

*Full Length Research Paper*

# **Ethnomedical survey of plants used for the management of HIV and AIDS-related conditions in Mbulu District, Tanzania**

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**The aim of this Study was to document medicinal plants used in the management of HIV and AIDS-related conditions in Mbulu District. An ethnomedical survey was conducted using a semi-structured questionnaire. The main HIV and AIDS-related conditions considered during this study were; cough, frequent fevers, diarrhea, weight loss, oral thrush, genital warts, candidiasis, abscesses, skin rashes, shingles and venereal diseases. Literature survey was also carried out to compile supplementary data on ethnomedical used and pharmacological activities of the respective plants. Thirty seven plant species from 23 families were reported. The plant families with the highest number of documented species were Acanthaceae, Caesalpiaceae, Compositae and Verbanaceae with three species each. Literature information on the 37 reported plant species showed that, 23 plants could be linked to supporting data on ethnomedical uses, 23 were related to biological activity and 12 had been reported to display varying activities against HIV-1. Sixteen identified medicinal plants recorded new ethnomedical uses related to HIV and AIDS-related conditions, while 8 and 16% of the plant species did not have any previously reported ethnomedical uses or pharmacological activities, respectively.**

**Key words:** Medicinal plants, indigenous knowledge, HIV and AIDS-related conditions.

## **INTRODUCTION**

Due to advances in the development of highly active antiretroviral therapy (HAART), HIV/AIDS has become a

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manageable chronic condition. However, HIV infection is still a disease of public health concern which in 2018 accounted for 770 000 deaths globally (WHO, 2018). Among reported worldwide HIV cases, more than 70% are from Sub Saharan Africa. In Tanzania, the prevalence of HIV is about 5.1% and in 2017 it was estimated that 1.5 million people were living with HIV, 65 000 new infections were reported and a total of 32 000 AIDS-related deaths occurred (NBS, 2017; WHO, 2018).

The prevalence of HIV in Tanzania by regions ranges from 0% in some areas of Unguja and Pemba to 11.4% in Njombe region (NBS, 2017). Manyara Region is currently among regions with low prevalence of HIV in Tanzania mainland. However, in 2002, Manyara Region was among the two regions with the highest prevalence of HIV based on prevalence estimated among blood donors (Tanzania, 2002). At that time, the highest prevalence was noted in Kagera (18.6%), followed closely by Manyara (17.5%) and Iringa (14.1%) regions. In the same year, the prevalence among females by region was highest in Manyara (19.8%), followed by Dar es Salaam (18.9%) and Iringa (18.4%) (Tanzania, 2002). However, currently the prevalence of HIV in Manyara Region is significantly lower than the national HIV prevalence with the most recent prevalence of 1.5 % as per 2011-2012 HIV impact survey and 2.3% as per 2016-2017 HIV impact survey (NBS, 2017; Tanzania, 2011).

The World Health Organization (WHO) estimates that about three quarter of the population in some African countries still relies on medicinal plants for their primary health care (WHO, 2008). The great biodiversity in sub-Saharan Africa has provided the indigenous people with a range of plants that are used for traditional medicinal purposes. Mbulu District in Manyara Region is inhabited by people of different tribes, particularly Iraqw', Datooga and Hadzabe with reported use of herbal medicines for treatment and management of their health challenges (Patel and Mwamhanga, 2014; Qwarse et al., 2018). The Hadzabe are hunter-gatherers who live in the eastern rift valley in Northern Tanzania and for most of the time they have relied on natural resources (Marlowe, 2002). This remote area with poor infrastructure has not been extensively reached for the inventory of medicinal plants. The rural community is almost totally dependent on traditional medicine for their health care needs. It is therefore, reasonable to speculate that the use of alternative health seeking and coping strategies in Mbulu, including the use of herbal therapies, may have contributed to the progressive reduction of HIV/AIDS prevalence.

Despite the huge biodiversity and the history of use of medicinal plants in Manyara Region, to the best of our knowledge, no study has documented plants used for the management of HIV and AIDS-related conditions. Therefore, the purpose of this study was to identify medicinal plants used for the management of HIV and AIDS-related conditions and to compile supplementary

data on ethnomedical used and pharmacological activities of respective plants.

## MATERIALS AND METHODS

### Study area

Mbulu District is one amongst the six districts in Manyara Region, northeastern Tanzania (Figure 1), with an estimated population of 320 279, according to the latest Tanzania National Census of 2012 (NBS, 2013). The district is bordered to the north by the Arusha region and lake Eyasi, to the east by the Babati rural district, to the south by the Hanang district, and to the west by the Singida region. People of different ethnicities inhabit this district, particularly Iraqw' (also called the Wambulu) one of the earliest agro-pastoralists who migrated south from the region of Ethiopia to Tanzania. The other indigenous ethnic groups are the Hadzabe, living in Yaeda chini and the Datooga people. Local inhabitants engage mainly in agriculture, livestock keeping, farming activities and hunting. There are plantations of onions and wheat in many places of Manyara region which attract many business people from across the country and from neighboring countries. Seasonal open markets for livestock and the presence of the Haydom Lutheran hospital, which provides specialized medical care are among factors that attract people from other parts of the region and the country to visit the district.

### Study design

This was a qualitative ethnomedical survey conducted in May 2019. This study design was selected as it offers opportunity for a homogeneous exploration, raise more issues through broad and open-ended inquiry (Choy, 2014). The study employed a purposive sampling method in which selection of respondents only included THPs recognized by Health authorities in the office of Mbulu District Medical Officer (DMO). This was important to reduce the likelihood of interacting with fake or inexperienced THPs. Acknowledging the contribution of THPs in health care provision in Tanzania, the Ministry responsible for health is currently advocating registration of THPs through the offices of DMOs all over the country. The legitimacy of a THP is checked well before he/she is registered through the involvement of witnesses like neighbors, village and ward officials where the THP resides or has been practicing. During the conduct of this study, the coordinator from the office of the DMO responsible for the registration of THPs was engaged to locate the THPs, and kindly offered translation services when it was required.

### Data collection

The study employed face-to-face interviews to document ethnomedical information about plants used for management of selected disease conditions mainly HIV and AIDS-related conditions using a semi-structured questionnaire. A narrative of symptoms helped in listing plants used by the THPs to treat HIV/AIDS-related conditions. The first sections of the questionnaire sought to gather demographic information about the THPs, and the conditions that the THPs are confident of treating/managing. The other sections aimed at documenting plants that are used to manage conditions/symptoms of HIV and AIDS-related diseases including; tuberculosis, *Herpes zoster* infection (commonly known as "*mkanda wa jeshi*" in Kiswahili and characterized by a pruritic rash around the chest or stomach), persistent cough, cough associated with chest pain, skin rashes, frequent fevers, chronic diarrhea, chronic wounds, genital warts and wasting.

Other conditions/symptoms probed were oral candidiasis/oral thrush, which the THPs recognize as “*Utando wa mdomoni*” in Kiswahili language and vaginal candidiasis. Other information solicited by the questionnaire included the common/local names of the plants, parts used, methods of preparation, dosage, frequency and duration of treatment and side effects. The study also considered and documented plants used for treatment of pneumonia (presented in Kiswahili language by the THPs as “*Kichomi*”).

Collection of voucher specimen of the listed plant species was done with the THPs and a botanist, Mr Selemani Haji, of the Department of Botany, University of Dar es Salaam to avoid misidentification. The voucher specimens are kept in the Herbaria of the Institute of Traditional Medicine, Muhimbili University of Health and Allied Sciences (MUHAS) and Department of Botany, University of Dar es Salaam in Tanzania.

### Literature survey to support medicinal plant uses

Literature information on the collected medicinal plant species was compiled using different search engines including Google Scholar, Pubmed/Medline, Research Gate and Hinari. The plant's name was used in combination with different keywords such as, ethnomedical, ethnopharmacology, ethnobotany, HIV, AIDS, antimicrobial, antibacterial, antifungal, anti-HIV, tuberculosis, *Herpes zoster*, oral candidiasis, sexually transmitted infections, cough, skin rashes, fevers, diarrhea, wounds, warts, oral thrush, weight loss, vaginal candidiasis etc. In this review, only articles written in English language were considered. The review covered the ethnobotanical and ethnopharmacological literature from 1989 to 2019.

### Data analysis

Data were entered into Excel spreadsheet and summarized using descriptive statistics. The descriptive statistics were applied to identify the number and percentage of species, genera and families of medicinal plants. They were also applied to identify the percentage distribution of plant parts used and diseases treated by the identified medicinal plants. The graphs were plotted by GraphPad prism software version 8.

### Ethical approval and consent to participate

This study was awarded Ethical clearance by the MUHAS institutional review board (Ethical clearance No. 2018-04-04/AEC/Vol. XII/87; Dated, 4<sup>th</sup> April 2018). Permission to conduct the study in Mbulu District was sought from all government authorities from the district to village level. All THPs gave prior informed consent before they were interviewed.

## RESULTS

### Socio-demographic characteristics of the THPs

The study interviewed six THPs from Mbulu District. Four of them were males and two were females. Six different wards of Mbulu District were visited for the survey including Gidhim, Labay, Endamilay, Masqaroda, Yaeda chini and Haydom. The wards were chosen purposively based on the availability of THPs recognized by the coordinators from the office of DMO responsible for

handling matters related to THPs. The average age of the THPs interviewed was 61.3 ranging from 45 to 75 years. The average training time and experience of the study participants was 12.2 and 22.5 years respectively. Four of the six THPs reported to have gained their knowledge of traditional medicines from their parents and the remaining two reported to have learned from their fellow THPs and other people with previous knowledge on traditional medicines. Four of the THPs had an apprentice under them. The average number of patients attended by these THPs per month was 101 ranging from 4 to 360 patients. Five THPs reported to be attending patients coming from all over Tanzania. Details are summarized in Table 1.

### General conditions treated by THPs

THPs are diverse in their professional skills and are sometimes specialized. In order to gain an insight in the overall expertise all THPs participating in this study were asked to mention disease conditions which they generally treat. All six interviewed THPs reported to be able to treat at least one type of cancer. The majority stated also being capable of treating other conditions including gonorrhoea 5(83%), typhoid fever 5(83%) and syphilis 4 (67%).

### HIV and AIDS-related conditions encountered by THPs

Most of the interviewed THPs were aware of the common symptoms of HIV related conditions including tuberculosis and candidiasis. The THPs reported that they often encounter several common symptoms of HIV/AIDS-related conditions including persistent cough (50%), cough and chest pain (66.7%), frequent fevers (66.7%), diarrhea (66.7%), skin rashes (66.7%), oral thrush (66.7%), genital warts (66.7%) and vaginal candidiasis (83.3%). However, patients complaining of weight loss were rarely attended by these THPs (16.7%).

### Medicinal plant species documented

This study documented 37 plant species used in Mbulu for the management of a variety of human disease conditions, majority of which (81%) were for management of HIV and AIDS-related conditions (Figure 1). The plants represent 23 families and the families with the highest number of species documented were Acanthaceae, Caesalpinaceae, Compositae and Verbenaceae with 3 species each (Figure 2).

Out of the 37 reported plant species, 23 (62%) had related cited ethnomedical uses, 23 (62%) had scientifically proven related cited biological activity and 12 (32%) had been reported to have varying activities

**Table 1.** Characteristics of the interviewed THPs.

THPs	Gender	Age	Marital status	Ward	Place of birth (District)	Education level	Knowledge gained from	Training time	Duration of practice	Training others	Estimated number of patients served per month	Patients from	Type of patients
1	F	60	Married	Gidhim	Mbulu	No formal education	Mother	5	10	Yes	20	All over Tanzania	Children and adults
2	M	45	Married	Labai	Karatu	No formal education	THP	2	15	No	12	All over Tanzania	Children and adults
3	F	69	Married	Endamila	Babati	Primary education	Mother	20	30	Yes	150	All over Tanzania	Children and adults
4	M	75	Married	Maskaruda	Mbulu	Primary education	Father and others	6	21	Yes	4	All over Tanzania	Children and adults
5	M	60	Married	Yaeda chini	Mbulu	No formal education	Father	20	40	No	60	Manyara region	Children and adults
6	M	59	Married	Haydom	Babati	Primary education	Several people	20	19	Yes	360	All over Tanzania	Children and adults

against HIV-1 (Table 2), while 8 and 16% species did not have any previously reported ethnomedical uses or pharmacological activities, respectively. About 44% of the plant species recorded new ethnomedicinal uses related to HIV and AIDS-related conditions. Some of these plants include *Conyza pyrrhopappa* Sch. Bip. ex A.Rich for persistent cough, *Croton megalocarpus* Hutch for candidiasis, *Croton cheffleri* Pax for cough and STIs, *Embelia schimperi* Vatke for HIV and STIs, *Ensete ventricosum* (Welw.) Cheesman for genital warts, candidiasis, tuberculosis and STIs, *Hymenodictyon floribundum* (Hochst. & Steud.) B.I.Rob for vaginal candidiasis, *Justia subsessilis* Oliv for STIs, *Balanites aegyptica* (L.) Delile for chronic wounds, *Ozoroa insignis* Delile for gonorrhoea and *Teclea simpliciformis* Thonn for diarrhea.

#### Plant part used, dosage forms and routes of administration

The most frequently used plant parts by the THPs

were roots (58.1%) whereby 37.2% use root barks and 20.9% reported to use whole roots. The other plant part used is stem bark (23.3%) followed by leaves (11.6%) (Figure 3). The main method of preparation used by the THPs was decoction (52%), followed by dry powder (38.1%) (Figure 4). The methods of drug administration were oral application (81.1%) and topical application, mainly used for wounds and other skin infections (19.9%).

#### Disease conditions treated by the plants

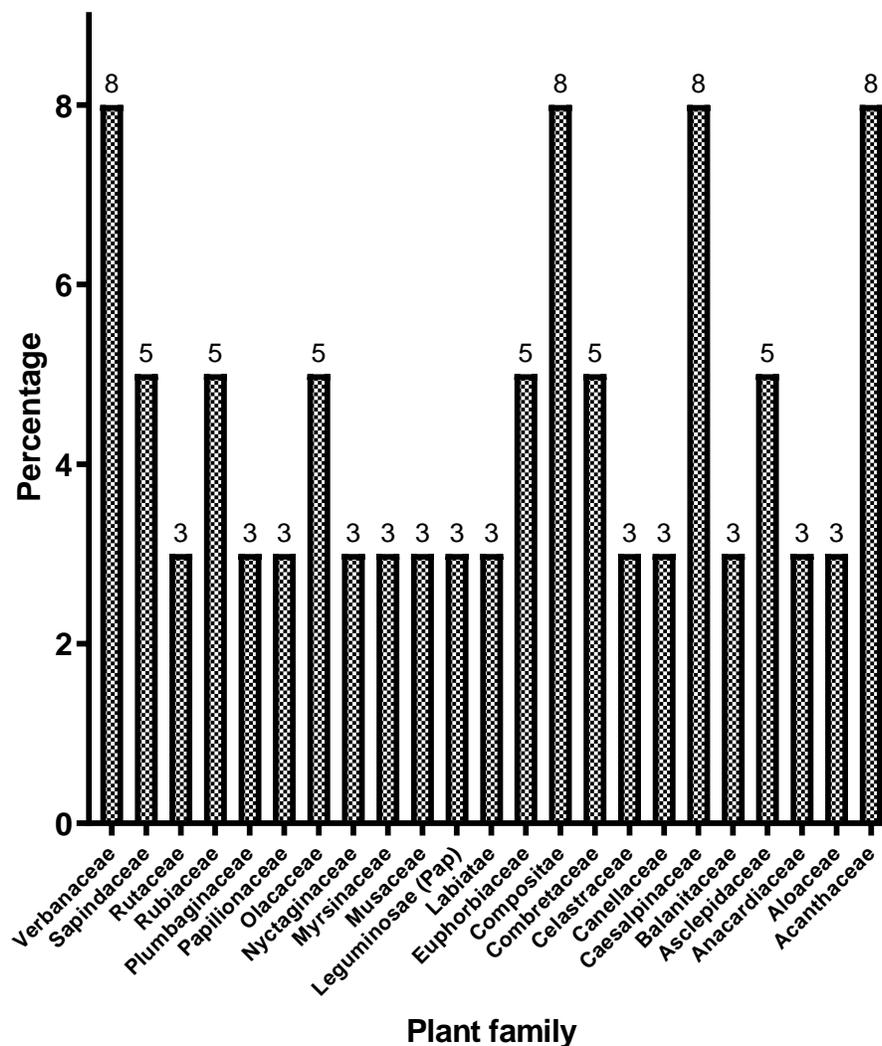
More than 20 different disease conditions are treated with the documented 37 plant species, including gonorrhoea (35%), syphilis (35%), cough (30%), chronic wounds (30%) and oral candidiasis (24%), (Figure 5). Fifty nine percent (59%) of the reported plant species were indicated for more than one conditions; *Elaeodendron buchananii* (Engl) Verdc and *Embelia schimperi* Vatke were indicated for five conditions, *Zanthoxylum*

*chalybeum* Engl was indicated for six conditions, *Ozoroa insignis* Delile and *Croton scheffleri* Pax were indicated for eight conditions, *Ximenia americana* L, *Ximenia caffra* Sond. and *Zanha africana* (Radlk) Exell were indicated for ten conditions and *Ensete ventricosum* (Welw.) Cheesman was indicated for twelve conditions.

#### DISCUSSION

The study reports 37 plant species which are used in the management of various conditions related to HIV/AIDS, of which 12 (32%) are previously reported to have anti-HIV activity, including *Balanites aegyptica* (L.) Delile, *Barleria eranthemoides* R.Br. ex C.B.Clarke, *Cassia abbreviata* subsp. *beareana* (Holmes) Brenan, *Erythrina abyssinica* DC, *Lippia javanica* L, *Pappea capensis* Eckl & Zeyh, *Plectranthus barbatus* Andrews, *Plumbago zeylanica* L, *Terminalia sericea* Burch. ex DC, *Warburgia ugandensis* Sprague, *Ximenia Americana* L and





**Figure 2.** Percentage distribution of families of the collected plants (N=37).

were also reported and collected which include *Cassia didymobotrya* and *Cassia singueana*. *C. didymobotrya* has been reported to have no anti-HIV activity as it failed to protect the MT-4 cells from HIV cytopathy measured by MTT (Cos et al., 2002). However, there are no reports on anti-HIV activity of the other plant *Cassia singueana*. In Mbulu, Tanzania, *C. abbreviata* is mixed with several other plants for treatment of diarrhea and some of these plants have been proven scientifically to have varying antimicrobial activities including anti-HIV-1 activity. These plants include *Elaeodendron buchananii*, *Ozoroa insignis*, *Ximenia americana* and *Zanha africana*. *Ximenia americana* has been reported to have ability to inhibit HIV-1 replication (Maroyi, 2014). Therefore, there is a need to test the individual plants and combinations to see if the combinations will have improved antimicrobial and/or anti-HIV activity.

High percentage of the reported plant species (62%)

had similar cited ethnomedical uses elsewhere and 62% have similar proven biological activities. All interviewed THPs in Mbulu reported to have ability to treat cancer and majority reported to be able to treat STIs (STIs), typhoid fever and brucellosis, diseases which are relevant in their area. Therefore, the results are indicative of how strong the THPs in Mbulu district are managing infections and cancers. This is supported by the big number of patients these THPs are receiving and attending per month. Some other reported plant species have not been screened for anti-HIV activity but some species from the same genus have been tested and found to have anti-HIV activity. A good example is *Vernonia glabra*, used in Mbulu for management of STIs and is confirmed to have weak antimalarial and antimicrobial activity (Frank, 2012; Kitonde et al., 2012; Ramadhani et al., 2015) but has no reports on anti-HIV activity. However, *Vernonia amygdalina* and *Vernonia*

**Table 2.** Plants used for management of selected conditions in Mbulu district, Manyara region.

Scientific name (voucher specimen number)	Family name	Vernacular name (tribe)	Uses	Part used	Method of preparation and use	Previous reported ethnomedical use	Pharmacological activities
<i>Aloe lateritia</i> Engl. (AIM-07)	<i>Aloaceae</i>	Ahhweri/ Awurmo (Iraqw')	Persistent cough	Roots	Dry powder mixed with porridge or tea	Leaves decoction is drunk or applied topically for fungal infections and also used against typhoid, wounds, and snakebites (Tanzania) (Hamza et al., 2006; Mbunde et al., 2017). Leaves are used for treatment of liver diseases, wounds, pneumonia and constipation (Rwanda) (Alphonse et al., 2010).	Toxic to brine shrimps (Moshi et al., 2007).
<i>Balanites aegyptiaca</i> (L.) Delile (AIM-25)	<i>Balanitaceae</i>	Putluputlu (Hadzabe)	Chronic wounds (Cancer), chronic abdominal ulcers	Roots	Decoction. One table spoonful is taken three times a day for three days.	Stem bark decoction is used in Tanzania for Cough and chest infections (Maregesi et al., 2007). In Uganda roots and leaves decoction is drunk for yellow fever (Tugume et al., 2016).	Anti-HIV/antiviral, antimicrobial, anticancer, wound-healing and anthelmintic properties (Chothani and Vaghasiya, 2011; Hussein et al., 1999; Kabbashi, 2015; Runyoro et al., 2006). An oral administration of the aqueous extract for the treatment of HIV patients has shown good results (Chothani and Vaghasiya, 2011).
<i>Barleria eranthemoides</i> R.Br. ex C.B.Clarke. (AIM-27)	<i>Acanthaceae</i>	Palangate (Hadzabe)	Fever (malaria)	Roots	Decoction. One tea cup is taken twice a day for two days.	In Tanzania root decoction or infusion of leaves is drunk for treatment of dysentery and it is very potent for several infectious diseases (Maregesi et al., 2007). In Ethiopia, it is used for wound healing and cancer (Bitew et al., 2019; Tuasha et al., 2018).	Methanol extract exhibited anti-HIV activity (Maregesi et al., 2010).
<i>Blepharis affinis</i> Lindau. (AIM-37)	<i>Acanthaceae</i>	Ngwilla (Hadzabe)	Frequent fevers, epilepsy	Roots	Decoction. One tea cup is taken twice a day until recovered.	No reports	No reports

Table 2. Contd.

<i>Cassia abbreviata</i> subsp. beareana (Holmes) Brenan. (AIM-33)	Caesalpinaceae	<i>Quarerei darma</i> (Iraqw')	Frequent fevers, all types of diarrhea	Root bark, stem bark	Dry powder is taken with water for treatment of frequent fevers. Mixed with <i>Ozoroa insignis</i> Delile. <i>Ximenia Americana</i> L. / <i>Ximenia caffra</i> Sond., <i>Elaeodendron buchananii</i> (Engl) Verdc. and <i>Zanha africana</i> (Radlk) Exell. for treatment of diarrhea.	Used in Zimbabwe for STIs (Kambizi and Afolayan, 2001), in Mozambique for eye infection, stomach ache, diarrhea, and malaria (Ribeiro et al., 2010). Used in Botswana for general cleansing, abdominal pain, womb problems, menstrual pains, and STIs (Leteane et al., 2012).	Anti-HIV activity (Leteane et al., 2012). It is reported to exhibit antimicrobial, antimalarial and anthelmintic activity (I, 2013; Shai et al., 2013)
<i>Cassia didymobotrya</i> Fresen (AIM-21)	Caesalpinaceae	<i>Qarerei aya</i> (Iraqw')	To induce vomiting before initiation of any treatment	Leaves, roots	Decoction	In Kenya leaves and roots are used for treatment of cancer, skin diseases, malaria, gonorrhea, ring worms, emetic, excess bile and as a purgative (Jeruto et al., 2008). In Rwanda it is used against ascariasis, and neuropsychopathy (Cos et al., 2002). In Tanzania it is used for treatment of anemia, as laxative and antihelmintic (Kamuhabwa et al., 2000).	It exhibited moderate cytotoxicity (Kamuhabwa et al., 2000) but had no anti-HIV activity (Cos et al., 2002). It also exhibited antimicrobial activity (Singh et al., 2010).
<i>Cassia singueana</i> Del (AIM-23)	Caesalpinaceae	<i>Gitalashayi</i> (Hadzabe)	Tape worm, Diabetes mellitus	Roots	Decoction. One cup is taken once per day for one day	In Zimbabwe it is used for treatment of STIs (Kambizi and Afolayan, 2001).	It is reported to have toxicity against brine shrimps LC50 of 11 µg/ml (Adoum, 2016).
<i>Clerodendrum myricoides</i> (Hochst.) R.Br. ex Vatke. (AIM-01)	Verbenaceae	<i>Tloqomo</i> (Iraqw')	STIs, chronic wounds (cancer)	Roots	Dry powder applied topically	Management of HIV/AIDS (Uganda) (Lamorde et al., 2010). Treatment of pneumonia and stomach ache (Kenya) (Radol et al., 2016). Constipation, hepatitis, syphilis (Rwanda) (Cos et al., 2002). Analgesic, management of fever, treatment of infections (Kamuhabwa et al., 2000).	No protection against HIV induced cytopathy (Cos et al., 2002). Cytotoxic (Kamuhabwa et al., 2000) but low cytotoxicity in plant from Rwanda (Cos et al., 2002). Strong activity against <i>Plasmodium berghei</i> (Deressa et al., 2010).

Table 2. Contd.

<i>Conyza pyrrhopappa</i> Sch.Bip. ex A.Rich. (AIM-04)	Compositae	Ankwey (Iraqw')	Persistent cough, frequent fevers	Leaves, roots	A decoction of the roots and infusion of the leaves are used for treatment of fevers. The infusion of the leaves with <i>Zanthoxylum chalebeum</i> Engl. leaves or roots is used for treatment of persistent cough.	Treatment of infections including STIs (Guinea) (Magassouba et al., 2010). Mixed with other plants in treatment of sores in infants (Tanzania) (Ramathal and Ngassapa, 2008). Used for treatment of diarrhea (Ethiopia) (Woldeab et al., 2018).	No reports
<i>Crassocephalum picridifolium</i> (DC.) S.Moore. (AIM-34)	Compositae	Amabei (Iraqw')	Boils	Roots	Dry powder infusion is drunk for treatment of boils	In Uganda it is used for management of weakness in pregnancy (Tugume et al., 2016)	No reports
<i>Croton megalocarpus</i> Hutch	Euphorbiaceae	Ailoi (Iraqw')	Sexually transmitted infections, vaginal candidiasis, brucellosis	Stem bark	Dry powder mixed with porridge or tea	It is used in Uganda for treatment of wounds (Njoroge and Bussmann, 2007). In Kenya the bark decoction is used for management of wounds and whooping cough (Peter et al., 2015). It is also used for syphilis, anthrax and snakebites (Kariuki et al., 2014).	Antibacterial activity (Kariuki et al., 2014).
<i>Croton scheffleri</i> Pax. (AIM-11)	Euphorbiaceae	Girgirimo/ Girgirimo Daat (Iraqw')	Gonorrhoea, syphilis, typhoid, brucella, mumps, tonsillitis, cough, urinary tract infections	Roots	Dry powder mixed with porridge or tea for treatment of tonsillitis, mumps and cough. Decoction used for treatment of gonorrhoea, syphilis, boils.	Used in Tanzania for treatment of fungal infections (Hamza et al., 2006).	High toxicity against brine shrimps (Moshi et al., 2007).
<i>Dregea macrantha</i> Klotzsch. (AIM-24)	Asclepidaceae	Tsamu (Iraqw')	Fungal infections with Tinea versicolor	Aerial parts	White sap from the fresh leaves and stem applied locally	No reports	No reports

Table 2. Contd.

<i>Elaeodendron buchananii</i> (Engl) Verdc (AIM-13)	Celastraceae	Gharma (Iraqw')	All types of diarrhea, oral thrush, genital warts, vaginal candidiasis, syphilis	Roots bark, stem bark	Dry powder can be applied topically for treatment of oral thrush, genital warts, vaginal candidiasis. It can be mixed with <i>Ozoroa insignis</i> Delile and taken orally for treatment of genital warts.	It is used in Kenya for treatment of microbial infections (Odak et al., 2018). Decoction used as aphrodisiac (Moshi et al., 2010).	Antibacterial and antifungal activities (Odak et al., 2018). Contains cytotoxic the compound elabunin (Kubo and Fukuhara, 1990).
<i>Embelia schimperi</i> Vatke. (AIM-30)	Myrsinaceae	Qaytla (Iraqw')	Helminthic infestation, Sexually transmitted infections, HIV, typhoid	Fruits, stem bark	Dry powder mixed with porridge and tea. Mixed with <i>Cassia singueana</i> Del. for treatment of tape worm infestation	Used in Tanzania to treat chronic cough, and tuberculosis (Thabeet et al., 2017) and tapeworm infestation (46). In Ethiopia it is used for treatment of leprosy, ascariasis and taeniasis (Giday et al., 2009).	Anti- Staphylococcal, anti-helminthic activity (Bogh et al., 1996; Debebe et al., 2015; Rondevaldova et al., 2015).
<i>Ensete ventricosum</i> (Welw.) Cheesman (AIM-36)	Musaceae	Ndizi pori (Swahili) Arwor do netlangw/ Arwir do netlangw (Iraqw)	Cough, tuberculosis, typhoid, brucellosis, skin rashes, oral thrush, vaginal candidiasis, wound, cancer, genital warts, diabetes mellitus, sexually transmitted infections	Seeds	Dry powder drunk with water or applied locally	In Ethiopia the roots are used for management of abdominal pain and diarrhea (Mesfin et al., 2009).	Antimicrobial and anti-nematodal activity (Tesfaye and Girma, 2017).
<i>Erythrina abyssinica</i> DC. (AIM-09)	Leguminosae (Pap)	Qanqari (Iraqw')	Sexually transmitted infections	Seeds	Dry powder applied locally	In Tanzania the stem bark and root decoction is used in dysentery and jaundice (Maregesi et al., 2007). In Uganda it is used in the management of HIV/AIDS-related conditions (Lamorde et al., 2010; Nyamukuru et al., 2017). In Rwanda it is used to treat dysentery (Maikere-Faniyo et al., 1989). In Zimbabwe it is used in the	It contains Anti-HIV-1 alkaloids (Mohammed et al., 2012)

Table 2. Contd.

<i>Hymenodictyon floribundum</i> (Hochst. & Steud.) B.L.Rob. (AIM-02)	Rubiaceae	Tsere (Iraqw')	Genital warts, vaginal candidiasis, cancers	Leaves/Stem bark	Dry powder applied locally and decoction drunk for treatment of diarrhea	treatment of STIs (Kambizi and Afolayan, 2001). In Ethiopia it is used for tonsillitis (Kebebew and Mohamed, 2017).	No reports
<i>Justicia subsessilis</i> Oliv. (AIM-35)	Acanthaceae	Tonganayi (Iraqw')	Sexually transmitted infections including gonorrhea. It is also used to manage anuria	Roots	One tea cup of decoction is taken before meal once a day for 3 days	It is used in Burundi for treatment of diarrheal diseases, leaves or aerial parts used for treatment of Skin mycosis, varicella, and dysentery (Ngezahayo et al., 2015; Ngezahayo et al., 2017).	Antimicrobial activity (Ngezahayo et al., 2017).
<i>Lippia javanica</i> L. (AIM-26)	Verbenaceae	Not provided	Pneumonia	Roots	Decoction	It is used in South Africa for treatment of cough, bronchitis, chest pain, asthma (South Africa) (Gail et al., 2015). Used as herbal tea, respiratory problems, GI problems, fever, malaria, insect repellent, wound, injuries, pain, skin infections (Maroyi, 2017).	Inhibition of HIV-1 reverse transcriptase enzyme by (E)-2(3)-tagetenone epoxide and piperitenone which are compounds from this plant (Mujovo et al., 2008). Antibacterial activity against <i>E. coli</i> and <i>S. aureus</i> (Manenzhe et al., 2004). The oil is also active against <i>Plasmodium falciparum</i> in micromolar concentrations (Manenzhe et al., 2004). Activity against <i>Entamoeba histolytica</i> (Samie et al., 2009).
<i>Mirabilis jalapa</i> L. (AIM-32)	Nyctaginaceae	Not provided	Wounds, ear infections	Seeds	Decoction applied locally	In Philippines it is used in the management of dermatological diseases	Antimicrobial activity against gram positive and gram negative bacteria, <i>Aspergillus niger</i> , <i>Fusarium solani</i> ,

Table 2. Contd.

<i>Ozoroa insignis</i> Delile (AIM-14)	Anacardiaceae	Makri (Iraqw')	Cough, diarrhea, genital warts, vaginal candidiasis, cancer, boils, gonorrhoea, syphilis	Root, bark	stem	Dry root bark powder is mixed with <i>Terminalia sericea</i> Burch. ex DC. stem bark for treatment of persistent cough. Dry powder is applied on genital warts. Root barks mixed with <i>Ximenia caffra</i> Sond. or <i>Ximenia Americana</i> L. roots, <i>Zanha Africana</i> (Radlk) Exell. roots and <i>Elaeodendron buchananii</i> (Engl) Verdc. stem bark/roots for treatment of diarrhea including dysentery	(Tantiado, 2012). It is used as antidiarrheal, carminative, detoxifier, digestive stimulant, diuretic, purgative, tonic, vermifuge. It is also used in wound healing and skin problems (Zachariah et al., 2011)	<i>Fusarium oxysporium</i> and <i>Fusarium granularium</i> (Hajji et al., 2010; Singh et al., 2010; Zachariah et al., 2011). Antiviral effect on the infectivity of potato virus (Vivanco, 1999).	
<i>Pappea capensis</i> Eckl & Zeyh. (AIM-06)	Sapindaceae	Getaquabay	Chronic wounds (Cancer)	Roots		Dry powder applied locally	Used in the management of diarrhea in South Africa (Semenya and Maroyi, 2012). Venereal diseases, painful eyes, aphrodisiac (Mulaudzi et al., 2011).	In Tanzania it is used in the management of skin rashes, Tuberculosis, Herpes simplex, Herpes zoster, Cryptococcal meningitis, Oral candidiasis, bilharzia (Kisangau et al., 2007; Moshi et al., 2009).	Very toxic to brine shrimps and cytotoxic to human hepatocellular carcinoma, human mammary adenocarcinoma and human hepatocellular carcinoma cells (Moshi et al., 2009; Rea, 2003) .
									Inhibition of HIV-1 reverse transcriptase and antimicrobial activities (Mulaudzi et al., 2011). Broad spectrum of activity against <i>Bacillus subtilis</i> , <i>Staphylococcus aureus</i> , <i>Escherichia coli</i> and <i>Candida albicans</i> (Pendota et al., 2017). Little or no cytotoxicity against Vero monkey kidney cells (Pendota et al., 2017).

Table 2. Contd.

<i>Pergularia daemia</i> (Forssk.) Chiov. (AIM-29)	<i>Asclepidaceae</i>	Tsamu (Iraqw')	Fungal infections with Tinea vesicolor	Aerial parts	White sap from the fresh leaves and stem applied locally	Used as anthelmintic, antiseptic, antivenin and also used for management of amenorrhea, diarrhea, asthma, whooping cough, wounds, bronchitis, and venereal diseases (Karthishwaran and Mirunalini, 2010).	Antifungal, antibacterial, and anticancer (Karthishwaran and Mirunalini, 2010).
<i>Plectranthus barbatus</i> Andrews. (AIM-08)	<i>Labiatae</i>	Hhonggay (Iraqw')	Genital warts	Roots	Dry powder is applied on the affected areas	In Tanzania it is used for treatment of oral candidiasis, Herpes zoster, Herpes simplex, skin rashes (Kisangau et al., 2007). It is also used to treat intestinal disturbance, liver disorders, respiratory disorders, heart diseases and nervous system disorders (Al Ashaal et al., 2010; Alasbahi and Melzig, 2010).	Inhibition of HIV-1 enzymes (120). Antibacterial activity against <i>S. aureus</i> , <i>P. aeureginosa</i> (Kisangau et al., 2007). Antifungal activity including anti-candida activity (Kisangau et al., 2007; Runyoro et al., 2006). Flavanoid extracted from <i>Plectranthus amboinicus</i> inhibit HIV-1 protease (Thayil and Thyagarajan, 2016).
<i>Plumbago zeylanica</i> L. (AIM-10)	<i>Plumbaginaceae</i>	Alaali (Iraqw')	Boils, cancer	Root barks	Dry powder mixed with porridge or tea. The powder can also be applied to the affected area locally	In Uganda it is used in the management of HIV/AIDS (Lamorde et al., 2010). Sexually transmitted infections, sores, external rashes, thrush, and herpes (Leteane et al., 2012). Management of diarrhea, hypercholesterolemia, abortifacient, anemia, loss of appetite, psoriasis and peptic ulcers (Yuvaraj, 2011)	Significant inhibition of HIV-1c (MJ4) replication (Leteane et al., 2012). Antiviral, antibacterial, antimycobacterial, anticancer and wound healing, activity (Gebremariam et al., 2006; Jain et al., 2014; Jeyachandran et al., 2009; Mossa et al., 2004).
<i>Pterocarpus angolensis</i> DC.	<i>Papilionaceae</i>	Tsere (Iraqw')	All types of diarrhea, chronic wounds	Stem bark	Dry powder is applied on the affected areas. Dry powder mixed with <i>Clerodendrum myricoides</i> (Hochst.) R.Br. ex Vatke. root powder for treatment of chronic wounds(cancers)	Used for treatment of cough in Namibia (Hedimbi and Chinsemu, 2012). Used for treatment genital illness in animals in South Africa (Luseba et al., 2007).	The plants contain compounds with reported antibacterial, antifungal and cytotoxic, activity (Abubakar and Majinda, 2016; Sigidi et al., 2016).

Table 2. Contd.

<i>Terminalia brownii</i> Fresen. (AIM-22)	Combretaceae	Sabamba (Hadzabe)	Pneumonia	Roots	Yellowish decoction	Used to treat diarrhea and other abdominal problems in Tanzania and in Congo it is used to treat urogenital infections, urethral pain, syphilis and gonorrhea (Mbwambo et al., 2007).	Antimicrobial activities against <i>Staphylococcus aureus</i> , <i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , <i>Klebsiella pneumoniae</i> , <i>Salmonella typhi</i> , and <i>Bacillus anthracis</i> and the fungi, <i>Candida albicans</i> , <i>Cryptococcus neoformans</i> etc mild cytotoxicity against brine shrimps (Mbwambo et al., 2007; Salih et al., 2017).
<i>Terminalia sericea</i> Burch. ex DC. (AIM-18)	Combretaceae	Ssohi (Iraqw')	Persistent cough, vomiting	Stem barks	Decoction mixed with decoction of <i>Ozoroa insignis</i> Delile root decoction for induction of vomiting just before initiation of treatment and mixed with <i>Zanha africana</i> (Radlk) Exell. stem bark decoction for treatment	Used for management of Diabetes, diarrhea and gonorrhoea in Tanzania (Moshi and Mbwambo, 2005). Used for treatment of sexually transmitted infections, measles, leprosy and wounds in South Africa (Chauke et al., 2015; Mongalo et al., 2016). In Namibia and Botswana it is used in management of meningitis, diarrhea, gonorrhoea, syphilis, stomach disorders and pneumonia (Chinsebu et al., 2015; Mukanganyama et al., 2011).	Strong HIV-1 reverse transcriptase enzyme inhibitory activity (Tshikalange et al., 2008). Antimycobacterial activity (Green et al., 2010; Mukanganyama et al., 2011). Have antibacterial activity against Gram-positive bacteria and antifungal activity against <i>Candida albicans</i> and <i>Aspergillus niger</i> and toxic on brine shrimps (Moshi and Mbwambo, 2005).
<i>Vernonia glabra</i> (Steetz) Vatke. (AIM-19)	Compositae	Afaxawi (Iraqw')	STIs, impotence	Roots	Dry powder or decoction	Review of the genus <i>Vernonia</i> have indicated a number of species which are widely reported to be used in the management of HIV infection including <i>Vernonia amygdalina</i> and <i>Vernonia adoensis</i> (Toyang and Verpoorte, 2013). Used in Tanzania for treatment of malaria (Ramadhani et al., 2015).	Antimicrobial activity (Frank, 2012; Kitonde et al., 2012). Some members from the same genus have been reported to have anti-HIV-1 activity (Toyang and Verpoorte, 2013). Weak antiplasmodial activity (Ramadhani et al., 2015).

Table 2. Contd.

<i>Ximenia americana</i> L. (AIM-20)	<i>Olacaceae</i>	Maayangu (Iraqw')	All types of diarrhea, STIs, vaginal candidiasis, brucellosis, typhoid, cancer, persistent cough, tuberculosis, cough with chest pain, oral thrush, genital warts, diabetes mellitus	Root bark	Decoction	Used in the treatment of gonorrhea and candidiasis in Namibia (Chinsemu, 2010; Hedimbi and Chinsemu, 2012). Used for treatment of diarrhea in South Africa (Semenya and Maroyi, 2012). It is used as antiabortifacient, and in the treatment of HIV/AIDS, menstrual cycle irregularities, stabbing heart, stomach ache, wounds in Mozambique (Ribeiro et al., 2010).	Inhibits HIV-1 replication (Maroyi, 2014). Methanolic root extract exhibited antimicrobial activity (James et al., 2007).
<i>Ximenia caffra</i> Sond. (AIM-15)	<i>Olacaceae</i>	Maayangu (Iraqw')	All types of diarrhea, STIs, vaginal candidiasis, brucellosis, typhoid, cancer, persistent cough, TB, cough with chest pain, oral thrush, genital warts, diabetes mellitus	Root bark	Decoction	Treatment of gonorrhea in Namibia (Hedimbi and Chinsemu, 2012), diabetes mellitus, sexually transmitted infections, eye aches, bilharzias in South Africa (Chauke et al., 2015). Diarrhea, dysentery, fever, cough and venereal diseases (98). Used for treatment of STIs in Zimbabwe (Kambizi and Afolayan, 2001). Treatment of thrush, herpes, STIs in Botswana (Leteane et al., 2012).	Inhibition of HIV-1 reverse transcriptase enzyme activity and varying antimicrobial activities (Mulaudzi et al., 2011). Weak anti- <i>Mycobacterium tuberculosis</i> activity (Green et al., 2010). Weak inhibition of HIV-1c replication measured by quantification of p24 antigen levels (Leteane et al., 2012). Antigonococcal activity (Nair et al., 2013).
<i>Zanha africana</i> (Radlk) Exell. (AIM-12)	<i>Sapindaceae</i>	Daalusamo (Iraqw')	Tuberculosis, asthma, persistent cough, all types of diarrhea, skin rashes, boils, sexually transmitted infections, typhoid, brucellosis, oral thrush, vaginal candidiasis, genital warts	Stem roots	barks, Dry powder mixed with porridge or tea	Treatment of tuberculosis in Tanzania (Augustino and Gillah, 2005). Treatment of STIs in Zimbabwe (Hedimbi and Chinsemu, 2012).	Significant inhibition against Gram-positive and Gram-negative bacteria (Kambizi and Afolayan, 2001). Antifungal activities (Runyoro et al., 2006).

Table 2. Contd.

<i>Zanthoxylum chalybeum</i> (AIM-16, AIM-03)	Engl.	Rutaceae	Marongi (Iraqw')	Persistent cough, Frequent fevers, UTI, gonorrhea, typhoid, brucellosis, tonsillitis	Roots, leaves, stem bark	Mixed with <i>Conyza pyrrhopappa</i> Sch.Bip. ex A.Rich leaves or roots and decoction used for treatment of persistent cough. Stem bark powder mixed with porridge for management of frequent fevers.	STIs (Tshikalange et al., 2008). Treatment of malaria in Kenya (Kiraithe et al., 2016).	Anti-HIV activity from a plant of the same genus <i>Zanthoxylum davyi</i> (Tshikalange et al., 2008). In-vitro antimycobacterial activity against <i>M. madagascariense</i> and <i>M. indicus pranii</i> (Chrian et al., 2011). Antimalarial activity comparable to chloroquine (Kiraithe et al., 2016).
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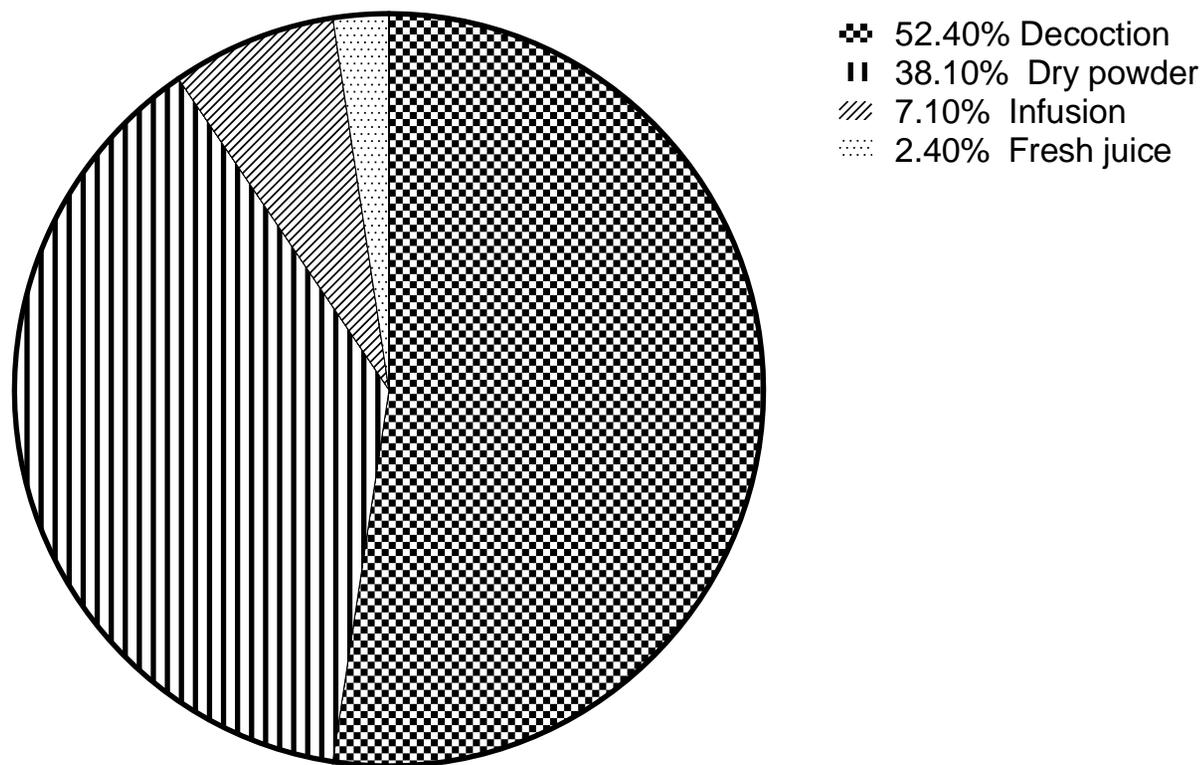


Figure 3. Percentage of method of preparation used.

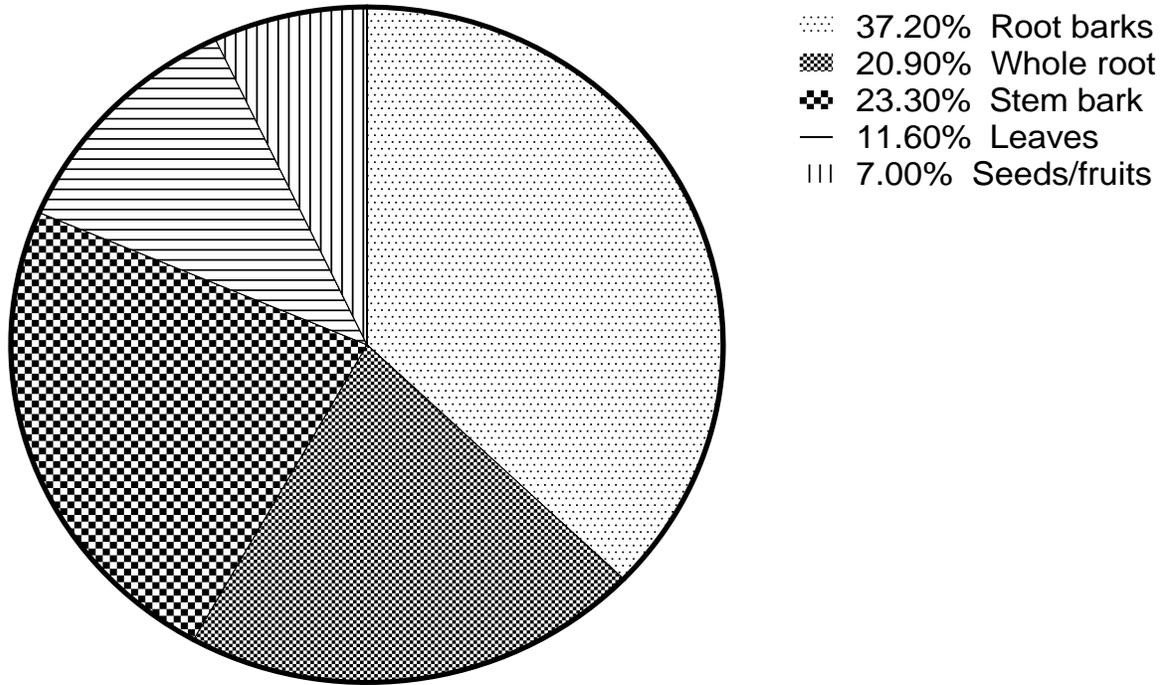


Figure 4. Percentage of plant parts used.

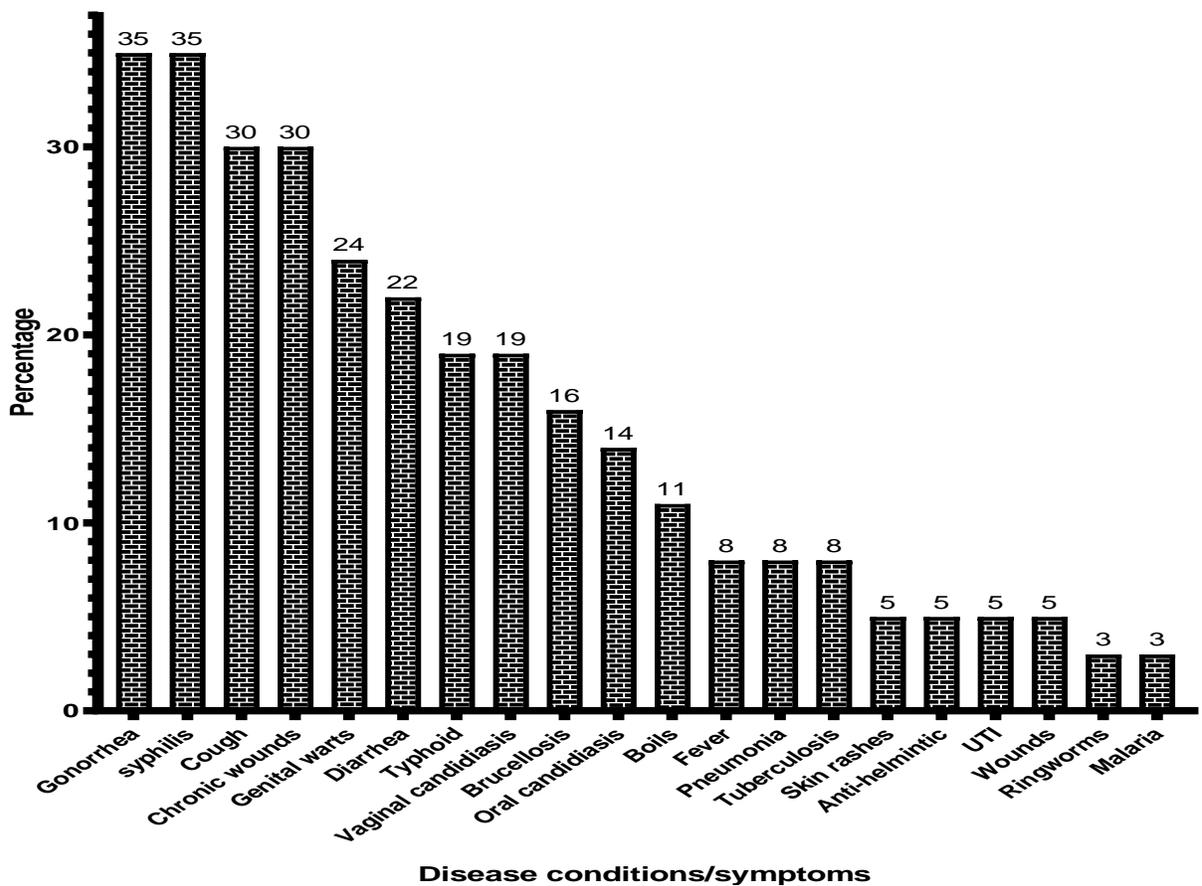


Figure 5. Percentage use of plants to treat disease conditions (N=37).

*adoensis* from the same genus have been reported to have anti-HIV-1 activity (Toyang and Verpoorte, 2013). Another plant is *Terminalia brownii* which is used in Mbulu for treatment of pneumonia. The plant is proven to have antimicrobial activity against a big number of microorganisms (Machumi et al., 2013; Salih et al., 2017). However, the plant has not been tested for anti-HIV activity but *Terminalia sericea* from the same genus has been reported to have strong HIV-1 reverse transcriptase inhibitory activity (Tshikalange et al., 2008). *Zanthoxylum chalybeum*, used for various infections in Mbulu and elsewhere, has no reports on anti-HIV activity while *Zanthoxylum davyi*, a member of the same genus, has anti-HIV activity (Tshikalange et al., 2008). In Mbulu the plant in some cases is combined with *Conyza pyrropapp* leaves or roots for treatment of persistent cough and therefore, the plant and the combination are worthy of screening for antimicrobial, anti-HIV and antimycobacterial activity. Despite the previous reported ethnomedicinal uses of some of the reported plants, reports on clinical evaluation of the patients who were treated with these plants are lacking. To support the traditional uses of these plants clinical evaluation in patients is important.

## Conclusion

This survey identified sixteen medicinal plants with new ethnomedicinal uses related to HIV and AIDS conditions. Ten of the documented plants had no reported biological reports related to HIV and AIDS-related conditions. Reports from the literature provide a strong support to the traditional medicinal use practices of Mbulu THPs for the management of HIV and AIDS-related conditions. Although the results of this study are consistent with ethnomedicinal and antimicrobial data from the literature, more studies are needed to validate the antimicrobial efficacies, pharmacological, cytotoxicity, and active phytochemicals in the plants.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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## REFERENCES

- Abubakar MN, Majinda RRT (2016). GC-MS Analysis and Preliminary Antimicrobial Activity of *Albizia adianthifolia* (Schumacher) and *Pterocarpus angolensis* (DC). *Medicines* 3(1):3.
- Adoum OA (2016). Screening of medicinal plants native to Kano & Jigawa states of northern Nigeria, using *Artemia* cysts (Brine Shrimp Test). *American Journal of Pharmacological Sciences* 4:7-10.
- Al Ashaal HA, Farghaly AA, Abd El Aziz MM, Ali MA (2010). Phytochemical investigation and medicinal evaluation of fixed oil of *Balanites aegyptiaca* fruits (Balantiaceae). *Journal of ethnopharmacology* 127:495-501.
- Alasbahi RH, Melzig MF (2010). *Plectranthus barbatus*: a review of phytochemistry, ethnobotanical uses and pharmacology - Part 1. *Planta medica* 76:653-661.
- Alphonse N, Bigendako M, Fawcett K, Yansheng G (2010). Ethnobotanical study around Volcanoes National Park, Rwanda. *New York Science Journal* 3:5.
- Aasiimwe S, Kamatenesi-Mugisha M, Namutebi A, Borg-Karlsson AK, Musiimenta P (2013). Ethnobotanical study of nutri-medicinal plants used for the management of HIV/AIDS opportunistic ailments among the local communities of western Uganda. *Journal of Ethnopharmacol* 150:639-648.
- Augustino S, Gillah PR (2005). Medicinal plants in urban districts of Tanzania: plants, gender roles and sustainable use. *International Forestry Review* 7:44-58.
- Bitew H, Gebregergs H, Tuem KB, Yeshak MY (2019). Ethiopian medicinal plants traditionally used for wound treatment: A systematic review. *Ethiopian Journal of Health Development* 33(2).
- Bogh HO, Andreassen J, Lemmich J (1996). Anthelmintic usage of extracts of *Embelia schimperi* from Tanzania. *Journal of Ethnopharmacology* 50:35-42.
- Chauke MA, Shai LJ, Mogale MA, Tshisikhawe MP, Mokgotho MP (2015). Medicinal plant use of villagers in the Mopani district, Limpopo province, South Africa. *African Journal of Traditional, Complementary and Alternative Medicines* 12(3):9-26.
- Chinsebu KC (2010). An ethnobotanical survey of plants used to manage HIV/AIDS opportunistic infections in Katima Mulilo, Caprivi region, Namibia. *Journal of Ethnobiology and Ethnomedicine* 6(1):25.
- Chinsebu KC, Hjarunguru A, Mbangi A (2015). Ethnomedicinal plants used by traditional healers in the management of HIV/AIDS opportunistic diseases in Rundu, Kavango East Region, Namibia. *South African Journal of Botany* 100:33-42.
- Chothani DL, Vaghasiya HU (2011). A review on *Balanites aegyptiaca* Del (desert date): phytochemical constituents, traditional uses, and pharmacological activity. *Pharmacognosy Reviews* 5:55-62.
- Choy LT (2014). The strengths and weaknesses of research methodology: Comparison and complimentary between qualitative and quantitative approaches. *IOSR Journal of Humanities and Social Science* 19:99-104.
- Chrían M, Erasto P, Otieno J (2011). Antimycobacterial activity and cytotoxicity effect of extracts of *Hallea rubrostipulata* and *Zanthoxylum chalybeum*. *Spatula* 1(3):147-152.
- Cos P, Hermans N, De Bruyne T, Apers S, Sindambiwe JB, Witvrouw M, De Clercq E, Vanden BD, Pieters L, Vlietinck AJ (2002). Antiviral activity of Rwandan medicinal plants against human immunodeficiency virus type-1 (HIV-1). *Phytomedicine* 9:62-68.
- Debebe Y, Tefera M, Mekonnen W, Abebe D, Woldekidan S, Abebe A, Belete Y, Menberu T, Belayneh B, Tesfaye B, Nasir I, Yirsaw K, Basha H, Dawit A, Debella A (2015). Evaluation of anthelmintic potential of the Ethiopian medicinal plant *Embelia schimperi* Vatke in vivo and in vitro against some intestinal parasites. *BMC Complementary and Alternative Medicine* 15:187.
- Deressa T, Mekonnen Y, Anmut A (2010). In Vivo anti-malarial activities of *Clerodendrum myricoides*, *Dodonaea angustifolia* and *Aloe debrana* against *Plasmodium berghei*. *Ethiopian Journal of Health Development* 24(1).
- Fernandes NAF, Canelo LIN, Mendonça DD, Mendonça AD (2015). Acetylcholinesterase Inhibitory Activity of Extracts from Angolan Medicinal Plants. *International Journal of Pharmacognosy and Phytochemical Research* 7:768-776.
- Frank N (2012). Evaluation of Malawian *Vernonia glabra* (Steetz) Vatke

- leaf and *Securidaca longepedunculata* (Fresen) root extracts for antimicrobial activities. *Journal of Applied Pharmaceutical Science* 2(11):26.
- Gail H, Tarryn B, Oluwaseyi A, Denver D, Oluchi M, Charlotte VK, Joop de J, Diana G (2015). An ethnobotanical survey of medicinal plants used by traditional health practitioners to manage HIV and its related opportunistic infections in Mpoza, Eastern Cape Province, South Africa. *Journal of Ethnopharmacology* 171:109-115.
- Ganapaty S, Vidyadhar K (2005). Phytoconstituents and biological activities of *Vitex*-a review. *Journal of Natural Remedies* 5:75-95.
- Gebre-Mariam T, Neubert R, Schmidt PC, Wutzler P, Schmidtke M (2006). Antiviral activities of some Ethiopian medicinal plants used for the treatment of dermatological disorders. *Journal of Ethnopharmacology* 104:182-187.
- Giday M, Asfaw Z, Woldu Z (2009). Medicinal plants of the Meinit ethnic group of Ethiopia: an ethnobotanical study. *Journal of Ethnopharmacology* 124:513-521.
- Green E, Samie A, Obi CL, Bessong PO, Ndip RN (2010). Inhibitory properties of selected South African medicinal plants against *Mycobacterium tuberculosis*. *Journal of Ethnopharmacology* 130:151-157.
- Hajji M, Jarraya R, Lassoued I, Masmoudi O, Damak M, Nasri M (2010). GC/MS and LC/MS analysis, and antioxidant and antimicrobial activities of various solvent extracts from *Mirabilis jalapa* tubers. *Process Biochemistry* 45:1486-1493.
- Hamza OJ, van den Bout-van den Beukel CJ, Matee MI, Moshi MJ, Mikx FH, Selemani HO, Mbwambo ZH, Van der Ven AJ, Verweij PE (2006). Antifungal activity of some Tanzanian plants used traditionally for the treatment of fungal infections. *Journal of Ethnopharmacology* 108:124-132.
- Hedimbi M, Chinsemu KC (2012). Ethnomedicinal study of plants used to manage HIV/AIDS-related disease conditions in the Ohangwena region, Namibia. *International Journal of Medicinal Plants Research* 1:004-011.
- Hussein G, Miyashiro H, Nakamura N, Hattori M, Kawahata T, Otake T, Kakiuchi N, Shimotohno K (1999). Inhibitory effects of Sudanese plant extracts on HIV-1 replication and HIV-1 protease. *Phytotherapy Research* 13:31-36.
- Jain P, Sharma H, Basri F, Baraik B, Kumari S, Pathak C (2014). Pharmacological Profiles of Ethno-Medicinal Plant: *Plumbago zeylanica* L.-A Review. *International Journal of Pharmaceutical Sciences Review and Research* 24:157-163.
- James D, Abu E, Wurochekke A, Orji G (2007). Phytochemical and antimicrobial investigation of the aqueous and methanolic extracts of *Ximenia americana*. *Journal of Medical Sciences* 2:284-288.
- Jeruto P, Lukhoba C, Ouma G, Otieno D, Mutai C (2008). An ethnobotanical study of medicinal plants used by the Nandi people in Kenya. *Journal of Ethnopharmacology* 116:370-376.
- Jeyachandran R, Mahesh A, Cindrella L, Sudhakar S, Pazhanichamy K (2009). Antibacterial activity of *Plumbagin* and root extracts of *Plumbago zeylanica*. *Acta Biologica Cracoviensia Series Botanica* 51:17-22.
- Kabbashi AS (2015). Antigiardial, antiamebic, antimicrobial, antioxidant activity, cytotoxicity and phytochemical of ethanolic fruits extract of *Balanites aegyptiaca* (L.) Del. from Sudan. *World Journal Pharmaceutical Research* 4:01-21.
- Kambizi L, Afolayan AJ (2001). An ethnobotanical study of plants used for the treatment of sexually transmitted diseases (njohera) in Gurube District, Zimbabwe. *Journal of Ethnopharmacology* 77:5-9.
- Kamuhabwa A, Nshimo C, de Witte P (2000). Cytotoxicity of some medicinal plant extracts used in Tanzanian traditional medicine. *Journal of Ethnopharmacology* 70:143-149.
- Kapewangolo P, Hussein AA, Meyer D (2013). Inhibition of HIV-1 enzymes, antioxidant and anti-inflammatory activities of *Plectranthus barbatus*. *Journal of Ethnopharmacology* 149:184-190.
- Karaan M, Ham C, Aithal A, Franzel S, Moombe K, Akinnifesi F, Jordaan D (2006). Baseline marketing surveys and supply chain studies for indigenous fruit markets in Tanzania, Zimbabwe and Zambia. <http://repository.businessinsightz.org/handle/20.500.12018/7406>
- Kariuki D, Miron J, Mugweru J, Kerubo L (2014). Antibacterial activity of five medicinal plant extracts used by the Maasai people of Kenya. *International Journal of Humanities, Arts, Medicine and Sciences* 2:1-6.
- Karthishwaran K, Mirunalini S (2010). Therapeutic potential of *Pergularia daemia* (Forsk.): the Ayurvedic wonder. *International Journal of Pharmacology* 6:836-843.
- Kebebew M, Mohamed E (2017). Indigenous knowledge on use of medicinal plants by indigenous people of Lemo district, Hadiya zone, Southern Ethiopia. *International Journal of Herbal Medicine* 5:124-135.
- Kiraithe MN, Nguta JM, Mbaria JM, Kiama SG (2016). Evaluation of the use of *Ocimum suave* Willd. (Lamiaceae), *Plectranthus barbatus* Andrews (Lamiaceae) and *Zanthoxylum chalybeum* Engl. (Rutaceae) as antimalarial remedies in Kenyan folk medicine. *Journal of Ethnopharmacology* 178:266-271.
- Kisangau DP, Lyaruu HV, Hosea KM, Joseph CC (2007). Use of traditional medicines in the management of HIV/AIDS opportunistic infections in Tanzania: a case in the Bukoba rural district. *Journal of Ethnobiology and Ethnomedicine* 3:29.
- Kitonde CK, Fidahusein DS, Lukhoba CW, Jumba MM (2012). Antimicrobial Activity and Phytochemical Study of *Vernonia Glabra* (Steetz) Oliv. & Hiern. in Kenya. *African Journal of Traditional, Complementary and Alternative Medicines* 10(1):149-157.
- Kubo I, Fukuhara K (1990). Elabunin, a new cytotoxic triterpene from an East African medicinal plant, *Elaeodendron buchananii*. *Journal of Natural Products* 53:968-971.
- Lamorde M, Tabuti JR, Obua C, Kukunda-Byobona C, Lanyero H, Byakika-Kibwika P, Bbosa GS, Lubega A, Ogwal-Okeng J, Ryan M, Waako PJ, Merry C (2010). Medicinal plants used by traditional medicine practitioners for the treatment of HIV/AIDS and related conditions in Uganda. *Journal of Ethnopharmacology* 130:43-53.
- Leteane MM, Ngwenya BN, Muzila M, Namushe A, Mwinga J, Musonda R, Moyo S, Mengestu YB, Abegaz BM, Andrae-Marobela K (2012). Old plants newly discovered: *Cassia sieberiana* D.C. and *Cassia abbreviata* Oliv. root extracts inhibit in vitro HIV-1c replication in peripheral blood mononuclear cells (PBMCs) by different modes of action. *Journal of Ethnopharmacology* 141:48-56.
- Luseba D, Elgorashi EE, Ntloedibe DT, Van Staden J (2007). Antibacterial, anti-inflammatory and mutagenic effects of some medicinal plants used in South Africa for the treatment of wounds and retained placenta in livestock. *South African Journal of Botany* 73:378-383.
- Machumi F, Midiwo JO, Jacob MR, Khan SI, Tekwani BL, Zhang J, Walker LA, Muhammad I (2013). Phytochemical, antimicrobial and antiplasmodial investigations of *Terminalia brownii*. *Natural Product Communications* 8:761-764.
- Magassouba FB, Diallo A, Kouyaté M, Mara F, Mara O, Bangoura O, Camara A, Traoré S, Diallo AK, Zaoro M, Lamah K, Diallo S, Camara G, Traoré S, Kéita A, Camara MK, Barry R, Kéita S, Oularé K, Barry MS, Donzo M, Camara K, Toté K, Berghe DV, Totté J, Pieters L, Vlietinck AJ, Baldé AM (2010). Corrigendum to "Ethnobotanical survey and antibacterial activity of some plants used in Guinean traditional medicine. *Journal of Ethnopharmacology* 114(1): 44-53.
- Maikere-Faniyo R, Van Puyvelde L, Mutwewingabo A, Habiyaemye F (1989). Study of Rwandese medicinal plants used in the treatment of diarrhoea I. *Journal of Ethnopharmacology* 26:101-109.
- Manenzhe NJ, Potgieter N, van Ree T (2004). Composition and antimicrobial activities of volatile components of *Lippia javanica*. *Phytochemistry* 65:2333-2336.
- Maregesi S, Van Miert S, Pannecouque C, Feiz HMH, Hermans N, Wright CW, Vlietinck AJ, Apers S, Pieters L (2010). Screening of Tanzanian medicinal plants against *Plasmodium falciparum* and human immunodeficiency virus. *Planta medica* 76:195-201.
- Maregesi SM, Ngassapa OD, Pieters L, Vlietinck AJ (2007). Ethnopharmacological survey of the Bunda district, Tanzania: plants used to treat infectious diseases. *Journal of Ethnopharmacology* 113:457-470.
- Marlowe F (2002). Why the Hadza are still hunter-gatherers. Ethnicity, huntergatherers, and the 'Other', ed. S. Kent. Association or Assimilation in Africa, Sue Kent (Ed.) Washington D.C.: Smithsonian Institution Press pp. 247-275.
- Maroyi A (2014). Alternative Medicines for HIV/AIDS in Resource-Poor Settings: Insight from Traditional Medicines Use in Sub-Saharan

- Africa. *Tropical Journal of Pharmaceutical Research* 13:1527.
- Maroyi A (2017). *Lippia javanica* (Burm.f.) Spreng: Traditional and Commercial Uses and Phytochemical and Pharmacological Significance in the African and Indian Subcontinent. *Evidence-Based Complementary and Alternative Medicine* 34 p.
- Mbunde MV, Innocent E, Mabiki F, Andersson PG (2017). Ethnobotanical survey and toxicity evaluation of medicinal plants used for fungal remedy in the Southern Highlands of Tanzania. *Journal of Intercultural Ethnopharmacology* 6:84-96.
- Mbwambo ZH, Moshi MJ, Masimba PJ, Kapingu MC, Nondo RS (2007). Antimicrobial activity and brine shrimp toxicity of extracts of *Terminalia brownii* roots and stem. *BMC Complementary and Alternative Medicine* 7(1):9.
- Mesfin F, Demissew S, Teklehaymanot T (2009). An ethnobotanical study of medicinal plants in Wonago Woreda, SNNPR, Ethiopia. *Journal of Ethnobiology and Ethnomedicine* 5:28.
- Mohammed MM, Ibrahim NA, Awad NE, Matloub AA, Mohamed-Ali AG, Barakat EE, Mohamed AE, Colla PL (2012). Anti-HIV-1 and cytotoxicity of the alkaloids of *Erythrina abyssinica* Lam. growing in Sudan. *Natural Product Research* 26:1565-1575.
- Mongalo NI, McGaw LJ, Segapelo TV, Finnie JF, Van Staden J (2016). Ethnobotany, phytochemistry, toxicology and pharmacological properties of *Terminalia sericea* Burch. ex DC. (Combretaceae) – A review. *Journal of Ethnopharmacology* 194:789-802.
- Moshi MJ, Cosam JC, Mbwambo ZH, Kapingu M, Nkonya MHH (2009). Testing Beyond Ethnomedical Claims: Brine Shrimp Lethality of Some Tanzanian Plants. *Pharmaceutical Biology* 42:547-551.
- Moshi MJ, Mbwambo ZH (2005). Some pharmacological properties of extracts of *Terminalia sericea* roots. *Journal of Ethnopharmacology* 97:43-47.
- Moshi MJ, Otieno DF, Mbabazi, PK, Weisheit A (2010). Ethnomedicine of the Kagera Region, north western Tanzania. Part 2: The medicinal plants used in Katoro Ward, Bukoba District. *Journal of Ethnobiology and Ethnomedicine* 6:19.
- Moshi MJ, van den Beukel C, Hamza OJ, Mbwambo ZH, Nondo RO, Masimba PJ, Matee M, Kapingu MC, Mikx F, Verweije P (2007). Brine shrimp toxicity evaluation of some Tanzanian plants used traditionally for the treatment of fungal infections. *African Journal of Traditional, Complementary and Alternative Medicines* 4:219-225.
- Mossa JS, El-Ferally FS, Muhammad I (2004). Antimycobacterial constituents from *Juniperus procera*, *Ferula communis* and *Plumbago zeylanica* and their in vitro synergistic activity with isonicotinic acid hydrazide. *Phytotherapy Research* 18:934-937.
- Mujovo SF, Hussein AA, Meyer JJ, Fourie B, Muthivhi T, Lall N (2008). Bioactive compounds from *Lippia javanica* and *Hoslundia opposita*. *Natural Product Research* 22:1047-1054.
- Mukanganyana S, Ntuny AN, Maher F, Muzila M, Andrae-Marobela K (2011). Screening for anti-infective properties of selected medicinal plants from Botswana. *African Journal of Plant Science and Biotechnology* 5:1-7.
- Mulaudzi RB, Ndhlala AR, Kulkarni MG, Finnie JF, Van Staden J (2011). Antimicrobial properties and phenolic contents of medicinal plants used by the Venda people for conditions related to venereal diseases. *Journal of Ethnopharmacology* 135:330-337.
- Nair JJ, Mulaudzi RB, Chukwujekwu JC, Van Heerden FR, Van Staden J (2013). Antigonococcal activity of *Ximenia caffra* Sond. (Olacaceae) and identification of the active principle. *South African Journal of Botany* 86:111-115.
- NBS (2013). 2012 Population and Housing Census. National Bureau of Statistics, United Republic of Tanzania.
- NBS (2017). Tanzania HIV impact survey (THIS) 2016-2017; Summary sheet: Preliminary findings.
- Ngezahayo J, Havyarimana F, Hari L, Stevigny C, Duez P (2015). Medicinal plants used by Burundian traditional healers for the treatment of microbial diseases. *Journal of Ethnopharmacology* 173:338-351.
- Ngezahayo J, Ribeiro SO, Fontaine V, Hari L, Stevigny C, Duez P (2017). In vitro Study of Five Herbs Used Against Microbial Infections in Burundi. *Phytotherapy Research* 31:1571-1578.
- Njoroge GN, Bussmann RW (2007). Ethnotherapeutic management of skin diseases among the Kikuyus of Central Kenya. *Journal of Ethnopharmacology* 111:303-307.
- Nyamukuru A, Tabuti JRS, Lamorde M, Kato B, Sekagya Y, Aduma PR (2017). Medicinal plants and traditional treatment practices used in the management of HIV/AIDS clients in Mpigi District, Uganda. *Journal of Herbal Medicine* 7:51-58.
- Odak JA, Manguro LOA, Wong K-C (2018). New compounds with antimicrobial activities from *Elaeodendron buchananii* stem bark. *Journal of Asian Natural Products Research* 20:510-524.
- Olila D, Opuda-Asibo J (2001). Antibacterial and antifungal activities of extracts of *Zanthoxylum chalybeum* and *Warburgia ugandensis*, Ugandan medicinal plants. *African Health Sciences* 1:66-72.
- Olilaa D, Opuda-Asibo J (2002). Screening of extracts of *Zanthoxylum chalybeum* and *Warburgia ugandensis* for activity against measles virus (Swartz and Edmonston strains) in vitro. *African Health Sciences* 2:2-10.
- Patel S, Mwamhanga J (2014). The Importance of ethno-medicinal plants amongst the Iraqw in the Karatu District: Cultural and conservation implications. *Undergraduate Research Journal for the Human Sciences* 13:1.
- Pendota SC, Aderogba MA, Moyo M, McGaw LJ, Mulaudzi RB, Van Staden J (2017). Antimicrobial, antioxidant and cytotoxicity of isolated compounds from leaves of *Pappea capensis*. *South African Journal of Botany* 108:272-277.
- Peter O, Esther M, Gabriel M, Daniel K, Christine B (2015). In vitro anti-Salmonella activity of extracts from selected Kenyan medicinal plants. *Journal of Medicinal Plants Research* 9:254-261.
- Qwarse M, Mihale MJ, Sempombe J, Mugoyela VLH, Sunghwa F (2018). Ethnobotanical Survey of Medicinal and Pesticidal Plants used by Agro-pastoral Communities in Mbulu District, Tanzania. *Tanzania Journal of Science and Technology* 1:22-35.
- Radol A, Kiptoo M, Makokha A, Tolo F (2016). Types of Herbal Medicine Used for HIV Conditions in Vihiga County, Kenya. *European Journal of Medicinal Plants* 13:1-23.
- Ramadhani SON, Denis Z, Mainen JM, Paul E, Samuel W, Moses NN, Vincent PKT, Abdul WK, Pax JM (2015). Ethnobotanical survey and in vitro antiparasitodal activity of medicinal plants used to treat malaria in Kagera and Lindi regions, Tanzania. *Journal of Medicinal Plants Research* 9:179-192.
- Ramathal DC, Ngassapa OD (2008). Medicinal Plants Used by Rwandese Traditional Healers in Refugee Camps in Tanzania. *Pharmaceutical Biology* 39:132-137.
- Rea A (2003). Cytotoxic activity of *Ozoroa insignis* from Zimbabwe. *Fitoterapia* 74:732-735.
- Ribeiro A, Romeiras MM, Tavares J, Faria MT (2010). Ethnobotanical survey in Canhane village, district of Massingir, Mozambique: medicinal plants and traditional knowledge. *Journal of Ethnobiology and Ethnomedicine* 6:33.
- Rondevaldova J, Leuner O, Teka A, Lulekal E, Havlik J, Van Damme P, Kokoska L (2015). In Vitro Antistaphylococcal Effects of *Embellia schimperi* Extracts and Their Component Embelin with Oxacillin and Tetracycline. Evidence-based complementary and alternative medicine : eCAM 2015, 175983.
- Rukungu GM, Kofi-Tsekpo MW, Kurokawa M, Kageyama S, Mungai GM, Muli JM, Tolo FM, Kibaya RM, Muthaura CN, Kanyara JN (2002). Evaluation of the HIV-1 reverse transcriptase inhibitory properties of extracts from some medicinal plants in Kenya. *African Journal of Health Sciences* 9:81-90.
- Runyoro DK, Matee MI, Ngassapa OD, Joseph CC, Mbwambo ZH (2006). Screening of Tanzanian medicinal plants for anti-Candida activity. *BMC Complementary and Alternative Medicine* 6:11.
- Salih EYA, Fyhrquist P, Abdalla AMA, Abdelgadir AY, Kanninen M, Sipi M, Luukkanen O, Fahmi MKM, Elamin MH, Ali HA (2017). LC-MS/MS Tandem Mass Spectrometry for Analysis of Phenolic Compounds and Pentacyclic Triterpenes in Antifungal Extracts of *Terminalia brownii* (Fresen). *Antibiotics* 6(4):37.
- Samie A, Housein A, Lall N, Meyer JJ (2009). Crude extracts of, and purified compounds from, *Pterocarpus angolensis*, and the essential oil of *Lippia javanica*: their in-vitro cytotoxicities and activities against selected bacteria and *Entamoeba histolytica*. *Annals of Tropical Medicine and Parasitology* 103:427-439.
- Semenya SS, Maroyi A (2012). Medicinal plants used by the Bapedi traditional healers to treat diarrhoea in the Limpopo Province, South Africa. *Journal of Ethnopharmacology* 144:395-401.

- Shai LJ, Chauke MA, Magano SR, Magala AM, Eloff JN (2013). Antibacterial activity of sixteen plants species from Phalaborwa, Limpopo Province, South Africa. *Journal of Medicinal Plants Research* 7:1889-1906.
- Sigidi MT, Anokwuru CP, Zininga T, Tshisikhawe MP, Shonhai A, Ramaite IDI, Traoré AN, Potgieter N (2016). Comparative in vitro cytotoxic, anti-inflammatory and anti-microbiological activities of two indigenous Venda medicinal plants. *Translational Medicine Communications* 1(1):9.
- Singh M, Kumar V, Singh I, Gauttam V, Kalia AN (2010). Anti-inflammatory activity of aqueous extract of *Mirabilis jalapa* Linn. leaves. *Pharmacognosy Research* 2:364-367.
- Tantiado RG (2012). Survey on Ethnopharmacology of Medicinal Plants in Iloilo, Philippines. *International Journal of Bio-Science and Bio-Technology* 4(4):11-26.
- Tanzania, N.A.C.P., 2002. HIV/AIDS/STI Surveillance Report.
- Tanzania, N.A.C.P., 2011. HIV/AIDS/STI Surveillance Report.
- Temam T, Dillo A (2016). Ethnobotanical study of medicinal plants of Mirab-Badwacho district, Ethiopia. *Journal of BioScience and Biotechnology* 5:151-158.
- Tesfaye A, Girma A (2017). Phytochemistry, Pharmacology and Nutraceutical Potential of Enset (*Ensete ventricosum*). *African Journal of Basic and Applied Sciences* 9:112-117.
- Thabeet GO, Shija S, Rweyemamu F (2017). Knowledge of plant species used by HIV/AIDS patients in managing opportunistic infections in Tazania. *Advanced Journal of Medicinal Plants Research* 1:007-016.
- Thayil SM, Thyagarajan SP (2016). PA-9: A Flavonoid Extracted from *Plectranthus amboinicus* Inhibits HIV-1 Protease. *International Journal of Pharmacognosy and Phytochemical Research* 6:1020-1024.
- Toyang NJ, Verpoorte R (2013). A review of the medicinal potentials of plants of the genus *Vernonia* (Asteraceae). *Journal of Ethnopharmacology* 146:681-723.
- Tshikalange TE, Meyer JJ, Lall N, Munoz E, Sancho R, Van de Venter M, Oosthuizen V (2008). In vitro anti-HIV-1 properties of ethnobotanically selected South African plants used in the treatment of sexually transmitted diseases. *Journal of Ethnopharmacology* 119:478-481.
- Tuasha N, Petros B, Asfaw Z (2018). Plants Used as Anticancer Agents in the Ethiopian Traditional Medical Practices: A Systematic Review. *Evidence-based complementary and alternative medicine : eCAM* 2018, 6274021.
- Tugume P, Kakudidi EK, Buyinza M, Namaalwa J, Kamatenesi M, Mucunguzi P, Kalema J (2016). Ethnobotanical survey of medicinal plant species used by communities around Mabira Central Forest Reserve, Uganda. *Journal of Ethnobiology and Ethnomedicine* 12(1):5.
- Vivanco JM (1999). Antiviral and Antiviroid Activity of MAP-Containing Extracts from *Mirabilis jalapa* Roots. *Plant Disease*, p. 83.
- World Health Organization (WHO) (2008). Fact sheet Number. 134: Traditional medicine, Geneva: . World Health Organization, Geneva
- World Health Organization (WHO) (2018). UNAID Data 2018. World Health Organization, Geneva
- Woldeab B, Regassa R, Alemu T, Megersa M (2018). Medicinal Plants Used for Treatment of Diarrhoeal Related Diseases in Ethiopia. *Evidence-based complementary and alternative medicine: eCAM* 2018, 4630371.
- Wube AA, Bucar F, Gibbons S, Asres K (2005). Sesquiterpenes from *Warburgia ugandensis* and their antimycobacterial activity. *Phytochemistry* 66:2309-2315.
- Yuvaraj DM (2011). A comprehensive review on *Plumbago zeylanica* Linn. *African Journal of Pharmacy and Pharmacology* 5(25):2738-2747.
- Zachariah SM, Aleykutty NA, Viswanad V, Jacob S, Prabhakar V (2011). In-vitro Antioxidant Potential of Methanolic Extracts of *Mirabilis jalapa* Linn. *Free Radicals and Antioxidants* 1:82-86.