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Review

Systematic review of macrofungi biodiversity in Eastern Africa countryside: uses, distribution, and conservation checklists

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Abstract. *Mushroom biodiversity covers some indispensable non-timber forest products that are wide-spread in Africa, although these resources are currently underutilized, underdeveloped, and left to face the vagaries of climate change and human activities unmanaged. The mushrooms of Eastern Africa have barely been identified or examined for their potential to better the livelihood of the inhabitants. This review of published-online-only literature was carried out to systematically document this biodiversity and its potentials. There were 135 edible mushrooms, 9 edible+medicine mushrooms, and 59 species with no ascribed uses out of 205 species altogether in Eastern Africa. Two mushrooms were identified as poisonous. There were 32 key edible mushrooms in Eastern Africa based on their usage. A tally of mushrooms species (based on country where they were sighted) showed that Ethiopia accounted for 96 species, Tanzania (75), Burundi (37), Rwanda (24), Kenya (18), and Uganda (6) while no information was available from the rest of the countries in the region. The most common genera of mushrooms included Termitomyces, Russula, Pleurotus, Marasmius, Lactarius, Coprinus, Cantharellus, Armillaria, Amanita, and Agaricus. While the most popular species (based on consumption by more locations/tribes) were Amanita zambiana, Hypholoma fasciculare (could be poisonous), Pleurotus cystidiosus, Polyporus tenuiculus, Termitomyces letestui, and Termitomyces striatus. However, it was observed that these tribes or locations were often only within a few countries. Therefore, truly regional mushrooms included Schizophyllum commune (could be poisonous), Suillus luteus, Termitomyces clypeatus, Termitomyces striatus, and Termitomyces microcarpus based on their being found in at least three or more countries. Fungi biodiversity conservation is inadequate in the region.*

Keywords: bioactive agents, biodiversity, edible mushrooms, ethnomycology, medicinal mushrooms, nutraceuticals

Introduction

Mushroom refers to the conspicuous enlarged compact complex aboveground fleshy fruiting body (sporophore) of a fungus which may be umbrella-shaped in certain fungi (especially in the order Agaricales) (Britannica, 2015). Many authors have variously estimated that the number of edible mushrooms on earth may be above 2000 species. Boa (2004) reported that mycophagy (consumption of mushrooms) of wild edible fungi is practised in more than 80 countries globally.

Native mushrooms abound in Africa (including Eastern Africa) and they are highly cherished. Ethnomycological information is abundant in Africa (Boa, 2004). Teferi et al. (2013) reported that 93.3% of Wacha Kebele residents (in Ethiopia) were aware of the practice of consuming mushrooms and its benefits but 66.5% of the residents were not aware that mushrooms can be cultivated.

Muruke et al. (2002) reported that mushrooms have long been valued as a high quality food/edible with a

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pleasant flavor and tasty, likeable texture, daintiness and healthy nature by different societies throughout the world. It is often said that mushrooms are likened to poor man's meat, but this is due to ignorance of the qualities of mushrooms. For instance, Dejene et al. (2017) reported that traditional taboos such as 'considering collecting wild edible mushrooms as a sign of poverty' has hindered mushroom utilization in most parts of Ethiopia.

Wandati (2013) stated that mushrooms are excellent bio-degraders (bioremediation agents) and can help in cleaning the environment and recycling soil nutrients. Mushrooms play important social roles (as source of food, medicine, mythological practice resources or even minor roles as recreational and beauty products). They also function in ecology, industry, and economic sector as sources of raw materials.

Global edible mushrooms market (n.d.) pointed out that the global edible mushroom market is expected to grow to US$ 62 193 billion by 2023, from US$ 42 419 billion in 2018. Muchane (2016) observed that mushroom farming is an emerging industry in Africa with great potential to provide a stable income to small-scale farmers. However, this researcher lamented that the mushroom farming is still dominated by a few exotic species that have poor regional adaptability, low yields and increased pest and disease susceptibility.

Muchane (2016) concluded that research on domestication of native edible mushrooms in Africa is still in its infancy. Zeleke et al. (2020) reported that among all the factors influencing use of wild mushrooms, age, nutritional knowledge, and indigenous taxonomic knowledge had no influence on the decision to consume mushrooms.

Makoye (2020) described a new strategy to cope with drought by farmers at Morogoro (in Tanzania) which necessitates switching to protein-rich oyster mushroom production to raise income and thus protect trees instead of cutting them down because of the need for income. The researcher reported that mushroom growers who produce their own spawn earn more income.

Mushroom growing in Uganda (n.d.) listed the challenges which hamper mushroom cultivation in Uganda. First and foremost, farmers may not be aware of the obvious availability of market for their produce. Secondly, lack of dryers compels farmers to sell their produce as fresh mushrooms. Thirdly, farmers lack information on mushroom processing. Moreover, there is inadequate information on the nutritional benefits of mushrooms among the farmers as well as the consumers. Finally, the technologies at research institutions need to be refined in order to fit the new farming systems and needs of resource-poor farmers.

Dejene et al. (2017) reported that "Although mushrooms are non-timber forest products, information on their diversity is hardly ever documented and that Ethiopia remains mycologically unexplored. So far, a limited number of species with saprobic or ectomycorrhizal habits have been reported from different regions".

Degreef et al. (2016) agreed with Yorou and De Kesel (2011) who pointed out that most of the International Union for Conservation of Nature (IUCN) criteria for establishing a national or regional Red List of endangered species are difficult to utilize for African fungi. Thus, Degreef et al. (2016) while researching on Eastern Africa macrofungi conceded that criteria dealing with the number of localities, the restricted surface of the habitat and the threats that rest upon them, can be used for assigning threat categories as far as mushrooms in Africa are concerned. Tibuhwa et al. (2011) reported that the Reyni diversity ordering showed tremendous decrease in species diversity in plots outside the park/reserve compared to those found inside the park. This result implies that ongoing disturbances affect mycofungi diversity, which calls for conservation and modification of agro-ecosystems.

Dejene et al. (2017) reported that wild mushrooms are generally not among non-timber forest products for sale in Ethiopia thus they are collected mostly for subsistence use. They explained that the wild mushroom season is short and everyone can collect mushrooms from the wild for their own consumption. They reiterated that where mushrooms are sold one can get *Agaricus* sp., *Laetiporus* sp., and *Termitomyces* sp. in Ethiopia. However, they reported that their market value is very low as the buyers are restricted amongst the local mycophagy practising tribes, and many people were found to be quite ignorant about edibility of mushrooms.

The Agew and Sidama tribes (in Ethiopia) reported that, despite their grandparents' consumption of wild mushroom species, they do not eat mushrooms themselves. This behavior, according to Zeleke et al. (2020), could eventually represent a loss of mycological knowledge in these two Ethiopian national groups. Furthermore, Teferi et al. (2013) observed that the reasons for the decreasing trend of wild edible mushrooms distribution in Eastern Africa included deforestation, chemical pollution, urbanization, over harvesting of mushrooms. The situation of indigenous mushrooms in Eastern Africa seems to be untenable. Changes in climate may be adversely affecting biodiversity of mushrooms in the region. The problem now, however, is that checklists of the mushrooms, their locations, uses, etc. are inadvertently unavailable. This

review was carried out to augment this gap in knowledge of the mushroom resources of Eastern Africa.

Material and methods

The materials and methods used in this study follow those described by Ndifon (2022). Systematic reviews use repeatable, logical methods to identify and collect relevant secondary data, which are then analysed during the evidence synthesis process based on the formulated research questions (Armstrong et al., 2011; Ndifon, 2022).

The sources of data generated were carefully traced and documented in the standalone checklist to ensure duplication of sources was eliminated. Only internet-based research publications specifically focusing on macrofungi from Eastern Africa were used to compile the checklists (PRISMA, n.d.; Armstrong et al., 2011; Li et al., 2020; Ndifon, 2022).

The Eastern African regions considered in this study consist of the following countries: Ethiopia, Tanzania, Burundi, Rwanda, Kenya, Djibouti, Eritrea, and Uganda. In addition to the names of the countries, critical search keywords included mushrooms, edible mushrooms, macrofungi, forest resources, deforestation, biodiversity conservation, and medicinal mushrooms. Common names for macrofungi in all languages were not included in the count. Data processing was conducted using IBM's Statistical Package for the Social Sciences (SPSS) version 25.

Results

The dataset shows that 27 tribes/vicinities (i..e., Hehe, W, Benna, SME Ken, SME Tan, Sv, Kiambu, Amhara, Agew, Sidama, F, KNP, PLM, RNP, RNFR, Arabuko-Sokoke, Tanga, Pwani, Dar Es Salaam, Menge, Miombo, Meseno, Lower montane forest, Highland forest region, SME, Rumonge, P, and Busitema) were covered in Eastern Africa region. All the tribes studied demonstrated a high level of indigenous mycological knowledge.

The dataset includes an expanded list of 135 edible mushroom species (Table 1). Table 2 presents the seven most popular edible mushroom species consumed solely as edible. These 7 most popular species used as edible only, by 3 or more tribes/localities include *Amanita zambiana, Hypholoma fasciculare, Pleurotus cystidiosus, Termitomyces letestui, Polyporus tenuiculus, Termitomyces striatus,* and *Trametes versicolor*. Table 3 presents the 32 key edible mushrooms found in Eastern Africa. They were selected based on their being consumed by 3 or more tribes or localities in the region. Only nine mushrooms are used for edible and medicinal purposes simultaneously (Table 4). On the same Table 4, two familiar mushrooms were reported to be poisonous. The dataset contains 59 species of mushrooms that the authors identified but for which no specific use was ascribed. These mushrooms were presented in Table 5.

Table 1. List of edible** macrofungi in Eastern Africa with references and sites/locations/tribes where they were sighted

SN	SCIENTIFIC NAME	TRIBES/ LOCALITIES	COUNTRIES	SOURCES
1	*Afroboletus luteolus* (Heinem.) Pegler & T.W.K. Young	W	Burundi	Degreef et al., 2016.
2	*Afrocantharellus platyphyllus*	Hehe, benna	Tanzania	Chelela et al., 2014
3	*Agaricus andrewii* A.E. Freeman	SME Ken	kenya	Tibuhwa et al., 2011.
4	*Agaricus arvensis* Schaeff.	Sv,	Rwanda, Ethiopia,	Degreef et al., 2016; Dejene et al., 2017; Dejene et al., 2017*.
5	*Agaricus augustus* Fr.	SME Tan.	Tanzania	Tibuhwa et al., 2011
6	*Agaricus bisporus*	Kiambu, SME Ken	Kenya, Ethiopia	Wandati, 2013; Tibuhwa et al., 2011; Teferi et al., 2013 Ashagrie et al., 2015
7	*Agaricus campestris* L.Fr.	SME Tan.	Tanzania, Ethiopia	Tibuhwa et al., 2011, Ashagrie et al., 2015; Dejene et al., 2017*
8	*Agaricus campestroides* Heinem & Gooss.-Font.	Amhara, Agew, Sidama,	Rwanda, Ethiopia,	Zeleke et al., 2020, Dejene et al., 2017
9	*Agaricus syhanticus* J. Otto	SME Tan.	Tanzania	Tibuhwa et al., 2011
10	*Agaricus sylvicola* (Vitt.) Lév.	F	Rwanda	Degreef et al., 2016.
11	*Agaricus subedulis* Heinem	Amhara, Agew, Sidama,	Rwanda, Ethiopia,	Zeleke et al., 2020, Dejene et al., 2017
12	*Agaricus xanthodermus* Gaer	SME Tan..	Tanzania, Ethiopia	Tibuhwa et al., 2011, Dejene et al., 2017*
13	*Agrocybe pediades* Fayod	Amhara, Agew, Sidama,	Ethiopia,	Zeleke et al., 2020; Dejene et al., 2017
14	*Amanita loosii* Beeli	W, Hehe, Benna	Burundi, Tanzania	Degreef et al. 2016; Chelela, et al., 2014
15	*Amanita mafingensis* Härk. & Saarim.	W, Hehe	Burundi, Tanzania	Degreef et al., 2016; Chelela, et al., 2014
16	*Amanita pudica* (Beeli) Walleyn	W	Burundi	Degreef et al., 2016.
17	*Amanita rubescens* Pers.	F, W	Burundi	Degreef et al., 2016.
18	*Amanita tanzanica* Härk. & Saarim.	W, Hehe	Burundi, Tanzania	Degreef et al., 2016; Chelela, et al., 2014

SN	SCIENTIFIC NAME	TRIBES/ LOCALITIES	COUNTRIES	SOURCES
19	*Amanita masasiensis*	Hehe, Benna	Tanzania	Chelela, et al., 2014
20	*Amanita verna* (Bull.) Lam.¥.	KNP	Tanzania	Nteziryayo et al., 2019
21	*Amanita zambiana* Pegler & Piearce	Hehe, benna, RNFR, PLM, RNP, Arabuko-Sokoke	Tanzania	Chelela, et al., 2014, Nteziryayo et al., 2019; Wadanti, 2013
22	*Amylosporus* sp.	Tanga, Pwani, Dar es Salaam	Tanzania	Juma et al., 2016
23	*Armillaria borealis* Marxmüller & Korhonen	F	Rwanda	Degreef et al., 2016.
24	*Armillaria cepistipes* Velen.	F	Rwanda	Degreef et al., 2016.
25	*Armillaria lutea* Gillet	F	Rwanda	Degreef et al., 2016.
26	*Armillaria ostoyae* (Romagn.) Herink	F	Rwanda	Degreef et al., 2016.
27	*Armillaria tabescens* (Scop.) Emel	F	Rwanda	Degreef et al., 2016.
28	*Auricularia auricula-judae* (Bull.) Quél.	F	Rwanda	Degreef et al., 2016; Muchane, 2016
29	*Auricularia cornea* Ehrenb.	F	Burundi, Rwanda	Degreef et al., 2016.
30	*Auricularia delicata* (Mont. ex Fr.) Henn.	F, SME Tan.	Burundi, Rwanda, Tanzania	Degreef et al., 2016; Tibuhwa et al., 2011.
31	*Auricularia polytrichia* (Mont) Saccc.	SME Tan., Tanga, Pwani Dar-es- Salaam	Tanzania	Tibuhwa et al., 2011; Juma et al., 2016
32	*Boletus loosii* Heinem.	W	Burundi	Degreef et al., 2016.
33	*Cantharellus congolensis* Beeli	W, Hehe	Burundi	Degreef et al., 2016; Chelela et al., 2014
34	*Cantharellus cyanoxanthus* R. Heim ex Heinem.	W, Hehe, Benna	Burundi, Tanzania	Degreef et al., 2016; Chelela, et al., 2014
35	*Cantharellus defibulatus* (Heinem.) Eyssart. & Buyck	W	Burundi	Degreef et al., 2016
36	*Cantharellus densifolius* Heinem.	W	Burundi	Degreef et al., 2016
37	*Cantharellus floridulus*	Hehe, Benna	Tanzania	Chelela, et al., 2014
38	*Cantharellus miomboensis* Buyck & V. Hofst.	W	Burundi	Degreef et al., 2016
39	*Cantharellus platyphyllus* Heinem. var. *cyanescens* (Buyck) Eyssart. & Buyck	W, Hehe	Burundi	Degreef et al., 2016; Chelela et al., 2014
40	*Cantharellus pseudocibarius* Henn.	W	Burundi	Degreef et al., 2016.
41	*Cantharellus ruber* Heinem.	W	Burundi	Degreef et al., 2016.
42	*Cantharellus symoensis*	Benna	Tanzania	Chelela, et al., 2014,
43	*Cantharellus tormentosus*	Benna	Tanzania	Chelela, et al., 2014,
44	*Clitocybe elegans* (Fr.) Staude	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020
45	*Collybia piperata* (Beeli) Singer	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020
46	*Coprinellus domesticus* (Bolton) Vilgalys, Hopple & Jacq. Johnson	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020
47	*Corprineflus domesticus* (Bolton) Vigalyts, Hoppie & Jacq.		Ethiopia	Dejene et al., 2017
48	*Coprinnosis nivea* (Pers) Racheal, Vigalyts & Moncalvco		Ethiopia	Dejene et al., 2017
49	*Coprinus cinereus*	Miombo	Tanzania, EA	Muchane, 2016; Härkönen et al., 2021
50	*Coprinus comatus* (O. F. Mull.) Pers.	SME Tan, Menge	Tanzania, Ethiopia	Tibuhwa et al., 2011; Sitotaw et al., 2020
51	*Coprinus disseminates* (Pers) Gray	SME Tan	Tanzania	Tibuhwa et al., 2011
52	*Coprinus domesticus*		Ethiopia	Dejene et al., 2017
53	*Coprinus nivea*		Ethiopia	Dejene et al., 2017
54	*Coprinus pseudoplicatilis* Volgino		Ethiopia	Dejene et al., 2017
55	*Entoloma* sp.	SME Ken	Kenya	Tibuhwa et al., 2011.
56	*Favolus roseus*	Tanga, Pwani, Dar es Salaam	Tanzania	Juma et al., 2016
57	*Funalia polyzona* (Pers) Ntemelii	SME Tan	Tanzania	Tibuhwa et al., 2011
58	*Ganoderma boninense* Pat	SME Tan	Tanzania	Tibuhwa et al., 2011
59	*Geastrum saccatum* sensu suctbrit.	SME Tan	Tanzania	Tibuhwa et al., 2011
60	*Geastrum triplex* Jimgh.	SME Tan	Tanzania, Ethiopia	Tibuhwa et al., 2011; Dejene et al.,2017*
61	*Gymnopilus pampeanus* (Speg.) Singer	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020
62	*Hygrophoropsis aurantiaca* (Wulfen) Maire	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020; Dejene et al., 2017
63	*Hymenagaricus fuscobrunneus* Heinem	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020
64	*Hypholoma fasciculare* (Huds.:Fr) P. Kumm¥	KNPm Amhara, Agew, Sidama	Tanzania, Ethiopia	Nteziryayo et al., 2019; Zeleke et al., 2020
65	*Lactarius kabansus*	Hehe	Tanzania	Chelela et al., 2014
66	*Lactarius luteolus*	Hehe, Benna	Tanzania	Chelela et al., 2014,
67	*Lactarius delicious* (Fries) S. F. Gray	RNFR, PLM, RNP	Tanzania	Nteziryayo et al., 2019
68	*Lactarius densifolius*	Hehe, Benna	Tanzania	Chelela, et al., 2014
69	*Lactarius edulis*	Hehe	Tanzania	Chelela, et al., 2014
70	*Lactarius volemoides*	Benna,	Tanzania	Chelela, et al., 2014

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71	*Lentinula edodes*		Ethiopia	Teferi et al., 2013; Ashagrie et al., 2015
72	*Lentinus sajor-caju*	Tanga, Pwani, Dar es Salaam	Tanzania	Juma et al., 2016
73	*Lentinus squarrosulus* Mont. (Singer)	Rumonge	Tanzania	Nteziryayo et al., 2019
74	*Lepiota sordida* (Schum:Fr.) singeer	SME Tan	Tanzania	Tibuhwa et al., 2011.
75	*Leucoagaricus leucothites* (Vittad.) Wasser	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020; Dejene et al., 2017
76	*Leucoagaricus rubrotinctus* (Peck) Singer.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020;Dejene et al., 2017
77	*Leucoagaricus holosericeus* (JJ Plancr) MM Moses		Ethiopia	Dejene et al., 2017
78	*Leucocoprinus birnbaumii* (Corda) Singer	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020; Dejene et al., 2017
79	*Leucocoprinus cepistipes* (Sowerby) Pat	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020; Dejene et al., 2017
80	*Lycoperdon pyriforme* Schaeff.	SME Tan	Tanzania	Tibuhwa et al., 2011.
81	*Macrolepiota dolichaula* (Berk. & Broome) Pegler & R.W. Rayner	Hehe, KNP,	Tanzania	Chelela, et al., 2014, Nteziryayo et al., 2019
82	*Macrolepiota procera* (Scop.) singer	SME Tan	Tanzania, Ethiopia	Tibuhwa et al., 2011; Dejene et al., 2017*
83	*Marasmius aurues* Beeli	SME Tan	Tanzania	Tibuhwa et al., 2011.
84	*Marasmius bekolocongolensis*	SME Tan	Tanzania	Tibuhwa et al., 2011.
85	*Marasmius rotula* (Scop) Fr.	SME Tan	Tanzania	Tibuhwa et al., 2011.
86	*Macrolepiota dolichaula* (Berk. & Broome) Pegler & R.W. Rayner	Menge	Ethiopia	Sitotaw et al., 2020
87	*Macrolepiota rhacodes*	Menge	Ethiopia	Sitotaw et al., 2020
88	*Microporus affinis* (Blume & T. Nees) Kunize	SME Tan	Tanzania	Tibuhwa et al., 2011.
89	*Mycena acicula* (Schseff ex Fr.)	SME Tan, SME Ken	Tanzania, kenya	Tibuhwa et al., 2011.
90	*Mycena delicatella*	SME Ken	kenya	Tibuhwa et al., 2011.
91	*Mycena Leptocephala* (Pers) Gillet	SME Tan	Tanzania	Tibuhwa et al., 2011.
92	*Oudemansiella tanzanica*		EA	Muchane, 2016
91	*Panoculus companulatus* (Bull. Ex. Fr.)	SME Ken	Kenya	Tibuhwa et al., 2011.
92	*Paxillus brunneotomentosus* Heinem. & Rammeloo	F	Rwanda	Degreef et al., 2016.
93	*Pleurotus citrinopileatus* Singer	KNP	Tanzania, EA	Nteziryayo et al., 2019, Muchane, 2016
94	*Phlebopus colossus* (R.Heim) Singer	W	Burundi	Degreef et al., 2016.
95	*Phocolus schweinitziii* (Fr.) Pac.	SME Ken	Kenya	Tibuhwa et al., 2011.
96	*Pleurotus cystidiosus* O.K. Mill.	F, Tanga, Pwani, Dar es Salaam	Burundi, Rwanda	Degreef et al., 2016; Juma et al., 2016
97	*Pleurotus djamor* (Rumph. ex Fr.) Boedijn	F	Rwanda	Degreef et al., 2016; Muchane, 2016
98	*Pleurotus flabellatus* Sacc.	F	Rwanda, EA	Degreef et al., 2016; Muchane, 2016
99	*Preurotus florida*	Kiambu	Kenya	Wandati, 2013
100	*Pleurotus tuber-regium* (Fr.) Singer	W	Burundi	Degreef et al., 2016.
101	*Pleurotus ostreatus*	Busitema	Uganda, Ethiopia.	Ogwok et al., 2017; Teferi et al., 2013; Ashagrie et al., 2015
102	*Polyporus tenuiculus* (P. Beauv.) Fr.	F, Tanga, Pwani, Dar es Salaam	Rwanda, Uganda	Degreef et al., 2016; Juma et al., 2016, Nakalembe et al., 2015.
103	*Psathyrella atroumbonata* Pegler	F	Rwanda	Degreef et al., 2016.
104	*Psathyrella tuberculata* (Path.) A.H. Sm.	F	Rwanda	Degreef et al., 2016.
105	*Pycroporus sanquinous* (L.) Murrill.	SME Tan	Tanzania	Tibuhwa et al., 2011
106	*Rubinoboletus balloui* (Peck) Heinem. & Rammeloo	W	Burundi	Degreef et al., 2016.
107	*Russula cellulata* Buyck	W, Hehe	Burundi, Tanzania	Degreef et al., 2016; Chelela, et al., 2014,
108	*Russula ciliata* Buyck	W	Burundi	Degreef et al., 2016.
109	*Russula compressa*	Hehe, Benna, Arabuko-Sokoke,	Tanzania, Kenya	Chelela, et al., 2014; Wadanti, 2013
110	*Russula congoana* Pat.	W, Hehe	Burundi, Tanzania	Degreef et al., 2016; Chelela, et al., 2014,
111	*Russula hiemisilvae* Buyck	W, Hehe	Burundi, Tanzania	Degreef et al., 2016; Chelela, et al.; 2014,
112	*Russula phaeocephala* Buyck	W	Burundi	Degreef et al., 2016.
113	*Russula roseoviolacea* Buyck	W, Hehe, Benna	Burundi	Degreef et al., 2016; Chelela, et al., 2014,
114	*Russula sejuncta* Buyck	W	Burundi	Degreef et al., 2016.
115	*Suillus granulatus* (L.) Roussel	p	Rwanda	Degreef et al., 2016.
116	*Suillus luteus* (L.) Roussel	P, Maseno	Burundi, Kenya, Ethiopia	Degreef et al.,2016; Dejene et al., 2017; Opande et al., 2017
117	*Termitomyces aurantiacus* R. Heim)	Hehe, Benna, SME Tan	Tanzania, Ethiopia	Chelela et al., 2014; Dejene et al., 2017; Tibuhwa et al., 2011; Ashagrie et al., 2015.
118	*Termitomyces eurhizus*	Hehe, SME Tan, Menge	Tanzania, Ethiopia	Chelela et al., 2014; Dejene et al., 2017; Tibuhwa et al. , 2011; Sitotaw et al., 2020

SN	SCIENTIFIC NAME	TRIBES/ LOCALITIES	COUNTRIES	SOURCES
119	*Termitomyces letestui* (Pat.) R. Heim	W, Sv, Hehe, SME Tan, Menge	Burundi, Tanzania, Ethiopia	Chelela et al., 2014; Degreef et al., 2016; Tibuhwa et al., 2011 Sitotaw et al., 2020; Ashagrie et al., 2015.
120	*Termitomyces mammiformis* R. Heim	W, Sv, SME Tan	Burundi, Tanzania	Degreef et al., 2016; Tibuhwa et al., 2011.
121	*Termitomyces schimperi* (Pat.) R. Heim	Sv, Menge	Burundi, Rwanda, Ethiopia	Degreef et al., 2016; Dejene et al., 2017; Sitotaw et al., 2020
122	*Termitomyces sigidensis*	Hehe	Tanzania	Saarimaki et al., 1994; Chelela et al., 2014
123	*Termitomyces striatus* (Beeli) R. Heim	W, Sv, Hehe, Benna, SME Tan., Menge	Burundi, Rwanda, Tanzania, Ethiopia	Degreef et al., 2016; Chelela et al., 2014; Tibuhwa et al., 2011; Sitotaw et al., 2020
124	*Termitomyces titanicus* Pegler & Piearce	Sv, SME Tan.	Burundi, Tanzania	Degreef et al., 2016, Tibuhwa et al., 2011.
125	*Termitomyces tylerianus orieno*	SME Tan.	Tanzania, Uganda	Tibuhwa et al., 2011, Nakalembe et al., 2015;
126	*Termitomyces umkowaani* (Cooke & Masse) D.A. Reid.	SME Tan., Menge	Tanzania, Ethiopia	Tibuhwa et al., 2011; Sitotaw et al., 2020
127	*Trametes elegans* (Spreng.) Fr	SME Tan.	Tanzania	Tibuhwa et al., 2011
128	*Trametes polyzona* (Pers.) Just	KNP	Tanzania	Nteziryayo et al., 2019
129	*Trametes versicolor* (L.) Lloyd	SME Tan. Amhara, Agew, Sidama	Tanzania Ethiopia	Tibuhwa et al., 2011; Zeleke et al., 2020.
130	*Tricholoma* sp.	SME Ken	Kenya	Tibuhwa et al., 2011.
131	*Tylopilus niger* (Heinem & Gooss-Fort) Wolfe		Ethiopia	Dejene et al., 2017
132	*Volvariella volvacea* (Bull) Singer	SME Tan.	Tanzania, EA	Tibuhwa et al., 2011; Muchane, 2016
133	*Vascrilium* sp. F. Smarda		Ethiopia	Dejene et al., 2017
134	*Xerocomus subspinulosus* Heinem.	W	Burundi	Degreef et al., 2016.
135	*Xylaria* sp.	SME Tan.	Tanzania	Tibuhwa et al., 2011.

Key:
W: miombo woodland; Sv: savanna; F: montane forest; P: Pinus plantation (Buyck, 1994; Nzigidahera, 2007 were relied on by Degreef et al., 2016 at times) RNFR = Forest Natural Reserve of Rumonge; KNP = Kibira National Park; PNR = Ruvubu National Park; PPM = Protected Landscape of Makamba. Serengeti Mara Ecosystems (SME).
* = Source did not provide uses. ** = Technically edible refers to ingestible mushrooms (in the form of food, teas, flavors, spices, colouring agents, and so on. The differences between edible and food mushrooms are yet to be accepted by all and sundry. ¥ = However, some species (e.g. Amanita verna and Hypholoma fasciculare) listed in this table may be poisonous. Many tribes have different methods of processing mushrooms and collect some mushrooms only at specific stages for consumption. Documenting native knowledge on consumption of mushrooms is our goal here. We will not judge, disparage or render any censure of them. We should rather learn from them, instead. For instance, Trametes versicolor is edible but it may not be considered as a food mushroom it is a hard conky mushroom. This issue of poisonous mushrooms can be illustrated using S. commune which is considered as poisonous in Central Africa but is consumed after cooking and discarding the liquid extract. Some indigenous collectors avoid mushrooms from some substrates since these may be poisonous.

Table 2. Seven most common edible species of mushrooms in Eastern Africa based on the number of tribes/localities that consumed them

SN	SCIENTIFIC NAME	TRIBES/LOCALITIES	COUNTRIES	SOURCES
1	*Amanita zambiana* Pegler & Piearce	Hehe, Benna, RNFR, PLM, RNP, Arabuko-Sokoke	Tanzania	Chelela et al., 2014; Nteziryayo et al., 2019; Wadanti, 2013
2	*Hypholoma fasciculare* (Huds.:Fr) P. Kumm	KNP, Amhara, Agew, Sidama	Tanzania, Ethiopia	Nteziryayo et al., 2019, Zeleke et al., 2020
3	*Pleurotus cystidiosus* O.K. Mill.	F, Tanga, Pwani, Dar es Salaam	Burundi, Rwanda	Degreef et al., 2016; Juma et al., 2016
4	*Polyporus tenuiculus* (P. Beauv.) Fr.	F, Tanga, Pwani, Dar es Salaam	Rwanda, Uganda	Degreef et al., 2016; Juma et al., 2016; Nakalembe et al., 2015.
5	*Termitomyces letestui* (Pat.) R. Heim	W, Sv, Hehe, SME Tan, Menge	Burundi, Tanzania, Ethiopia	Chelela et al., 2014; Degreef et al., 2016; Tibuhwa et al., 2011; Sitotaw et al., 2020; Ashagrie et al., 2015.
6	*Termitomyces striatus* (Beeli) R. Heim	W, Sv, Hehe, Benna, SME Tan., Menge	Burundi, Rwanda, Tanzania, Ethiopia	Degreef et al., 2016; Chelela et al., 2014; Tibuhwa et al., 2011; Sitotaw et al., 2020
7	*Trametes versicolor* (L.) Lloyd	SME Tan., Amhara, Agew, Sidama	Tanzania Ethiopia	Tibuhwa et al., 2011; Zeleke et al., 2020.

Key:
W: miombo woodland; Sv: savanna; F: montane forest; P: *Pinus* plantation (Buyck, 1994; Nzigidahera, 2007 were relied on by Degreef et al., 2016 at times) RNFR = Forest Natural Reserve of Rumonge; KNP = Kibira National Park; PNR = Ruvubu National Park; PPM = Protected Landscape of Makamba. Serengeti Mara Ecosystems (SME). Source* = did not provide uses.

Table 3. Extract of compiled list of key edible macrofungi in Eastern Africa with references and sites/locations/tribes where they are found

SN	SCIENTIFIC NAME	TRIBES/LOCALITIES	COUNTRIES	SOURCES
1	*Agaricus campestroides* Heinem & Gooss.-Font.	Amhara, Agew, Sidama,	Rwanda, Ethiopia,	Zeleke et al., 2020; Dejene et al. 2017.
2	*Agaricus subedulis* Heinem	Amhara, Agew, Sidama,	Rwanda, Ethiopia,	Zeleke et al., 2020; Dejene et al., 2017.
3				
4	*Agrocybe pediades* Fayod	Amhara, Agew, Sidama,	Ethiopia,	Zeleke et al., 2020; Dejene et al., 2017.
5	*Amanita loosii* Beeli	W, Hehe, Benna	Burundi, Tanzania	Degreef et al., 2016; Chelela, et al., 2014.
6	*Amanita zambiana* Pegler & Piearce	Hehe, Benna, RNFR, PLM, RNP, Arabuko-Sokoke	Tanzania	Chelela et al., 2014; Nteziryayo et al., 2019; Wadanti, 2013.
7	*Amylosporus* sp.	Tanga, Pwani, Dar es Salaam	Tanzania	Juma et al., 2016
8	*Cantharellus cyanoxanthus* R. Heim ex Heinem.	W, Hehe, Benna	Burundi, Tanzania	Degreef et al., 2016; Chelela et al., 2014.
9	*Clitocybe elegans (Fr.)* Staude	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020
10	*Collybia piperata* (Beeli) Singer	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020
11	*Coprinellus domesticus* (Bolton) Vilgalys, Hopple & Jacq. Johnson	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020
12	*Favolus roseus*	Tanga, Pwani, Dar es Salaam	Tanzania	Juma et al,. 2016
13	*Gymnopilus pampeanus* (Speg.) Singer	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020
14	*Hygrophoropsis aurantiaca* (Wulfen) Maire	Amhara, Agew, Sidama	Ethiopia	Zeleke et al,. 2020; Dejene et al., 2017.
15	*Hymenagaricus fuscobrunneus* Heinem	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020
16	*Hypholoma fasciculare* (Huds.:Fr) P. Kumm	KNPm Amhara, Agew, Sidama	Tanzania, Ethiopia	Nteziryayo et al., 2019; Zeleke et al., 2020.
17	*Lactarius delicious* (Fries) S. F. Gray	RNFR, PLM, RNP	Tanzania	Nteziryayo et al., 2019
18	*Lentinus sajor-caju*	Tanga, Pwani, Dar es Salaam	Tanzania	Juma et al., 2016
19	*Leucoagaricus leucothites* (Vittad.) Wasser	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020; Dejene et al., 2017.
20	*Leucoagaricus rubrotinctus* (Peck) Singer.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020; Dejene et al., 2017.
21	*Leucocoprinus birnbaumii* (Corda) Singer	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020; Dejene et al., 2017.
22	*Leucocoprinus cepistipes* (Sowerby) Pat	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020; Dejene et al., 2017.
23	*Pleurotus cystidiosus* O.K. Mill.	F, Tanga, Pwani, Dar es Salaam	Burundi, Rwanda	Degreef et al., 2016; Juma et al., 2016.
24	*Polyporus tenuiculus* (P. Beauv.) Fr.	F, Tanga, Pwani, Dar es Salaam	Rwanda, Uganda	Degreef et al. 2016, Juma et al. 2016, Nakalembe et al., 2015.
25	*Russula compressa*	Hehe, Benna, Arabuko-Sokoke,	Tanzania, Kenya	Chelela et al., 2014; Wadanti, 2013.
26	*Russula roseoviolacea* Buyck	W, Hehe, Benna	Burundi	Degreef et al., 2016; Chelela et al., 2014.
27	*Termitomyces aurantiacus* R. Heim)	Hehe, Benna, SME Tan	Tanzania, Ethiopia	Chelela et al., 2014; Dejene et al., 2017, Tibuhwa et al., 2011, Ashagrie et al., 2015.
28	*Termitomyces eurhizus*	Hehe, SME Tan, Menge	Tanzania, Ethiopia	Chelela et al., 2014; Dejene et al., 2017; Tibuhwa et al., 2011; Sitotaw et al., 2020.
29	*Termitomyces letestui* (Pat.) R. Heim	W, Sv, Hehe, SME Tan, Menge	Burundi, Tanzania, Ethiopia	Chelela et al., 2014; Degreef et al., 2016; Tibuhwa et al., 2011; Sitotaw et al., 2020; Ashagrie et al., 2015.
30	*Termitomyces mammiformis* R. Heim	W, Sv, SME Tan	Burundi, Tanzania	Degreef et al., 2016; Tibuhwa et al., 2011.
31	*Termitomyces striatus* (Beeli) R. Heim	W, Sv, Hehe, Benna, SME Tan., Menge	Burundi, Rwanda, Tanzania, Ethiopia	Degreef et al., 2016; Chelela, et al., 2014, Tibuhwa et al., 2011; Sitotaw et al., 2020.
32	*Trametes versicolor* (L.) Lloyd	SME Tan. Amhara, Agew, Sidama	Tanzania Ethiopia	Tibuhwa et al., 2011; Zeleke et al., 2020.

Key:
W: miombo woodland; Sv: savanna; F: montane forest; P: *Pinus* plantation (Buyck, 1994; Nzigidahera, 2007 were relied on by Degreef et al., 2016 at times) RNFR = Forest Natural Reserve of Rumonge; KNP = Kibira National Park; PNR = Ruvubu National Park; PPM = Protected Landscape of Makamba. Serengeti Mara Ecosystems (SME). Source* = did not provide uses

Table 4. List of macrofungi in Eastern Africa with other uses apart from being edible only, references and sites/locations/tribes where they were found

SN	SCIENTIFIC NAME	USES	TRIBES/ LOCALITIES	COUNTRIES	SOURCES
1	*Amanita muscaria*	Poisonous	Miombo	Tanzania	Härkönen et al., 2021
2	*Armillaria heimii* Pegler	Edible, medicine	F,	Rwanda, Ethiopia	Degreef et al., 2016; Dejene et al., 2017
3	*Chlorophyllum molybdites*	Poisonous	Miombo, Menge	Tanzania, Ethiopia	Härkönen et al., 2021, Sitotaw et al., 2020; Dejene et al., 2017*
4	*Calvatia rubroflava* Fr	Edible, medicine	Amhara, Agew, Sidama,	Ethiopia	Zeleke et al., 2020; Dejene et al., 2017
5	*Laetiporus sulfureus* (Bull.: Fr.) Murrill or *Laetiporus sulphureus*	Edible, medicine	KNP, SME, Menge	Tanzania, Ethiopia	Nteziryayo et al., 2019; Tibuhwa et al. 2011, Teferi et al. 2013, Dejene et al., 2017*; Dejene et al., 2017; Sitotaw et al., 2020; Ashagrie et al., 2015.
6	*Lycoperdon perlatum* Pers	Edible, medicine	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020.
7	*Schizophyllum commune* Fr.	Edible, medicine	F, SME Tan	Burundi, Tanzania, Ethiopia	Degreef et al., 2016; Dejene et al., 2017; Tibuhwa et al., 2011.
8	*Termitomyces clypeatus* (R. Heim)	Edible, medicine	SME Tan, Menge	Tanzania, Ethiopia, Uganda	Tibuhwa et al., 2011; Dejene et al., 2017; Teferi et al., 2013; Nakalembe et al., 2015; Sitotaw et al., 2020; Ashagrie et al., 2015.
9	*Termitomyces microcarpus* (Berk. & Broome) R. Heim	Edible, medicine	W, Sv, Hehe, Benna, SME Tan., Busitema, Menge	Burundi, Rwanda, Tanzania, Uganda, Ethiopia	Degreef et al., 2016; Chelela et al., 2014; Tibuhwa et al., 2011; Ogwok et al., 2017; Dejene et al., 2017; Teferi et al., 2013; Sitotaw et al., 2020; Nakalembe et al., 2015; Ashagrie et al., 2015.
10	*Termitomyces robustus* (Beeli) R. Heim	Edible, medicine	F, Sv, Menge	Burundi, Rwanda, Ethiopia	Degreef et al., 2016; Dejene et al., 2017.
11	*Volvariella speciosa*	Edible, medicine		Uganda	Wendiro et al., 2019; Nakalembe et al., 2015

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Table 5. List of macrofungi (with unspecified uses) in Eastern l Africa with references and site/location/tribe where they were found

SN	SCIENTIFIC NAME	TRIBES/LOCALITIES	COUNTRIES	SOURCES
1	*Agaricus trisulphuratus* Berk.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
2	*Agaricus xanthodermulus* Callac & Guinb.		Ethiopia	Dejene et al., 2017* .
3	*Amanita rannesces*	Maseno	Kenya	Opande et al., 2017*
4	*Amauroderma regulicolor* Murrill	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
5	*Bjerkandera adusta* (Willd.) P. Karst.		Ethiopia	Dejene et al., 2017*
6	*Catathelasma ventricosum* (Peck) Singer		Ethiopia	Dejene et al., 2017*
7	*Clitocybe gibba*	Maseno	Kenya.	Opande et al., 2017*
8	*Climacodon septentrionalis* (Fr.) P. Karst.		Ethiopia	Dejene et al. 2017*
9	*Clitocybe nuda* (Bull.) H.E. Bigelow & A.H. Sm.		Ethiopia	Dejene et al. 2017*
10	*Conocybe* sp. Fayod	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
11	*Corticiaceae spp.* Herter		Ethiopia	Dejene et al., 2017*
12	*Craterellus* spp. Pers.		Ethiopia	Dejene et al., 2017*
13	*Crepidotus* sp. (Fr.) Staude	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
14	*Cyptotrama asprata* (Berk.) Redhead & Ginns.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*

SN	SCIENTIFIC NAME	TRIBES/LOCALITIES	COUNTRIES	SOURCES
15	*Daedalia quercina*	Maseno	Kenya	Opande et al., 2017*
16	*Daedalia unicolor*	Maseno	Kenya	Opande et al., 2017*
17	*Dictyophora indusiata* (Vent.) Desv.		Ethiopia	Dejene et al., 2017*
18	*Diplomitoporus rimosus* (Murrill) Gilb. & Ryvarden		Ethiopia	Dejene et al., 2017*
19	*Favolaschia calocera* R. Heim.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
20	*Formitopsis gibba*	Maseno	Kenya.	Opande et al., 2017*
21	*Fomitiporia tenuis* Decock, Bitew & Castillo	Highland forests region	Ethiopia	Dejene et al., 2017*
22	*Fomitiporia aethiopica* Decock, Bitew & G. Castillo			Dejene et al., 2017*
23	*Fomitiporia pseudopunctata* (A. David, Dequatre & Fiasson) Fiasson		Ethiopia	Dejene et al., 2017*
24	*Fomitiporia robusta* (P. Karst.) Fiasson & Niemelä		Ethiopia	Dejene et al., 2017*
25	*Ganoderma applanatum* (Pers.) Pat.		Ethiopia	Dejene et al., 2017*
26	*Gerronema hungo* (Henn.) Degreef & Eyi	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
27	*Gymnopilus junonius* (Fr.) P.D. Orton	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
28	*Gymnopus eucalyptorum* (Pers.)		Ethiopia	Dejene et al., 2017*
29	*Gyromitra* spp. Fr.		Ethiopia	Dejene et al., 2017*
30	*Laccaria bicolor*	Maseno	Kenya.	Opande et al., 2017*
31	*Lentinellus cochleatus* (Pers.) P. Karst.		Ethiopia	Dejene et al., 2017*.
32	*Lenzites betulina* (L.) Fr.		Ethiopia	Dejene et al., 2017*.
33	*Lepiota cristata* (Bolton) P.Kumm	Amhara, Agew, Sidama	Ethiopia	Zeleke et al. 2020*
34	*Lycoperdon echinatum*	Maseno	Kenya	Opande et al,. 2017*
35	*Morchella esculenta* (L.) Pers.		Ethiopia	Dejene et al., 2017*.
36	*Marasmius buzungolo* Singer	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
37	*Marasmius katangensis* Singer.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al. 2020*
38	*Marasmius rotalis* Berk & Broome	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
39	*Morchella esculenta* (L.) Pers.		Ethiopia	Dejene et al., 2017*.
40	*Mycoacia brunneofusca* Hjortstam & Ryvarden		Ethiopia	Dejene et al., 2017*.
41	*Omphalotus olearius* (DC.) Singer		Ethiopia	Dejene et al., 2017*.
42	*Onnia tomentosa* (Fries) P. Karsten		Ethiopia	Dejene et al., 2017*.
43	*Parasola* sp1. Redhead, Vilgalys & Hopple.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
44	*Phallales* spp. E. Fisch		Ethiopia	Dejene et al., 2017*.
45	*Phellinus populicola* Niemelä		Ethiopia	Dejene et al., 2017*.
46	*Pholiota adipose* (Fr.) P. Kumm.		Ethiopia	Dejene et al., 2017*.
47	*Poliporous cinnabarinus*	Maseno	Kenya,	Opande et al., 2017*
48	*Polyporus badius* (Pers.) Schwein.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
49	*Polyporus tuberaster* (Jacq. ex Pers.) Fr.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
50	*Psilocybe cyanescens* Wakef.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
51	*Psilocybe merdaria* (Fr.) Ricken.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020*
52	*Rubinoboletus acriannulata* Buyck sp. nov	Lower montane forest	Tanzania	Härkönen et al., 1993
53	*Rubinoboletus hiemisilvae* Buyck sp. nov.	Lower montane forest	Tanzania	Härkönen et al., 1993*
54	*Russula sublaevis* (Buyck) Buyck stat. nov	Lower montane forest	Tanzania	Härkönen et al., 1993*
55	*Russula tanzaniae* Buyck sp. nov.	Lower montane forest	Tanzania	Härkönen et al., 1993*
56	*Russula tenuithrix* Buyck sp. nov.	Lower montane forest	Tanzania	Härkönen et al., 1993*
57	*Russula usambarae* Buyck sp. nov	Lower montane forest	Tanzania	Härkönen et al., 1993*
58	*Tremella mesenterica (*Schae_.) Retz.	Amhara, Agew, Sidama	Ethiopia	Zeleke et al., 2020* .
59	*Xerula radicata*	Maseno	Kenya	Opande et al., 2017*

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Therefore, there were 144 edible mushrooms (in Tables 1 and 4) out of 205 species altogether in Eastern Africa. The total number of species of mushrooms encountered all in all was 205 mushroom species whether they were used by inhabitants or not (in Tables 1, 4 and 5).

The grouping of the mushroom species based on the country where they were sighted showed that Ethiopia accounted for 96 species, Tanzania (75), Burundi (37), Rwanda (24), Kenya (18), and Uganda (6 species) while no information was available from the rest of the countries in the region (Figure 1).

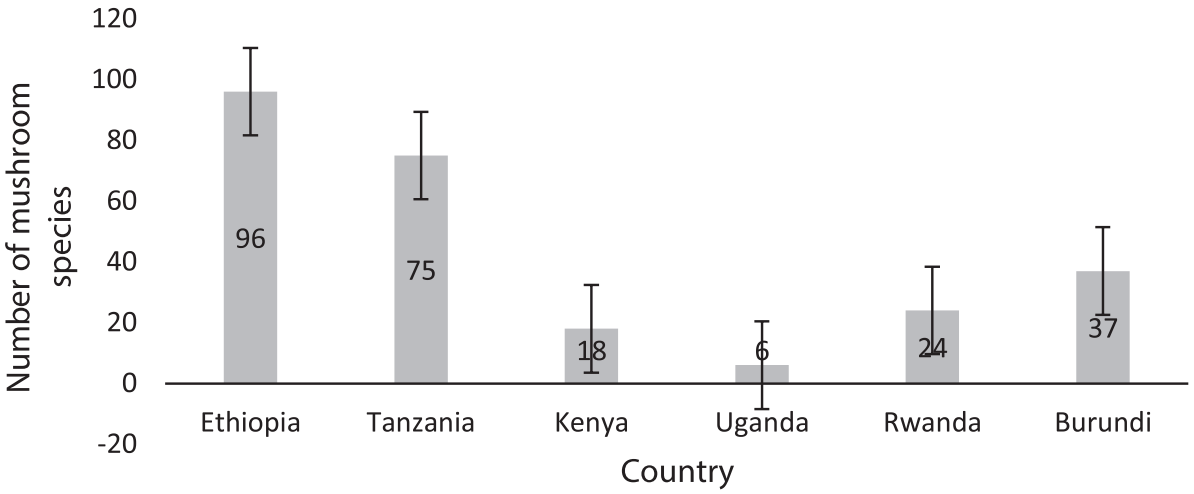

Figure 1. The number of mushroom species reported from Eastern Africa by country

The most common genera of mushrooms in Eastern Africa based on number of species per genus are presented in Figure 2. The most common genera of mushrooms include *Termitomyces, Russula, Pleurotus, Marasmius, Lactarius, Coprinus, Cantharellus, Armillaria, Amanita,* and *Agaricus*.

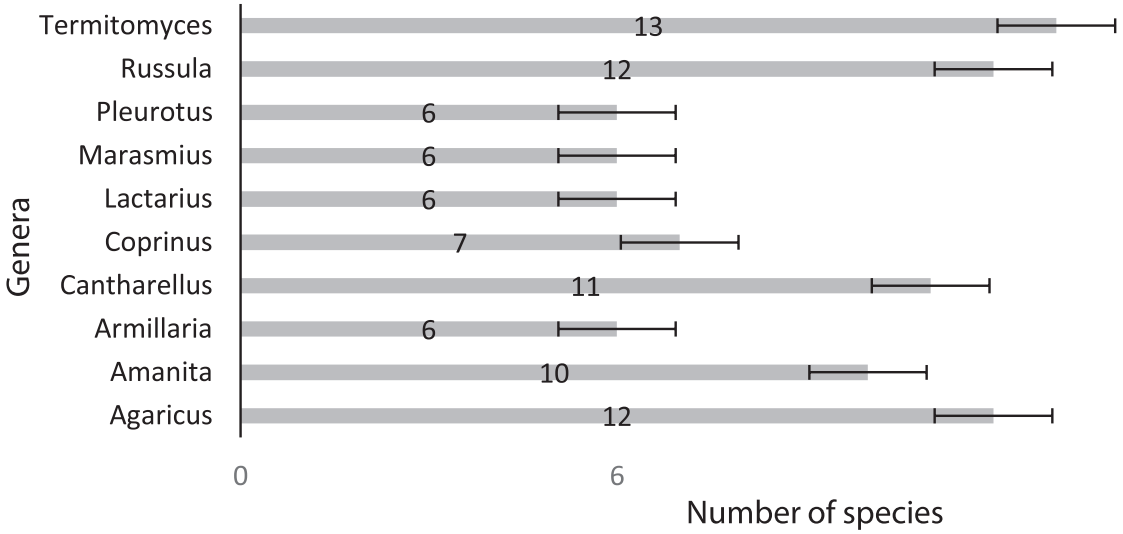

Figure 2. The most common genera of mushrooms in Eastern Africa based on number of species per genus

The most popular species (Figure 3), determined by consumption across more localities/tribes, include *Amanita zambiana, Hypholoma fasciculare, Pleurotus cystidiosus, Polyporus tenuilus, Termitomyces letestui,* and *Termitomyces striatus.* However, it was observed that these tribes or localities were often concentrated within one or two countries. Therefore, mushrooms with a truly regional distribution include *Schizophyllum commune, Suillus luteus, Termitomyces clypeatus, Termitomyces striatus,* and *Termitomyces microcarpus* based on their being found in at least three or more countries (Figure 4).

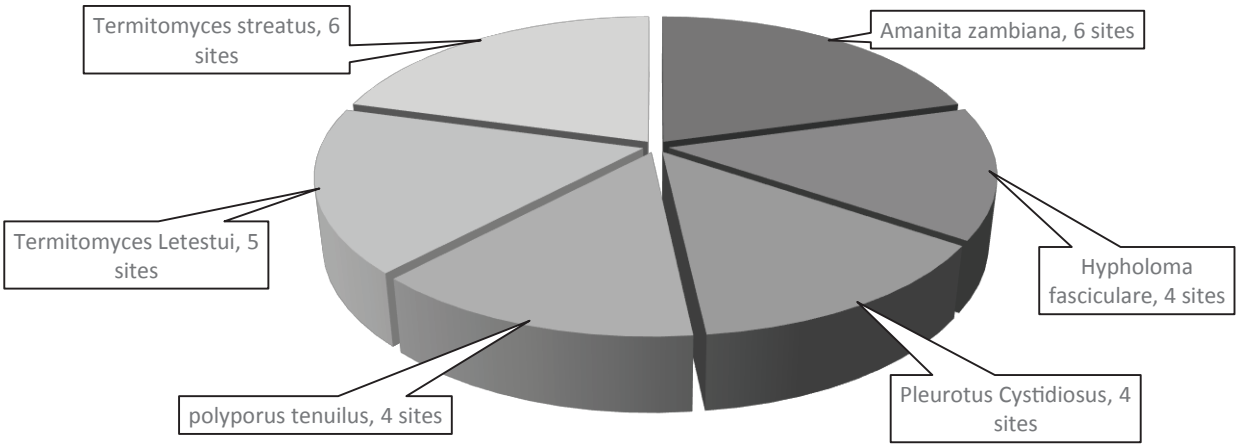

Figure 3. The most common mushroom species based on number of sites

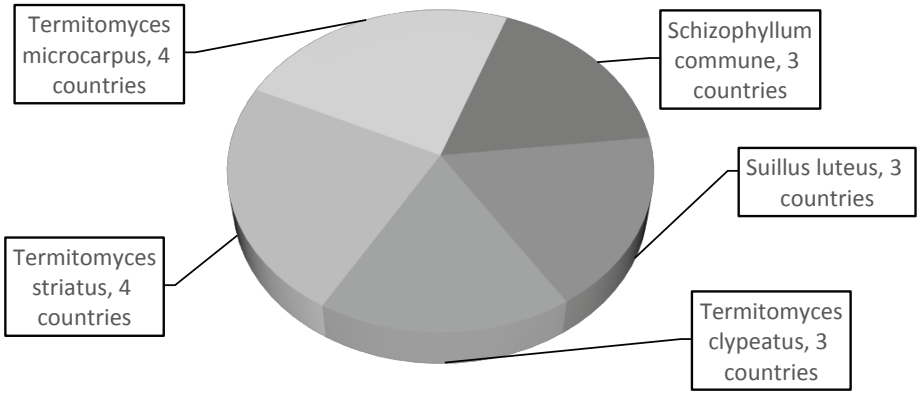

Figure 4. The most common mushroom species based on number of countries

Discussion

These outcomes on fieldwork distribution corroborated the findings of Dejene et al. (2017) that all the available ethnomycological research seemed to be focused on specific areas of a country (e.g. such as the west and southwest parts of Ethiopia), and most of the country(ies) still remain unexplored. They pointed out that in cases where many tribes were found in a region the information remained incomplete and inadequate. The spatial spread of mushrooms in Eastern Africa shows that the likelihood of any species becoming endangered or even extinct is very high given the narrow territory each covers. The region has little or no information on medicinal mushrooms hence their extinction can go unnoticed because most of the research focused on comestible mushrooms.

Muchane (2016) reported the presence of 258 species of wild edible mushrooms in two Eastern Africa countries but this review did not corroborate that tally even on regional bases. Their review revealed that Tanzania accounted for 118 edible species followed by Malawi (47). Among these, 82 species were edible ectomycorrhizae species and the rest were saprophytic fungi species. Muchane (2016) reported that 9 species (*Pleurotus flabellatus, Coprinus cinereus, Volvariella volvocea, Pleurotus citrinopileatus, Auricularia auricula, Pleurotus djamor, Pleurotus* HK-37, *Pleurotus* sp,, and *Oudemansiella tanzanica*) among the saprophytic group have been tissue cultured, tested for spawn production and cultivation.

One reason for this difference in the total number of macrofungi could be that the current taxonomic scrutiny of mushroom names from the region removed incomplete, incorrect, and common names. Thus, some names, especially those with only genus taxon, were discarded. Moreover, publications from Africa generally lack visibility. The outcomes showed that distribution of macrofungi was uneven which corroborates the findings of Tibuhwa et al. (2011) who pointed out that species belonging to seven families were encountered only in the Serengeti in Tanzania which is close to Kenya, yet the distributions

differed significantly. Another observation made was that Ethiopia had more species of mushrooms, this could be tied to the low visibility of publications from more humid parts of Eastern Africa.

Dejene et al. (2017) reported that in Ethiopia, women are typically involved in the collection of mushrooms and they recognize more mushroom species than men. Children are also involved in the collection of some specific species like some *Termitomyces* spp. Chelela et al. (2014) worked with Benna and Hehe folks (in Tanzania), where they reported that women dominated collection (70%) and sale (93.5%) of mushrooms, which is typical of Africa. They reported that mushroom collectors were able to amass 1000-1500 kilograms of mushrooms per season and earn between US$ 500-650 per season, while retailers sell between 750-800 kilograms of mushrooms for US$ 750-1000 per season in Tanzania.

To cap these appealing earnings, mushroom growing in Uganda (n.d.) reported that a kilogram of fresh mushrooms, may earn about 3 500 Uganda shillings (US$ 1.5) and a kilogram of dried mushrooms earns 3 000 Uganda shillings (US$ 1.2). Thus if the Uganda collector assembles the same quantities as those in Tanzania, he/she will earn US$ 750-975 for fresh mushrooms and US$ 600-780 for dry mushrooms. This could be a lot of Uganda shillings (750 000 to 1 462 500 Uganda shillings/season from fresh mushrooms), earned even without take-off capital, moreover this could even be a side business.

Besides, a report about mushroom growing in Uganda (n.d.) stated that mushroom harvesting starts after 14 days of growth and continue (every 2 days) for about 3 months. This continually generates more income from the same investment. They conceded that the reason for this was that mushrooms (exotic and indigenous) are easy to grow and bring very quick returns. Wandati (2013) reported that the consumption of wild mushrooms in Kenya is low. The collectors sometimes prefer to sell mushrooms and buy meat without knowing the health benefits of mushrooms compared to red meat. This finding reveals the need to immediately start enlightening the inhabitants about the importance of natural resources like macrofungi in the environments.

Teferi et al. (2013) reported that mushroom cultivation only started in Ethiopia in 1998 but it was thriving. Nteziryayo et al. (2019) lamented that very little work has been carried out in Burundi to identify and commercialize high yielding native mushrooms. Härkönen et al. (2021) interviewed 33 Tanzanian tribal folks and reported that the main edible mushrooms were *Armillaria, Auricularia, Pleurotus* and *Polyporus* species. Some indigenous mushrooms may be very rich sources of proteins, bioactive agents, medicinal nutraceuticals, and even minerals. These mushrooms have the potential to be sources of foreign exchange earnings.

Härkönen et al. (2021) reported that in the Miombo woodlands of Tanzania, the most commonly used species were from *Amanita, Cantharellus, Lactarius, Russula,* and *Termitomyces*. They warned that *Amanita muscaria* and *Chlorophyllum molybdites* which are poisonous are easily confused with other *Amanita* species in the pine plantations. This could be fatal especially to children who pick them without instructions. Semwal et al. (2014) reported Majangir tribe and Wacha inhabitants were conversant of mushroom consumption although they reported that the cultivation and exploration of mushrooms in Ethiopia were rare. The cultivation of the oyster mushroom (*Pleurotus ostreatus*), followed by the button mushroom (*Agaricus* sp.) and shiitake mushroom (*Lentinus* sp.), was ongoing.

In Kenya, Wendiro et al. (2019) listed some small-scale cultivated species of mushrooms as follows: *Volvariella speciosa, Termitomyces* species, *Agaricus* sp., *Agrocybe* sp., and one exotic species of *Pleurotus* which were used as edible or in medicine. Opande et al. (2017) identified 10 species of mushrooms: *Daedalia quercina, Formitopsis gibba, Poliporous cinnabarinus, Xerula radicata, Amanita rannesces, Lycoperdon echinatum, Laccaria bicolor, Clitocybe gibba, Suillus luteu,* and *Daedalia unicolor* in Maseno University (in Kenya).

In Ethiopia, Teferi et al. (2013) reported that the oyster mushroom (*Pleurotus ostreatus*), the button mushroom (*Agaricus bisporus*) followed by the shitake mushroom (*Lentinula edodes*) were currently being cultivated. They reported the cultivation of indigenous edible species like *Termitomyces clypeatus, Termitomyces microcarpus,* and *Laetiporus sulphureus*. In Teso, Uganda, Opige et al. (2006) reported the presence of 15 species of mushrooms in all the microclimates surveyed during the rainy season. They identified only two species to epithet level: *Termitomyces microcarpus* and *Termictomyces aurantiacus,* while other species included *Agaricus* spp., *Tricholoma* sp., and *Lepiota* sp. It can be seen that mushroom cultivation is gaining grounds in the area. More government support can help the growers.

Eilu et al. (2007) reported the collection of 5 genera of mushrooms from Rakai District in Uganda. They were able to identify *Volvariella speciosa, Podabrella microcarpa, Pluteus* sp. but the other accessions were not clearly identified. Nteziryayo et al. (2019) assessed four protected areas (Kibira National Park,

Rumonge Forest Natural Reserve, Makamba Protected Landscape, and Ruvubu National Park) and identified *Amanita zambiana*, *Pleurotus citrinopileatus*, *Amanita verna* (could be poisonous), *Lactarius delicious*, *Lentinus squarrosulus*, *Hypholoma fasciculare* (could be poisonous), *Macrolepiota dolichaula*, *Trametes polyzona, Laetiporus sulfureus*. *Macrolepiota dolichaula*, *Pleurotus citrinopileatus*, *Amanita verna*, *Hypholoma fasciculare*, *Trametes polyzona,* and *Laetiporus sulfureus.* They noted that *Lentinus squarrosulus* was found only in Rumonge while *Lactarius delicious* and *Amanita zambiana* were recorded in all the areas.

Degreef et al. (2016) compiled a list of wild edible mushrooms from different ecosystems (Miombo: savanna, woodland, montane forest, and exotic tree plantations) of Burundi and Rwanda. They listed 77 species of edible mushrooms which included 39 new records of species eaten in the region. Musieba et al. (2011) reported the occurrence of the edible *Pleurotus* sp. in Kakamega Forest (in Kenya). *Tibuhwa* et al. (2011) pointed out that species belonging to families Schizophyllaceae, Ganodermataceae, Geastraceae, Auriculariaceae, Sarcoscyphaceae, Xylariaceae, and Sclerodermataceae were encountered only in the Serengeti in Tanzania, consequently the macrofungi encountered in Tanzania and Kenya differed significantly. Given the information provided above, the need to establish fungi conservation units becomes evident. The area occupied by some of these mushrooms is so small.

Dejene et al. (2017) identified 17 native edible mushrooms in Ethiopian forests. Tibuhwa et al. (2011) carried out field work and collected 92 species of macrofungi distributed as follows: 55.4% were from Tanzania and 44.5% were from Kenya. Macrofungi species of the family Lyophyllaceae (23%), Agaricaceae (21%) and Polyporaceae (12%) were the most common taxa in the ecosystems they surveyed. Chelela, et al. (2014) collected 45 species of wild edible mushrooms from the Miombo that belonged mainly to *Lactarius, Russula, Cantharellus,* and *Amanita* species.

Tibuhwa et al. (2011) assessed the Serengeti Mara ecosystem (SME) in Tanzania and Kenya (which comprised of the Serengeti National Park, Ngorongoro, and Conservation Area in Tanzania and the Maasai Mara National Reserve in Kenya) for macrofungi biodiversity. They observed that woodland habitat had the highest number of macrofungi species (47%) followed by grassland (37%) and farmlands (16%). Thus, the damp region recorded significantly high macrofungi species compared to arid region.

Nteziryayo et al. (2019) reported that fruiting body production was successful for the indigenous *Pleurotus citrinopileatus*, *Lentinus squarrosulus*, *Hypholoma fasciculare* (could be poisonous), and *Trametes polyzona*. Meanwhile *Macrolepiota dolichaula* and *Laetiporus sulfureus* remained at the secondary mycelium stage but *Amanita zambiana*, *Lactarius delicious* and *Amanita verna* (could be poisonous) did not develop even the mother spawn. This researcher reiterated that species of the genus *Pleurotus* are important mushrooms because of their ease of cultivation, their nutritional value and their medicinal properties.

Woldegiorgis et al. (2015) reported that all the 12 mushrooms they evaluated in Ethiopia contained 18 amino acids. Ogwok et al. (2017) at Busitema University (in Uganda) reported that the fat content of mushrooms (*P. ostreatus, Amanita* spp., and *T. microcarpus)* ranged between 0.24 and 5.23%. These researchers showed that *P. ostreatus*, *Amanita* spp., and *T. microcarpus* were healthy foods with regard to their low fat content. Nakalembe et al. (2015) in Uganda, determined the composition of native *P. tenuiculus T. tyleranus*, *T. clypeatus*, *V. Speciosa,* and *T. microcarpus*.

Nakalembe et al. (2015) reported that on dry weight basis, all the nutrient compositions were higher in mushroom species obtained from the humid zone compared to those from arid areas, with exception of total carbohydrates and energy values. They observed that mushrooms from humid agro-ecological zones had relatively higher overall mineral and vitamin content than those from arid regions. Härkönen et al. (1993) identified 21 species of *Russula* saying that 19 of these species were reported to be first collections in Tanzania. Calonge et al. (1997) reported that no Tanzanian tribe used any Gasteromycetes as edible but in several places these mushrooms, especially puffballs were used to sedate honey bees in order to harvest the honey. In Tanzania, Saarimaki et al. (1994) announced the discovery of a new edible mushroom; Termitomyces singidensis Saarim. & Hark.

Zeleke et al. (2020) reported that among three tribes (Amhara, Agew, and Sidama in Ethiopia), the Sidama have the most extensive ethnomycological knowledge. They reported that the medicinal mushrooms (*Lycoperdon perlatum* Pers. and *Calvatia rubroflava* (Cragin) Lloyd) were eminent and used for treatment of wounds and skin diseases. Also, they reported that storage of wild mushroom species was unknown among the Ethiopian tribes.

Wandati (2013) carried out survey of mushrooms and collected samples from the coast, central and western parts of Kenya and the proximate analysis showed presence of lipids, insoluble fiber, ash, protein and soluble carbohydrates. The potassium proportion was the highest macro-mineral constituent and iron was the most abundant trace element. Ashagrie et al. (2015) analysed edible mushrooms collected from Ethiopia (i.e. *P. ostreatus, L. edodes, A. bisporus, A. campestris, L. sulphureus, T. clypeatus, T. microcarpus, T. aurantiacus, T. Letestui,* and *Termitomyces* spp.) for their nutrient compositions. This shows how nutrient-rich indigenous mushrooms are, and it would be a big mistake not to make good use of these natural resources both as nutrient supplement, safe medicines, and sources of raw materials. Mushrooms are also useful in the environment in many areas as earlier enumerated.

Conclusion

This research was carried out to augment the gap in knowledge on the mushroom resources of Eastern Africa by providing a checklist of mushroom biodiversity in the region. This was deemed necessary because changes in climate may be adversely affecting biodiversity of mushrooms in the region. The review came up with 205 species of mushrooms among which 144 were edible.

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