground (instead of plucking) and remaining soil from the base of the stipe should be cut off to keep the mushrooms clean in the container thereby avoiding any later washing. Every mushroom should be split into two halves to see if there are no maggots inside. Unknown mushrooms should be kept away from edible ones which are known.

***Container*:** The newly available cotton bags or weave basket out of organic material (e.g. bamboo) should be used for collecting mushrooms. Closed containers like plastic bags or buckets accelerate the decomposition of the mushrooms. Stacking layers of mushrooms should be avoided since mushrooms are very delicate and risk to be spoiled quickly. The same principle should also be applied for packaging of the mushrooms for its transport from the collection centres to the market.

Preservation techniques: Fresh mushrooms have to be consumed rapidly in order to avoid deterioration of their quality. However, there are quite big differences between species. For example, termite mushrooms have to be consumed the day they were picked. On the other hand, chanterelles in general can be preserved in good quality for several days if stored properly. The development of appropriate preservation techniques will not only be in profit of marketing mushrooms but also of self-consumption during the dry season of properly dried mushrooms what will improve the quality of the diet of the locals.

***Sun drying*:** Mushroom should be cut in slices of 3-4 mm of thickness before drying in the sun (open-air and solar dryer). Fully dried mushrooms break very easily. Dried mushrooms should be preserved in a covered container to prevent them from absorbing air moisture what would accelerate spoiling of the mushrooms by microorganisms. ADAP staff should be actively involved in drying (including the assessment of possible changes in the flavour of the mushrooms) and preservation tests by carrying out their own tests to gain practical experiences. The necessity of boiling mushrooms before drying them will be discussed in the mission report. Proper drying will also promote the domestic consumption during the dry season of this highly priced food.

***Storage*:** Mushrooms should be stored in clean, dry and well aerated places.