Ethnomycological study of Termitomyces mushrooms at Judea-Lyabboroma and Katima rural in the Zambezi Region, Namibia

Mukwata, A.[1], Kadhila, N. P.[2]* and Horn, L. N.[2]
[1]Department of Biochemistry, Microbiology and Biotechnology, University of Namibia, P/Bag 13301, Windhoek, Namibia
[2]Zero Emission Research Initiative, Multidisciplinary Research Services, University of Namibia, P/Bag 13301, Windhoek, Namibia

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ABSTRACT

In this study, face-to-face interviews were conducted to collect data on the indigenous uses and traditional knowledge of *Termitomyces* mushrooms in Judea-Lyabboroma and Katima rural, Zambezi Region, Namibia. The results showed that *Termitomyces* were used in the form of powder or paste to heal diseases such as cancer and kidney problems, sexually transmitted infections (STIs), heart disease, severe diarrhea, cancer-related diseases, kidney problems and in the prevention of miscarriages. In both constituencies, the pseudorhiza for the *Termitomyces* mushroom was reported to be an important part that is used in healing various diseases. The results not only motivate the research team to continue finding more possible potential benefits that *Termitomyces* can provide but to encourage validation and pharmaceutical studies to be carried out for drug discovery on these mushrooms in order to provide conclusive results on the potential use of the *Termitomyces* in Namibia and beyond.

1 Introduction

Termitomyces fungus are a monophyletic group of gilled mushrooms that belong to the genus *Termitomyces* (Aryl and Budathoki, 2016). They are known to grow in a symbiotic relationship with termites (Nobre and Aanen, 2010). This symbiotic relationship between termites and mushrooms may have originated from a co-evolutionary process in the African rainforest. In addition to Namibia, in Africa *Termitomyces* species are also found in Cameroon, Nigeria, Tanzania, and Uganda as well as in some parts of South Africa, Zimbabwe, Zambia, and Madagascar (Heim, 1942). These mushrooms are also found in Southeast Asia in countries such as India, China, Nepal, Pakistan, Sri Lanka, Thailand, Taiwan, Philippines, Burma, Malaysia, and Indonesia (Heim, 1942; Turnbull and Watling, 1999). Alasoadura (1966) described *Termitomyces* mushrooms as weather-oriented organisms, meaning their fruiting bodies are only available during the rainy season. The fruiting bodies of the *Termitomyces* are the main food source of the fungus-growing termites (Seelan *et al.*, 2020).

Ethnomycological studies are carried out to develop a database on mushroom diversity and traditional uses (Yongabi *et al.*, 2004). Traditional knowledge about mushrooms is transferred from one generation to the next orally and this is regarded as the only method of preserving useful traditional information about mushrooms (Kamalebo *et al.*, 2018). The passed-on ethnomycological knowledge allows local elders to recognize several very important issues such as edibility, habitat of growth, temporality, and sustainable use (Besnik and Arianit, 2020). The exodus of people to urban areas causes many local communities to gradually lose an important part of the indigenous knowledge of mushrooms (Tibuhwa, 2012b). Furthermore, people lose a portion of mycological

*Corresponding author: *E-mail address:* npkadhila@unam.na (N.P. Kadhila)

knowledge when moving to new places (Tibuhwa, 2013; Härkönen *et al.*, 2015). Besnik and Arianit (2020) stated that this traditional erosion of knowledge can lead to the use of some toxic fungi and then health consequences such as irreversible damage of the vital organs, such as the liver and kidneys.

According to Živković *et al.* (2021), mushrooms are functional foods, containing components that can contribute to human wellness and mitigate threats that render the human body vulnerable to several life-threatening diseases. *Termitomyces* mushrooms are rich in protein and are used as a source of sugar, fiber, lipid, vitamins, and minerals (Hsieh and Ju, 2018; Apetorgbor *et al.*, 2005). They are also used medicinally to lower blood pressure, rheumatism, kwashiorkor, obesity, diarrhea, and as laxatives (Apetorgbor *et al.*, 2005). According to Aryl and Budathoki (2016) termite mushrooms have a delicious taste and serve as a source of food due to their nutritional value, and many species such as *Termitomyces albuminosus* and *Termitomyces clypeatus* have been used traditionally as medicine in Nepal as a remedy for measles and yellow fever in the form of syrup.

Some *Termitomyces* mushrooms, such as *Termitomyces clypeatus*, are traditionally used as medicine in West Bengal for the treatment of a skin disease known as pox (Debnath *et al.*, 2019). Termitomyces reticulatus are traditionally used to lower high blood pressure and in treating rheumatism by the many tribes in India (Panda and Tayung, 2015). Other types of *Termitomyces* mushrooms such as *Termitomyces schimperi* and *Termitomyces sagittiformis* are traditionally used as medicine by the people of the Oshana and Ohangwena regions in Namibia in the treatment of wounds in children's heads, in the form of cream mixed with oil that is applied on the affected areas (Kadhila-Muandingi and Chimwamurombe, 2012). Aryl and Budathoki (2016) stated that *Termitomyces letestui* is used to heal appetence, abdominal disorders, indigestion, and stomachache.

The aim of this study was to document the traditional uses and indigenous medicinal knowledge of *Termitomyces* mushrooms in Judea-Lyabboroma and Katima rural, Zambezi Region, Namibia.

2 Materials and methods

The study was conducted in two constituencies namely Judea-Lyabboroma and Katima rural in Zembezi region of Namibia. The collected mushrooms samples were identified using a guide for mushrooms of Southern Africa by Westhuizen and Eicker (1994). All ethnomycological information in the field was recorded using a questionnaire. The qualitative data were obtained by interviewing 80 people between the ages of 20 and 80 years in the two constituencies in the Zambezi Region. A picture of the *Termitomyces* mushroom was used during the study and asked the participants whether they knew it, to provide the local name, uses, growing habitat, medicinal use and how to prepare it.

Before the collection of mushrooms, a collection permit no. AN20200223, was obtained from the National Commission on Research, Science, and Technology (NCRST) and the Ministry of Environment and Tourism. In addition, an ethical clearance certificate and research permission were acquired from the Centre for Postgraduate Studies at the University of Namibia. Furthermore, permission to conduct interviews in the community was granted by the local authorities (the Mayeyi Traditional Authority, Masubia Traditional authority and Mafwe Traditional Authority) in the Zambezi Region. The COVID-19 safety regulations were followed throughout this project, especially during the interviews of people from the different villages and laboratory sessions.

3 Results and discussion

Indigenous uses of Termitomyces mushroom

In this study, a total of 80 people were interviewed from the two constituencies in the Zambezi Region. From each constituency, forty people among the age groups ranging between 20-39 and 40-80 were interviewed

respectively. There were 16 male and 24 female participants from Judea-Lyabboroma, and 18 male participants, and 22 females from Katima rural. In both constituencies, there were more female participants than males, which shows the interested of women than men.

The percentage of gender representation in the entire study was 57% female and 43% male. This is in line with other similar studies conducted in other parts of Africa which revealed that women outnumbered men. It is believed that women have more knowledge about mushroom and possess more indigenous knowledge of it in their local communities because of their involvement in the collection (Tibuhwa, 2012a; Härkönen *et al.*, 2015). The other reason why women possess more indigenous knowledge on mushrooms is that in the olden days could be that women stayed at home in most villages taking care of children and households, while their male counterparts were in search of employment in the cities.

In this study, most participants (71%) were from the age group between 40-80, while the least (29%) participants were between the age group of 20-39 in both constituencies. This is supported by the study done by Niikondo (2010) which revealed that many young people do not stay in the villages, as they are scattered in the cities looking for employment leaving the pensioners and children in the villages. The study revealed that 22 participants from Judea-Lyabboroma and 33 from Katima rural constituencies had no knowledge of *Termitomyces* mushrooms in general and they all consumed various types of mushrooms (**Table 1**). This might be due to the cultural differences that may exist among the participants from the two different constituencies, several studies have revealed that local mushroom knowledge varies with people's cultures and beliefs as reported by Kamalebo *et al.* (2018).

The study also revealed that the participants used mushrooms for different purposes, for example, 50% of the people from Judea-Lyabboroma indicated that they use mushrooms for medicinal purposes more than those from Katima rural (**Table 1**). Forty-eight people were interviewed from the two constituencies, indicated that they did not use mushrooms for other purposes other than food (**Table 1**). This indicates that people from Judea-Lyabboroma had more knowledge about the uses of mushrooms compared to those from Katima rural.

Kamalebo *et al.* (2018) and Härkönen *et al.* (2015) reported that traditional knowledge is transferred from one generation to the next orally; this can be used to explain why many of the participants might not know the medicinal uses of the mushrooms. It may be likely that there was poor communication from the old generation to the younger generation and as result, the traditional medicinal knowledge of mushrooms was not passed on from the older generation to the younger one. Härkönen *et al.* (2015) reported that people lose part of mycological knowledge when moving to new areas, it is very likely that the participants from both constituencies that indicated that they had no idea of the medicinal purpose of mushrooms had migrated when they were young or have forgotten their indigenous knowledge on the medicinal uses of mushrooms.

In addition, it can be clearly seen that the 28 participants from both constituencies that indicated that they use mushrooms as medicine, have been spending much of their time with the older generation belonging to families of herbalists or families that are good in passing on and preserving indigenous knowledge as stated by Tibuhwa (2013), who stated that transferring traditional knowledge from one generation to the next is the only method that was regarded by indigenous people as the best way of preserving useful information about mushrooms.

The study also investigated if the people of Zambezi from both constituencies knew a certain type of the *Termitomyces* mushroom that commonly grows at the base of the termite hill. These mushrooms were described as having scales on top of the basidiocarp, white in color, and having long pseudorhiza that are longer than one meter (Degreef *et al.*, 1997). Morris (1986) described the mushroom as *T. schimperi*. The study further revealed that this type of mushroom was not only consumed, but it was a very important type of mushroom in the region that people and Herbalists use to heal various types of diseases, such as miscarriages and severe diarrhea which is supported by Aryl and Budathoki (2016) that heart diseases, cancer, kidney problems and healing the umbilical cord of newly born babies.

This indicates that the people of Judea-Lyabboroma realized that the *Termitomyces* mushrooms contain healing properties that would heal various types of diseases, hence its importance to all the people including the herbalist. In both the cultural values and beliefs of the people from both constituencies, they have a strong belief in the healing properties of this type of mushrooms, and hence it was very vital to both as indicated by similarities in their traditional knowledge and beliefs.

The study indicated that 22 participants from Judea-Lyabboroma and 31 participants from Katima rural (a total of 53 participants from the two constituencies), indicated that they did not know the use of *Termitomyces* mushrooms other than eating (**Table 2**). Two participants from Judea-Lyabboroma and one from Katima rural area indicated that the *Termitomyces* mushrooms were used to heal miscarriages in women that were giving birth before their time or to still babies. Eleven participants from Judea-Lyabbora and three from Katima rural indicated that the *Termitomyces* mushrooms are used to heal dysentery or severe diarrhea. A study by Aryl and Budathoki (2016) also reported similar findings.

Participants from both constituencies indicated that the *Termitomyces* mushroom is used as a remedy to heal a sexually transmitted infection (STI) known as manasa, in the treatment of heart diseases, speeding up healing of the umbilical cords for the newly born babies, in the treatment of cancer-related diseases as well as kidney problems (**Table 2**). Only 5% of the participants from both constituencies indicated the that mushrooms were used in the treatment of cancer and kidney related diseases. Only 8% of the participants indicated that the *Termitomyces* mushrooms were used in the treatment of severe diarrhea while about 4% of the participants indicated that the *Termitomyces* mushrooms were used in the treatment of miscarriages.

A higher number of participant (66%) had no idea on the medicinal uses of *Termitomyces* (**Figure 5**). The results indicated that Judea-Lyabboroma and Katima rural areas have knowledge on the medicinal uses *Termitomyces* and have been using it to treat various diseases in their communities through various traditional methods. It is reported that some mushrooms including *Termitomyces* have been used as component in healing process, for example Kadhila (2019), reported that the Namibian *T. schimperi* contain mycochemicals such as reducing sugars, triterpenes, steroids, flavonoids and alkaloids which are chemical compounds that occur naturally in mushrooms and known for yielding important biological and medicinal trait. Therefore, the ethnomycology reported on these mushrooms are a result of the mycochemicals presence within them.

The study also revealed that *Termitomyces* mushrooms were used in various forms as medicine, such as in powder form or soaked in water. Twenty-three participants from Judea-Lyabboroma and 33 participants from Katima rural area indicated that they had no idea of the various forms in which the mushrooms were used as medicine as shown in table 2. In other words, 70% of the participants from both Judea-Lyabboroma and Katima rural areas had no idea (**Figure 6**). In addition, 11 participants from Judea-Lyabboroma and 2 participants from Katima rural making up 16% indicated that the fresh fruiting bodies of mushrooms are crushed, soaked in water, and then taken orally (**Table 2**). Additionally, 6 participants from Judea-Lyabboroma and 5 participants from Katima rural area making up 14% indicated that the *Termitomyces* mushrooms are dried and ground into powder, mixed with water, and then taken by drinking the mixture, or the powder could be added to any relish and eaten until healing occurred.

Findings from the study showed that majority participants in Judea-Lyabboroma indicated that they used the *Termitomyces* mushrooms by soaking it in water for medicinal use, and fewer people were recorded in Katima rural using the method of soaking in water. This indicates that all participants in both consistencies use *Termitomyces* mushrooms as medicine in dried powdered form and in a form where the fresh mushrooms are crushed and soaked in water or boiled in water. This indicates similarities in culture because they all used the same types of methods on how they consumed the *Termitomyces* mushrooms as medicine however there were more participants from Judea-Lyabboroma compared to Katima rural.

The study also found that in both constituencies, the *Termitomyces* mushrooms were used in form of powder for

medicinal use (Aryl and Budathoki, 2016). Moreover, in Judea-Lyabboroma the pseudorhiza of the *Termitomyces* mushroom are used to heal severe diarrhea when the mushroom is dried and mixed with certain leaves and roots of trees, then boiled in water for a few minutes and then drunk as medicine to cure diarrhea. It was also found that the pseudorhiza of the *Termitomyces* mushrooms is used to heal severe diarrhea in babies, by slicing and drying the pseudorhiza to make a chain that is placed around the baby's waist until the diarrhea is cured completely. The above statement is supported by Kamalebo *et al.* (2018) who stated that they might be a spiritual connection between people and wild fungi. Placing a chain made of the sliced pseudorhiza of *Termitomyces* around the waist of a baby to heal severe diarrhea was mentioned in Judea-Lyabboroma as an effective practice to treat the babies. The healing of severe diarrhea in both adults and babies is supported by (Aryl and Budathoki, 2016).

It can be clearly seen that these people might have gotten this knowledge from their forefathers and this clearly indicates cultural diversity and ethnomycological expertise which they have inherited from their extensive culture and traditions. It also indicates that these people have developed excellent ways of preserving their traditions and beliefs. In Katima rural it was revealed that the pseudorhiza of the *Termitomyces* mushrooms are used to heal miscarriages in pregnant ladies by boiling the pseudorhiza of the *Termitomyces* mushroom in water and allowing the pregnant mother who has been experiencing miscarriages to drink the syrup until when the baby is born. The pseudorhiza can be used to make the umbilical cord of a newly born baby heal faster. In the latter, the pseudorhiza is dried, powdered, and made into a paste that can be applied daily to the umbilical cord until it heals. In both constituencies, the pseudorhiza of the *Termitomyces* mushroom seemed to be an important part that is used in healing various diseases.

The findings from the study indicated that 11% of the participants in the study reported that it took between 1 to 2 days for someone to heal; followed by 10% who indicated that it took between 6 to 7 days to heal. However, very few 3% stressed that it took between 3 to 5 days for a patient to heal, as shown in figure 7. It was also observed that most of the participants in the study had no idea about how many days it would take for patients to take *Termitomyces* mushroom as medicine to heal from their ailment.

Figure 1: *Termitomyces* mushrooms harvested from Judea-Lyabboroma and Katima rural constituencies.

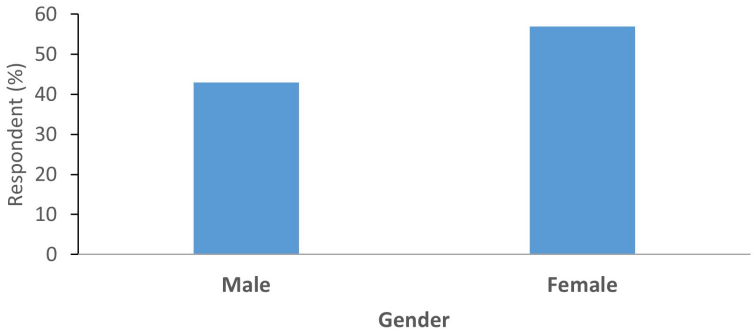

Figure 2: Gender of participants for included in the study.

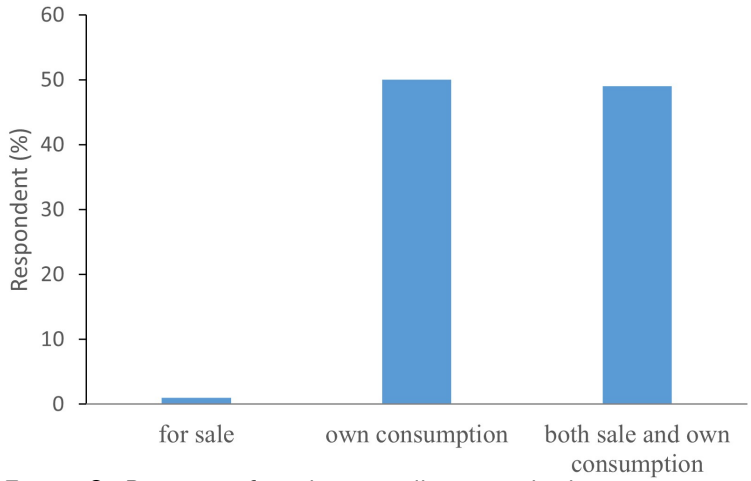

Figure 3: Purposes of mushroom collection in both constituencies.

The results obtained from combined analyses among the constituencies revealed that there were no significant differences between the purposes for collecting mushrooms with 50% for own consumption and 49% for both own consumptions and for sale respectively. In addition, it was observed that collecting mushrooms for selling was very low at (1%) (**Figure 3**).

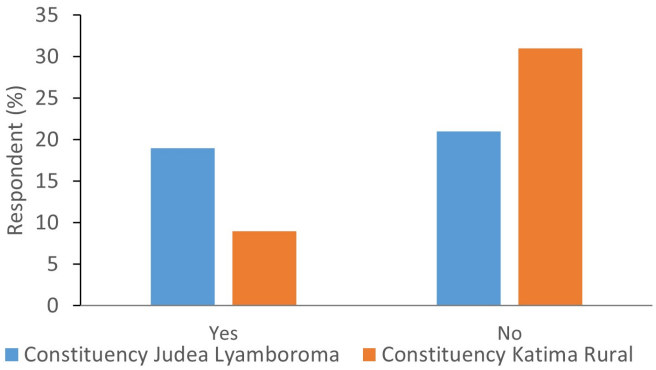

Figure 4: Uses of mushrooms for medicinal purposes.

Results from the study showed that there was a huge disparity in the numbers of participants between the two constituencies who used mushrooms for medicinal purposes as can be seen in **Figure 4**.

Ethnomycology for Termitomyces mushrooms

From these findings, it is evident that Termitomyces mushroom is used for healing purposes in general and the results presented in **Table 1**.

Table 1: Ethnomycology of *Termitomyces* mushrooms in each constituency (Judea-Lyabboroma and Katima rural).

Uses of mushrooms	Name of constituency	
	Judea-Lyabboroma	Katima rural
No idea	22	31
Preventing miscarriages	2	1
Healing severe diarrhea	11	3
Healing Sexually Transmitted Infections (STI) and heart diseases	1	0
Healing the umbilical cord of the baby	4	1
Healing cancer and kidney problems	0	4

Findings from the study unveiled that most of the participants in Katima rural included in the study had no idea on the ethnomycology for the mushroom in question while from Judea-Lyabboroma with few from Katima rural indicated that the *Termitomyces* were used for treating severe diarrhea, healing the umbilical cord of the baby, healing of cancer and kidney problems, treatment of miscarriages as well as that of STI and heart diseases. Results obtained on the composition of use for the *Termitomyces* are presented in **Figure 5**.

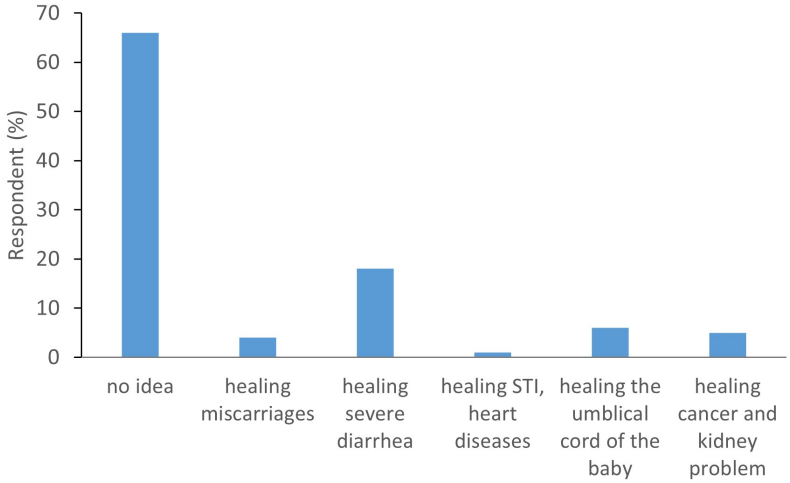

Figure 5: Uses of *Termitomyces* mushrooms in both constituencies.

Results from the study revealed that most of the participants (66%) had no idea about the uses of *Termitomyces* mushroom (**Figure 5**). Nevertheless, results indicated that among all the other uses of *Termitomyces* mushroom, its use in healing severe diarrhea was highest with 18%, followed by healing the umbilical cord of the newborn babies (6%), healing of cancer and kidney problems at (5%), preventing of miscarriages stands at (4%) and the least use at 1% on the healing of STIs and heart diseases (**Figure 5**).

Form of use and the number of days it takes before healing

Participants were requested to indicate the form in which they used the *Termitomyces* mushrooms, and the results obtained are presented in table 2 below.

Table 2: Various forms in which the *Termitomyces* mushrooms are used in different constituencies.

Form of use	Judea-Lyabboroma	Katima rural
No idea	23	33
Powder	6	5
Soaked in water	11	2

Table 2 Illustrates a distribution of results from the participants in regard to the form in which the mushroom is used. The results regarding the form in which the participants used *Termitomyces* mushroom in the entire region are presented in a pie chart (**Figure 6**).

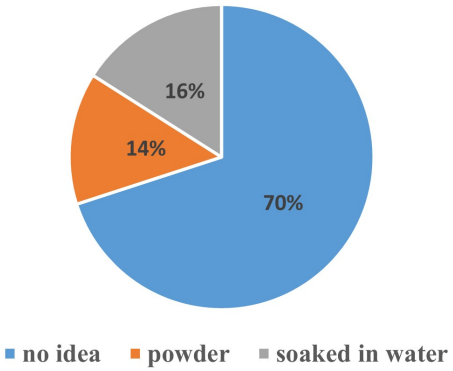

Figure 6: Various forms in which the *Termitomyces* mushrooms are used in different constituencies.

Where the study results indicate that the *Termitomyces* mushrooms are used for healing different diseases, participants were requested to indicate the days taken before a patient is healed. Results obtained are presented in **Figure 7**.

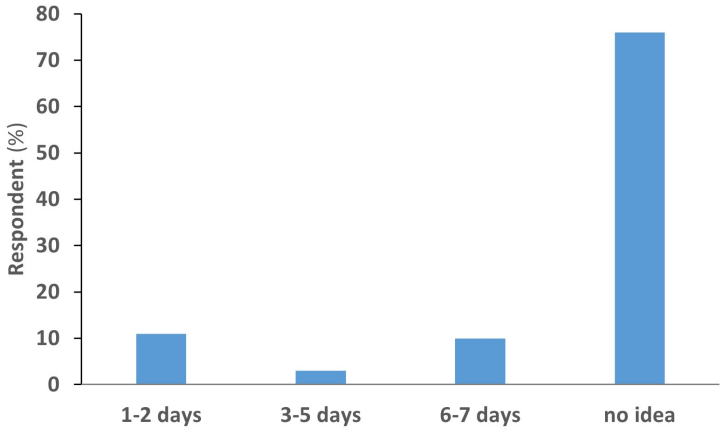

Figure 7: Number of days taken to healing after taking *Termitomyces* mushrooms as medicine. The longest days reported to take for one to get healed was 7 days.

4 Conclusion

The documentation of the traditional knowledge on wild mushrooms is vital for the application of appropriate management strategies, for the transmission of indigenous knowledge to new generations and for sustainable harvesting and conservation. This study filled the gaps in ethnomycological knowledge for *Termitomyces* mushroom in the Lyabboroma and Katima rural constituencies of Zambezi region in Namibia. The study revealed that the people living in the constituencies who were included in this study not only consume *Termitomyces* mushrooms but also use them for medicinal purposes to heal various forms of diseases as well as to generate income.

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