



# Ethnopharmacological Survey of Medicinal Plants Used in the Management of HIV and AIDS-Related Conditions in Makete District, Southern Highlands of Tanzania

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## Authors' contributions

This work was carried out in collaboration among all authors. Authors AIM, MM, KAM, MQ and EI designed the study. Authors AIM and MM participated in data collection. Author AIM compiled the information and drafted the initial manuscript. All authors read and approved the final manuscript.

## Article Information

DOI: 10.9734/EJMP/2020/v31i1430317

### Editor(s):

(1) Dr. Paola Angelini, University of Perugia, Italy.

(2) Marcello Iriti, University of Milan, Italy.

### Reviewers:

(1) Jemimah Ayuma Simbauni, Kenyatta University, Kenya.

(2) Khairuddin Djawad, Hasanuddin University, Indonesia.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/61477>

Original Research Article

Received 17 July 2020  
Accepted 23 September 2020  
Published 08 October 2020

## ABSTRACT

**Aims:** Plants used in traditional medicine have contributed to the development of modern medicines, but in order to boost the discovery of novel drugs to fight diseases such as HIV/AIDS and emerging new diseases, systematic evaluation of many more plants needs to continue. The aim of the present study was to document medicinal plants used in the management of HIV and AIDS-related conditions in Makete District, Tanzania.

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**Study Design:** This was qualitative ethnopharmacological survey.

**Place and Duration of Study:** Makete District in Njombe Region, Tanzania between March and April 2019.

**Methodology:** This ethnopharmacological survey was conducted using a semi-structured questionnaire. The study focused only on traditional health practitioners (THP) registered by government health authorities in Makete District. The HIV and AIDS-related conditions considered in this study were tuberculosis, *Herpes zoster*, candidiasis, sexually transmitted infections, cough, skin rashes, frequent fevers, chronic diarrhea, chronic wounds, warts, oral thrush and weight loss. Literature survey was carried out to evaluate strength of the THP claims based on similar ethnopharmacological claims and proven pharmacological activities of the plants.

**Results:** Among the ten THP interviewed seven were male and three were female. The average age and years of practice were 57.5 and 26.5 years, respectively. Thirty-seven plant species representing 36 genera and 27 families were reported to be used for the treatment of different HIV and AIDS-related conditions. Twelve (32.4 %) and 15 (40.5 %) species did not have previously reported ethnopharmacological and pharmacological activities, respectively. Among the 37 plant species identified 13 species (35%) have been previously reported for similar ethnopharmacological uses and 12 (32%) species had literature reports on respective biological activities. Nine species have reported antiviral activity and seven of them displayed specific activities against HIV-1.

**Conclusion:** A significant number of medicinal plants identified in this study are reported here for the first time in relation to their use for HIV and AIDS-related conditions. The study also provides information that correlates well with previously published ethnopharmacological information or laboratory results of tests against HIV-1 or related conditions, thus justifying the need for screening and detailed studies intended to isolate and characterize compounds active against HIV and related conditions.

**Keywords:** *Traditional medicine; HIV and AIDS-related conditions; Makete; Tanzania.*

## 1. INTRODUCTION

Despite substantial efforts made to control HIV/AIDS for the past three decades, the disease still constitutes a leading global health challenge and there is no cure [1]. Presently, highly active antiretroviral therapy (HAART) is the main option at hand in controlling the disease, but the development of drug-resistant HIV-1 strains to almost all available classes of anti-HIV-1 drugs and their high toxicity profiles undermines efforts to control the disease [2,3].

Medicinal plants have been used for centuries to treat different human ailments. According to the World Health Organization (WHO), about three-quarters of the African population rely on plants for the treatment of their illnesses [4]. Plants are rich resources for many novel biologically active compounds with potential for use in modern medicine. Despite the increasing sophisticated techniques to design molecular modifications in the laboratories, "Mother Nature" is still the best designer, since nearly half of all new molecular entities introduced in the past three decades have been derived from natural products [5,6].

Identification and documentation of plant species used for management of HIV and AIDS-related

conditions can promote the search for products to supplement the available therapeutic options, especially in resource-limited countries. Many previous, successful screening studies to discover anti-HIV compounds, studied plants which are used to treat HIV and AIDS-related conditions [7-9]. For example, some of plant species previously reported to be used traditionally in Tanzania for treatment of HIV and AIDS-related conditions have been reported elsewhere to have anti-HIV activity [10].

So far, many natural product-derived compounds have been reported, targeting different stages of HIV replication like Calanolide A/B, Tulsi/Holy Basil, Kuwanon-L, Rheum-palatum L, and Patentiflorin A which inhibit HIV reverse transcriptase enzyme, Kuwanon-L and Rheum-palatum L have anti-integrase activity. Bowman-Birk inhibitor increases cellular expression of HIV restriction factors and betulinic acid which prevents release of infectious viral particles [11]. Although currently there is no plant-derived drug that is in clinical use to treat HIV and AIDS, promising activities have been shown by several natural product-derived candidates in preclinical and clinical trials. The number of compounds exhibiting anti-HIV activity isolated from natural sources is increasing progressively. One among

the promising anti-HIV compounds is calanolide A which was isolated from *Calophyllum lanigerum* tree latex. Calanolide A which is a coumarin, has undergone early stages of clinical trials [12]. Another example of natural product-derived candidate which has reached clinical trial phase is bevirimat [3-O-(3',3'-dimethylsuccinyl)-betulinic acid]. The phase I and II study of safety, virologic effect, and pharmacokinetics/pharmacodynamics of its single oral doses against HIV reported bevirimat to be well tolerated and demonstrated a dose-dependent reduction in viral load [13].

An earlier study [14], showed how natural products have served as important leads for the discovery of more potent molecules including, bevirimat and DCK (3'R,4'R-di-O-(-)-camphanoyl-(+)-*cis*-khellactone) which were designed on the basis of anti-HIV activity of naturally occurring betulinic acid and suksdorfins, respectively. Although some natural products such as clusianone, propolone A, the lectin Ban Lec, and mirabamide A have shown anti-HIV activity in the nanomolar/picomolar range, further efforts are still warranted to find new lead molecules for HIV and AIDS from natural sources [14].

In Tanzania, the highest prevalence of HIV has for more than a decade been reported in the southern highland regions. Currently, Njombe region is leading with a prevalence of 11.4% followed closely by Iringa and Mbeya regions with a prevalence of 11.3% and 9.3% respectively [15]. One could therefore hypothesize that the overwhelming impact of HIV and AIDS pandemic in these regions might have forced the population to search for alternative weapons to alleviate this problem, such as resorting to the use of herbal therapies for its management. Despite the huge biodiversity in this region [16], to our knowledge, there is no comprehensive ethnopharmacological survey of medicinal plants used in the management of HIV and AIDS-related conditions that has been done. The present study therefore, intended to document medicinal plants used in the management of HIV and AIDS-related conditions in Makete District in order to increase potential therapeutic options to strengthen the HIV and AIDS public health response.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The study was conducted in Makete District, Njombe Region, a Tanzanian region bordered to

the north and west by the Mbeya Region, to the east by the Njombe District and to the south by the Ludewa District. It is one of the six Districts of Njombe Region and is located in the Southern Highlands of Tanzania about 115 km from the regional headquarters (Fig. 1). According to Tanzania National Population and Housing Census projections of 2012, Makete District has a total population of 97,266 people [17]. The District is dominated by Wakinga ethnic tribe which speaks Kinga language as their local language. Agriculture provides the livelihood of most people in this district. Because of the temperate climate with temperatures ranging from 2 to 30°C, wheat and potatoes are widely cultivated. The district has high levels of mobility due to seasonal workers employed in farms and numerous timber tree plantations.

### 2.2 Study Design

This qualitative ethnopharmacological survey was conducted between March and April 2019. The study employed a purposive sampling in which selection of respondents only focused on traditional health practitioners (THPs) registered by Health Authorities in the office of Makete District Medical Officer (DMO). This was important to reduce the likelihood of dealing with fake or inexperienced THPs. Acknowledging the contribution of THPs in health care provision in Tanzania, the Ministry of Health, Community development, Gender, Elderly and Children is currently advocating for registration of THP through the offices of DMOs all over the country. The legitimacy of the THPs is checked well before he/she is registered through the involvement of witnesses like neighbours, village and ward officials where the THP resides or has been practicing. The coordinators from the office of DMO responsible for the registration of THPs were engaged to locate the THPs and kindly offered translation services when it was required.

### 2.3 Permission to Conduct the Study and Plant Identification

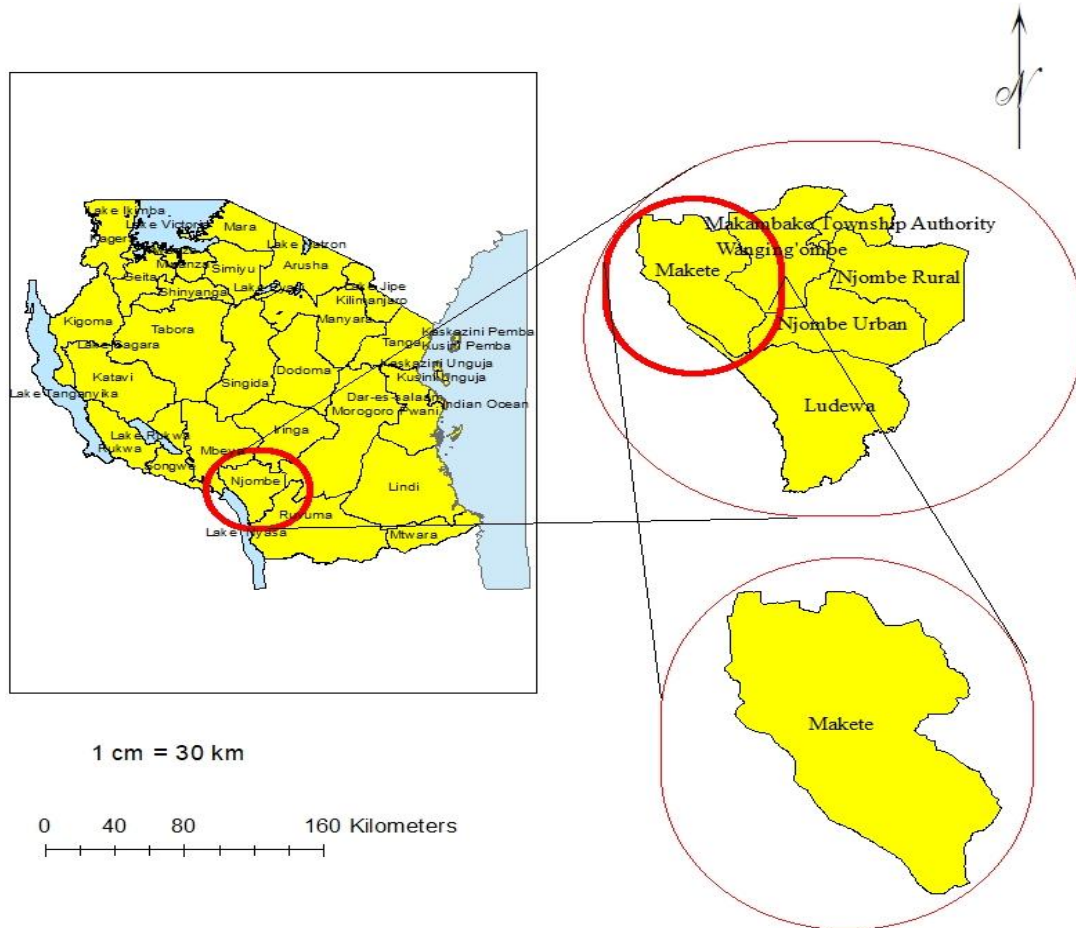
Permission to conduct the study in Makete District was sought from all authorities from the district to village level. Medicinal plants voucher specimens were collected in the wild together with THPs and a botanist to avoid misidentification of plants. The voucher specimens were authenticated in the Department of Botany of the University of Dar es Salaam. Vouchers were kept in the Herbarium of the Institute of Traditional Medicine, Muhimbili

University of Health and Allied Sciences and Herbarium of the Department of Botany, University of Dar-es-Salaam.

## 2.4 Data Collection

Interviews using a semi-structured questionnaire were conducted during data collection. The first sections of the questionnaire were seeking to gather demographic details about the THP and information about the diseases that the THP is capable of treating. The other sections aimed at documenting medicinal plants that form part of regimens to manage conditions/symptoms of HIV and AIDS-related diseases including; *Herpes zoster* (in Makete it is commonly known as “moto wa mungu” meaning god’s fire), persistent cough (cough for more than two weeks), cough associated with chest pain, warts which were

described to the THPs as a condition characterized by itching small, flesh colored bumps or have cauliflower-like appearance. Oral candidiasis and vaginal candidiasis which are prominent opportunistic infections were also probed. Oral candidiasis in Kiswahili was explained to the THPs as “*Utando mweupe wa mdomoni*” literally meaning white patches of bumps on inner cheeks, tongue, gums or lips. Vaginal candidiasis was described to the THPs as a condition characterized by itching associated with odor-free discharge [18]. Other conditions/symptoms considered were skin rashes, frequent fevers, chronic diarrhea (diarrhea for more than two weeks), chronic wounds, and wasting (weight loss). The THPs were also probed to find out if they could treat some conditions like tuberculosis if the patient has hospital diagnosis.



**Fig. 1.** Map showing the location of Makete District in Njombe Region, Tanzania. The map was originally generated using ArcGIS software version 10.7.1 (<https://www.esri.uconn.edu/software/arcgis-student/>)

Other sections of the questionnaire documented the common/local names of the plants, parts used, the diseases treated, the methods of preparation, dosage, frequency and duration of treatments and side effects.

## 2.5 Literature Survey to Support Medicinal Plant Uses

Literature information of the identified plants was gathered from different search engines including Pubmed/Medline, Google Scholar, ResearchGate and Hinari. For data searching related to each identified plant, different keywords were used such as plant's name, ethnomedicines, 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. The strength and validity of information obtained from the informant was evaluated based on there being found similar ethnopharmacological claims in the literature or evidence of laboratory results that support the claims.

## 2.6 Data Analysis

Ethnopharmacological 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 used in the community. They were also applied to identify the percentage distribution of plant part used and diseases treated by the identified medicinal plants.

## 3. RESULTS AND DISCUSSION

### 3.1 Socio-Demographic Characteristics of the THPs

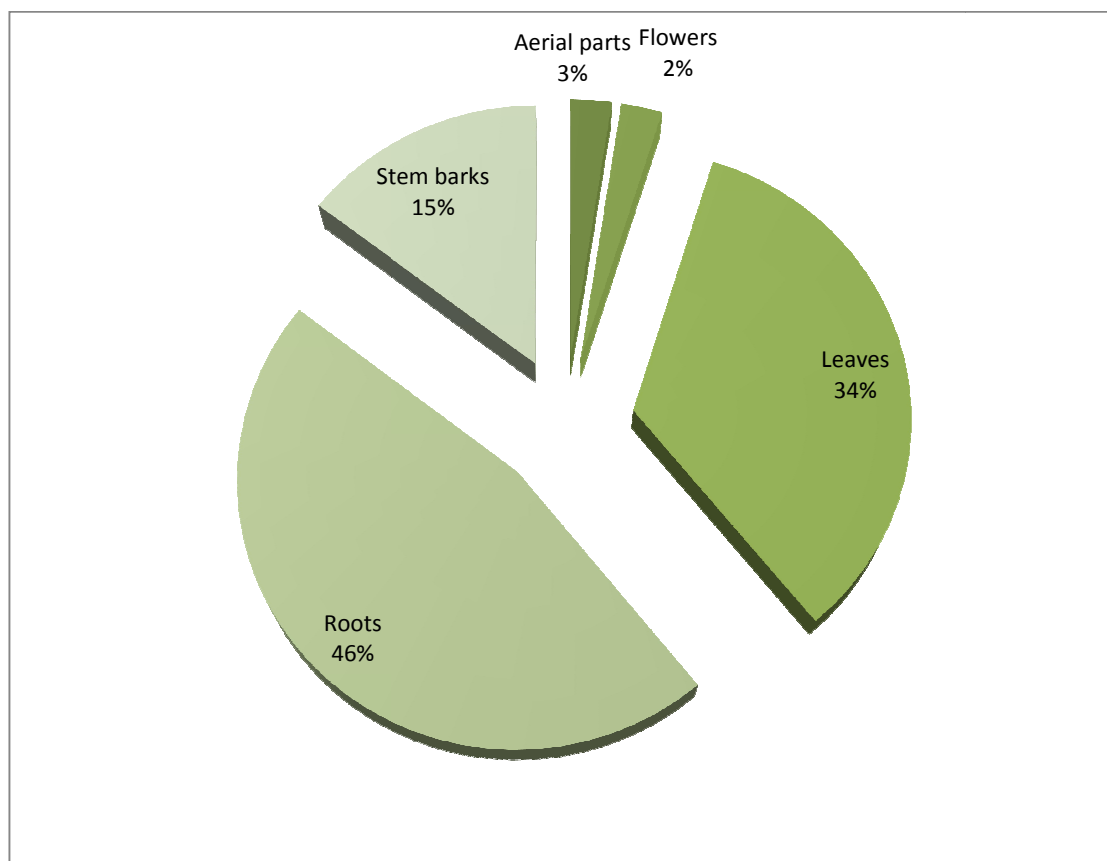
Traditional Health Practitioners (THPs) were interviewed in seven different wards of Makete District that include Lupila, Luwumbu, Ukwama, Makangarawe, Ipepo, Iwawa and Lupalilo. These wards were chosen based on the availability of registered THPs kindly made available by the office of Makete District Medical Officer. The ethnopharmacological survey involved 10 registered THPs who were available and consented to be interviewed. Out of these, 7 were male and 3 were female. The average age of the THPs was 57.5 ranging from 40 to 86 years. The THP had average practice experience of 26.5 years, ranging from 8 to 45 years.

However, the majority (62.5%) had less than 26.5 years of practice experience. Only one THP declined to participate in this study. None of the THPs had an apprentice under their tutelage and therefore are not transferring their skills to the next generation. Thus, this study not only document medicinal plants use, but also contributes to preserve valuable information we obtained from THPs in Makete. Most of the THPs (60%) acquired their knowledge through spiritual calling. The rest of the THPs obtained their knowledge from various sources, such as parents, other relatives, friends and fellow THPs.

### 3.2 Medicinal Plant Species Documented

A total of 37 plant species used by the Wakinga tribe for the treatment of various HIV and AIDS-related conditions were documented (Table 1). The plants represent 27 families whereby Compositae and Leguminosae are represented by 5 species each, the highest number of documented species. The most frequently used plant parts were roots (46%), leaves (34%), and stem barks (15%) (Fig. 2). The forms of presentation included liquid preparations mainly decoctions, juices obtained by crushing the plant material and by squeezing, ashes and latex. Solid preparations included dry powdered materials in Vaseline or fat. Most of the preparations were prescribed for oral intake, while topical application was mainly used for wounds and other skin conditions.

Out of 37 reported plant species, 13 (35%) have been previously reported for similar ethnopharmacological uses; 12 (32%) species were associated with literature reports on respective biological activities. Out of these, extracts of nine species showed antiviral activity and seven of these displayed specific activities against HIV-1 (Table 1). However, 12 (32.4%) and 15 (40.5%) plants were found to have no ethnopharmacological and pharmacological reference in the literature, respectively. Therefore, it would be interesting to test them for antimicrobial and anti-HIV activity since they could be good sources for isolation of novel bioactive compounds. For example, anti-HIV alkaloids have been obtained from *Erythrina abyssinica* DC [19]. In Makete this plant is used together with *Parinari curatellifolia* Benth (stem barks) for management of diarrhea associated with HIV and AIDS and this combination is supported by the reported and relevant pharmacological activities of this plant which include strong and broad activity against bacteria [20-22].



**Fig. 2. Percentage use of plant parts**

*Asparagus africana* L. reported for syphilis and warts has been widely reported to be used in other infections including tuberculosis, diarrhea and pneumonia [23-25]. Most importantly it has been proven scientifically to possess *in vivo* anti-malarial, anti-mycobacterial and anti-inflammatory activity [26,27], but there are no reports for antiviral activity.

*Myrica salicifolia* is reported to inhibit HIV-1 reverse transcriptase enzyme [28] but there is no report on the responsible phytochemicals. In Makete, the plant is used in combination with *Parinari excelsa* Sabine, a plant with reported *in-vitro* anti-leishmanial and anti-plasmodial activity [29]. The plant is also reported to be used for management of sexually transmitted diseases in Nigeria [30].

*Bridelia micrantha* Benth is reported to inhibit HIV-1 reverse transcriptase enzyme and it exhibited broad spectrum antimicrobial activity, including activity against *Mycobacterium*

*tuberculosis* and some fungi [31-35]. Therefore, the use of this plant by the Wakinga THP for treatment of diarrhea, vaginal candidiasis, tuberculosis and pneumonia is supported by these reported pharmacological activities.

Another plant with reported activity against HIV is *Rhoicissus tridentata* (L.f.) Wild & R.B. Drumm. It is associated with HIV-1 reverse transcriptase inhibitory activity together with activity against *Mycobacterium tuberculosis* and antifungal activity [35-37]. The use of this plant for the treatment of warts and dysentery could be supported by the reported anti-microbial activities. *Rubia cordifolia* L., on the other hand, has been reported to have *in-vitro* anti-HIV activity, anti-adipogenic activity, anti-oxidant effect, wound healing activity, eczema, anti-inflammatory activity [38-41]. All these biological activities are relevant to HIV/AIDS and therefore the plant could be useful in managing some HIV opportunistic ailments.

*Vernonia amygdalina* Del. which was reported by the THPs to be used in management of oral thrush has been widely studied in terms of biological activity and it has been reported to have immune-stimulating activity in HIV/AIDS patients, *in-vitro* anti-HIV activity, anti-microbial and anti-cancer activity [42-45]. Cancers like Kaposi sarcoma is regarded as AIDS-defining malignancies and therefore plants which are reported to be used in its management especially in areas with high prevalence of HIV and AIDS could be relevant [46].

*Myrothamnus flabellifolia* Welw, was reported to contain 3,4,5-tri-galloylquinic acids which have anti-HIV reverse transcriptase activity [47]. It also has antiviral activity against *Herpes simplex* virus type 1 by inhibition of viral adsorption and penetration [48]. Since this plant is mixed with *Toddalia sciatica* (L.) Lam. roots by the Makete THPs for management of diarrhea it would be relevant to test for antimicrobial and anti-HIV activity of the separate plants and the combination. Both plants have been reported to have anti-HIV activity but the effect of combining

the two plants on the anti-HIV activity is yet to be investigated.

### 3.3 Diseases Treated by the THPs

During the survey, a total of 24 different conditions were found to be treated with the documented 37 plant species by THP. Most of these plants were indicated in the management of diarrhea (30%), *Herpes zoster* (24%), warts (24%), cough (19%), oral thrush (11%), and weight loss (11%) (Fig. 3). Almost half of the plant species documented (46%) were reported to be used for management of more than two HIV and AIDS related conditions. *Ficalhoa laurifolia* Hiern. and *Parinari excelsa* Sabine each was reported for treatment of five different ailments followed by *Bridelia micrantha* Benth and *Diospyros whyteana* (Hiern) F. White. with four ailments each. *Adenia gummifera* (Harv.) Harms, *Pimpinella buchananii* H. Wolf, *Nuxia congesta* R. Br. ex. Fresen, *Rhoicissus tridentata* (L.f.) Wild & R.B. Drumm, *Parinari curatellifolia* Benth and *Aloe lateritia* each was reported for three different HIV and AIDS-related conditions.

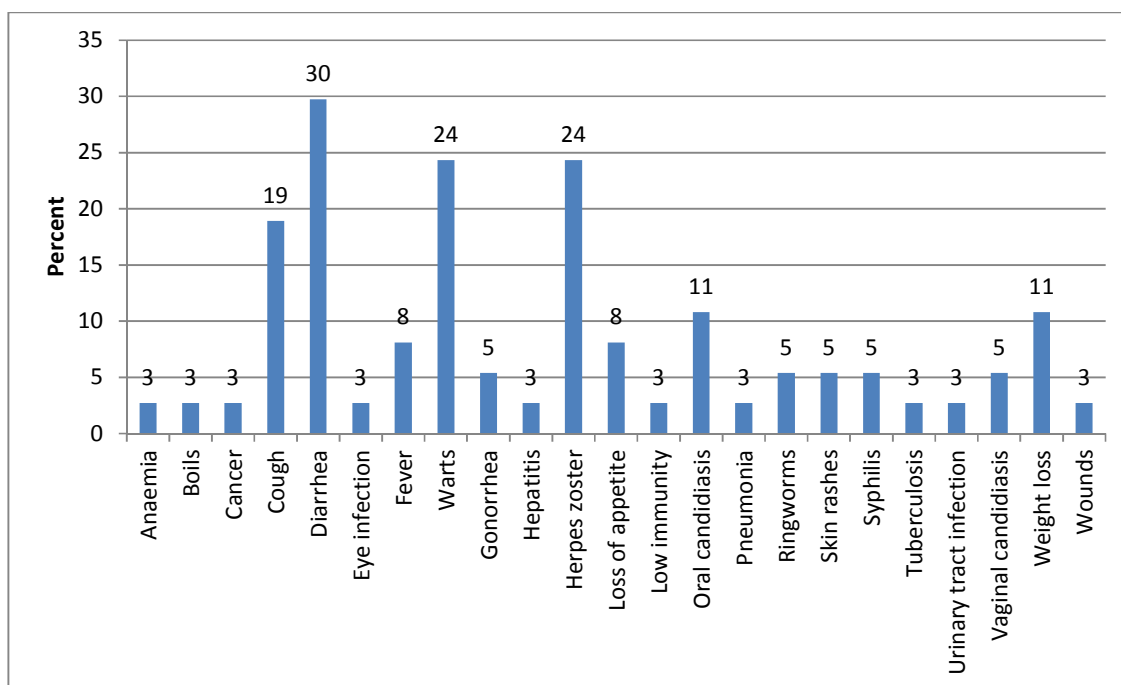


Fig. 3. Proportion of plants used to treat different disease conditions

Table 1. Plants used for management of HIV and AIDS related conditions in Makete District, Njombe Region

| Family name   | Scientific name (voucher specimen number)    | Vernacular name (Kinga) | Uses   | Part used | Method of preparation and use   | Previous supporting ethnomedical use (Country)  | Reported Pharmacological activities                  |
|---------------|--|-------------------------|--|-----------|---|---|--|
| Acathaceae    | <i>Acanthus polystachus</i> Delile (AIM 058) | Linyamutu               | <i>Herpes zoster</i>   | Leaves    | Mixed with <i>Telfairia pedata</i> burned, ashes mixed with fat or vaseline and applied to the affected area until healed.  | Malaria, vomiting and intestinal worms (Ethiopia) [49, 50]                              | Leaves reported to have wound healing activity [51]. |
| Asphodelaceae | <i>Aloe lateritia</i> Engl. (AIM 07)         | Likhulakula/muluvelo    | Ringworms, genital warts, vaginal candidiasis, skin rashes, persistent cough, <i>Herpes zoster</i> | Leaves    | Slice leaves and apply the gel on the affected area until healed for management of ring worms. Take 1/2 a tea cup of Aloe leaves crushed and mixed with water twice a day until healed for treatment of genital warts. Leaves mixed with another plant ( <i>Myrica salicifolia</i> roots) crushed, mixed with water and drunk for treatment of skin rashes and <i>Herpes zoster</i> . | Leaves are used in management of fungal infections, typhoid and wounds (Tanzania) [52]. | No report has been found                             |
| Bignonicaceae | <i>Tecomaria nyassae</i> L (AIM 038)         | Linyunyu                | Oral candidiasis   | Leaves    | Leaves crushed and boiled with water and gargle twice a day until healed. For oesophageal   | No report has been found  | No report has been found                             |



| Family name      | Scientific name<br>(voucher specimen<br>number)    | Vernacular name<br>(Kinga) | Uses               | Part used     | Method of<br>preparation and use  | Previous<br>supporting<br>ethnomedical<br>use (Country)   | Reported<br>Pharmacologic<br>al activities   |
|------------------|--|----------------------------|--------------------|---------------|---|---|--|
| Chrysobalanaceae | <i>Parinari curatellifolia</i><br>Benth. (AIM 047) | Lisavula                   | Cough,<br>diarrhea | Stem<br>barks | candidiasis gargle<br>and swallow twice a<br>day until healed.<br>Boil the roots and<br>decoction drunk for<br>treatment of diarrhea<br>and cough associated<br>with chest pain. Stem<br>bark can be chewed<br>raw and swallow the<br>juice. Remove the<br>external dry part.<br>Powder can be<br>administered in tea or<br>porridge. Mixed with<br><i>Erythrina abyssinica</i><br>(roots) and decoction<br>drunk for<br>management of<br>persistent diarrhea<br>even the one<br>associated with<br>HIV/AIDS. | Skin rashes,<br><i>Herpes zoster</i> ,<br><i>Herpes simplex</i> ,<br>Tuberculosis,<br>Chronic<br>diarrhea<br>(Namibia) [53].<br>Treatment of<br>diarrhea (Ivory<br>Coast) [54]. | Leaf extracts<br>inhibit biofilm<br>formation in<br><i>Mycobacterium<br/>smegmatis</i> [55].<br>Active against<br><i>Mycobacterium<br/>avium</i> [20].<br>Strong<br>antimicrobial<br>activities<br>against<br><i>Staphylococcus<br/>aureus</i> ,<br><i>Escherichia<br/>coli</i> ,<br><i>Pseudomonas<br/>aeruginosa</i> ,<br><i>Bacillus cereus</i> ,<br><i>Bacillus subtilis</i> ,<br><i>Salmonella<br/>typhi</i> , <i>Candida<br/>albicans</i> ,<br><i>Streptococcus<br/>pyrogenes</i> [21,<br>22].<br>Hepatoprotective<br>effect [56]. |

| Family name | Scientific name<br>(voucher specimen<br>number)             | Vernacular name<br>(Kinga) | Uses   | Part used   | Method of<br>preparation and use  | Previous<br>supporting<br>ethnomedical<br>use (Country)   | Reported<br>Pharmacologic<br>al activities   |
|-------------|---|----------------------------|--|---|---|---|--|
|             | <i>Parinari excelsa</i><br>Sabine. (AIM 040)                | Likanzaula                 | Warts,<br>cough, oral<br>thrush,<br>genital<br>swellings | Nodules<br>on the<br>leaves or<br>branches/s<br>tem barks | Nodules mixed with<br><i>Schoenoplectus</i><br><i>conymbosus</i> roots<br>ashes, cooked beans<br>and applied twice a<br>day for treatment of<br><i>Herpes simplex</i> . Dried<br>pulverized stem barks<br>mixed with water or<br>porridge and 1 tea<br>cup taken 3 times a<br>day for 8 days for<br>treatment of<br>persistent cough,<br>cough associated with<br>chest pain or oral<br>thrush. Dried<br>pulverized stem barks<br>mixed with fat or<br>vaseline applied to<br>the genital swelling<br>once a day until<br>healed. | Used for<br>treatment of<br>sexually<br>transmitted<br>diseases<br>(Nigeria) [30].<br>Management of<br>abdominal pain<br>and<br>constipation<br>[54]. | <i>In-vitro</i><br>antileishmanial<br>and<br>antiplasmodial<br>activity [29].                            |
| Compositae  | <i>Helichrysum</i><br><i>potulifolium</i> Bak.<br>(AIM 045) | Lufumba                    | Persistent<br>cough                                      | Roots   | Boiled with water and<br>1 tea cup is drunk 3<br>times a day for 2<br>weeks   | No report has<br>been found   | Anti-HIV<br>compounds<br>have been<br>isolated from<br><i>Helichrysum</i><br><i>populifolium</i><br>[57] |
|             | <i>Crassocephalum</i>                                       | Ludondo                    | Chronic  | Flowers   | Flower wool crushed   | Management of   | Antitumor  |

| Family name | Scientific name<br>(voucher specimen<br>number)            | Vernacular name<br>(Kinga) | Uses   | Part used | Method of<br>preparation and use   | Previous<br>supporting<br>ethnomedical<br>use (Country)  | Reported<br>Pharmacologic<br>al activities   |
|-------------|--|----------------------------|--|-----------|--|--|--|
|             | <i>crepidioides</i> (Benth)<br>S. Moore (AIM 048)          |                            | wounds even<br>those<br>associated<br>with HIV<br>AIDS |           | and applied on the<br>affected area and the<br>wound washed after<br>every 2 weeks.                                      | HIV/AIDS<br>(Uganda) [58].   | activity and<br>macrophage<br>nitric oxide<br>producing<br>action [59].<br>Anthelmintic<br>activity against<br><i>Haemonchus<br/>contortus</i> [60].   |
|             | <i>Sphaeranthus<br/>steetzii</i> Oliv &<br>Hiern.(AIM 051) | Lusumba                    | <i>Herpes<br/>zoster</i>                               | Leaves    | Crush and mix with<br>water. Some amount<br>is applied topically at<br>the affected area and<br>some amount is<br>drunk. | No report has<br>been found  | No report has<br>been found  |
|             | <i>Emilia basifolia</i> Bak.<br>(AIM 057)                  | Motodaasi                  | <i>Herpes<br/>zoster</i>                               | Leaves    | Apply crushed fresh<br>leaves on the affected<br>area. Drink the<br>decoction.   | No report has<br>been found  | No report has<br>been found  |
|             | <i>Vernonia amygdalina</i><br>Del. (AIM 066)               | Likalati                   | Oral<br>candidiasis<br>and painful<br>teeth            | Roots     | Dry and powder the<br>root bark and sieve.<br>Used for brushing<br>teeth until healed.                                   | Skin rashes,<br>Chronic<br>diarrhoea,<br><i>Herpes zoster</i> ,<br><i>Herpes simplex</i> ,<br>Cryptococcal<br>meningitis<br>(Tanzania) [61].<br>Sexually<br>transmitted<br>diseases<br>(Nigeria) [30]. | Immune<br>stimulating<br>activity on<br>HIV/AIDS<br>patients [42]. <i>In<br/>vitro</i> anti-HIV-1<br>activity [43].<br>Weak<br>actimicrobial<br>activity against<br><i>B subtilis</i> , <i>K.<br/>pneumoniae</i> , <i>P.</i> |

| Family name   | Scientific name<br>(voucher specimen<br>number)      | Vernacular name<br>(Kinga) | Uses                                    | Part used | Method of<br>preparation and use  | Previous<br>supporting<br>ethnomedical<br>use (Country)          | Reported<br>Pharmacologic<br>al activities  |
|---------------|--|----------------------------|---|-----------|---|--|---|
|               |  |                            |   |           |   | Bacterial and<br>fungal<br>infections<br>(Uganda) [62].          | <i>aeruginosa</i> , <i>P.<br/>vulgaris</i> , <i>S.<br/>dysenteriae</i> and<br><i>S. aureus</i> , anti-<br>cancer [44, 45] |
| Cucurbitaceae | <i>Telfairia pedata</i><br>Hook. f. (AIM 071)        | Litandwe                   | <i>Herpes<br/>zoster</i> ,<br>ringworms | Leaves    | Mixed with <i>Acanthus<br/>polystachins</i> burned<br>ashes mixed with<br>vaseline and applied<br>on the affected area<br>for treatment of<br><i>Herpes zoster</i> .<br>Leaves are crushed<br>and applied on the<br>affected area for<br>treatment of<br>ringworms. | No report has<br>been found                                      | No report has<br>been found   |
|               | <i>Coccinia adoensis</i><br>(A. Rich) Cogn.          | Likwawawa                  | Genital warts                           | Leaves    | Dry, burn, pulverize<br>and apply on the cut<br>genital warts   | Chicken pox,<br>cleans uterus<br>and abortive<br>(Tanzania) [63] | Anti-fungal and<br>anti-bacterial<br>activities [63].   |
| Cyperaceae    | <i>Schoenoplectus<br/>corymbosus</i> L. (AIM<br>046) | Lilulu                     | Genital<br>warts, other<br>warts        | Roots     | Pound, dry and<br>applied topically on<br>the cut genital<br>swellings for<br>management of<br>genital warts. Mixed<br>with <i>Paripari excelsa</i><br>nodules on leaves<br>and stem, cooked<br>beans and applied   | No report has<br>been found                                      | No report has<br>been found   |

| Family name    | Scientific name (voucher specimen number)             | Vernacular name (Kinga) | Uses   | Part used        | Method of preparation and use  | Previous supporting ethnomedical use (Country)   | Reported Pharmacologic al activities   |
|----------------|---|-------------------------|--|------------------|--|--|--|
|                |   |                         |  |                  | twice a day to skin for management of warts.   |  |  |
| Ebenaceae      | <i>Diospyros whyteana</i> (Hiern) F. White. (AIM 073) | Takamimbi               | <i>Herpes zoster</i>   | Leaves           | Mixed with <i>Panicum sp</i> leaves. Pound together. You can mix with fat or vaseline and apply once a day.  | Dysmenorrhea, rashes and antibacterial (South Africa) [64]   | Antimutagenic activity [64]  |
| Euphorbiaceae  | <i>Bridelia micrantha</i> (Hochst.) Bail (AIM 041)    | Likongoti               | All types of diarrhoea, vaginal candidiasis, tuberculosis, pneumonia | Roots/stem barks | Cut into small pieces, boiled with water and drunk 1 tea cup of the decoction twice a day until healed for management of all types of diarrhea and pneumonia. For management of vaginal candidiasis dried, pulverized and mixed with fat or vasceline applied and the decoction drunk once a day until healed. | Management of HIV/AIDS (Uganda) [58]. Management of sexually transmitted diseases (Kenya) [65]. Management of diarrhea (Kenya) [66]. | Inhibition of HIV-1 reverse transcriptase enzyme [32, 33]. <i>In vitro</i> anti-tuberculosis activity [35]. Antibacterial activity against <i>S aureus</i> , <i>S sonnei</i> , <i>S typhimurium</i> and <i>H pylori</i> [34]. Week antifungal activity [31]. |
| Flacourtiaceae | <i>Aphloia theiformis</i> (vahl) Benn. (AIM 067)      | Litekenyelela           | Weight loss  | Roots            | Mixed with <i>Nuxia congesta</i> roots. One teacup of decoction is drunk 3 times a day for 3 days.   | A tea made from the leaves is drunk for dysentery, jaundice and fever [67].  | Antibacterial activity against <i>E. coli</i> , <i>P. aeruginosa</i> , <i>S. typhi</i> , <i>S. aureus</i> [67]. Immunostimula  |

| Family name          | Scientific name<br>(voucher specimen<br>number)                               | Vernacular name<br>(Kinga) | Uses  | Part used | Method of<br>preparation and use   | Previous<br>supporting<br>ethnomedical<br>use (Country) | Reported<br>Pharmacologic<br>al activities  |
|----------------------|---|----------------------------|---|-----------|--|---|---|
|                      |   |                            |   |           |  |   | nt effect on<br>monocytes and<br>granulocytes at<br>high doses [68].  |
| Graminae             | <i>Panicum sp.</i> (AIM<br>070)   | Lusuta                     | Skin rashes,<br>herpes<br>zoster            | Leaves    | Crushed and applied<br>on the affected areas<br>once a day during the<br>night for treatment of<br>skin rashes. Mixed<br>with <i>Diospyris</i><br><i>whyteana</i> roots and<br>pounded together. It<br>can be mixed with<br>vasceline and applied<br>once a day for<br>treatment of <i>Herpes</i><br><i>zoster</i> | No report has<br>been found                             | Some plants<br>from this genus<br>have been<br>reported to<br>have antifungal<br>and<br>antibacterial<br>activities<br>including<br><i>Panicum</i><br><i>turgidum</i> and<br><i>Panicum</i><br><i>maximum</i> [69,<br>70] |
| Leguminosae          | <i>Indigofera atriceps</i><br>Hook. f.  | Luvunguvungu               | Persistent<br>cough                         | Roots     | Roots rolled in<br>banana leaves and<br>warmed on fire. The<br>roots are then<br>chewed and juice<br>swallowed for<br>management of<br>persistent cough  | No report has<br>been found                             | No report has<br>been found   |
| Leguminosae<br>(Pap) | <i>Humularia</i><br><i>drepanocephala</i><br>(Baker) P.A Duvign.<br>(AIM 064) | Sitsukuni                  | Oral<br>candidiasis<br>and painful<br>teeth | Roots     | Dry, powder the root<br>bark and sieve. Used<br>for brushing teeth<br>until healed.  | No report has<br>been found                             | No report has<br>been found   |
|                      | <i>Eriosema affine</i> de   | Kinektsuva                 | Frequent                                    | Roots     | Boil fresh roots with  | No report has   | No report has   |

| Family name | Scientific name<br>(voucher specimen<br>number)          | Vernacular name<br>(Kinga) | Uses  | Part used  | Method of<br>preparation and use   | Previous<br>supporting<br>ethnomedical<br>use (Country)  | Reported<br>Pharmacologic<br>al activities   |
|-------------|--|----------------------------|---|------------|--|--|--|
|             | Wild (065)   |                            | fevers  |            | water. The water is<br>used for bathing.   | been found   | been found   |
|             | <i>Erythrina abyssinica</i><br>DC. (AIM 068)             | Livenge                    | Diarrhoea<br>including HIV<br>associated<br>diarrhoea | Roots      | Mixed with <i>Paripari<br/>curatellifolia</i> (stem<br>barks). One litre of<br>decoction is taken<br>once a day for 2<br>weeks.          | Stem bark and<br>root decoction<br>used in diarrhea<br>dysentery and<br>jaundice<br>(Tanzania) [71].<br>Used in the<br>management of<br>HIV/AIDS<br>related<br>conditions<br>(Uganda) [58,<br>72]. Dysentery<br>(Rwanda) [73]. | It contains Anti-<br>HIV-1 alkaloids<br>[Mohammed et<br>al 2013]   |
|             | <i>Dolichos<br/>kilimandscharicus</i><br>Taub. (AIM 062) | Nyolia                     | Diarrhea,<br>stomach<br>problems                      | Root/Tuber | Grind, boil with water<br>and sieve. One tea<br>cup taken once a day<br>for 5 days.  | Dysentery,<br>Newcastle in<br>chicken,<br>rheumatism,<br>scabies and<br><i>Herpes zoster</i><br>(Malawi) [74].   | Antibacterial<br>and anticancer<br>activities [75].<br>In-vitro and<br>in-vivo broad<br>spectrum and<br>antifungal<br>activity [76, 77]. |
| Liliaceae   | <i>Asparagus africanus</i><br>L. (AIM 043)               | Linyenyele                 | <i>Herpes<br/>zoster</i> ,<br>syphilis                | Roots      | Fresh roots boiled<br>with water and 1/2 a<br>litre is taken twice a<br>day for 2 weeks for<br>treatment of herpes<br>zoster or syphilis | Diarrhoea,<br>pneumonia<br>(Zimbabwe)<br>[23]. Skin<br>lesions<br>(Ethiopia) [24].<br>Tuberculosis   | Antimycobacteri<br>al activity [27].   |

| Family name         | Scientific name<br>(voucher specimen<br>number)              | Vernacular name<br>(Kinga) | Uses   | Part used | Method of<br>preparation and use   | Previous<br>supporting<br>ethnomedical<br>use (Country)<br>and related<br>ailments<br>(Uganda) [25].<br>Eczema<br>(Namibia) [78]. | Reported<br>Pharmacologic<br>al activities      |
|---------------------|--|----------------------------|--|-----------|--|---|---|
| Loganiaceae         | <i>Nuxia congesta</i> R.<br>Br. ex. Fresen (AIM<br>072)      | Likongoti                  | Weight loss,<br>gonorrhea,<br>frequent<br>fevers | Roots     | Mixed with <i>Aphlola<br/>theiformis</i> roots and<br>take 1 tea cup up to 3<br>times a day for 3 days<br>for management of<br>weight loss. Mixed<br>with <i>Protea<br/>angolensis</i> Leaves<br>and 1/2 a tea cup of<br>decoction is drunk<br>twice a day until<br>healed, some amount<br>may be applied locally<br>on the genitals for<br>treatment of<br>gonorrhea. 1/2 a tea<br>cup of leaves<br>decoction drunk twice<br>a day for treatment of<br>frequent fevers. | No report has<br>been found   | No report has<br>been found                     |
| Melastomatoce<br>ae | <i>Dissotis polyantha</i><br>Gilg. (AIM 042)                 | Likekele                   | Persistent<br>cough                              | Roots     | One litre of decoction<br>is taken per day for 7<br>days   | No report has<br>been found   | No report has<br>been found                     |
| Myristicaceae       | <i>Myrica salicifolia</i><br>Hochst. exA. Rich.<br>(AIM 044) | Likufya/Likhuswa           | Diarrhoea  | Roots     | Mixed with <i>Paripari<br/>excelsa</i> boiled with<br>water or crushed and   | Tuberculosis,<br>chronic<br>diarrhea,   | Inhibition of<br>HIV-1 reverse<br>transcriptase |



| Family name    | Scientific name<br>(voucher specimen<br>number)      | Vernacular name<br>(Kinga) | Uses     | Part used | Method of<br>preparation and use   | Previous<br>supporting<br>ethnomedical<br>use (Country)   | Reported<br>Pharmacologic<br>al activities   |
|----------------|--|----------------------------|----------|-----------|--|---|--|
|                |  |                            |          |           | mixed with water and filtered. 1/2 a litre taken in the morning and 1/2 a litre of <i>Paripari excelsa</i> preparation to be taken in the evening. | Cryptococcal meningitis, <i>Herpes simplex</i> (Tanzania) [79].   | enzyme [28]. Antifungal activities against <i>C. albicans</i> and <i>C. neoformans</i> [80]  |
| Myrothamnaceae | <i>Myrothamnus flabellifolius</i> Welw (AIM AIM 069) | Mwangiwe                   | Dysentry | Leaves    | Mixed with <i>Toddalia asiatica</i> roots, and 1 tea cup of decoction is drunk 3 times a day to treat dysentery without stomach pain               | Inhalation of smoke from burning leaves to treat chest complaints, together with butter of aromatic salves for wound sterilization, herbal teas and decoctions to treat coughs, influenza, mastitis, backache, kidney disorders, haemorrhoids and abdominal pains as well as the mastication of the leaves to treat scurvy, | 3,4,5-tri-O-galloylquinic acids have anti-HIV reverse transcriptase activity [82]. Antiviral activity against <i>Herpes simplex</i> virus type 1 by inhibition of viral adsorption and penetration [48]. |

| Family name    | Scientific name (voucher specimen number)               | Vernacular name (Kinga) | Uses   | Part used         | Method of preparation and use  | Previous supporting ethnomedical use (Country)                         | Reported Pharmacologic al activities  |
|----------------|---|-------------------------|--|-------------------|--|--|---|
|                |   |                         |  |                   |  | halitosis and Vincent's gingivitis [81].                               |   |
| Oleaceae       | <i>Olea europaea</i> L. (AIM 039)                       | Lidonko                 | Frequent fevers, boils   | Stem barks        | Pounded, dried and the powder taken with water twice a day for 9 days for management of frequent fevers. The powder can be mixed with fat or vaselline and applied on the boils once a day until healed. | Fever, bacterial infections, diarrhoea, urinary tract infections [83]. | Anticancer, antimicrobial, antifungal, antiviral and antioxidant activity [83]. Antimicrobial activity against <i>H. pylori</i> and <i>C. jejuni</i> [84]. Anti-diarrhea activity [85]. |
| Orelidaceae    | <i>Eulophia angolensis</i> (Rchb.f.) Summerh. (AIM 060) | Linzapila               | Genital warts  | Tuber (root)      | Rub the warts with a sliced tuber. Apply twice or thrice a day until it is removed. Decoction can be prepared.   | No report has been found   | No report has been found  |
| Passifloraceae | <i>Adenia gummifera</i> (Harv.) Harms. (AIM 055)        | Ngolomoko               | Weight loss, loss of appetite, <i>Herpes zoster</i> , low immunity |                   | Crushed, boiled with water and the decoction drunk   | Oral candidiasis (Tanzania) [61]. Gonorrhoea (South Africa) [86].      | No report has been found  |
| Proteaceae     | <i>Protea angolensis</i> Welw. (AIM 053)                | Lihenye                 | Diarrhea, gonorrhoea   | Stem barks/leaves | Decoction mixed with <i>Ficalhoa laurifolia</i> dried root powder and 1 tea cup is drunk   | No report has been found   | No report has been found  |

| Family name | Scientific name<br>(voucher specimen<br>number) | Vernacular name<br>(Kinga) | Uses                                    | Part used    | Method of<br>preparation and use   | Previous<br>supporting<br>ethnomedical<br>use (Country)  | Reported<br>Pharmacologic<br>al activities   |
|-------------|---|----------------------------|---|--------------|--|--|--|
|             |   |                            |   |              | twice a day for management of diarrhea in adults and babies can take 1 table spoonful twice a day after meal. Leaves mixed with <i>Nuxia congesta</i> dried, boiled with water and 1/2 a tea cup drunk twice a day until healed. Some amount can be applied locally around the genitals. |  |  |
| Rubiaceae   | <i>Rubia cordifolia</i> L.<br>(AIM 059)         | Lukenekene                 | Loss of appetite and anaemia            | Roots        | Boil or grind and 1 tea spoonful is taken twice a day.   | Stomach problems (India) [87]  | In-vitro anti-rotavirus activity [88]. In-vitro anti-HIV activity [38].  |
| Rutaceae    | <i>Toddalia asiatica</i> (L)<br>Lam. (AIM 063)  | Tonang'ele                 | All types of diarrhea, warts, hepatitis | Roots/leaves | Mixed with <i>Myrothamnus flabellifolius</i> leaves and 1 tea cup of decoction is drunk 3 times a day for treatment of dysentery. Leaves mixed with <i>Diospyris whyteana</i> leaves pounded, dried, mixed with fat/vaselline and  | Decoctions or concoctions and administered orally for the management of a number of disease conditions including stomach problems, | Anti-HIV-1 alkaloids [90]. Isolated compound Flindersine has antibacterial and antifungal activities [91]. Anticancer activity [92]. |

| Family name | Scientific name<br>(voucher specimen<br>number) | Vernacular name<br>(Kinga) | Uses   | Part used            | Method of<br>preparation and use   | Previous<br>supporting<br>ethnomedical<br>use (Country) | Reported<br>Pharmacologic<br>al activities  |
|-------------|---|----------------------------|--|----------------------|--|---|---|
|             |   |                            |  |                      | applied topically for warts. Roots pound and the decoction drunk together with eating sugar cane   | cough, chest pain, sore throat (East Africa) [89].      |   |
| Solanaceae  | <i>Physalis peruviana</i> L.<br>(AIM 049)       | Lisongo                    | Diarrhoea  | Leaves               | Taken with <i>Myrica salicifolia</i> leaves boiled with water or crushed and mixed with water, filtered and 1/2 a litre drunk in the evening while <i>Myrica salicifolia</i> decoction is drunk in the morning.  | Gastrointestinal infections (Uganda) [62].              | Antimicrobial activity against <i>E. coli</i> , <i>K. pneumoniae</i> , <i>P. aeruginosa</i> , <i>P. vulgaris</i> , <i>S. aureus</i> , <i>C. albicans</i> , <i>E. aerogenes</i> ; anti-cancer properties [93, 94]. |
| Theaceae    | <i>Ficalhoa laurifolia</i><br>Hiern. (AIM 056)  | Ligemusi                   | Cough,<br>diarrhea,<br>urinary tract<br>infections,<br>eye<br>infections | Roots/ste<br>m barks | Roots mixed with <i>Pimpinella b Buchananii</i> roots and 2 table spoonful of the powder is taken in tea 3 times a day for 2 weeks for treatment of persistent cough. Decoction of the stem bark is taken twice a day for treatment of cough associated with chest pain. Stem barks mixed with | No report has been found                                | No report has been found  |

| Family name  | Scientific name<br>(voucher specimen<br>number)       | Vernacular name<br>(Kinga) | Uses   | Part used | Method of<br>preparation and use   | Previous<br>supporting<br>ethnomedical<br>use (Country) | Reported<br>Pharmacologic<br>al activities |
|--------------|---|----------------------------|--|-----------|--|---|--|
|              |   |                            |  |           | <i>Protea angolensis</i><br>roots and the dry<br>powder mixed with<br>decoction from <i>Protea<br/>angolensis</i> roots for<br>treatment of diarrhea,<br>1 tea cup is drunk<br>twice a day and<br>babies can take 1<br>table spoonful twice a<br>day after meal.<br>Decoction from stem<br>barks used in the<br>treatment of urinary<br>tract infections and<br>eye infections, 1/2 a<br>tea cup is taken 3<br>times a day until<br>cured. |   |  |
| Umbelliferae | <i>Pimpinella<br/>buchananii</i> H. Wolf<br>(AIM 052) | Luguguna                   | Persistent<br>cough,<br>weight loss,<br>loss of<br>appetite,<br>syphilis | Roots     | Mixed with <i>Ficalhoa<br/>laurifolia</i> stem bark.<br>Mixed, pounded,<br>boiled with water and<br>a tea mixed with 2<br>table spoonful of the<br>decoction is taken 3<br>times a day for 2<br>weeks for persistent<br>cough. One tea cup of<br>decoction is drunk<br>twice a day for   | No report has<br>been found                             | No report has<br>been found                |

| Family name | Scientific name<br>(voucher specimen<br>number)                        | Vernacular name<br>(Kinga) | Uses                         | Part used       | Method of<br>preparation and use  | Previous<br>supporting<br>ethnomedical<br>use (Country) | Reported<br>Pharmacologic<br>al activities   |
|-------------|--|----------------------------|------------------------------|-----------------|---|---|--|
|             |  |                            |                              |                 | management of weight loss and loss of appetite. Dried powder mixed with <i>Aloe sp</i> and water drunk 3 times a day for treatment of syphilis.   |   |  |
| Vitidaceae  | <i>Rhoicissus tridentata</i><br>(L.f.)Wild &<br>R.B.Drumm (AIM<br>061) | Lingubengube               | Warts,<br>Prostate<br>cancer | Aerial<br>parts | Decoction is drunk for treatment of prostate cancer. Mixed with <i>Myrothamnus flabellifolius</i> leaves and <i>Toddalia asiatica</i> and 1 tea cup of decoction is drunk 3 times a day for management of dysentery. Mixed with <i>Toddalia asiatica</i> leaves pounded, dried and mixed with fat or vascelline and applied topically for treatment of warts. | <i>Herpes zoster</i><br>(Tanzania) [61].                | HIV-1 reverse transcriptase activity, antimicrobial and anti-inflammatory activities [36]. In- <i>vitro</i> anti- <i>Mycobacterium tuberculosis</i> activity [35]. Antifungal activities [37]. |

#### 4. CONCLUSION

The ethnopharmacological data generated in this study can serve as a resource for identification and characterization of traditional medicinal plants as sources for search of anti-HIV or anti-microbial therapeutic natural products. The data can serve in provision of leads in the discovery of indigenous novel anti-retroviral and anti-microbial drugs. Moreover, studies are required to systematically determine the anti-HIV, anti-microbial, cytotoxic activity, dosages and active chemical compounds of the plants. Also studies on effect of combination of plants may give an insight into their effect in treatment as used by the indigenous communities.

#### CONSENT

All THPs gave prior written informed consent before they were interviewed.

#### ETHICAL APPROVAL

This study was awarded Ethical Clearance by the Muhimbili University of Health and Allied Sciences 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 Makete District was sought from all authorities from the District to village level.

#### ACKNOWLEDGEMENTS

We are grateful to the THPs who participated in this study and shared their knowledge of the use of medicinal plants including Mr. Cosmas Thobias, Ms. Alitsa Kalenga Sanga, Mr. Sinamali N Nundu, Ms. Lina Philemon Kyando, Ms. Grace Jackson Chengula, Mr. Paulo Simon Tweve, Mr. Hassanali Ludali Tweve, Mr. Major Pakipande Sanga, Mr. Tukutage Maganga Sanga and Mr. Kijiji Desturi Kalomo Chaula. We are also thankful to Mr. Selemani Haji, Botanist from University of Dar es Salaam for plant identification. The authors are thankful to TRISUSTAIN project "Economic, ecological and therapeutic sustainability in the development of phytopharmaceuticals for Sub-Saharan Africa" funded by the Federal Ministry of Education and Research (BMBF, 01DG17008B) and the German Academic Exchange Service (DAAD 57369155).

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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