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ABSTRACT

A survey was conducted to assess mycological knowledge and socio-economic benefits along the wild edible mushrooms value chain among *Benna* and *Hehe* ethnic groups in the Southern Highlands of Tanzania. The mushroom hunters, collectors, processors and retailers from the local communities in Njombe and Iringa regions were interviewed. The information on indigenous mycological knowledge, collecting and retailing of wild edible mushrooms in *Benna* and *Hehe* communities were gathered. The wild edible mushrooms were collected in the *Miombo* woodland surrounding six villages during rainy season in January 2014. From the survey, mushroom collection and selling was gender oriented dominated by women at 70% and 93.5% respectively. Moreover, it was found that 30% of men were involved in collecting and only 6.5% in selling. About 45 species of wild edible mushrooms were collected mainly from *Lactarius, Russula, Cantharellus* and *Amanita* species. Mushroom collectors were able to collect 1000 to 1500 kilograms earning US $ 500 to 650 per season. Also, retailers were able to sell 750 to 800 kilograms, earning US $ 750 to 1000 per season. Generally, wild mushrooms collection and retailing can contribute to improved socioeconomic status, thus providing alternative employment and food security to rural minority especially women and elderly in *Benna* and *Hehe* communities in the Southern Highlands of Tanzania.

Key words: Wild edible mushrooms, value chain, *Benna*, *Hehe* and livelihoods

Running title: Wild edible mushrooms value chain for improved livelihoods of the *Benna* and *Hehe* communities in Tanzania

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INTRODUCTION

Tanzania with its vast areas of woodland is having the diversity of the natural miombo ecosystems which provide high potential of producing indigenous mushrooms (Bloesch and Mbago, 2008) edible and inedible. Wild edible fungi have been collected and consumed by people for thousands of years. Wild edible fungi are important source of food, income and ecological role by maintaining health of the forest (Boa, 2004). In Tanzania, over 60 edible mushroom species have been identified (Bloesch and Mbago, 2008; Tibuhwa, 2001; Härkönen, 2003), most of these are usually collected from the wild during rainy season. Globally, there are 2327 recorded useful species; 2166 are edible of which 1069 species are used as food, with at least other 100 known food species lacking published evidence (Boa, 2004). According to Mizuno (1995), Wasser (1995), Wasser *et al*. (1999) and Ferreira *et al*. (2010), approximately 700 species of higher *Basidiomycetes* have been found to possess significant pharmacological activities. Wild edible mushrooms are collected, consumed and sold in over 80 countries worldwide and amount collected each year is several tonnes with a minimum value of US $ 2.0 billion (Boa, 2004). Mushrooms have long been valued as a high quality food with a pleasant flavour and tasty, appealing texture, delicacy and healthy nutritious by different societies throughout the world (Muruke *et al.*, 2002. Mushrooms have a wide array of medicinally important compounds that have anticancer and antiviral activity; offering great hope for the production of new drugs for ailments like HIV/AIDS, Avian influenza and the many cancers that afflict humanity today (Kidukuli *et al*., 2010). Wild edible fungi are an important source of income for communities and national economies, and are especially valuable to rural people in the developing countries (Boa, 2004). The diversity of the natural *Miombo* ecosystems in Tanzania provides the rural population with varied and nutritious diet and potentially high standard of living due to mushroom trade (EC-FAO, 2010). However, awareness of wild mushrooms as a potential source of income is very low particularly in developing countries. Mushroom sector in the Asian countries is highly developed and contributes to the forex while in most of the African countries; mushrooms are still collected in the wild using

ethno-mycology hence under exploitation of mushrooms as a potential source of nutrients, medicinal and income.

The *Benna* and *Hehe* are two ethnic groups found in the Southern Highlands of Tanzania practicing wild edible mushroom hunting, collection and selling as one of their socio-economic activity contributing to their wellbeing. Since mushroom farming is not a common practice in the area, distinction on its edibility is usually done by using indigenous knowledge. In many parts of the world mushroom identification depends much on folk taxonomy whereby the knowledge is being inherited and transferred from one generation to another (Tibuhwa, 2012). Previously, it was reported that folk taxonomy and general indigenous knowledge is limited among *Benna* and *Hehe* ethnic groups (Tibuhwa 2013), resulting to local people rejecting some species that are edible. Several studies on the description, biology, cultivation and nutritional status of many edible mushrooms in Tanzania have been reported by (Mshandete, 2007; Bloesch and Mbago, 2008; Tibuhwa, 2011; Tibuhwa, 2011; Tibuhwa, 2011; De Crop, 2012; Tibuhwa, 2012; Tibuhwa, 2012; Tibuhwa, 2012 and Tibuhwa, 2013). Despite all the efforts done by other researchers, mushroom sector in Tanzania is still underexploited to tape the potential of mushrooms as a source of income and socioeconomic development. Contribution of wild mushrooms to the livelihoods of the rural communities has been given less priority regardless of plenty edible wild mushroom species. The significance of wild edible fungi lies with their extensive subsistence uses in developing counties, although this is an area where there are still significant gaps in information (Boa, 2004). Thus, further study on the socioeconomic contribution of wild edible mushroom value chain in the rural communities is necessary to give an insight on the potential of wild edible mushrooms as a source of food and income. The present study aimed at documenting some wild edible mushrooms species growing naturally in Njombe and Mufindi districts, and assessing its socioeconomic benefits along the value chain among the *Benna* and *Hehe* ethnic groups.

METHODOLOGY

Study site description and data acquisition

This study was conducted in Njombe and Mufindi districts in Njombe and Iringa regions in the Southern Highlands of Tanzania. A total of 150 individuals were interviewed in the two districts. In each district, three villages were selected based on the availability and higher consumption of wild

mushrooms. In Njombe district, Nyombo, Ikuna and Matiganjola villages were selected whereas Kikombo, Matanana and Nyololo villages were selected from Mufindi district. Also, wild mushroom retailers in Njombe and Mafinga townships were involved. The inhabitants of this area are mainly *Benna* and *Hehe* tribes engaged in subsistence agriculture, livestock keeping, mushroom hunting and gathering among other socioeconomic activities. The study area composed of mixed forest where the miombo woodland with *Brachystegia* and *Uapaca spp.* are dominant. A semi structured questionnaire was used in a field survey to collect information on wild edible mushrooms value chain (hunting, collection, preservation and retailing). Information on edibility, medicinal, preservation methods and other uses was also collected. All wild edible mushrooms were collected in January, 2014. A total of 120 people from the six villages (20 individuals from each village) comprised of local mushroom pickers, and 30 mushroom retailers (15 each) from Njombe and Mufindi townships where involved.

Data analysis

Demographic features and cross-relationships of the participants were evaluated descriptively using a Statistical Package for Social Sciences (SPSS) Program Version 20.0. Microsoft Excel (2010) was used to calculate average income generated.

RESULTS AND DISCUSSION

Wild edible mushrooms collection

Mushroom production is uneven throughout the year; their appearance in temperate forests is restricted to the rain season where hunting and collection is mostly done. Collection of wild mushrooms was done in January, 2014 to the nearby miombo woodland forests, fields, termite mounts and forest plantations in Njombe and Mufindi districts depending on the type of mushroom. Mushrooms are highly influenced by the type of vegetation that grows in Tanzania, and are collected during rainy season (Mshandete and Cuff, 2007; 2008) with no specific harvesting methods (Boa, 2004). Mushroom gathering requires greater knowledge or understanding of the habitat, niche, and morphology of useful mushrooms. Moreover, locating a particular species becomes more challenging for gatherers usually forage in fixed paths or forest areas. World over, traditions on mushroom collection do vary although generally now more people gather from the wild than before (Boa, 2004). Mushroom gathering is associated with identification of the species to make sure that they forage a

right one and not poisonous species. Folk taxonomy through traditional knowledge and experience is usually used to identify edible mushrooms from poisonous. Tanzanians pick the traditional edible mushrooms and reject all others and they pay no attention to the identification of inedible fungi (Bloesch and Mbago, 2008). From the survey, it was found that knowledge on folk taxonomy was being transmitted from parents, grandparents, neighbors and friends. Identification of species is mostly done by looking on features such as color, texture, smell, substrate where it grows and sometimes taste is used, naming of the species is done to keep memory and transfer the knowledge to next generation. The same way of identifying edible mushrooms from poisonous was observed by Adhikari (2004) in Nepal. It was observed that most of the species found in the same family were named by a single traditional (vernacular) name, since morphologically they resemble to each other hence unable to be differentiated by folk taxonomy. For example "*Unyamikwe*" was used to describe mushrooms in family of *Russulaceae* like *Russula roseovelata, Russula hiemisilvae* and *Russula congoana* (**Table 1**). Some difficulties in identifying and differentiating some species using folk taxonomy were also reported by Ayodele *et al*. (2009; 2011) and Adhikari *et al*. (2006). The wild edible mushrooms mostly hunted and collected by *Benna* and *Hehe* people are shown in **Table 1** below.

Demographic characteristics and community involvement

Wild mushroom value chain is seen to be gender oriented dominated by women in collection (70%), selling (93.5%), processing and preservation (98%) while men occupies only 30%, 6.5% and 2% respectively (**Table 2**). Other researchers have reported that women are the key players in mushroom market chain and ethno-mycology (Garibay-Orijel et al., 2012; Tibuhwa, 2013). Poor engagement of men might be due to the belief that mushroom collection and selling is for the lowly and poor minority especially women. In the rural areas of Njombe and Mufindi districts, women are usually unemployed, dedicating themselves to household and subsistence activities. Mushroom collection and selling is one of their sources of income and food, contributing to the food security in the communities. Women are a central role on mushroom processing both for self-consumption and sale. Also, the study showed that women own enormous traditional knowledge on mushroom folk taxonomy and ecology. The study also revealed that, hunting and collection activities are dominated by people of mid age especially those of 36 - 50 years (47%) as opposed to sellers 18 - 35 (50%), in addition to few elders (collectors 13% and retailers 3.3%). It was also observed that, 79% of the mushroom collectors and 83.3% of sellers had primary education respectively **(Table 2)**. Similar findings on age distribution were also reported by Tibuhwa (2013).

Table 1: Edible wild mushroom species found in Njombe and Mufindi Districts

SN	*Hehe* local name(s)	*Benna* local name(s)	Scientific name	Habitat
1	*Wikulwe*	Not found	*Termitomyces letustui*	Cultivated fields, edges of forests, miombo woodlands
2	*Witali*	Not found	*Termitomyces sigidensis*	Termites mounts
3	*Wigwingwi*	Not found	*Amanita tanzanica*	Miombo woodlands
4	*Wigwingwi(kahawia)*	Not found	*Amanita mafingensis*	Miombo woodlands
5	*Wigwingwi*	*Ugongoli* or *Wigongoli*	*Amanita masasiensis*	Miombo woodlands
6	*Ulelema*	*Wilelemi*	*Amanita zambiana*	Miombo woodlands
7	*Wilelema*	*Wilelemi*	*Amanita loosi*	Miombo woodlands
8	*Unyasenga*	Not found	*Macrolepiota dolichaula*	On dungs, cultivated lands with cow dungs
9	*Wigingili*	Not found	*Russula cellulata*	Miombo woodlands
10	*Unyamikwe*	*Unyambete*	*Russula roseovelata*	Miombo woodlands
11	*Unyamikwe*	Not found	*Russula congoana*	Miombo woodlands
12	*Unyamikwe*	Not found	*Russula hiemisilvae*	Miombo woodlands
13	*Wisikisa*	Not found	*Lactarius kabansus*	Miombo woodlands
14	*Wisimba*	Not found	*Lactarius edulis*	Miombo woodlands
15	*Wisogolo*	Not found	*Cantharellus congolensis*	Miombo woodlands
16	*Wisogolo*	Not found	*Cantharellus platyphllus*	Miombo woodlands
17	*Vidungwe*	*Widungu*	*Termitomyces aurantiacus*	Cultivated fields with termites
18	*Vidungwe*	*Widungu*	*Termitomyces striatus*	Miombo woodlands
19	Not found	*Widungu*	*Russula compressa*	Miombo woodlands
20	*Unyakigulu*	*Unyonso/twinyonso*	*Termitomyces microcarpus*	Termite mounts
21	*Unyakuwemba*	*Wifimi*	*Lactarius densifolius*	Miombo woodlands
22	*Unyakuwemba*	*Wigulu*	*Lactarius luteolus*	Miombo woodlands
23	*Wisogolo*	*Unyamalagata*	*Cantharellus floridulus*	Miombo woodlands
24	*Wisogolo*	*Unyamalagata*	*Afrocantharellus platyphyllus*	Miombo woodlands
25	Not found	*Wifindi*	*Cantharellus symoensis*	Miombo woodlands
26	*Wisogolo (Njano)*	*Wifindi (Njano)*	*Cantharellus cyanoxanthus*	Miombo woodlands
27	*Chova*	Not found	*Termitomyces eurhizus*	Miombo woodlands
28	Not found	*Wimungulu* or *umyamguhu*	*Lactarius volemoides*	Miombo woodlands
29	Not found	*Wipatwe*	*Cantharellus tormentosus*	Miombo woodlands

Table 2: **Demographic of mushroom collectors and retailers**

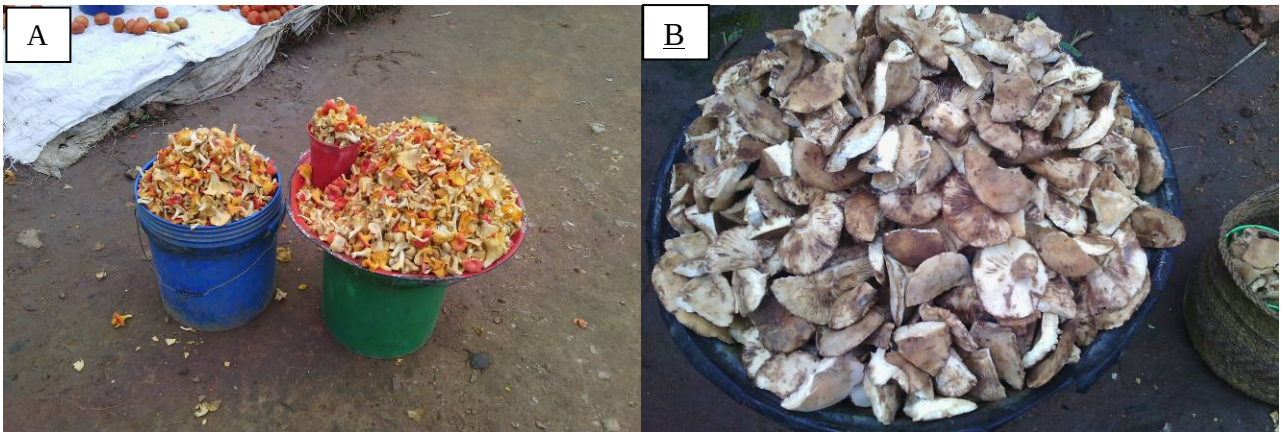
		Processing (%)	Collectors/Hunters (%)	Retailers/Sellers (%)
Gender	Female	98	70	93.5
	Male	2	30	6.5
Age	12-17		8	16.7
	18-35		32	50
	36-50		47	30
	> 50		13	3.3
Education	Non-formal		8	0
	Primary		79	83.3
	Secondary		9	16.7
	Higher education		4	0

Economic aspects of wild mushrooms

The economic contribution of different actors in the wild edible mushroom value chain is shown in **Table 3**. The mushroom hunters collect 15 - 30 kgs per day and 1000 - 1500 kgs per season. The average price for a kilogram of mushroom in villages is US $ 0.3 - 0.4. An average income of about US $ 500 - 650 can be generated by a collector per season. In towns, the retailers could sell (bought from collectors), an average of 20 to 45 kilograms per day and 750 to 800 kgs per season. The average price of a kilogram of mushroom in town is US $ 0.5 - 0.6 and the total income generated range from US $ 750 to 1000 per season (**Table 3**). It was also observed that not only fresh mushrooms were sold in the market or along road sides but also dried mushrooms. A similar observation was also reported by Mbago (2008). Mushroom retailing was also reported in Ruvuma region where dealers were buying from rural areas or brokers and sell in Songea or Tunduru markets at a much higher price (Mbago, 2008). According to Boa (2004), the global trade in wild edible fungi has been estimated at US $ 2 billion. The true value, however, include the value of wild edible fungi to the millions of the rural people around the world who gain benefits from consumption and selling. However, these results on economic earnings from mushrooms are not far from what was reported by Tibuhwa (2013).

Table 3: Income earning by mushroom collectors and retailers

Mushroom	Quantity per day (kgs)	Quantity per season (kgs)	Average price ($)	Average income per season ($)
Collection/Hunting	15 - 30	1000 - 1500	0.3 - 0.4	500 - 650
Selling/Retailing	20 - 45	750 - 800	0.5 - 0.6	750 - 1000



Picture A: A mixture of *Canthareceae* mushroom species in Mafinga and Njombe markets. Picture B: *Russulaceae* mushroom species collected in Nyombo village.

Mushroom edibility

The Southern Highlands of Tanzania have a rich diversity of wild mushrooms which might have been contributed by the tropical forests, mostly *Miombo* woodlands, and higher rainfall. Mushrooms are frequently collected by the local population, mainly for own consumption. A total of 29 species of wild mushrooms were collected and identified. The commonly identified wild edible mushrooms were in the genus of *Cantharellus, Lactarius, Termitomyces, Amanita, Russula, Afrocantharellus* and *Macrolepiota* species. Most of the collected mushrooms were found to have vernacular names commonly used in the area for easy identification. Despite having many edible wild mushroom species (**Table 1**), wild inedible mushroom species were also abundant (**Data not shown**). Inedible

mushrooms are considered to have no value and mostly regarded as poisonous. Additionally, mushrooms with bad and chocking smell, sour or bitter taste, are also sometimes mistakenly considered as inedible. Besides, about 5 species of mushrooms reported as inedible by the local communities were identified as edible by a taxonomist, justifying that proper taxonomic identification is very important. Local practices are typically based on the empirical evidence of edibility, though local beliefs may falsely exclude edible species. Gaps in taxonomic knowledge are limiting further utilization of wild edible fungi whereby local classification provide a useful guide to edible and 'not eaten' species (these may be poisonous or not) (Boa, 2004). Combining both local and scientific knowledge for mushroom identification may efficiently identify edible from poisonous mushrooms. Otherwise, an intensive scientific study has to be done in order to verify their toxicity hence their edibility, and maximize utilization of mushroom resources. Scientific identification provides a powerful guide to properties of wild fungi and can help to clarify the edibility of species (Boa, 2004).

Mushroom preservation

Mushrooms are highly perishable and seasonal, available mostly during rainy season. Extension of shelf life through different preservation methods is essential for value addition. Commonly used as mushroom preservation methods are soaking (in fresh or cold water), salting, boiling and sun drying, as well as smoking. In the study area, sun drying (65%) and boiling 35% were the commonly used methods. Preservation is done mainly for home purposes only and little for selling nevertheless dried mushrooms were also found being sold in the markets or along roadsides. Preservation may substantially improve sensory and nutritional quality hence value addition to wild edible mushrooms. Post-harvest processes of mushrooms are done for shelf life extension and enhanced marketability (Boa, 2004). Mushroom preservation through boiling and drying was also reported by (Bloesch and Mbago, 2008). Drying was used as mushroom preservation method along Selou-Niassa corridor (Bloesch and Mbago, 2008). From the study, salting was found to be used is mostly for household use only. Different mushrooms preservation methods were also reported by (Garibay-Orijel et al., 2012; Tibuhwa, 2013).

Mushroom nutritional and medicinal information

From the study, it was found that about 96% of mushroom consumers were unaware of its nutritional and medicinal values despite of its delicious taste as opposed to only 4% with partial understanding. Mushrooms are regarded as alternative food to meat. Ayodele *et al*. (2009; 2011), reported a

knowledge gap on the health benefits of mushrooms nevertheless of its potential as substitute for meat, appealing taste, palatability, soup thickener and routine consumption were highly recognized. According to Baraza *et al*. (2007), Barros (2008) and Ergonul *et al.* (2012), mushrooms are low in fat, good source of fiber, rich in digestible protein, low in simple carbohydrates, and rich in high molecular weight polysaccharides among other nutritional constituents. Also, they contain unsaturated fatty acids, which constitute over 70% of the total content of fatty acids and low in calories, essentials fatty acids, and high in vegetable proteins, minerals and vitamins. In addition, mushrooms are also rich source of secondary metabolites which may be potential for nutraceuticals, pharmacological and medicinal applications. Dembitsky *et al*. (2010) and Kidukuli *et al*. (2010) reported that, some mushrooms have therapeutic activity which is useful in preventing diseases such as hypertension, hypercholesterolemia, atherosclerosis and cancer. Therefore, raising awareness to the communities on the potentials of mushrooms as source of nutrition and medicinal values is very important. Mushrooms, if well addressed in the society, are potential source of food and nutrition security specifically in developing countries.

Challenges of mushroom collection activity

The study also reports the challenges mushroom hunters and collectors are facing to make this activity less effective. Amongst many, disappearance of once available mushroom species, human activities such as farming, overgrazing has contributed to degradation of the ecosystem as well as annual fire outbreak in the environment. Similar observations were report by Akpaja *et al*. (2003) and Okhuoya *et al*. (2010) among the Igbo people in Nigeria. Wild animals have also been seen as a threat to most of women and children during mushroom hunting and collection. This reduces the output per day which has direct impact on the income generated. Mushroom poisoning is another challenge since it is very difficult to differentiate between edible and poisonous mushrooms as some of mushrooms in the same families are very similar. The same observation on mushroom poisoning as a challenge to mushroom collectors was also reported by Tibuhwa (2013).

CONCLUSION

From the study, 29 species of edible wild mushrooms were collected and identified. Mushroom hunting, collection and selling was mainly done by women. Mostly, folk taxonomy verbally transferred from one generation to another was used to locally identify edible from poisonous

mushrooms. Preservation of mushrooms was mainly through soaking, drying boiling and salting. The wild edible mushroom value chain plays a vital role to improving livelihoods of local people involved at every stage. The wild edible mushrooms positively contributed to income generation in *Benna* and *Hehe* communities. Additionally, edible wild mushrooms can serves as a vital source of nutritious food and if well exploited can contribute to food and nutritional security especially in rural areas. Sustainable conservation of forests can also be achieved through proper harvesting methods to ensure continuous supply of mushrooms. Awareness on proper harnessing, processing and preserving should be provided to communities in rural areas where mushrooms are seasonally harvested as source of income generation and food. Mushroom's domestication and farming should be highly prioritized for sustainable production.

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