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Ethnobotanical study of medicinal plants used to manage HIV/AIDS opportunistic infections in Rungwe, Mbeya Region, Tanzania

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The current ethnobotanical study identified medicinal plant species used to manage HIV/AIDS opportunistic infections by the communities in Rungwe District, Tanzania. Data were collected using questionnaires (n=193), interviews (n=9) and field observations. A total of 31 plant species from 23 families are used in managing HIV/AIDS opportunistic infections. *Compositae* and *Rosaceae* were predominantly used in disease management by 15% each. Of the plant parts, leaves were the most used (44%), followed by roots (28%), bark (7%), fruits, seeds and stem (5%) while the least used plant parts were tubers (4%) and the whole (2%). Tuberculosis utilized 60% of the species, Herpes simplex 55%, chronic diarrhea 40%, oral candidiasis 35% and Herpes zoster 30%. *Dissotis phaeotricha* scored the highest fidelity value (73%), followed by *Berberis holstii* (60%). The knowledge on medicinal plants among respondents was influenced by; informal education ($p<0.01$), village location ($p<0.01$) and ethnic background ($p<0.05$). The study exposed the presence of reasonable knowledge of traditional medicinal plants among communities in Rungwe District. The results contribute to the conservation of experimental experiential knowledge of medicinal plants used in the management of HIV/AIDS opportunistic infections hence, shouldering world's efforts geared towards anti-HIV/AIDS innovations.

Key words: Ethnobotany, conservation, medicinal plants, traditional practitioner.

INTRODUCTION

Medicinal plant products constitute the largest percent of traditional medicine which anchors the lives of majority (Zhou, 2015). The reports by the world health organization (WHO) confirm that 80% of the world's population in developing countries rely on traditional medicine (WHO, 2013). The importance of traditional

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medicinal plants in people's welfare is opened for studies across the world.

According to Kisangau et al. (2007) and Bukuluki et al. (2014), 60% of the Tanzanians rely on traditional medicine for their primary health care. Generally, the use of medicinal plants has been reported to rise (Moshi et al., 2010; Ekor, 2014; Agisho et al., 2014). The reasons attributed to the trend include; constraints associated with the antiretroviral therapies (Chinsembu and Hedimbi, 2010), modern drug resistance in managing some diseases including HIV/AIDS opportunistic infections and conceived side effects of conventional medicine (Mustapha, 2014), the existing shortage of modern health personnel and stigma (Chinsembu, 2016; Denver et al., 2014).

The current reports by WHO and the United Nations AIDS (UNAIDS), cited by the Tanzanian national AIDS control programme (NACP), indicate that 36.7 million people across the world nations were living with HIV at the end of 2015, with 2.1 million new infections, and 1.1 million people died of HIV/AIDS opportunistic infections (NACP, 2016).

In general, morbidity and mortality among the people living with HIV/AIDS are connected to related infections (Yineger et al., 2007). In sub-Saharan Africa, the number of AIDS-related deaths was cut down by 39% in 2013, but, still there are many people (74%) who were reported to die from HIV/AIDS-opportunistic infections such as tuberculosis (TB), candidiasis, herpes simplex and herpes zoster (UNAIDS, 1998; Kisangau et al., 2011).

Runyoro et al. (2006), Kisangau et al. (2011), Magadula et al. (2014) and Omolo et al. (2014), conducted studies on medicinal plants which are used in managing HIV/AIDS opportunistic infections in Tanzania. The studies have revealed sound knowledge of plant species used by HIV/AIDS patients in managing opportunistic infections. However, most of the identified species varied among communities; the difference indicate the importance of considering the background of communities when studying knowledge about medicinal plants. Hence, this study was carried out to assess the knowledge of medicinal plants by communities in Rungwe District.

MATERIALS AND METHODS

Study area

Rungwe District is located between latitudes 08°30' and 09°30' south of the Equator and longitudes 33°00' and 34°00' east of the Greenwich Meridian (Figure 1).

Rungwe District (the highest altitudes of Rungwe and Poroto have attracted valuable forests for medicinal plant species) rises up between 770 and 2865 meters above sea level making it one of the mountainous districts in Tanzania. The district covers approximately 2 211 sq.km of which 75% is arable land. The cool climate due to high altitudes makes the district renown for higher rainfalls which favour evergreen thick vegetation which is a potential source of plant medicine. Moreover, the District is one of the densely populated areas in Tanzania recorded to have 371 451 people in 2015 with 168 per sq.km (Mbeya Region, 2016). One of the reasons for high population is the availability of plenty food. When not well managed, high population can have impacts on the utilization of resources including medicinal plants. The HIV/AIDS status of the District presumes for authentic source of data for the scientific documentation of medicinal plants often used in managing HIV/AIDS opportunistic infections. It is for this reason, Rungwe District was chosen. The District is recorded with HIV prevalence of 11% with 22 251 people living with HIV (UNAIDS, 2014; President's Emergency Plan for AIDS Relief in Tanzania, PEPFAR/T,2015).

Field survey

This study commenced with a desk review of literature followed by field work where a cross sectional design enabled data to be collected from representative population at a single point in time. Cross section designs are popular in collecting information related to practices, attitudes, knowledge and beliefs of a certain population (Mann, 2003; Carlson and Morrison, 2009).

The main respondents for this study involved people living with HIV/AIDS from seven purposively sampled villages located adjacent to Mount Rungwe Nature Reserve and Poroto Forest Reserve. The respondents were obtained through snowball techniques as these are effective in recruiting hidden populations such as the HIV patients (Voicu and Babonea, 2007; Barirega et al., 2012). A total of 193 people living with HIV/AIDS were interviewed after informed consents being obtained from respondents. Semi- structured questionnaires were used to gather quantitative data. The information collected included: commonly known plants used to manage HIV/AIDS OIs, specific infections treated, their local or common names, parts used and other related information. Similar information was collected from key informants.

Specimen identification

Preliminary identification of species was done in the field by using manuals and unidentified specimens were identified using herbarium materials, expert and taxonomic keys found in the volumes of the flora of Tanzania. The collected specimens with voucher numbers, family names, species and vernacular names, dates and collection sites were recorded and deposited at the University of Dar es Salaam herbarium.

Data analysis

The data were organised and analysed by using Microsoft Excel spreadsheet software, through which computations of proportions on plant species used, plant part (s) used and categories of infections managed were achieved.

Fidelity level

Of equal importance is the fidelity level (FL) which reveals quality, reliability or loyalty of the medicinal plant species. Through fidelity level calculations the relative healing ability of the identified medicinal plants is determined (Friedman et al.,1986). Studies that have adopted this approach include; Giday et al. (2010), Ugulu (2012), Abera (2014) and Parthiban et al. (2016). The fidelity level (FL) is defined as the ratio of the number of informants who independently suggested the use of a species for the same major purpose and the total number of informants who mentioned the plant for any other use. In the FL, *Np* is the number of informants

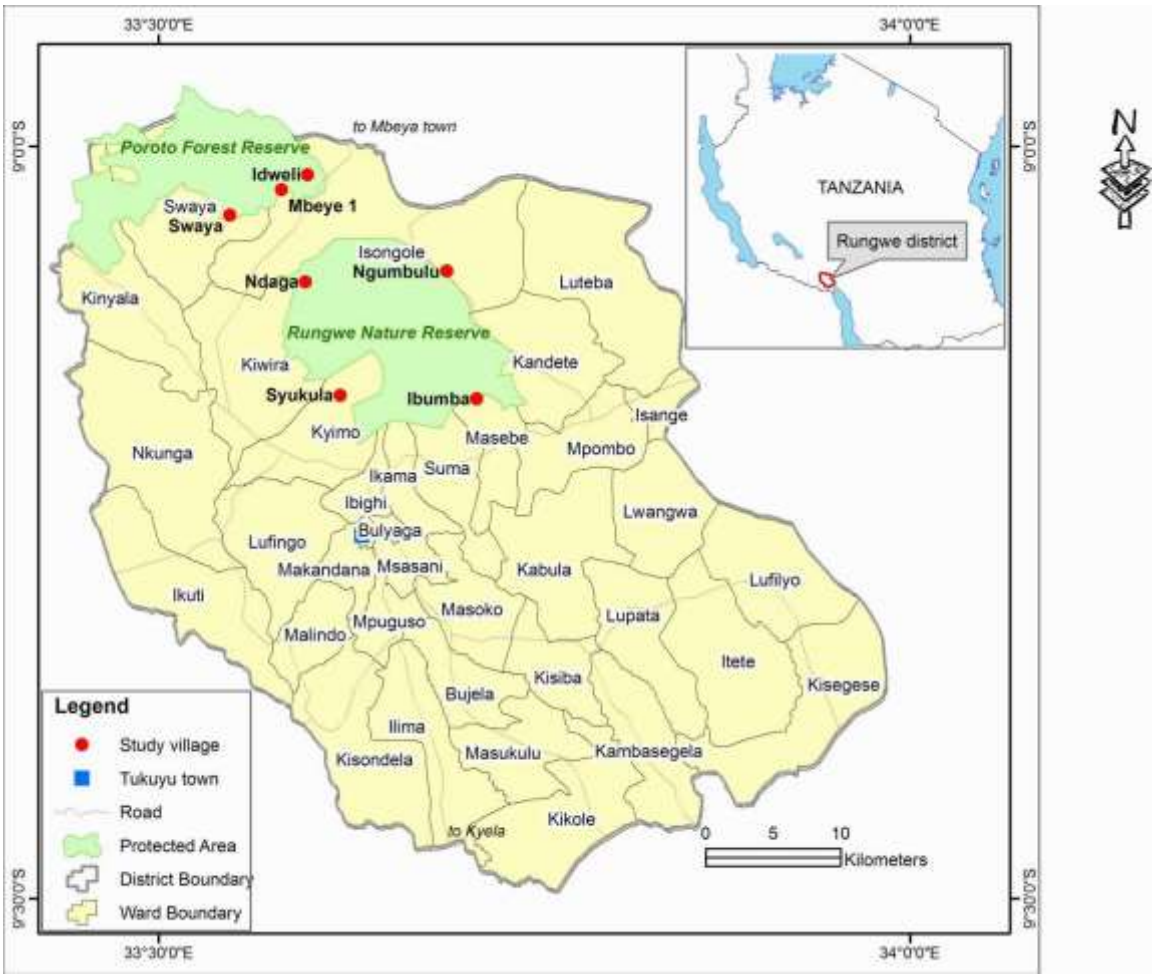

Figure 1. Map showing study villages adjacent to Rungwe Nature Reserve and Poroto Forest Reserve in Rungwe District, Tanzania.

who reported the use of a plant species to treat a particular disease, and *N* is the number of informants who used the plants as a medicine to treat any given disease (Friedman et al., 1986);

$$FL = \frac{Np}{N} \times 100$$

The highest FL (=100) indicates that a species manages the major disease equally with other ailments and vice versa.

Distribution of medicinal plants knowledge among the respondents

The collected ethnobotanical data with regards to distribution of medicinal plants knowledge based on socio-demographic characteristics were summarized using descriptive and inferential statistics. The presence or absence of significant differences among the variables was computed using the binary logit model because the dependent variables were categorical. The rationale for choosing this model relies on its suitability in cross-sectional data analysis as confirmed by Cramer (2003).

In the binary case, some event *Y* either occurs *(Y* =1) or not*(Y* =0). This model was specified as;

$$\ln(odds(highknowl = \ln(\frac{prob(highknowledge)}{prob(lowknowledge)}) \quad (1)$$

This model was modified from (Cox, 1958).

$$z = b_0 + b_1X_1 + bX_2 + \ldots\ldots + bX_k \quad (2)$$

Where z is the dependent variable or slope parameters and Xs are independent variables influencing z whereas bs are slope coefficients.

RESULTS

Identified medicinal plant species used to manage HIV/AIDS opportunistic infections

This study revealed a total of 31 plant species distributed among 23 families to be used for medicinal purposes particularly in managing HIV/AIDS opportunistic

infections in Rungwe District (Table 1). The mostly used families involved: Compositae and Rosaceae by 15% each. These were followed by Amaryllidaceae, Leguminosae, Musaceae and Myrtaceae by 10% each (Figure 2).

Some plant species have the ability to deal with multiple ailments, this study exposed four plants among the total identified medicinal plant species to be useful in managing four or more HIV/AIDS related conditions. The list includes; Conyza bonariensis (Compositae) which was mentioned to be potential in managing all six infections that were set as case studies in this study.
Those mentioned that deal with four ailments include *Berberis holstii* (Berberidaceae)*, Dissotis phaeotricha* (Melastomataceae) and *Myricia salicifolia* (Myricaceae). The fidelity values are given in Table 1.

With regards to plant parts extracted for medicine, the mostly used plant parts (s) were leaves (44%) and roots (28%). While bark (s) was used by 7%, fruits, seeds and stem were equally used at 5%. The least used plant parts found in this study were tubers and whole plant by 4% and 2% respectively (Figure 3). Moreover, the proportions of medicinal plant species which are known for managing specific HIV/AIDS opportunistic infections included: Tuberculosis (60%), Herpes simplex (50%), chronic cough (45%), chronic diarrhea (40%), Oral candidiasis (35%) and Herpes zoster (30%) (Figure 4).

DISCUSSION

HIV/AIDS is still a major health problem in Tanzania. Medical practitioners are struggling to invent a cure for the pandemic, but with little success, as a result, traditional medicine continues to gain popularity. The popularity attached to traditional medicinal plants especially in managing HIV/AIDS-related infections has prompted for this study which enabled documentation of plant species that are known to be useful in the management of the HIV/AIDS associated infections.

Considering plant families, Compositae and Rosaceae, Amaryllidaceae, Leguminosae, Musaceae and Myrtaceae were revealed as the most sources of medicinal plant species in managing HIV/AIDS opportunistic infections. The relative high uses of the surveyed species are attributed to their healing potentialities. Similar to this study, Kisangau et al. (2007) identified Myrtaceae as one of the predominant plant families used in managing HIV/AIDS opportunistic infections. Differently, Chinsembu and Hedimbi (2010) found Combretaceae, Anacardiaceae, Mimosaceae and Ebanaceae as the most used plant families in the management of the HIV/AIDS opportunistic infections. The difference demonstrated in plant families' use across areas signifies the reliance of medicinal plants on indigenous knowledge for identification. Indigenous knowledge is context based hence, extensive documentations of medicinal plant species is crucial.

The popular use of leaves and roots for medicine preparations correspond with the report by Chinsembu and Hedimbi (2010). Further, a more recent study in Zambia, confirms leaves being the most used plant parts in making medicine for managing HIV/AIDS opportunistic infections (Chinsembu, 2016). More studies with similar findings include: Giday et al. (2010), Otang et al. (2012) and Nankaya (2014). The relative high use of leaves could probably be due to the fact that they are easily to be found and collected over a long period of time. Moreover, people know that plucking leaves of the plant selectively ensures conservation of the plant. On the contrary, a conservation implication of the plants which the most used parts or the most extracted part (s) for medicines are their roots the sustainability of the plants remains uncertain.

With regards to tuberculosis consuming most of the plants indicates its prevalence among the HIV/AIDS patients in the study area. A close study by Kisangau et al. (2007) reported the highest percentage of plant species used to manage TB by Haya traditional practitioners. Other studies which revealed TB among the infections consuming largest percent of species include those of: Orwa et al. (2008), Singh et al. (2008), Gutiérrez et al. (2009), Amri and Kisangau (2012), Stackpole et al. (2013), Maana et al. (2014), Amuka et al. (2014), Gebeyehu et al. (2014),Cascaes et al. (2015) and Silva et al. (2015).

Moreover, Herpes simplex was managed by many plant species by communities in Rungwe District. For example *Ricinus communis* species is used in managing herpes simplex and studies elsewhere report its usage in managing body itchy (Agisho et al., 2014). Body itch can be related to herpes simplex. Chronic cough is another reported as common opportunistic infection among people living with HIV/AIDS. Similar to this study, there are evidences of some medicinal products found to manage chronic coughs, they involve; *Psidium guajava* (Chinsembu and Hedimbi, 2010) in Namibia, and *Myricia salicifolia* (Kariuki et al., 2014; Kigen et al., 2014) in Kenya.

Oral candidiasis was among the lowest in the list of opportunistic infections that was managed using few medicinal plants. The reason for few medicinal plant species use for oral candidiasis may imply that it is not common in the area and so the traditional practitioners have not been able to identify many species for the infection. Moreover, limited species that are known to manage herpes zoster as revealed in the study may be due to its complex features in relation to managements. As reported in other studies, *Aloe* species were frequently cited to be used in the purpose of managing the infection (Chinsembu and Hedimbi, 2010).

With regards to *Conyza bonariensis,* the plant contributes much in the health care as it was cited to be useful across all the cited HIV/AIDS opportunistic

Table 1. Traditional medicinal plants used in managing HIV/AIDS opportunistic infections.

Family	Scientific name	Local name	Part used	Infection managed	Fidelity Level	Voucher Number
Amaryllidaceae	*Allium sativum*	Kitungulu saumu	Tuber	Chronic cough, Tuberculosis	7.6	Not collected
	Allium cepa	Kitungulu	Tuber	Chronic cough	0.6	Not collected
Berberidaceae	*Berberis holstii*	Rungwe	Whole	Chronic diarrhea, Chronic cough, Herpes simplex, Tuberculosis	60.1	KMS-S64-2015
Caricaceae	*Carica papaya*	Mpapai	Leaves, Roots	Tuberculosis	0.6	Not collected
Compositae	*Conyza bonariensis*	Nzumba/ mbaluka	Leaves,Roots	Oral candidiasis, Chronic diarrhea, Chronic cough, Herpes zoster, Herpes simplex, Tuberculosis	30.1	KMS-S03-2015
	Vernonia adoensis	Ipasapasa	Leaves	Herpes zoster	3.5	KMS-S22-2015
	Bidens pilosa	Mitatila	Leaves	Herpes simplex	2.0	KMS-S02-2015
Convolvulaceae	*Ipomoea batata*	Mbatata	Leaves	oral candidiasis	0.6	Not collected
Cucurbitaceae	*Momordica foetida*	Nkungufya	Leaves, Roots	Chronic cough, Herpes simplex	2.7	KMS-S19-2015
Euphorbiaceae	*Ricinus communis*	Mijembajemba	Leaves, Seeds	Herpes simplex	0.6	KMS-S27-2015
Lamiaceae	*Geniosporum rotundifolium*	Nkulilo	Leaves	Herpes simplex	2.0	KMS-S33-2015
Lauraceae	*Persea americana*	Ntakapela	Leaves, Leaves, Barks	Tuberculosis	9.7	KMS-S31-2015
Leguminosae	*Vignaungu iculata*	Mbange	Roots	oral candidiasis	0.6	Not collected
	Erythrina abyssinica	Nsebhe	Barks	Herpes simplex	0.6	KMS-S28-2015
Melastomataceae	*Dissotis phaeotricha*	Kyumika	Leaves	Chronic diarrhea, Herpes zoster, Herpes simplex, Oral candidiasis,	73.4	KMS-S35-2015
Meliaceae	*Azadirachta indica*	Mwarobaini	Leaves, Roots, Seeds	Herpes zoster, Herpes simplex, Tuberculosis	5.6	Not collected
Musaceae	*Musa* spp.	Ndyali	Roots	Oral candidiasis	1.3	Not collected
	Ensete ventricosa	Ibhangalala	Pulp	Chronic diarrhea	1.3	Not collected
Myricaceae	*Myricia salicifolia*	Nsibhisibhi	Leaves,Roots	Oral candidiasis, Chronic diarrhea, Chronic cough, Tuberculosis	29.3	KMS-S08-2015
Myrtaceae	*Psidium guajava*	Ngajabi	Leaves	Chronic diarrhea, Chronic cough	40.5	KMS-S68-2015
	Eucalyptus maidenii	Ndongoti	Leaves, Roots, Barks	Chronic cough, Tuberculosis	14.6	KMS-S23-2015
Poaceae	*Bambuseae*	Ilasi	Roots	Oral candidiasis	0.6	Not collected
Polygonaceae	*Rumex usamberensis*	Nsemwasemwa	Leaves	Herpes zoster, Herpes simplex	5.6	KMS-S05-2015
Primulaceae	*Embelia schimperi*	Lisonzoko/ Lusonjogo	Stem	Chronic cough, Tuberculosis	2.0	KMS-S10-2015
Rosaceae	*Eriobotrya japonica*	Songwa	Leaves, Roots	Chronic diarrhea, Herpes zoster, Tuberculosis	46.1	KMS-S30-2015

Table 1. Contd.

	Hagenia abyssinica	Mtululunga/Ntululunga	Leaves, Roots,	Chronic diarrhea	2.0	KMS-S09-2015
	Prunus persica	Mfyulisi	Leaves, Roots	Chronic cough	0.6	KMS-S36-2015
Rutaceae	*Citrus limon*	Malalanji	Fruit	Chronic cough	5.6	Not collected
Verbenaceae	*Lippia javanica*	Lufiso	Leaves	Chronic diarrhea	13.9	KMS-S12-2015
Xanthorrhoeaceae	*Aloe* spp.	Alovera	Leaves	Herpes zoster, Herpessimplex, Tuberculosis	47.5	Not collected
Zingiberaceae	*Zingiber officinale*	Mbwigha	Stem	Oral candidiasis, Chronic cough,	40.5	Not collected

Not collected **=** species not collected in the field.

infections. The plant has a support in literature to indicate that a single plant species can be used to manage more than one infection. This is termed as broad spectrum use of the plant (Chinsembu and Hedimbi, 2010).

Generally, the respondents' recognition of most species in managing HIV/AIDS opportunistic infections for example, *Zingiber officinale* indicates importance of the species in disease management. Close related results were revealed in North-West Cameroon by Noumi and Manga (2011). Also, Sankaranarayanan et al. (2010) associated *Z. officinale* with chronic cough treatments and *P. guajava* reported in the present study has been acknowledged in literature to be historical potential in dealing with diarrhea cases elsewhere for example in Nigeria (Famuyide et al., 2013), diarrhea and tuberculosis (Kisangau et al., 2011), diarrhea (Hazarika et al., 2015). The fact that medicinal plants are being used for the same function by more than one community might be a sign of their pharmacological effectiveness (Giday et al., 2010).

The medicinal plants *Dissotis phaeotricha* (used against Chronic diarrhea), *Berberis holstii* (used against Tuberculosis) and *Aloe* spp. (used against skin related infections) indicated highest fidelity level values. According to Trotter and Logan (1986), plants which are used in some repetitive manner are more likely to be biologically active. *Berberis holstii* has been cited to be useful in managing various diseases (Maliwichi-Nyirenda et al., 2011; Srivastava et al., 2015). *Aloe* spp. have been reported for their miracles in healing various diseases in different areas (Verma et al., 2015).

Analytically, the knowledge on medicinal plants that manage HIV/AIDS opportunistic infections was independent of sex and age categories of a respondent. It was expected that the level of knowledge would vary among the respondents as it has been found in other studies such as Giday et al. (2010), but it was not the case in this study (Table 2). This could probably be because the interviewees fell under homogenous sample (HIV patients) hence they possess almost the same experience.

Likewise the level of knowledge on medicinal plants among the respondents does not depend on primary education because knowledge on medicinal plants is mostly obtained outside classroom. Therefore, ethnobotanical knowledge is normally acquired through experience verbally and traditionally, elders passing the knowledge to younger generation (Absolon, 2010).

Origin of people can have an impact on knowledge. For instance the Kinga for this case have less knowledge on the list of medicinal plants that manage opportunistic infections compared to the Nyakyusa. The difference was attributed by being not Rungwe natives rather immigrants from another part of the District. The same was found by Pouliot (2011) in her study. The likelihood of knowing medicinal plants that manage opportunistic infections for respondents in Ibumba village was high, but this was by chance because Ibumba is not the only village closest to the forest, rather there are other villages like Syukula and Ngumbulu which are found at the foot of the mountain forest. Chance events may have influence on knowledge of respondents as disclosed by Byg et al. (2010).

Conclusion

The community in Rungwe District is knowledgeable on ethnobotanical knowledge especially on those used to manage HIV/AIDS opportunistic infections. The people's knowledge was exhibited among other things, and their ability to identify multiple uses of medicinal plants which confirms broad-spectrum of antimicrobial agents of the species. The information by this study adds up to the existing ethnobotanical body of knowledge. Also, it forms a base for future discovery of novel drugs to fight HIV/AIDS related infections along with a need to prove safety and

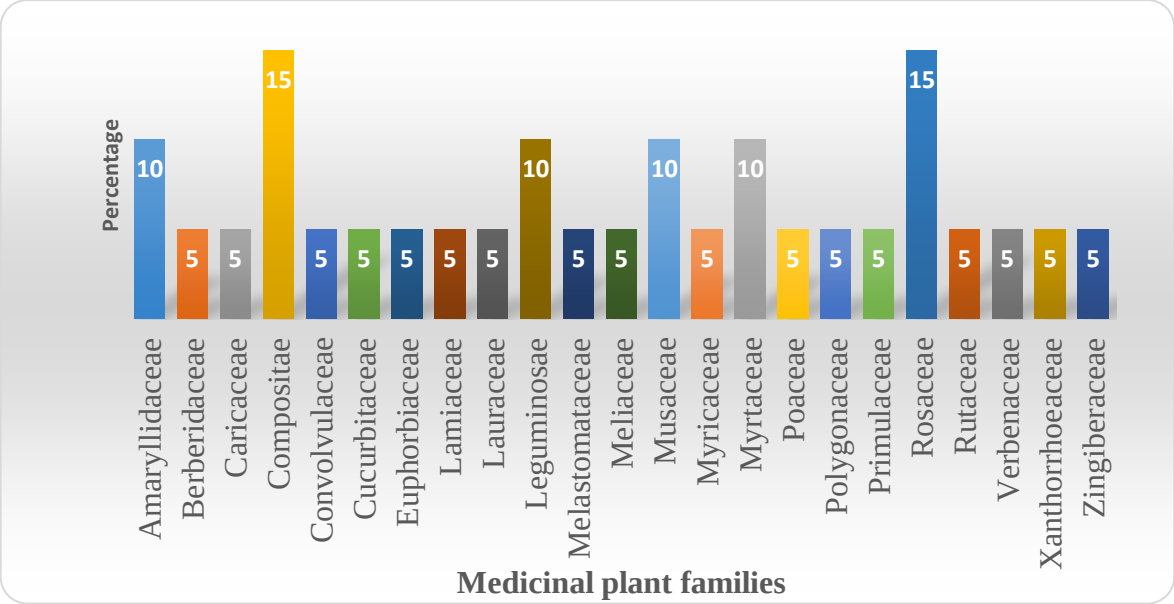

Figure 2. Percentage of plant families used in infections management.

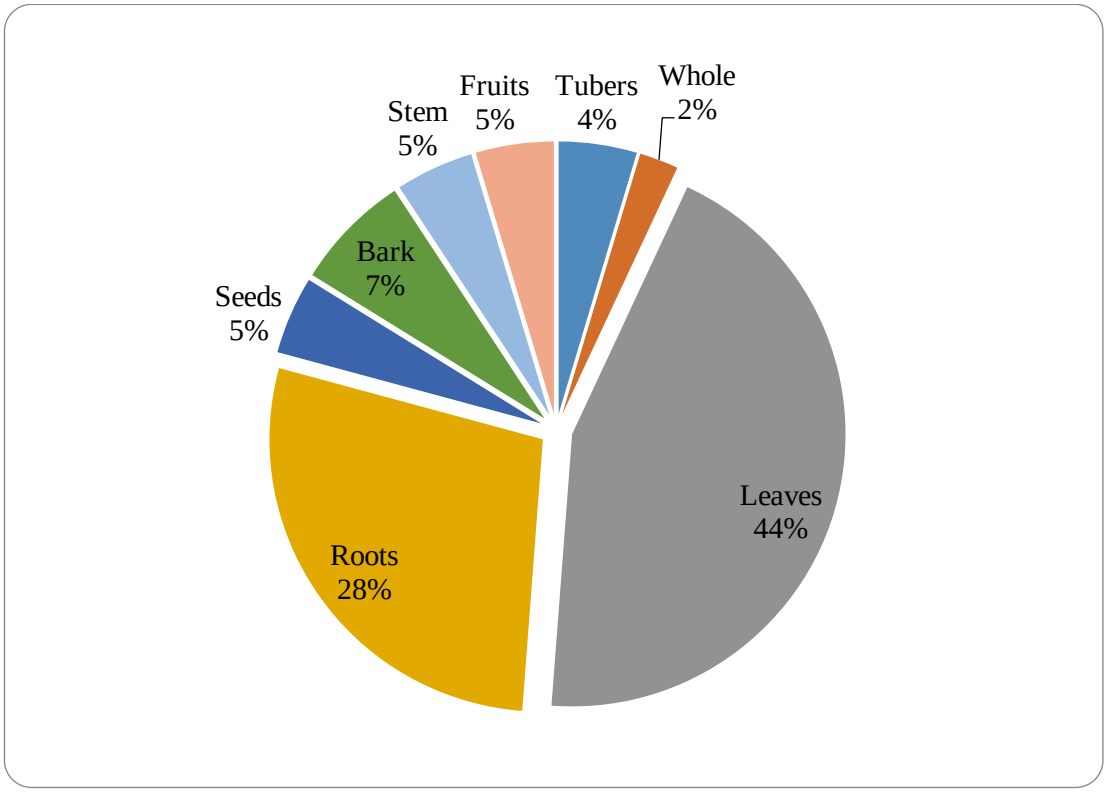

Figure 3. Plant parts used in disease management by percentage.

efficacy of medicinal plants hence, building confidence to medicinal plant users. The study recommends more studies on identification and documentation of species potential for managing HIV/AIDS opportunistic infections.

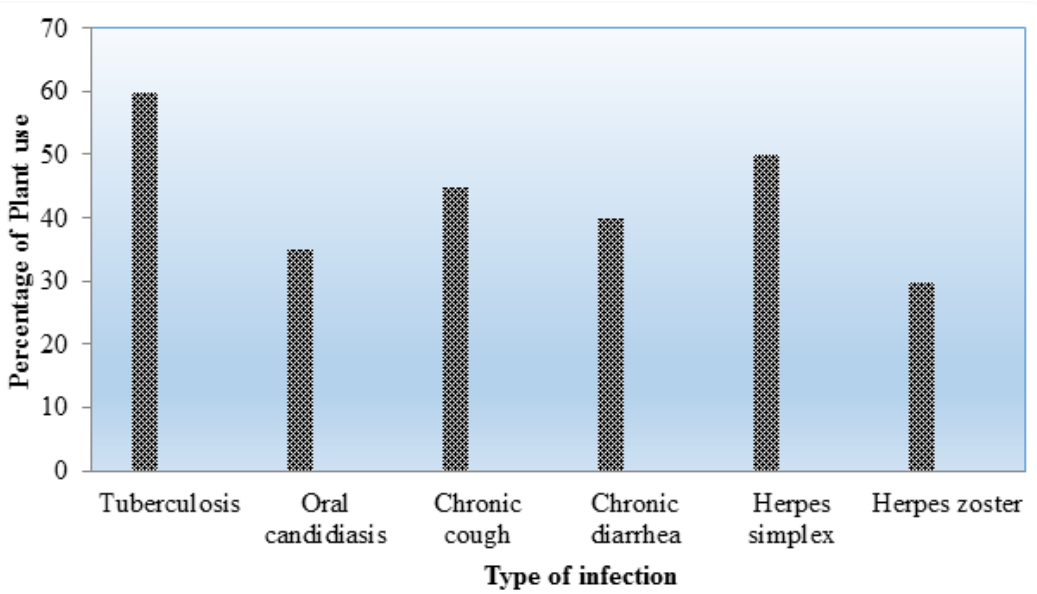

Figure 4. Percentage use of plants per infection.

Table 2. Influence of socio-demographic factors on ethnobotanical knowledge.

Chosen independent variable	Odd ratio	P-value
Sex	**0.76**	**0.34**
Education level		
2(Secondary)	1.07	0.89
3(Tertiary)	0.59	0.89
4(Informal)	3.29**	0.00
Ethnic background		
2(Safwa)	1.15	0.82
3(Nyamwanga)	2.49	0.55
4(Kinga)	0.03**	0.00
5(Malila)	1.18	0.76
Village location		
2 (Ibumba)	4.51**	0.00
3 (Ndaga)	5.04	0.11
4 (Ngumbulu)	2.64	0.52
5 (Mbeye1)	6.39	0.09
6 (Idweli)	4.21	0.17
Constant	0.52	0.09

*, **, *** Significant at 10, 5, 1% level of significance.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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