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A rich mushroom diversity at Maseno University, Siriba campus, Maseno (Kenya)

George T. Opande*[1], David M. Musyimi[2], Tirop C. Sarah[3]

School of Physical and Biological Sciences, Department of Botany, Maseno University, Maseno, Kenya

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Abstract

Mushrooms diversity study is not a new phenomenon, different workers in different parts of the world have always undertaken such studies to better understand the macro fungi flora that occur in those areas. The local non-edible and edible wild mushrooms occurrence, distribution and diversity in Western Kenya and East Africa in general have not been fully understood even though they are useful to urban and rural communities living in this region. Mushrooms are useful to humans as; Source of medicine, Environmental balance, food and ornamentals. Before this study, no study had been conducted in Maseno University Siriba campus, and forest ecosystem to show the existing mushroom flora. This study was therefore initiated to identify and record the available mushroom flora. Maseno university area is located within the geographical coordinates 0°0′ 17.36″ S, 34°36′ 1.62″ E at an altitude of 1503 meters above sea level. The terrain where the collection was made was mainly of built up campus and sloppy forest vegetation, the mean temperature during the collection period was between 19°C and 27°C. Standard sampling was used and the area of study divided into 2 portions/sites. Mushrooms were collected on their vegetative stages and sorted accordingly. The location and substrate on which mushrooms grew were also recorded and photos using a digital camera kept as permanent records. All the species collected were identified based on their morphological characteristics. When identification was complete, *Daedalia quercina, Formitopsis gibba, Poliporous cinnabarinus, Xerula radicata, Amanita rannesces, Lycoperdon echinatum, Laccaria bicolor, Clitocybe gibba, Suillus luteu* and *Daedalia unicolor* were the species found to be resident at the Maseno University Siriba campus and the surrounding ecosystem.

* **Corresponding Author:** George T. Opande ✉ opandeg@gmail.com

Introduction

Mushrooms diversity study is not a new phenomenon, different workers in different parts of the world have always undertaken such studies to better understand the macro fungi flora that occur in those areas (Praveen *et al*, 2014, Phongeun *et al* 2010, Brown *et al*, 2006). Yet the local non-edible and edible wild mushrooms occurrence, distribution and diversity in Western Kenya and East Africa in general have not yet been fully documented and understood even though they are consumed as food and used for medicinal aspects by urban and rural communities living in this region.

Maseno University, Siriba campus is located in an area surrounded by an ecosystem with adequate rain fall and a rich plant diversity leading to the occurrence of organic rich soils. Maseno is found at the geographical coordinates of 0°0′ 17.36″ S, 34°36′ 1.62″ E and an altitude of 1503 meters above sea level. The surrounding terrain is mainly made up of a forest vegetation that is sloppy, a market center in a small town with residential zones and a built up University campus. The general area has a warm tropical temperature with an average ranging between 19°C and 27°C.

Maseno a small town with a population of 14,000, located in Western Kenya has a poor or no organized liquid and solid waste disposal services provided by either the university or the Kisumu county government was a suitable area for this study because the poorly disposed organic substrates that litter the surrounding environment creating a suitable habitat onto which mushrooms and other saprophytic members of the fungi kingdom are able to grow profusely.

Mushrooms or gill fungi have been defined as a macro-fungus with a distinctive fruiting body, which can be hypogenous or epigeous, large enough to be seen with the naked eye and to be picked by hand (Chang, 1989).

They are classified in the division Basidiomycota of the fungi kingdom because their fruiting body form an umbrella shaped basidiocarp with gills onto which are found basidia (Alexopoulos *et al*., 1996). They mostly grow in terrestrial environments. A large majority is saprophytic but there are a few parasitic types known whose hosts range from algae to a wide variety of angiosperms (Alexopoulos *et al*., 1996). Their plant body consists of multicellular septate hyphae that may be branched and filamentous. Most mushroom species grow in a span of 14-21 days and to maturity (Alexopoulos *et al*., 1996).

They have a high food value to human beings because they are documented as being rich in proteins, minerals, vitamins while they are low in lipids (Mattila *et al*., 2001) They also have phytochemicals and other compounds which are strong antioxidants. (Mattila *et al*., 2001). Phenolic compounds like; alkaloids, saponins, flavonoids, tannins, sterols, triterpenes, coumarins and cyanogenic glycosides have been detected in wild mushrooms analyzed in Sudan and Nigeria (Adekunle *et al*. 2005). These compounds seem to mop the free radicals generated in the normal natural metabolism of aerobic cells, mostly in the form of reactive oxygen species (ROS). Mushrooms therefore are reported to have medicinal value attributed to a new class of compounds extractable from either the mycelium or fruit body of mushrooms (Adekunle *et al*. 2005). Consumption of mushrooms embodies both their nutritional and medicinal features as a dietary supplement as enriched food materials which are used for maintenance of healthy diet with potential therapeutic applications (Chang, 1989). Some mushrooms or extracts are used or studied as possible treatments for diseases, such as cardiovascular disorders. Some mushroom materials, including polysaccharides, glycoprotein's and proteoglycans are under basic research for their potential to modulate immune system responses and inhibit tumor growth,

whereas other isolates show potential antiviral, antibacterial, anti-parasitic, anti-inflammatory, and anti-diabetic properties in preliminary studies. Currently, several extracts have widespread use in Japan, Korea and China, as adjuncts to radiation treatments and chemotherapy, even though clinical evidence of efficacy in humans has not been confirmed (Chihara, 1993).

There are only a small number of deadly species known; consumption of such species can cause particularly severe complications and unpleasant symptoms to humans (Da Silva, 2005). *Amanita* genus, most recognizably *A. muscaria*, and *A. pantherina*, among others are some of the toxic members of this genus known. The *Amanita* in toxication is similar to Z-drugs in that it includes Central Nervous System (CNS) depressant and sedative-hypnotic effects, but also dissociation and delirium in high doses (Apetorgbor *et al*., 2005).

Mushrooms are important to humans not only for their food value but also for medicinal, environmental balance and ornamental purposes among others. Knowledge of their occurrence and distribution in Maseno was important, because there was little information on their diversity in Maseno area before this study.

Materials and methods

Study area.

The study was conducted at Maseno University campus and the surrounding area, located in Maseno, Western Kenya, within geographical coordinates 0°0′ 17.36″ S, 34°36′ 1.62″ E at an altitude of 1503 meters above sea level. Two areas of collection were selected namely (1) The forest ecosystem (amphitheater) that had a terrain consisting mainly of sloppy wet forest vegetation and (2) Siriba campus area that were rich in organic materials and hence able to support growth of mushrooms. The average environmental temperature ranged between 19°C and 21°C.

Collection and identification of macro fungi

Standard methods of collection as earlier described (Kumar 1990, Atria 2003) were used. A digital camera was used to record field pictures (Praveen *et al* 2014) of mushrooms specimen collected were taken at their habitat to act as permanent records on the vegetative stages, location, substrate and habitat on which the specimens were collected (Praveen *et al.,* 2014). Macroscopic details such as shape, size, color and were recorded prior to preservation and a record maintained Taxonomic positioning was conducted using morphological and anatomical characters exhibited by the collected samples taken to the University herbarium at the Department of Botany, Maseno University where the fruiting bodies were maintained in 4% formaldehyde solution (Praveen *et al.,* 2014).

Results and discussion

10 different species of mushroom namely *Daedalia quercina, Formitopsis gibba, Poliporous cinnabarinus, Xerula radicata, Amanita rannesces, Lycoperdon echinatum, Laccaria bicolor, Clitocybe gibba, Suillus luteu* and *Daedalia unicolor* were found to be resident at the Maseno University Siriba campus and the surrounding ecosystem. Captured records of their different morphological characteristics, such as color, shapes and sizes are shown in Table 1. There were clear differences in life spans observed among the 10 species collected, where some were short-lived, annuals and perennials. Some collected species were either edible or inedible due to their chemical compositions.

Fig. 1. *Laccaria bicolor.*

Laccaria bicolor (Fig. 1), an edible fungi with a range of tress, having a cap that was convex and depressed, bare stipe, adnate hymenium with gills was collected at the University farm next to sewage line and around the guest house at college campus, and behind the old makerere hostels in Siriba campus A close examination of the fungus showed that it had a white fleshy fruiting body that had no apparent distinctive smell or taste, thereby confirming its identity.

Fig. 2. *Clitocybe gibba.*

Clitocybe gibba (Fig. 2), an edible species of mushrooms characterized by funnel shaped cap, fibrous flesh and a white to cream, yellow, grey to beige colored basidiocarp was collected at Tsunami/sunrise hostels area in the Siriba sampling area. Specimens collected were found growing on wood and on the ground.

Fig. 3. *Suillus luteus.*

Suillus luteus a mushroom (Fig. 3) commonly known as slippery Jack bolete having a smooth brown cap, white flesh and tube openings radiating out from the stalk in a linear pattern was collected at the amphitheatre sampling area.

This edible macro fungus is known to be mycorrhizal with pines in other parts of the world where it is found.

Fig. 4. *Daedalia unicolor.*

Daedalia unicolor (Fig. 4) a saprophytic fungus was found growing on deadwood of hardwoods were caused a white rot was found . It enjoying a luxuriant growth behind the guidance and counseling department, opposite the University transport department in the Siriba sampling area. This annual fungus mostly grew in overlapping clusters. The collected specimen had a kidney shaped basidiocarp that was whitish and fleshy having a dark area just beneath the cap surface (Fig. 4).

Fig. 5. *Daedalia quercina.*

Daedalia quercina (Fig. 5) a macro fungus commonly known as the maze bracket, placed in the order polyporales with no distinct cap and had a hymenium that was decurrent with pores on it was collected at the amphitheater forest sampling area. This mushroom is not known to be edible due to its rigid cork-like texture. It lives mostly as a saprophyte on a majorly of oaks and trunks of dead trees in the amphitheater forest of Maseno.

Fig. 6. *Formitopsis pinicola.*

Formitopsis pinicola (Fig. 6) a saprophytic and inedible mushroom was collected and identified at the millennium area next to the Dean of students' office in Siriba campus. This macro fungus is a polypore stem-decaying fungus that lacked a stipe and appeared to have recurrent hymenia that had pores on it and no distinct basidiocarp.

Fig. 7. *Polyporous cinnabarinus.*

Polyporous cinnabarinus (Fig. 7) an inedible perennial saprophytic specimen was collected behind the school of special needs department at the Siriba sampling site, where it showed an orange-red, broadly attached leathery basidiocarp when it was collected on rotting wood that exhibited a white sapwood rot symptoms (Fig. 7).

Fig. 8. *Xerula radiate.*

Xerula radiata (Fig. 8) commonly known as the Deep Root mushroom due to its deeply rooted stalk. Collected specimens exhibited the clear appearance of a flat or umbonate basidiocarp that had a bare stipe. *X. radiata* was found in almost every dumpsite across Siriba campus. It showed a luxuriant growth specifically at the Tsunami dumpsite. The surface of the collected samples of *X. radiata* was sticky or slimy when moist, and had an underside displaying wide white gills or lamella. *X. radiata* grew on substrates that mainly consisted of litter.

Fig. 9. *Amanita brunnescens.*

Amanita brunnescens (Fig. 9) a nonedible poisonous macro fungus having a white to cream, brown or grey to beige colored basidiocarp, that was convex in shape with a ring on its stalk was collected at the old Makerere hostel pit in Siriba campus collection area.

A. brunnescens was found mostly growing on the organic rich soils in Siriba rarely on litter.

Fig. 10. *Lycoperdon echinatum.*

Lycoperdon echinatum (Fig. 10*)* a member of the puffball mushrooms was found growing on dead barks of trees, The collected specimen had a spiny basidiocarp, that was brown in colouration at maturity. This species considered to be important in microbial activity was found growing at the university farm around the cattleshed. Fungi as a kingdom are the most variable group of living organisms, which demonstrate a great variety of form, morphology and life cycles. This study has shown that there is a rich diversity of mushroom species in Maseno University Siriba campus and the forest ecosystem, due to the a presence of a high amount of substrate on to which the macro fungi can grow.

Table 1. The mushroom species growing in Maseno University.

Mushroom Species	Division	Substrate	Life span	Sampling spot
Laccaria bicolor	Basidiomycota	Soil	4-7days	makerere hostels, University farm along sewage line
Clitocybe gibba	Basidiomycota	Dead wood	4-7days	Tsunami/sunrise hostels
Suillus luteus	Basidiomycota	Soil	7 days	Amphitheatre
Daedalia unicolor	Basidiomycota	Dead wood	Summerfall	Sunrise hostels, behind G&C department.
Daedalia quercina	Basidiomycota	Deadwood	Summerfall	Amphitheatre
Formitopsis gibba	Basidiomycota	Dead wood	Perennial	Millennium next to dean of students, office.
Poliporous cinnabarinus	Basidiomycota	Dead trees	perennial	School of special needs office.
Xerula radicata	Basidiomycota	Litter	Few days of rain	Tsunami dumpsite
Amanita brannesces	Basidiomycota	Litter	Days of rain	Old makerere dumpsite
Lycoperdon echinatum	Basidiomycota	Dead bark of tress	Days of rain	University farm

The species collected in this study exhibit different characteristic and substrate preferences that depend on their specific nutrient needs. Species collected in this study exhibited major differences in their sizes, pileus color (brown, white, yellow and pink), shapes of the caps and stipes, structure of the pileus, veil and other characteristics such as the attachment of the pileus to the stipe as either being central, eccentric or lateral, the main characters that made identification of each species possible.

Previous surveys conducted though in much larger study areas in different ecozones (Singh 2004, Singh 1977, Nag *et al* 1991, Doshi *et al* 1994) have also shown the existence of diversity in those areas, such findings show that the diversity of macro fungi is still rich worldwide though there is an urgent need of preservation in view of continuous anthropological interference as Praveen *et al* 2014 encountered in the Rajastan desert ecozone of India.

In the current study, the occurrence of a wide range of substrates in Maseno university, Siriba campus due to human activity that support growth of different mushroom species in the University environment may be the reason for the diversity seen. Most mushroom species collected during these studies were saprophytic growing on dead trunks of trees e.g. *Daedalia unicolor*, others were found growing on litter e.g. *Xerula radicata. A* few species collected were able to grow on soil or they were mycorrhizal e.g. *Laccaria bicolor.* Fungi are important organisms that serve many vital functions in the ecosystems including; decomposition, nutrient cycling, symbiotic relationships with trees, plants and animals.

The threat of loss of macro fungi biodiversity is of great concern in Maseno due to human activities such as global warming, deforestation, pollution and changes in traditional land use patterns that have collectively resulted in substantial alteration of habitats. The best example of demographic changes in the study area is illustrated by the continuous increase in student numbers at Maseno University that started with a minimal student population of less than a thousand in 1990 but now has a resident population of more than ten thousand. Such a demographic change has initiated a chain of events such as need for food, clothing, housing etc. both by the student community and the local resident town population.

Conclusion and suggestions for future research

Maseno University area has rich macro fungal diversity, although they exist at specific spots associated to their substrates i.e. favorable growth niches. Most species collected during these studies grew luxuriantly due to the warm temperatures of the lake equatorial climate. The findings of this research will create awareness not only on species diversity, but occurrences and distinction between poisonous mushroom species and the edible ones found in Maseno.

This research was conducted during the wet rainy season so there is need to conduct a similar study during the dry season, additionally further studies should be carried out to identify the chemical compositions of the various present mushroom species, specifically their photochemical compositions, effects and significances to other living organisms.

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