

Original Research Article

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

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.

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. MATERIAL 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 °, 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.

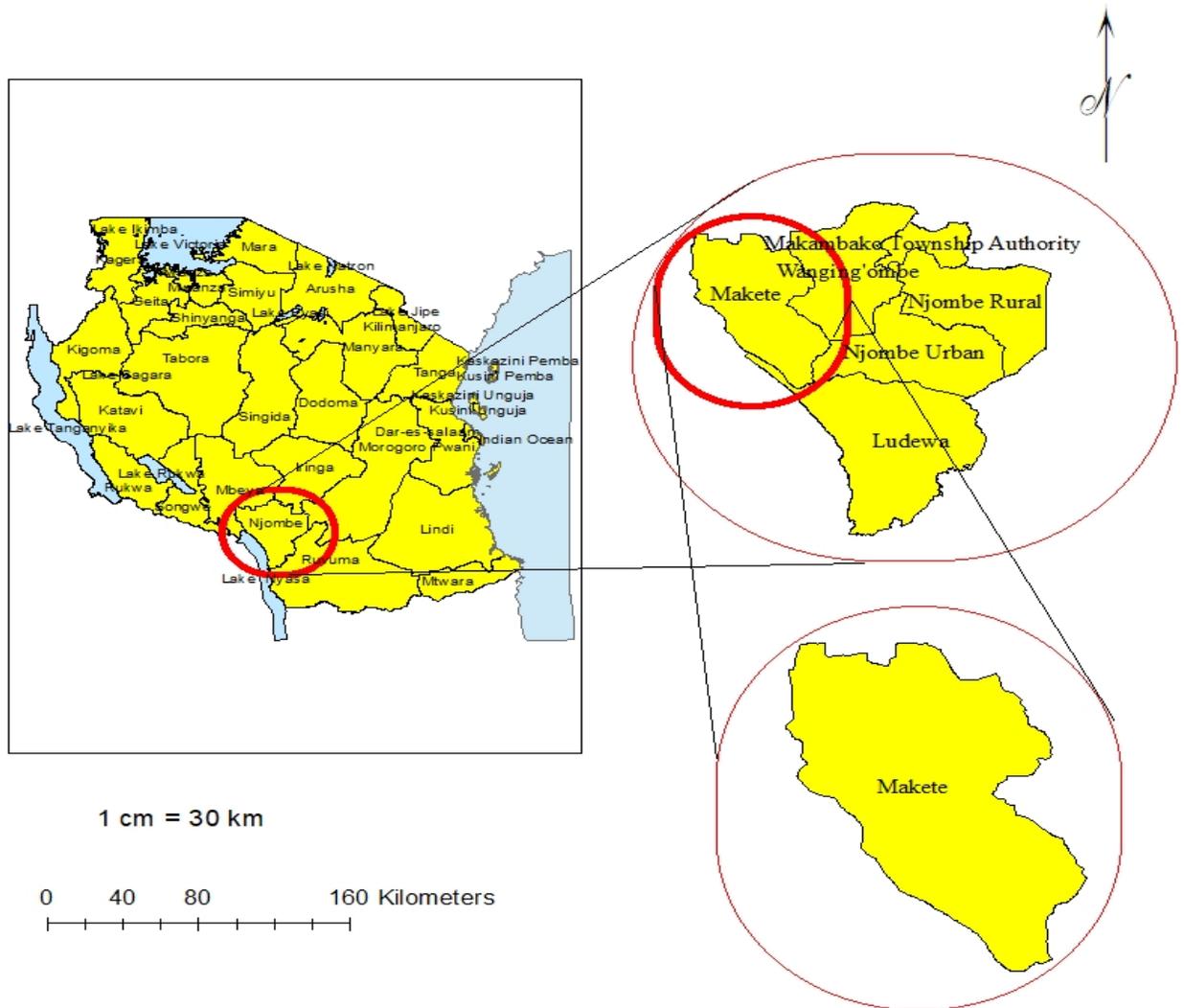


Fig. 1. Map showing the location of Makete District in Njombe Region, Tanzania. The map was originally generated using ArcGIS software version 10.7.1 (<https://www.esri.uconn.edu/software/arcgis-student/>)

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” literally 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.

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.

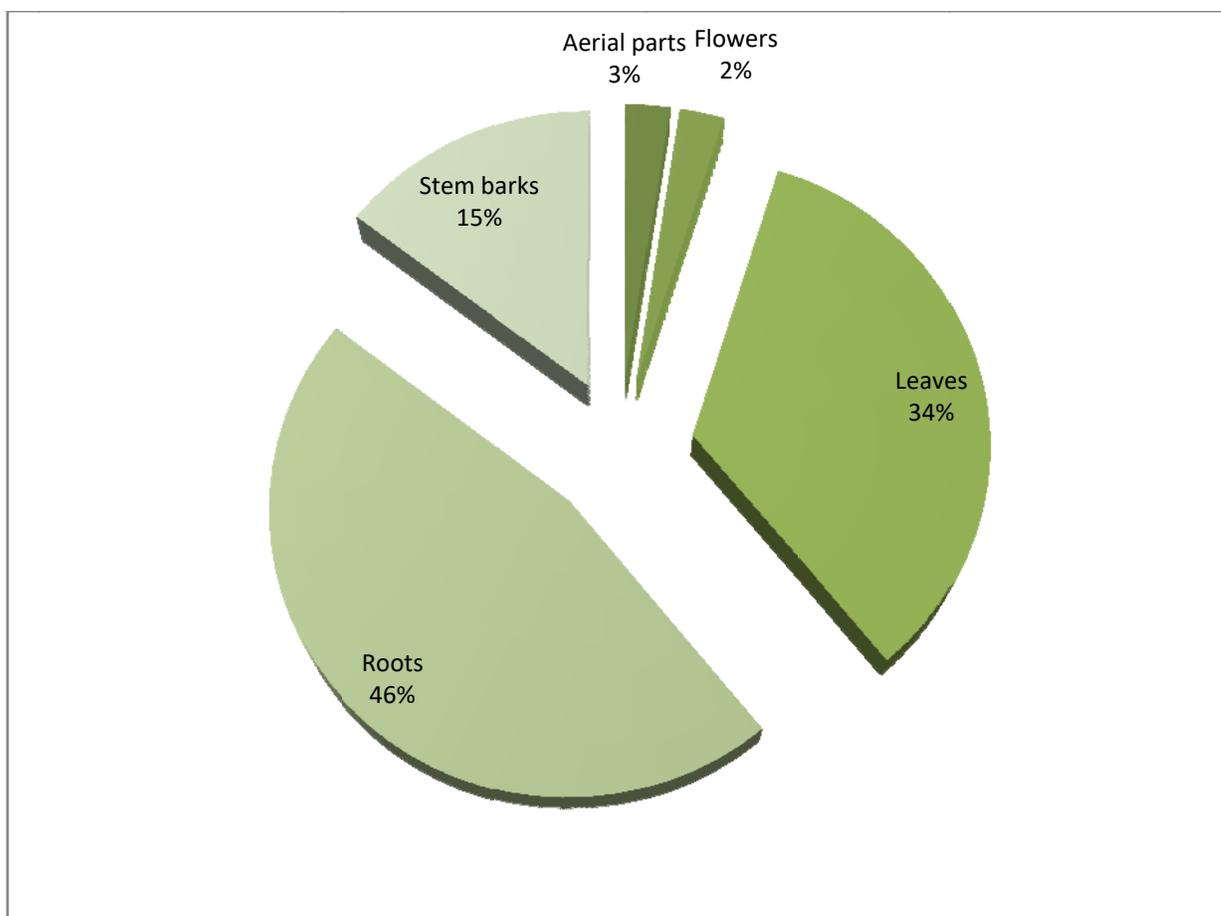


Fig. 2. Percentage use of plant parts

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].

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 antimicrobial 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, antimicrobial 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.

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/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/muluv elo	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	Leaves are used in management of fungal infections, typhoid and wounds (Tanzania) [52].	No report has 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 Pharmacological activities
Bignoniaceae	<i>Tecomaria nyassae</i> L (AIM 038)	Linyunyu	Oral candidiasis	Leaves	Leaves with water and drunk for treatment of skin rashes and <i>Herpes zoster</i> . Leaves crushed and boiled with water and gargle twice a day until healed. For oesophageal candidiasis gargle and swallow twice a day until healed.	No report has been found	No report has been found
Chrysobalanaceae	<i>Parinari curatellifolia</i> Benth. (AIM 047)	Lisavula	Cough, diarrhea	Stem barks	Boil the roots and decoction drunk for treatment of diarrhea and cough associated with chest pain. Stem bark can be chewed raw and swallow the	Skin rashes, <i>Herpes zoster</i> , <i>Herpes simplex</i> , Tuberculosis, Chronic diarrhea (Namibia) [53]. Treatment of diarrhea	Leaf extracts inhibit biofilm formation in <i>Mycobacterium smegmatis</i> [55]. Active against <i>Mycobacterium avium</i> [20]. Strong antimicrobial activities against

Family name	Scientific name (voucher specimen number)	Vernacular name (Kinga)	Uses	Part used	Method of preparation and use	of Previous supporting ethnomedical use (Country)	Reported Pharmacological activities
					juice. Remove the external dry part. Powder can be administered in tea or porridge. Mixed with <i>Erythrina abyssinica</i> (roots) and decoction drunk for management of persistent diarrhea even the one associated with HIV/AIDS.	(Ivory Coast) [54].	<i>Staphylococcus aureus</i> , <i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , <i>Bacillus cereus</i> , <i>Bacillus subtilis</i> , <i>Salmonella typhi</i> , <i>Candida albicans</i> , <i>Streptococcus pyrogenes</i> [21, 22]. Hepatoprotective effect [56].
	<i>Parinari excelsa</i> Sabine. (AIM 040)	Likanzaula	Warts, cough, oral thrush, genital swellings	Nodules on the leaves or branches/stem barks	Nodules mixed with <i>Schoenoplectus conymbosus</i> roots ashes, cooked beans and applied twice a day for treatment of <i>Herpes simplex</i> . Dried	Used for treatment of sexually transmitted diseases (Nigeria) [30]. Management of abdominal pain and constipation [54].	<i>In-vitro</i> antileishmanial and antiplasmodial activity [29].

Family name	Scientific name (voucher specimen number)	Vernacular name (Kinga)	Uses	Part used	Method of preparation and use	of Previous supporting ethnomedical use (Country)	Reported Pharmacological activities
Compositae	<i>Helichrysum populifolium</i> Bak. (AIM 045)	Lufumba	Persistent cough	Roots	pulverized stem barks mixed with water or porridge and 1 tea cup taken 3 times a day for 8 days for treatment of persistent cough, cough associated with chest pain or oral thrush. Dried pulverized stem barks mixe with fat/vaseline applied to the genital swelling once a day until healed.	No report has been found	Anti-HIV compounds have been isolated from <i>Helichrysum populifolium</i> [57]
	<i>Crassocephalum crepidioides</i>	Ludondo	Chronic wounds	Flowers	Flower crushed	wool and	Management of HIV/AIDS activity and

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
	(Benth) S. Moore (AIM 048)		even those associated with HIV AIDS		applied on the affected area and the wound washed after every 2 weeks.	(Uganda) [58].	macrophage nitric oxide producing action [59]. Antihelmintic activity against <i>Haemonchus contortus</i> [60].
	<i>Sphaeranthus steetzii</i> Oliv & Hiern.(AIM 051)	Lusumba	<i>Herpes zoster</i>	Leaves	Crush and mix with water. Some amount is applied topically at the affected area and some amount is drunk.	No report has been found	No report has been found
	<i>Emilia basifolia</i> Bak. (AIM 057)	Motodaasi	<i>Herpes zoster</i>	Leaves	Apply crushed fresh leaves on the affected area. Drink the decoction	No report has been found	No report has been found
	<i>Vernonia amygdalina</i> Del. (AIM 066)	Likalati	Oral candidiasis and painful teeth	Roots	Dry and powder the root bark and sieve. Used for brushing teeth until healed.	Skin rashes, Chronic diarrhoea, <i>Herpes zoster</i> , <i>Herpes simplex</i> , Cryptococcal	Immune stimulating activity on HIV/AIDS patients [42]. <i>In vitro</i> anti-HIV-1 activity [43]. Weak

Family name	Scientific name (voucher specimen number)	Vernacular name (Kinga)	Uses	Part used	Method of preparation and use	of Previous supporting ethnomedical use (Country)	Reported Pharmacologic activities
Cucurbitaceae	<i>Telfairia pedata</i> Hook. f. (AIM 071)	Litandwe	<i>Herpes zoster</i> , ringworms	Leaves	Mixed with <i>Acanthus polystachins</i> burned ashes with vaseline and applied on the affected area for treatment of <i>Herpes zoster</i> . Leaves are crushed and applied on the affected area for treatment of ringworms.	meningitis (Tanzania) [61]. Sexually transmitted diseases (Nigeria) [30]. Bacterial and fungal infections (Uganda) [62]. No report has been found	actimicrobial activity against <i>B subtilis</i> , <i>K. pneumoniae</i> , <i>P. aeruginosa</i> , <i>P. vulgaris</i> , <i>S. dysenteriae</i> and <i>S. aureus</i> , anti-cancer [44, 45] No report has been found
	<i>Coccinia adoensis</i> (A. Rich) Cogn.	Likwawawa	Genital warts	Leaves	Dry, burn, pulverize and apply on the	Chicken pox, cleans uterus and abortive	Anti-fungal and anti-bacterial activities [63].

Family name	Scientific name (voucher specimen number)	Vernacular name (Kinga)	Uses	Part used	Method of preparation and use	of Previous supporting ethnomedical use (Country)	Reported Pharmacological activities
Cyperaceae	<i>Schoenoplectus corymbosus</i> L. (AIM 046)	Lilulu	Genital warts, other warts	Roots	cut warts Pound, dry and applied topically on the cut genital swellings for management of genital warts. Mixed with <i>Paripari excelsa</i> nodules on leaves and stem, cooked beans and applied twice a day to skin for management of warts.	genital (Tanzania) [63] No report has been found	No report has been found
Ebenaceae	<i>Diospyros whyteana</i> (Hiern) White. (AIM 073)	Takamimbi F. (AIM)	<i>Herpes zoster</i>	Leaves	Mixed with <i>Panicum sp</i> leaves. Pound together. You can mix with fat/vaseline and apply once a day.	Dysmenorrhoea, rashes and antibacterial (South Africa) [64]	Antimutagenic activity [64]
Euphorbiaceae	<i>Bridelia micrantha</i>	Likongoti	All types of diarrhoea,	Roots/stem barks	Cut into small pieces, boiled	Management of HIV/AIDS	Inhibition of HIV-1 reverse

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
	(Hochst.) Bail (AIM 041)		vaginal candidiasis, tuberculosis, pneumonia		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, pulverizee and mixed with fat/vascelline applied and the decoction drunk once a day until healed.	(Uganda) [58]. Management of sexually transmitted diseases (Kenya) [65]. Management of diarrhea (Kenya) [66].	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 (voucher specimen number)	Vernacular name (Kinga)	Uses	Part used	Method of preparation and use	Previous supporting ethnomedical use (Country)	Reported Pharmacological activities
Graminae	<i>Panicum</i> sp. (AIM 070)	Lusuta	Skin rashes, herpes zoster	Leaves	Crushed and applied on the affected areas once a day during the night for treatment of skin rashes. Mixed with <i>Diospyris whyteana</i> roots and pounded together. It can be mixed with vasceline and applied once a day for treatment of <i>Herpes zoster</i>	No report has been found	ant effect on monocytes and granulocytes at high doses [68]. Some plants from this genus have been reported to have antifungal and antibacterial activities including <i>Panicum turgidum</i> and <i>Panicum maximum</i> [69, 70]
Leguminosae	<i>Indigofera atriceps</i> Hook. f.	Luvunguvungu	Persistent cough	Roots	Roots rolled in banana leaves and warmed on fire. The roots are then chewed and juice swallowed for	No report has been found	No report has 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 Pharmacological activities
Leguminosae (Pap)	<i>Humularia drepanocephala</i> (Baker) P.A Duvign. (AIM 064)	Sitsukuni	Oral candidiasis and painful teeth	Roots	management of persistent cough Dry, powder the root bark and sieve. Used for brushing teeth until healed.	No report has been found	No report has been found
	<i>Eriosema affine</i> de Wild (065)	Kinektsuva	Frequent fevers	Roots	Boil fresh roots with water. The water is used for bathing.	No report has been found	No report has been found
	<i>Erythrina abyssinica</i> DC. (AIM 068)	Livenge	Diarrhoea including HIV associated diarrhoea	Roots	Mixed with <i>Paripari curatellifolia</i> (stem barks). One litre of decoction is taken once a day for 2 weeks.	Stem bark and root decoction used in diarrhea dysentery and jaundice (Tanzania) [71]. Used in the management of HIV/AIDS related conditions (Uganda) [58, 72]. Dysentery (Rwanda)	It contains Anti-HIV-1 alkaloids [Mohammed et al 2013]

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
	<i>Dolichos kilimandscharicus</i> Taub. (AIM 062)	Nyolia	Diarrhea, stomach problems	Root/Tuber	Grind, boil with water and sieve. One tea cup taken once a day for 5 days.	Dysentery, Newcastle in chicken, rheumatism, scabies and <i>Herpes zoster</i> (Malawi) [73].	Antibacterial and anticancer activities [75]. In-vitro and invivo broad spectrum and antifungal activity [76, 77].
Liliaceae	<i>Asparagus africanus</i> L. (AIM 043)	Linyenyele	<i>Herpes zoster</i> , syphilis	Roots	Fresh roots boiled with water and 1/2 a litre is taken twice a day for 2 weeks for treatment of herpes zoster or syphilis	Diarrhoea, pneumonia (Zimbabwe) [23]. Skin lesions (Ethiopia) [24]. Tuberculosis and related ailments (Uganda) [25]. Eczema (Namibia) [78].	Antimycobacterial activity [27].
Loganiaceae	<i>Nuxia congesta</i> R. Br. ex. Fresen (AIM 072)	Likongoti	Weight loss, gonorrhoea, frequent fevers	Roots	Mixed with <i>Aphlola theiformis</i> roots and take 1 tea cup up to 3 times a day for 3 days for	No report has been found	No report has 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 Pharmacological activities
					management of weight loss. Mixed with <i>Protea angolensis</i> Leaves and 1/2 a tea cup of decoction is drunk twice a day until healed, some amount may be applied locally on the genitals for treatment of gonorrhoea. 1/2 a tea cup of leaves decoction drunk twice a day for treatment of frequent fevers.		
Melastomatoceae	<i>Dissotis polyantha</i> Gilg. (AIM 042)	Likekele	Persistent cough	Roots	One litre of decoction is taken per day for 7 days	No report has been found	No report has been found
Myristicaceae	<i>Myrica salicifolia</i> Hochst. exA.	Likufya/Likhuswa	Diarrhoea	Roots	Mixed with <i>Paripari excelsa</i> boiled	Tuberculosis, chronic diarrhea,	Inhibition of HIV-1 reverse transcriptase

Family name	Scientific name (voucher specimen number)	Vernacular name (Kinga)	Uses	Part used	Method of preparation and use	of Previous supporting ethnomedical use (Country)	Reported Pharmacological activities
	Rich. (AIM 044)				with water or crushed and 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	Dysentery	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,	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	of Previous supporting ethnomedicinal use (Country)	Reported Pharmacological activities
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/vaselline and applied on the boils once a day until	Fever, bacterial infections, diarrhoea, urinary tract infections [83]. mastitis, backache, kidney disorders, haemorrhoids and abdominal pains as well as the mastication of the leaves to treat scurvy, halitosis and Vincent's gingivitis [81].	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].

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
Orelidaceae	<i>Eulophia angolensis</i> (Rchb.f.) Summerh. (AIM 060)	Linzapila	Genital warts	Tuber (root)	healed. 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 twice a day for management of diarrhea in adults and babies can take 1 table spoonful twice	No report has been found	No report has been found

Family name	Scientific name (voucher specimen number)	Vernacular name (Kinga)	Uses	Part used	Method of preparation and use	of Previous supporting ethnomedical use (Country)	Reported Pharmacological activities
Rubiaceae	<i>Rubia cordifolia</i> L. (AIM 059)	Lukenekene	Loss of appetite and anaemia	Roots	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.	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) 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	Decoctions or concoctions and administered orally for the management of a number of disease conditions including stomach	Anti-HIV-1 alkaloids [90]. Isolated compound Flindersine has antibacterial and antifungal activities [91]. Anticancer activity [92].

Family name	Scientific name (voucher specimen number)	Vernacular name (Kinga)	Uses	Part used	Method of preparation and use	of Previous supporting ethnomedical use (Country)	Reported Pharmacological activities
Solanaceae	<i>Physalis peruviana</i> (AIM 049)	Lisongo	Diarrhoea	Leaves	with <i>Diospyris whyteana</i> leaves pounded, dried, mixed with fat/vaselline and applied topically for warts. Roots pound and the decoction drunk together with eating sugar cane 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.	problems, cough, chest pain, sore throat (East Africa) [89]. 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].

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
Theaceae	<i>Ficalhoa laurifolia</i> Hiern. (AIM 056)	Ligemusi	Cough, diarrhea, urinary tract infections, eye infections	Roots/stem barks	Roots mixed with <i>Pimpinella b Buchananii</i> roots and 2 table spoonfull 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 <i>Protea angolensis</i> roots and the dry powder mixed with decoction from <i>Protea angolensis</i>	No report has been found	No report has been found

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

Family name	Scientific name (voucher specimen number)	Vernacular name (Kinga)	Uses	Part used	Method of preparation and use	of Previous supporting ethnomedical use (Country)	Reported Pharmacological activities
Vitidaceae	<i>Rhoicissus tridentata</i> (L.f.)Wild & R.B.Drumm (AIM 061)	Lingubengube	Warts, Prostate cancer	Aerial parts	decoction is taken 3 times a day for 2 weeks for persistent cough. One tea cup of decoction is drunk twice a day for 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. Decoction drunk for treatment of prostate cancer. Mixed with <i>Myrothamnus flabellifolius</i> leaves and <i>Toddalia sciatica</i> and 1	is <i>Herpes zoster</i> (Tanzania) [61].	HIV-1 reverse transcriptase activity, antimicrobial and anti-inflammatory activities [36]. In-vitro anti- <i>Mycobacterium tuberculosis</i> activity [35].

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
					tea cup of decoction is drunk 3 times a day for management of dysentery. Mixed with <i>Toddalia sciatica</i> leaves pounded, dried and mixed with fat/vascelline and applied topically for treatment of warts.		Antifungal activities [37].

UNDER PEER REVIEW

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 b 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.

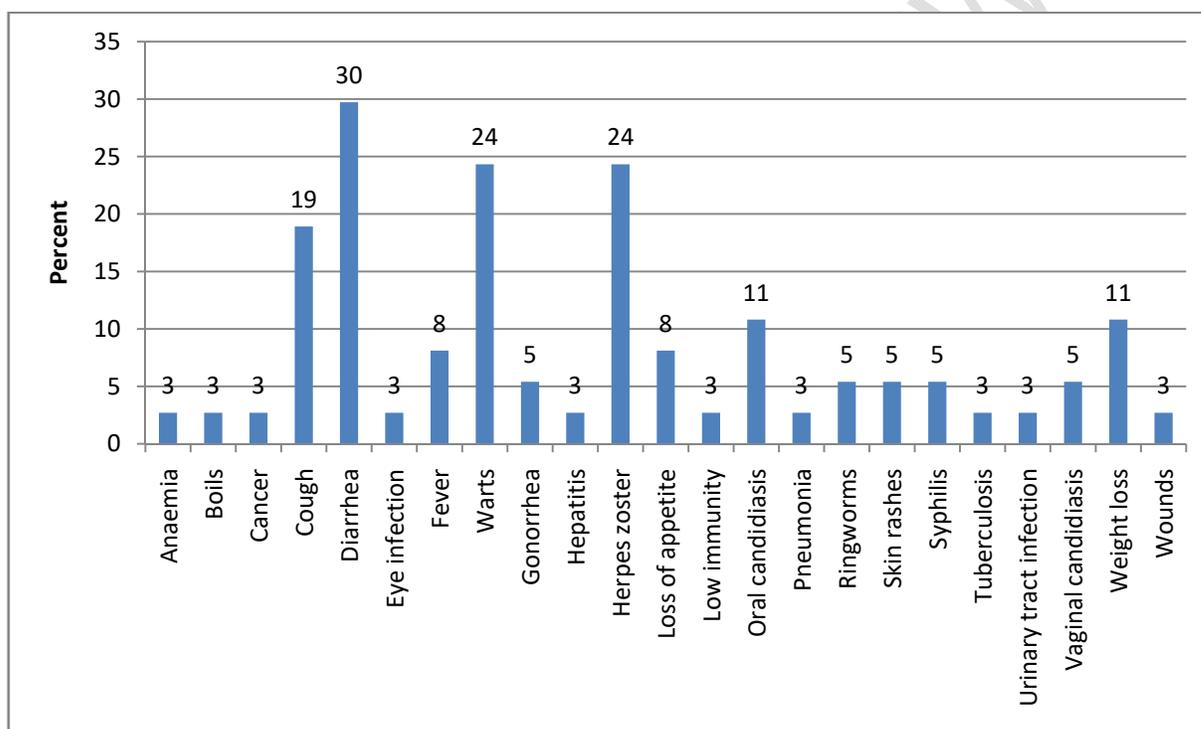


Fig. 3. Proportion of plants used to treat different disease conditions

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 (WHERE EVER APPLICABLE)

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, 4th April 2018). Permission to conduct the study in Makete District was sought from all authorities from the District to village level.

REFERENCES

1. WHO: UNAID Data 2018. Geneva: World Health Organization; 2018.
2. Gupta RK, Jordan MR, Sultan BJ, Hill A, Davis DH, Gregson J, Sawyer AW, Hamers RL, Ndembu N, Pillay D: Global trends in antiretroviral resistance in treatment-naive individuals with HIV after rollout of antiretroviral treatment in resource-limited settings: a global collaborative study and meta-regression analysis. *Lancet*. 2012; 380(9849):1250-1258.
3. Sharma B: Anti-HIV-1 drug toxicity and management strategies. *Neurobehav. HIV Med*. 2011; 3(27-40).
4. WHO: Fact sheet Number. 134: Traditional medicine. In Geneva: . Geneva: World Health Organization; 2008.
5. Newman DJ, Cragg GM: Natural products as sources of new drugs over the 30 years from 1981 to 2010. *J. Nat. Prod*. 2012; 75(3):311-335.
6. Patridge E, Gareiss P, Kinch MS, Hoyer D: An analysis of FDA-approved drugs: natural products and their derivatives. *Drug Discov. Today*. 2016; 21(2):204-207.
7. Kisangau DP, Herrmann TM, Lyaru H, Hosea K, Joseph C, Mbwambo Z, Masimba P: Traditional knowledge, use practices and conservation of medicinal plants for HIV/AIDS care in rural Tanzania. *Ethnobot. Res. Appl*. 2011; 9(043-057).
8. Chauke M, Shai L, Mogale M, Mokgotho M: Antibacterial and anti HIV 1 reverse transcriptase activity of selected medicinal plants from Phalaborwa, South Africa. *Res. J. Med. Plant*. 2016; 10(388-395).
9. Narayan C, Rai RV, Tewtrakul S: A screening strategy for selection of anti-HIV-1 integrase and anti-HIV-1 protease inhibitors from extracts of Indian medicinal plants. *Int. J. Phytomedicine*. 2011; 3(3):312.
10. Maroyi A: Alternative Medicines for HIV/AIDS in Resource-Poor Settings: Insight from Traditional Medicines Use in Sub-Saharan Africa. *Trop J Pharm Res*. 2014; 13(9):1527.
11. Cary DC, Peterlin BM: Natural products and HIV/AIDS. *AIDS Res. Hum. Retrovir*. 2018; 34(1):31-38.
12. Gurib-Fakim A: Medicinal plants: traditions of yesterday and drugs of tomorrow. *Mol Aspects Med*. 2006; 27(1):1-93.
13. Smith PF, Ogundele A, Forrest A, Wilton J, Salzwedel K, Doto J, Allaway GP, Martin DE: Phase I and II study of the safety, virologic effect, and pharmacokinetics/pharmacodynamics of single-dose 3-O-(3', 3'-dimethylsuccinyl) betulonic acid (bevirimat) against human immunodeficiency virus infection. *Antimicrob Agents Chemother*. 2007; 51(10):3574-3581.
14. Singh IP, Bodiwala HS: Recent advances in anti-HIV natural products. *Nat. Prod. Rep*. 2010; 27(12):1781-1800.
15. TACAIDS: Tanzania HIV Impact Survey 2016/2017. Tanzania Commission for AIDS; 2017.
16. Davenport TRB, Markes S: Touchwood-The Beauty and Biodiversity of Tanzania's Southern highlands. Arusha, Tanzania 2018.
17. NBS: 2012 Population and Housing Census. National Bureau of Statistics, United Republic of Tanzania; 2013.
18. Runyoro D, Ngassapa O, Matee M, Joseph C, Moshi M: Medicinal plants used by Tanzanian traditional healers in the management of Candida infections. *J. Ethnopharmacol*. 2006; 106(2):158-165.

19. Mohammed MM, Ibrahim NA, Awad NE, Matloub AA, Mohamed-Ali AG, Barakat EE, Mohamed AE, Colla PL: Anti-HIV-1 and cytotoxicity of the alkaloids of *Erythrina abyssinica* Lam. growing in Sudan. Nat. Prod. Res. 2012; 26(17):1565-1575.
20. Chimponda T, Mukanganyama S: Antimycobacterial activities of selected medicinal plants from Zimbabwe against *Mycobacterium aurum* and *Corynebacterium glutamicum*. Trop. Biomed. 2010; 27(3):595-610.
21. Chitemerere TA, Mukanganyama S: In vitro antibacterial activity of selected medicinal plants from Zimbabwe. AJPSB. 2011; 5(1):1-7.
22. Audu T, Amupitan OJ: The bioactivity of *Parinari curatellifolia*. Res. J. Biol. Sci. 2006; 1(1-4):60-62.
23. Maroyi A: An ethnobotanical survey of medicinal plants used by the people in Nhema communal area, Zimbabwe. J. ethnopharmacol. 2011; 136(2):347-354.
24. Teklehaymanot T: Ethnobotanical study of knowledge and medicinal plants use by the people in Dek Island in Ethiopia. J. ethnopharmacol. 2009; 124(1):69-78.
25. Tabuti JR, Kukunda CB, Waako PJ: Medicinal plants used by traditional medicine practitioners in the treatment of tuberculosis and related ailments in Uganda. J. ethnopharmacol. 2010; 127(1):130-136.
26. Yared D, Mekonnen Y, Debella A: In vivo antimalarial activities of fractionated extracts of *Asparagus africanus* in mice infected with *Plasmodium berghei*. Pharmacologyonline. 2012; 3(88-94).
27. Madikizela B, Ndhlala AR, Finnie JF, Van Staden J: Antimycobacterial, anti-inflammatory and genotoxicity evaluation of plants used for the treatment of tuberculosis and related symptoms in South Africa. J Ethnopharmacol. 2014; 153(2):386-391.
28. Rukunga GM, Kofi-Tsekpo MW, Kurokawa M, Kageyama S, Mungai GM, Muli JM, Tolo FM, Kibaya RM, Muthaura CN, Kanyara JN: Evaluation of the HIV-1 reverse transcriptase inhibitory properties of extracts from some medicinal plants in Kenya. Afr. J. Health Sci. 2002; 9(1):81-90.
29. Attioua B, Yeo D, Lagnika L, Harisololo R, Antheaume C, Weniger B, Kaiser M, Lobstein A, Vonthron-Senecheau C: In vitro antileishmanial, antiplasmodial and cytotoxic activities of a new ventiloquinone and five known triterpenes from *Parinari excelsa*. Pharm. Biol. 2012; 50(7):801-806.
30. Gbadamosi IT: Ethnobotanical survey of plants used for the treatment and management of sexually transmitted infections in Ibadan, Nigeria. Ethnobot. Res. Appl. 2014; 12(659-669).
31. Samie A, Tambani T, Harshfield E, Green E, Ramalivhana J, Bessong P: Antifungal activities of selected Venda medicinal plants against *Candida albicans*, *Candida krusei* and *Cryptococcus neoformans* isolated from South African AIDS patients. Afr. J. Biotechnol. 2010; 9(20).
32. Bessong PO, Rojas LB, Obi LC, Tshisikawe PM, Igunbor EO: Further screening of Venda medicinal plants for activity against HIV type 1 reverse transcriptase and integrase. Afr. J. Biotechnol. 2006; 5(6):526-528.
33. Bessong PO, Obi CL, Igumbor E, Andreola M-L, Litvak S: In vitro activity of three selected South African medicinal plants against human immunodeficiency virus type 1 reverse transcriptase. Afr. J. Biotechnol. 2004; 3(10):555-559.
34. Adefuye A, Samie A, Ndip R: In-vitro evaluation of the antimicrobial activity of extracts of *Bridelia micrantha* on selected bacterial pathogens. J. Med. Plant Res. 2011; 5(20):5116-5122.
35. Green E, Samie A, Obi CL, Bessong PO, Ndip RN: Inhibitory properties of selected South African medicinal plants against *Mycobacterium tuberculosis*. J. Ethnopharmacol. 2010; 130(1):151-157.
36. Mamba P, Adebayo S, Tshikalange TE: Anti-microbial, anti-inflammatory and HIV-1 reverse transcriptase activity of selected South African plants used to treat sexually transmitted diseases. Int. J. Pharmacogn. Phytochem. Res. 2016; 8(11):1870-1876.
37. Samie A, Mashau F: Antifungal activities of fifteen Southern African medicinal plants against five *Fusarium* species. J. Med. Plants Res. 2013; 7(1839-1848).
38. Verma A, Kumar B, Alam P, Singh V, Gupta SK: *Rubia cordifolia*-a review on pharmacology and phytochemistry. Int. J. Pharm. Sci. Res. 2016; 7(7):2720.
39. Meena A, Pal B, Panda P, Sannd R, Rao M: A review on *Rubia cordifolia*: its phyto constituents and therapeutic uses. Drug Invent. Today. 2010; 2(5):244-246.
40. Patil R, Mohan M, Kasture V, Kasture S: *Rubia cordifolia*: a review. Orient Pharm Exp Med. 2009; 9(1):1-13.
41. Karodi R, Jadhav M, Rub R, Bafna A: Evaluation of the wound healing activity of a crude extract of *Rubia cordifolia* L.(Indian madder) in mice. Int. j. appl. res. nat. prod. 2009; 2(2):12-18.

42. Momoh MA, Muhamed U, Agboke AA, Akpabio EI, Osonwa UE: Immunological effect of aqueous extract of *Vernonia amygdalina* and a known immune booster called immunace® and their admixtures on HIV/AIDS clients: a comparative study. *Asian Pac. J. Trop. Biomed.* 2012; 2(3):181-184.
43. Cos P, Hermans N, De Bruyne T, Apers S, Sindambiwe JB, Witvrouw M, De Clercq E, Vanden Berghe D, Pieters L, Vlietinck AJ: Antiviral activity of Rwandan medicinal plants against human immunodeficiency virus type-1 (HIV-1). *Phytomedicine.* 2002; 9(1):62-68.
44. Akinpelu DA: Antimicrobial activity of *Vernonia amygdalina* leaves. *Fitoterapia.* 1999; 70(4):432-434.
45. Ijeh II, Ejike CE: Current perspectives on the medicinal potentials of *Vernonia amygdalina* Del. *J. Med. Plant Res.* 2011; 5(7):1051-1061.
46. Silverberg MJ, Abrams DI: AIDS-defining and non-AIDS-defining malignancies: cancer occurrence in the antiretroviral therapy era. *Curr Opin Oncol.* 2007; 19(5):446-451.
47. Chinsebu KC, Hedimbi M: An ethnobotanical survey of plants used to manage HIV/AIDS opportunistic infections in Katima Mulilo, Caprivi region, Namibia. *J Ethnobiol Ethnomed.* 2010; 6(25).
48. Gescher K, Kuhn J, Lorentzen E, Hafezi W, Derksen A, Deters A, Hensel A: Proanthocyanidin-enriched extract from *Myrothamnus flabellifolia* Welw. exerts antiviral activity against herpes simplex virus type 1 by inhibition of viral adsorption and penetration. *J. ethnopharmacol.* 2011; 134(2):468-474.
49. Giday M, Teklehaymanot T, Animut A, Mekonnen Y: Medicinal plants of the Shinasha, Agew-awi and Amhara peoples in northwest Ethiopia. *J. ethnopharmacol.* 2007; 110(3):516-525.
50. Asnake S, Teklehaymanot T, Hymete A, Erko B, Giday M: Antimalarial medicinal plants used by Gumuz people of Mandura Woreda, Benishangul-Gumuz Regional State, Ethiopia. 2016.
51. Demilew W, Adinew GM, Asrade S: Evaluation of the Wound Healing Activity of the Crude Extract of Leaves of *Acanthus polystachyus* Delile (Acanthaceae). *Evid Based Complement Alternat Med.* 2018; 2018(2047896).
52. Mbunde MV, Innocent E, Mabiki F, Andersson PG: Ethnobotanical survey and toxicity evaluation of medicinal plants used for fungal remedy in the Southern Highlands of Tanzania. *J Intercult Ethnopharmacol.* 2017; 6(1):84-96.
53. Chinsebu KC, Hedimbi M: An ethnobotanical survey of plants used to manage HIV/AIDS opportunistic infections in Katima Mulilo, Caprivi region, Namibia. *J Ethnobiol Ethnomed.* 2010; 6(1):25.
54. Kone WM, Vargas M, Keiser J: Anthelmintic activity of medicinal plants used in Cote d'Ivoire for treating parasitic diseases. *Parasitol Res.* 2012; 110(6):2351-2362.
55. Bhunu B, Mautsa R, Mukanganyama S: Inhibition of biofilm formation in *Mycobacterium smegmatis* by *Parinari curatellifolia* leaf extracts. *BMC Complement Altern Med.* 2017; 17(1):285.
56. Olaleye MT, Amobonye AE, Komolafe K, Akinmoladun AC: Protective effects of *Parinari curatellifolia* flavonoids against acetaminophen-induced hepatic necrosis in rats. *Saudi J Biol Sci.* 2014; 21(5):486-492.
57. Heyman HM, Senejoux F, Seibert I, Klimkait T, Maharaj VJ, Meyer JJM: Identification of anti-HIV active dicaffeoylquinic-and tricaffeoylquinic acids in *Helichrysum populifolium* by NMR-based metabolomic guided fractionation. *Fitoterapia.* 2015; 103(155-164).
58. Lamorde M, Tabuti JR, Obua C, Kukunda-Byobona C, Lanyero H, Byakika-Kibwika P, Bbosa GS, Lubega A, Ogwal-Okeng J, Ryan M, et al: Medicinal plants used by traditional medicine practitioners for the treatment of HIV/AIDS and related conditions in Uganda. *J. ethnopharmacol.* 2010; 130(1):43-53.
59. Tomimori K, Nakama S, Kimura R, Tamaki K, Ishikawa C, Mori N: Antitumor activity and macrophage nitric oxide producing action of medicinal herb, *Crassocephalum crepidioides*. *BMC Complement Altern Med.* 2012; 12(1):78.
60. Bogning C, Oloulade A, Alowanou G, Nguemfo E, Azebaze A, Dongmo A, HounzangbeAdote S: In vitro anthelmintic activity of aqueous extract of *Crassocephalum crepidioides* (Benth.) S. Moore on *Haemonchus contortus*. *J Exp Integr Med.* 2016; 6(1):31.
61. Kisangau DP, Lyaruu HV, Hosea KM, Joseph CC: Use of traditional medicines in the management of HIV/AIDS opportunistic infections in Tanzania: a case in the Bukoba rural district. *J Ethnobiol Ethnomed.* 2007; 3(29).
62. Mugisha MK, Asimwe S, Namutebi A, Borg-Karlson AK, Kakudidi EK: Ethnobotanical study of indigenous knowledge on medicinal and nutritious plants used to manage opportunistic infections associated with HIV/AIDS in western Uganda. *J. Ethnopharmacol.* 2014; 155(1):194-202.
63. de Boer HJ, Kool A, Broberg A, Mziray WR, Hedberg I, Levenfors JJ: Anti-fungal and anti-bacterial activity of some herbal remedies from Tanzania. *J. ethnopharmacol.* 2005; 96(3):461-469.

64. Verschaeve L, Van Staden J: Mutagenic and antimutagenic properties of extracts from South African traditional medicinal plants. *J. ethnopharmacol.* 2008; 119(3):575-587.
65. Njoroge GN, Busmann RW: Ethnotherapeutic management of Sexually Transmitted Diseases (STDs) and reproductive health conditions in Central Province of Kenya. *INDIAN J TRADIT KNOW.* 2009; 8(255-261).
66. Njoroge GN, Kibunga JW: Herbal medicine acceptance, sources and utilization for diarrhoea management in a cosmopolitan urban area (Thika, Kenya). *Afr. J. Ecol.* 2007; 45(65-70).
67. Jelager L, Gurib-Fakim A, Adersen A: Antibacterial and Antifungal Activity of Medicinal Plants of Mauritius. *Pharm. Biol.* 2008; 36(3):153-161.
68. Hsoidrou S, Bousta D, Lachkar M, Said Hassane SO, El Youbi-Hamsas A, Mansouri LEL, Benjilali J, El-Hajaji H, Farah A: Phytochemical screening, immunomodulatory and anti-inflammatory activities of the phenolic fraction of *Aphloia theiformis* (Vahl) Benn. plant used in comorian traditional medicine. *Phytothérapie.* 2014; 12(6):354-359.
69. El-Desoukey RMA: Phytochemical and antimicrobial activity of *Panicum turgidum* (thummam) as a grazing herb against some animal pathogens. *EC Microbiology.* 2017; 5(1):22-29.
70. Kanife U, Odesanmi O, Doherty V: Phytochemical composition and antifungal properties of leaf, stem and florets of *Panicum maximum* Jacq.(Poaceae). *Int. J. Biol.* 2012; 4(2):64.
71. Maregesi SM, Ngassapa OD, Pieters L, Vlietinck AJ: Ethnopharmacological survey of the Bunda district, Tanzania: plants used to treat infectious diseases. *J. Ethnopharmacol.* 2007; 113(3):457-470.
72. Nyamukuru A, Tabuti JRS, Lamorde M, Kato B, Sekagya Y, Aduma PR: Medicinal plants and traditional treatment practices used in the management of HIV/AIDS clients in Mpigi District, Uganda. *J. Herb. Med.* 2017; 7(51-58).
73. Maikere-Faniyo R, Van Puyvelde L, Mutwewingabo A, Habiyaemye F: Study of Rwandese medicinal plants used in the treatment of diarrhoea I. *J. Ethnopharmacol.* 1989; 26(2):101-109.
74. Mwafongo E, Nordal I, Magombo Z, Stedje B: Ethnobotanical study of Hyacinthaceae and non-hyacinthaceous geophytes in selected districts of Malawi. *Ethnobot. Res. Appl.* 2010; 8(075-093).
75. Shava C, Mutsaka P, Moyo B, Sithole S, Chitemerere T, Mukanganyama S: Antibacterial and Anticancer Properties of *Dolichos kilimandscharicus*(Fabaceae). *Journal of Biologically Active Products from Nature.* 2016; 6(2):112-135.
76. Tegegne G, Pretorius JC: In vitro and in vivo antifungal activity of crude extracts and powdered dry material from Ethiopian wild plants against economically important plant pathogens. *BioControl.* 2007; 52(6):877-888.
77. Marston A, Gafner F, Dossaji S, Hostettmann K: Fungicidal and molluscicidal saponins from *Dolichos kilimandscharicus*. *Phytochemistry.* 1988; 27(5):1325-1326.
78. Hedimbi M, Chinsebu KC: Ethnomedicinal study of plants used to manage HIV/AIDS-related disease conditions in the Ohangwena region, Namibia. *International Journal of Medicinal Plants Research.* 2012; 1(1):004-011.
79. Kisangau DP, Lyaruu HV, Hosea KM, Joseph CC: Use of traditional medicines in the management of HIV/AIDS opportunistic infections in Tanzania: a case in the Bukoba rural district. *J ETHNOBIOL ETHNOMED.* 2007; 3(1):29.
80. Kilonzo M, Ndakidemi PA, Chacha M: In vitro antifungal and cytotoxicity activities of selected Tanzanian medicinal plants. *Trop. J. Pharm. Res.* 2016; 15(10):2121.
81. Moore JP, Lindsey GG, Farrant JM, Brandt WF: An overview of the biology of the desiccation-tolerant resurrection plant *Myrothamnus flabellifolia*. *Ann Bot.* 2007; 99(2):211-217.
82. Chinsebu KC, Hedimbi M: Ethnomedicinal plants and other natural products with anti-HIV active compounds and their putative modes of action. *Int. J. Biotechnol. Mol. Biol.* 2010; 1(6):74-91.
83. Hashmi MA, Khan A, Hanif M, Farooq U, Perveen S: Traditional Uses, Phytochemistry, and Pharmacology of *Olea europaea* (Olive). *Evid Based Complement Alternat Med.* 2015; 2015(541591).
84. Sudjana AN, D'Orazio C, Ryan V, Rasool N, Ng J, Islam N, Riley TV, Hammer KA: Antimicrobial activity of commercial *Olea europaea* (olive) leaf extract. *Int J Antimicrob Agents.* 2009; 33(5):461-463.
85. Amabeoku GJ, Bamuamba K: Evaluation of the effects of *Olea europaea* L. subsp. *africana* (Mill.) PS Green (Oleaceae) leaf methanol extract against castor oil-induced diarrhoea in mice. *J Pharm Pharmacol.* 2010; 62(3):368-373.

86. De Wet H, Nzama VN, Van Vuuren SF: Medicinal plants used for the treatment of sexually transmitted infections by lay people in northern Maputaland, KwaZulu–Natal Province, South Africa. *S. Afr. J. Bot.* 2012; 78(12-20).
87. Panda SK: Ethno-medicinal uses and screening of plants for antibacterial activity from Similipal Biosphere Reserve, Odisha, India. *J. ethnopharmacol.* 2014; 151(1):158-175.
88. Sun Y, Gong X, Tan JY, Kang L, Li D, Vikash, Yang J, Du G: In vitro Antiviral Activity of *Rubia cordifolia* Aerial Part Extract against Rotavirus. *Front Pharmacol.* 2016; 7(308).
89. Orwa JA, Jondiko IJ, Minja RJ, Bekunda M: The use of *Toddalia asiatica* (L) Lam. (Rutaceae) in traditional medicine practice in East Africa. *J. Ethnopharmacol.* 2008; 115(2):257-262.
90. Rashid MA, Gustafson KR, Kashman Y, Cardellina JH, McMahon JB, Boyd MR: Anti-HIV Alkaloids from *Toddalia asiatica*. *Nat Prod Lett.* 1995; 6(2):153-156.
91. Duraipandiyar V, Ignacimuthu S: Antibacterial and antifungal activity of Flindersine isolated from the traditional medicinal plant, *Toddalia asiatica* (L.) Lam. *J. ethnopharmacol.* 2009; 123(3):494-498.
92. Rajkumar M, Chandra R, Asres K, Veeresham C: *Toddalia asiatica* (Linn.) Lam.-a comprehensive review. *Pharmacogn. Rev.* 2008; 2(4):386.
93. Puente LA, Pinto-Muñoz CA, Castro ES, Cortés M: *Physalis peruviana* Linnaeus, the multiple properties of a highly functional fruit: A review. *Food Res. Int.* 2011; 44(7):1733-1740.
94. Göztkok F, Zengin F: The antimicrobial activity of *Physalis peruviana* L. *Bitlis Eren. University Journal of Science and Technology.* 2013; 3(1):15-17.