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Ethnobotanical study of nutri-medicinal plants used for the management of HIV/AIDS opportunistic ailments among the local communities of western Uganda



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ABSTRACT

Ethnopharmacological relevance: Herbal remedies are a source of therapeutics for nearly 80% of the population in Uganda. Poor health facilities and limited access to antiretroviral drugs have perpetuated and increased the use of traditional medicine especially in rural areas for the treatment of opportunistic ailments of HIV/AIDS. To document the traditional uses of nutri-medicinal plants in the management of immunocompromised ailments associated with HIV/AIDS. To document the parts and growth forms of plants used, methods of preparation and administration of the herbal remedies.

Materials and methods: The study was conducted in Mbarara and Isingiro districts of western Uganda between December 2010 and May 2011. Ethnobotanical information was collected from 64 respondents who were sampled based on recommendations of local elders and administrators. Ethnobotanical data on the use of nutri-medicinal plants for traditional treatment of HIV/AIDS opportunistic ailments were collected by employing semi-structured interviews with selected respondents, house hold visits and field observations as described by (Martin, 1995a). The respondents were mainly traditional medical practitioners who treat patients who are already receiving antiretroviral drugs. Fidelity levels of plant species and informant consensus factor were determined to show the percentage of informants claiming the use of certain plant species for the same major purpose and to analyse people's knowledge of plant use.

Results: The study revealed 81 plant species most of which were herbs (49%). Leaves (71%) were the most frequently used parts in remedy preparations which were mainly administered orally (85%). The majority of plants (54%) were harvested from wild populations. *Hibiscus sabdariffa* L., *Plumeria obtusa* L., and *Abutilon guineense* (Shumach.) Baker. F and Exell were the nutri-medicinal plants that scored the highest Fidelity level values. The informant's consensus about usages of plants ranged from 0.75 to 0.80. Plants that are presumed to be effective in treating a certain disease have higher informant consensus factor (ICF) values. Family Asteraceae accounted for 18% of the total species recorded. Thirteen species (16%) of the plants are edible and provide nutritional support.

Conclusion: The study recorded plant species with potential to treat ailments associated with immunocompromised people living with HIV/AIDS in western Uganda. Such studies can help stimulate confidence in traditional medicine and enhance appreciation of herbal medicine among the people and to appreciate the value of the plant resources and therefore enhance conservation efforts of the plant species. The high consensus means the majority of informants agree on the use of plant species and this reflects the intercultural relevance and the agreement in the use of the nutri-medicinal plants to the people. We recommend the documented plants for further Ethnopharmacological studies.

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1. Introduction

HIV/AIDS is an acquired immunodeficiency syndrome (AIDS) caused by the human immunodeficiency virus (HIV). It is a condition characterised by life threatening opportunistic infections or

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malignancies in a patient with severe depression of the T-cell mediated immune system caused by infection with HIV. The virus reduces progressively the effectiveness of the immune system and leaves the patient susceptible to such infections as tuberculosis, diarrhoea, skin rashes, thrush, candida, recurrence of varicella zoster virus infection and persistent fever (Murray and Pizzorno, 1999). Currently, 34 million people are living with HIV worldwide of which 22.5 million are from Sub Saharan Africa. Uganda's HIV seroprevalence rate of 7.3% is among the world's highest (UNAIDS, 2010, 2012).

Medicinal plants are a source of raw materials for both traditional systems and modern medicine (Bandaranayake, 2006). Many patients take a range of natural products in addition to the conventional therapeutic products to manage various ailments (Kisangau et al., 2007; Lamorde et al., 2010). Treatment of HIV/AIDS-related ailments is an important factor for the management of HIV/AIDS cases since these ailments remain one of the leading causes of mortality globally among HIV/AIDS patients (UNAIDS, 2009; Kazhila and Marius, 2010). In Africa, herbal medicines are used in primary treatment of HIV/AIDS opportunistic infections (Mills et al., 2005), and are sometimes used to offset the side effects from antiretroviral treatment (Kazhila and Marius, 2010). In many village settings, basic pharmaceutical drugs are not available and households rely entirely on medicinal plants for treatment of opportunistic infections (Kolberg and Anyange, 2002).

Despite the increased use of medicinal plants in treatment of HIV/AIDS opportunistic infections, nutrition as a key ingredient in treatment has been largely ignored. Studies have indicated that HIV infection can jeopardise the body's efficiency to utilise food nutrients and can lead to malnutrition, while poor diet can speed the progress of the disease. It has been suggested that proper nutrition enables HIV patients to take medication, manage side effects from antiretroviral drugs and maintain adequate nourishment by restoring intestinal function and weight gain (Tinnerello, 1998; Guarino et al., 2002). Patients on highly active antiretroviral therapy (HAART) suffer side effects like poor appetite and nausea due to interference with absorption and utilisation of nutrients (Ridder, 2003). Research indicates that HIV patients have low levels of micronutrients such as Vitamins A, C, D and B12; selenium, Zinc, iron and carotenoids in the blood which are important in maintaining the immune system to fight opportunistic infections (Tinnerello, 1999). This calls for more research into nutri-medicinal plants.

Herbal remedies are a source of therapeutics for nearly 80% of the population in Uganda (Kamatenesi and Oryem-Origa, 2006). The people in Uganda have been using plants for food and medicine for centuries (Tabuti et al., 2003) and traditional knowledge is passed on verbally from generation to generation (Cheikhoussef et al., 2011). In order to conserve herbal medicine knowledge, it is important to document traditional knowledge of plants with therapeutic value. Although the use of herbal medicine is widespread, there is still insufficient research and documentation of herbal medicines specifically used to manage HIV/AIDS-related ailments. Hence, the aim of this study was to document the nutritional and medicinal plants used by local communities in the management of immunocompromised ailments associated with HIV/AIDS. Documentation of such plants can help preserve indigenous knowledge about traditional medicines for future generations and identify plant species for future pharmacological and phytochemical research.

2. Methods

2.1. Study area

The study was carried out in Mbarara and Isingiro districts (0° 36'S 30° 36'E and 0° 50'S 30° 50'E) in Western Uganda (Fig. 1).

The main livelihood activity is agriculture which includes cultivation of crops and rearing of cattle and goats. The region experiences a mean annual rainfall ranging from 1,100 mm to 1,200 mm and temperatures ranging from 17 °C to 30 °C; where there are two wet seasons and 2 dry seasons.

2.2. Collection of ethnobotanical information

Ethnobotanical data were collected between December 2010 and May 2011. The research team first reported to the Local administrators and community elders of the area who led them to the respected healers. Key informants who included herbalists, traditional birth attendants and other knowledgeable people like the elderly women were selected purposively (Martin, 1995b; Ma Dolores, 2007) based on their skills, knowledge and practices in medicinal plants usage. Before conducting interviews, the aim of the study was explained clearly and informants were asked for their consent. Respondents were asked to list some of the main symptoms of HIV/AIDS related ailments. The Traditional healers were able to recognise signs and symptoms of HIV/AIDS opportunistic infections, for instance, herpes zoster (locally known as 'Kisipi') and tuberculosis ('akakonko'). The healers were also treating patients who were already receiving Antiretroviral drugs (ARVs) prescribed by allopathic medical personnel.

The HIV/AIDS opportunistic infections considered during the study include Tuberculosis, herpes zoster and oral candidiasis. Other symptomatic but undefined conditions were cough, malaria, skin rash and diarrhoea. Immunocompromised conditions related to Nutrition include anaemia, boosting of appetite, immunity, and energy. Semi-structured questionnaires (Martin, 1995a) designed for the traditional healers about medicinal plants knowledge mainly focused on local names of plants used, parts used and growth forms, ailments treated/managed, conservation status, mode of preparation and application of the herbal remedies. The biographic characteristics of the respondents in this study include gender, age, religion, education, ethnicity and occupational status. Interviews were conducted in the respective local dialects, Runyankore and Rukiga with few exceptions in Kinyarwanda. Plant voucher specimens were collected and identified at Makerere University herbarium. Plant names were verified using the International Plant Name Index (IPNI).

2.3. Data analysis

Ethnobotanical data obtained during the study were summarised using descriptive statistics (Hoft et al., 1999) and analysed using three quantitative tools.

- The percentage of respondents who have knowledge (PRK) regarding the use of a species (percent use value) in the treatment of diseases was estimated using the formula: (number of people interviewed citing species/the total number of people interviewed) × 100 (Friedman et al., 1986).
- In order to analyse ethnobotanical importance of the reported species used and to estimate the level of informant consensus on the use of herbal remedies between culturally different communities, informant consensus factor, ICF, was calculated (Heinrich et al., 1998). The ICF is calculated as follows: number of use reports in each category (n_{ur}) minus the number of species used (n_t), divided by the number of use reports in each category minus one: $ICF = \frac{n_{ur} - n_t}{n_{ur} - 1}$. The relative importance of a species is evaluated by the proportion of respondents who cited it.
- The percentage of informants claiming the use of a plant species for the same major purpose was estimated using the Fidelity level index, $FL = \frac{I_p}{I_u} \times 100$, where I_p is number of

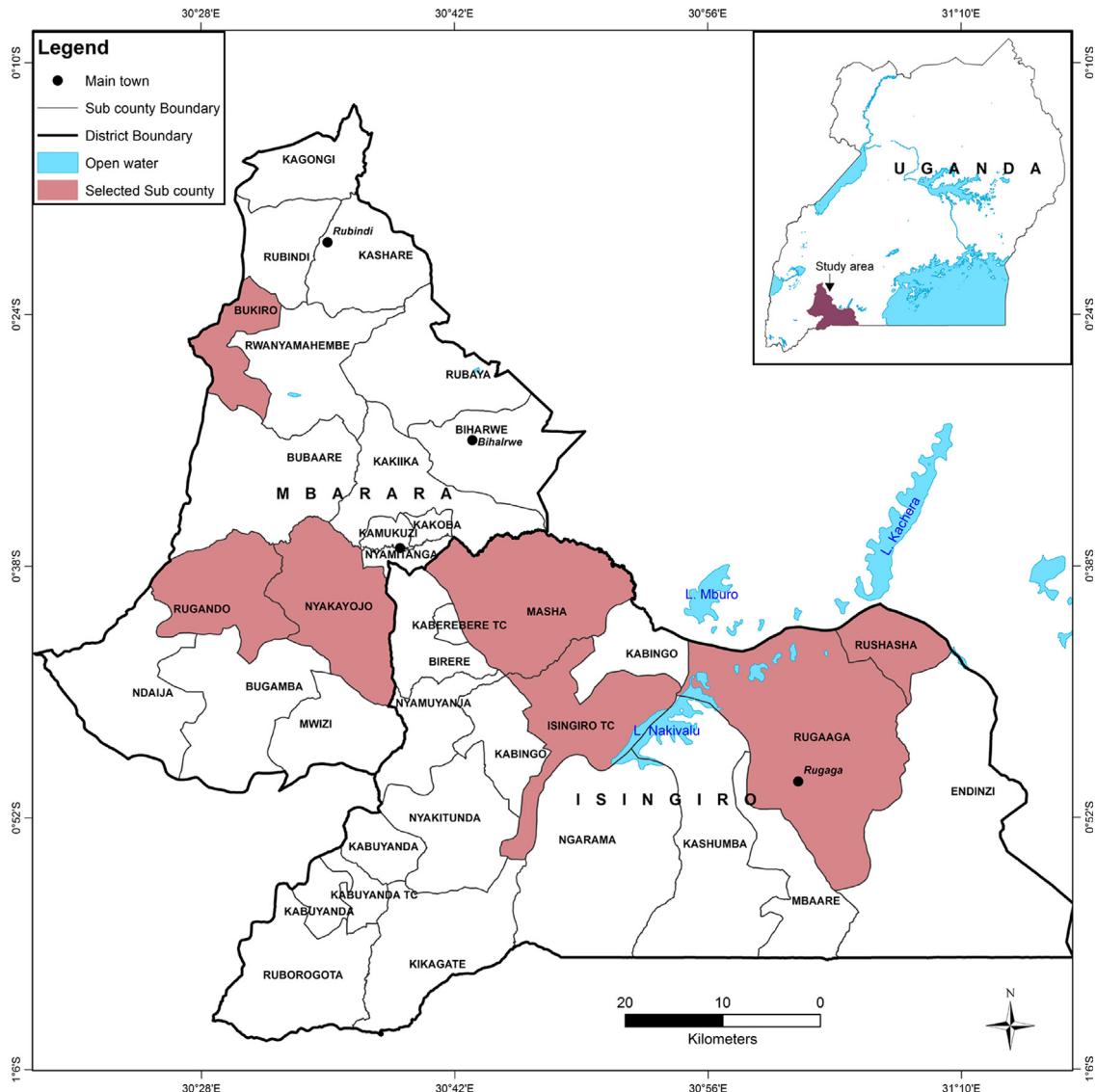


Fig. 1. Location of study areas in western Uganda.

informants who indicate use of a species for the same major ailment, I_u is the total number of informants who mentioned the plant for any other use (Friedman et al., 1986).

3. Results and discussion

3.1. Demographic characteristics of respondents

Eighty one percent of respondents were women healers. This is because women play a key role in preserving the knowledge of nutri-medicinal plants as home care takers, responsible for looking after children's health and nutrition. One woman asserted that "egyo n'emirimo y'abakazi abarareberera eka neby'obuhangwa" [this is a woman's domain who are charged with care giving, food preparation and preserving cultural heritage]. Most of the respondents with substantive knowledge were above 40 years of age (Table 1). Indigenous knowledge is acquired through time as it is handed down from generation to another, through knowledge transfer from parents to the favored children. A study conducted in Niger indicates that ethnobotanical knowledge increases with age (Guimbo et al., 2011). Women learn from their mothers through routine observations since traditional knowledge is freely passed

Table 1
Socio-demographic data of respondents (n=64).

Characteristics	Alternatives	Count	Percentage
Gender	Female	52	81.3
	Male	12	18.7
Age (years)	20–29	5	08
	30–39	16	25
	> 40	43	67
Religion	Protestant	26	40.6
	Catholic	35	54.7
	Pentecostal	03	4.7
Marital status	Single	05	7.8
	Married	56	87.5
	Widowed	03	4.7
Education	Illiterate	58	90.6
	Primary level	05	7.8
	Diploma	01	1.6
Occupational status	Farmer	20	31.2
	*TH and TBA	40	62.5
	Business	3	4.7
	Pastor	1	1.6

* TH – Traditional healer, TBA – Traditional birth attendant.

on among family members. Traditional healing was seen as a source of income and 62.5% of respondents were traditional medical practitioners (Table 1). This shows that a large proportion of people earn a living from using medicinal plants, hence the need to promote and conserve the plants. According to (WHO, 2002), 80 % of the world's people depend on traditional medicine for their primary health care needs. In this study, findings indicate that the majority of respondents (54.7%) belonged to the Roman Catholic Church. While plants in themselves have no specific spiritual influence, the religious beliefs of the people can influence their attitudes towards traditional herbal medicine (Winkler et al., 2010). In this study, respondents mentioned that it is not only traditional medicine, but also prayers in the Christian sense that seem to play an important role in people's beliefs regarding successful treatment of ailments. Similar findings were revealed by a study in Tanzania (Winkler et al., 2010). In Uganda, the use of medicinal plants is also associated or regarded as a form of witch craft especially among the Christian converts, commonly known as, 'Born again'. So, as people convert from their traditional religions to the Born again cult, they tend to break away from the traditional use of medicinal plants, which may lead to loss of indigenous knowledge of medicinal plants. According to Adogame, (2007), international and African discourses on the HIV/AIDS pandemic and intervention neglect the role of religion and religious organisations, yet Christian praying is an integral part of healing (Winkler et al., 2010). In a study carried out in Tanzania, respondents thought that Christian prayers could treat the cause or symptoms of epilepsy (Winkler et al., 2010).

3.2. Nutri-medicinal plants and their uses

Eighty one (81) plant species from 38 families were documented. The most represented families were Asteraceae (15 species), Fabaceae (7 species), Lamiaceae (7) and Euphorbiaceae (4). The rest of the families were represented by less than 4 species. These families are consistently recorded in different ethnomedical inventories (Hamil et al., 2000; Seifu et al., 2006; Giday et al., 2007; Moshi et al., 2010; Kamatenesi et al., 2011; Namukobe et al., 2011) which could be because the families are large and characterised by several species that are abundant and widely distributed (Bonet et al., 1999). In Tanzania, Kisangau et al. (2007) found that plant species from families Asteraceae, Euphorbiaceae, Lamiaceae, Rubiaceae, Fabaceae and Anacardiaceae were used by traditional healers to manage HIV/AIDS opportunistic infections.

The frequently reported plant species for their therapeutic value include *Albizia coriaria* Welw. (27), *Hoslundia opposita* Vahl. (17), *Hibiscus sabdariffa* L. (15), *Dicliptera laxata* C. B. Clarke (15), *Abutilon guineense* (Schumach.) Baker f. and Exell (12) and *Senecio hadiensis* Forssk (11) respectively.

The frequency of mention could be an indication of the therapeutic value of a species (Kamatenesi et al., 2011). In this study, the frequently mentioned plants were also used to treat more than one ailment and therefore, could be of great importance in the management of immunocompromised ailments. *Albizia coriaria* was reported to be used for cough, tuberculosis, diarrhoea, herpes zoster and infections of bacterial and fungal origin and thus an important species for management of immune compromised ailments. Ethnobotanical studies in other areas reported *Albizia coriaria* as one of the most frequently used plants; something confirming related traditional knowledge on medicinal plant species in different areas (Kisangau et al., 2007; Namukobe et al., 2011).

3.3. Informant consensus

The level of informants' agreement (mean Fic=0.77) was high for all ailment categories (Table 2). This indicates agreement

Table 2
Informant consensus factor (Fic) for the ailment categories.

Ailment category	*Number of species (n_t)	Number of use reports (n_{ur})	Fic
Appetite and immunity boosting	39	170	0.78
Bacterial and fungal infections	19	64	0.71
Diarrhoeal infections	22	93	0.77
Cough and tuberculosis	31	156	0.80
Herpes zoster	11	42	0.75

* A species may be listed in more than one category.

amongst respondents on the use of different plant species to manage the reported ailments as well as their significance. The results of the ICF showed that cough and tuberculosis category had the greatest agreement with Fic of 0.80. Within this category, the main reported ailment was cough (90 reports). High consensus among users in different communities reflects the intercultural relevance and agreement in the use of the nutri-medicinal plants to the people.

3.4. Bacterial and fungal infections

This category of illness had 19 plant species of which 11% of the remedies were prepared by mixing plants (Table 3). Studies indicate that plants are often combined to create synergy, reduce toxicity and increase bioavailability and palatability ADDIN EN.CITE ADDIN EN.CITE.DATA (Tabuti et al., 2010; Bussmann et al., 2011; Namukobe et al., 2011).

The species contributing to the high Fic value was *Hoslundia opposita* reported by 15% of respondents. This category includes ailments related to Candidiasis (both oral and vaginal), syphilis and skin infections. Remedies for skin infections were prepared by mixing leaf powder with jelly and applying on skin, or by bathing decoction or infusion. Oral thrush was treated by chewing plant material or mouth washing with leaf extract.

3.5. Cough and tuberculosis

This category of illness had the highest number of species of which *Albizia coriaria* was reported by 28% of respondents (Table 4). The use of *Albizia coriaria* to treat cough has been reported by Namukobe et al. (2011). Trees were the commonly used growth forms accounting for 39% of the species used while leaves accounted for 81% of the plant parts used in this category of ailments. Some plants have more than one part used, for instance *Albizia coriaria* and *Mangifera indica* whose leaves, roots and stem barks are used. This form of harvesting roots and stem barks is threatening to the survival of a plant.

3.6. Diarrhoeal infections

The informant's consensus for this category was 0.77 and the species with high frequency of mention was *Abutilon guiseense*, reported by 18% of respondents (Table 5). During the study, Traditional healers reported cases of patients with chronic diarrhoea. Research shows that diarrhoea in HIV/AIDS can be caused by common pathogens including bacteria, fungi and helminths (Lidia and Claes-Henrik, 2010). Researchers reveal that chronic diarrhoea is one of the hallmarks of advanced human immunodeficiency virus (HIV) disease and its symptoms have a significant impact on the patient's quality of life. In severe cases it may lead to extreme abnormalities in fluids and electrolytes and can even cause death (Lidia and Claes-Henrik, 2010). Diarrhoea is experienced by over

Table 3

Plants used to treat bacterial and fungal infections.

Species identity*	Growth habit	Parts used	Habitat	Mode of preparation and administration	Use reports (n=64)	PRK
Aloaceae <i>Aloe vera</i> L. Rukaka (Ru) Kikaka-rubamba (Ki) AS054	Herb	Leaf sap	C	Boil and bathe; dry, mix powder with jelly and apply on skin	5	7.81
Apocynaceae <i>Plumeria obtusa</i> L. Omusikamori (Ru) AS029	Tree	Leaf	C	Apply sap or powder in jelly on affected area	2	3.12
Asteraceae <i>Artemisia annua</i> L. AS038	Herb	Leaf	C	Chew	1	1.56
<i>Bidens grantii</i> Sherff Ehongwa (Ru) AS006	Herb	Leaf	W	Decoction bathed twice a day	3	4.68
<i>Crassocephalum vitellinum</i> S. Moore Esunuunu (Ru) AS055	Herb	Leaf	W	Decoction drunk 500 ml daily	2	3.12
<i>Guizotia scabra</i> Chiov. Ekiterankuba (Ru) AS033	Herb	Leaf	W	Apply extract on affected area	3	4.68
<i>Crassocephalum bojeri</i> (DC) Omukunda (Ru) AS002	Herb	Leaf/Root	W	Rinse mouth with extract	2	3.12
Canellaceae <i>Warburgia ugandensis</i> Sprague Omwiha (Ru) AS041	Tree	Leaf	W/C	Boil and bathe or add powder in Jelly and smear affected area	1	1.56
Celestraceae <i>Maytenus senegalensis</i> (Lam) Exell AS060	Tree	Bark, root, leaf	W	Chew the bark; bathe decoction twice a day	6	9.37
Convolvulaceae <i>Ipomea hildebrandtii</i> Vatke Bingirebita (Ru) AS009	Herb	Leaf	C	Boil and bathe	6	9.37
Cucurbitaceae <i>Zehneria scabra</i> Akabindiizi (Ru) AS034	Climber	Whole plant	W	Infusion bathed	4	6.25
Euphorbiaceae <i>Euphorbia hirta</i> L. Enkoninyabuto (Ru) AS027	Herb	Leaf	W	Mix with the bark of <i>Warburgia Ugandensis</i> , dry, boil and drink 2 table spoons 3 times a day for 14 days	1	1.56
Fabaceae <i>Albizia coriaria</i> Welw. Omusisa (Ru) AS005	Tree	Leaf/Bark/Root	W	Decoction drunk, 100 ml twice a day; bathe	4	6.25
Lamiaceae <i>Hoslundia opposita</i> Vahl. Esiteimwe (Ru) AS008	Shrub	Leaf/Flower	W	Decoction drunk 1 glass twice daily; decoction bathed; mix with leaves of <i>Chenopodium opulifolium</i> and smear body	10	15.6
<i>Ocimum suave</i> Willd. Omwenyi (Ru) Umwenya (Ki) AS059	Herb	Leaf	W /C	Powder mixed with jelly and smeared on skin	2	3.12
<i>Plectranthus amboinicus</i> (Lour.) Spreng. Akacuncu akakye (Ru) AS053	Herb	Leaf	C	Decoction bathed	5	7.81
<i>Solenostemon latifolius</i> (Hochst. Ex. Benth) J.K Morton Marwa (Ru) AS044	Herb	Leaf	C	Steam and bathe; mouth wash	1	1.56
Meliaceae <i>Azadirachta indica</i> A. Juss Neem AS019	Tree	Leaf	C	Mix leaf extract with honey and drink	1	1.56
Myrsinaceae <i>Maesa lanceolata</i> Forssk. Omuhanga (Ru) AS020	Shrub	Seeds	W	Powder mixed with jelly and smeared on skin	5	7.81

Column 4: C – Cultivated, W – Wild; Column 7: PRK – Percentage respondents' knowledge.

* Column 1: identity includes family, species and local names; Ethnic language (Ru:Runyankore; Ki: Kinyarwanda), Voucher specimen code.

50% of AIDS patients at some time during the course of their illness and is the cause of morbidity and mortality in up to a quarter of all HIV patients (Sande and Volberding, 1997).

3.7. Nutri-medicinal plants

Good nutrition is a key component in the care and support for people living with HIV/ AIDS to curb opportunistic infections. In this study, thirteen plants (16%) were edible and formed part of the diet as food (Table 6). Such plants are sources of Vitamins such as A, C, D and B12 and mineral nutrients such as selenium, Zinc, iron and carotenoids in the blood which are important in maintaining the immune system to fight opportunistic infections. Research indicates that human health is connected to nutrition. For instance, *Amaranthus graecizans*, *Cleome gynandra* and *Solanum nigrum* contain nutrients and micronutrients important for human health (Kamatenesi, 2010).

3.8. Appetite and immunity boosting

This category obtained the second highest consensus factor (0.78) and number of citations (117). The important species were *Hibiscus sabdariffa* and *Dicliptera laxata* each reported by 23% of the respondents (Table 7). Traditionally, *Hibiscus sabdariffa* used to treat conditions such as anaemia, cough, hypertension, is eaten as

a vegetable and taken as a herbal tea (Katende et al., 1999). In this study, twenty six plant species (31.3%) were used to boost appetite, immunity and energy and anaemia in patients. Such plants are sources of mineral nutrients such as selenium, Zinc and iron which are important in maintaining the immune system to fight opportunistic infections. Research indicates that nutritional intervention may restore intestinal absorption and increase CD4 cell numbers (Guarino et al., 2002). In this study, one respondent mentioned that the seeds of *Amaranthus dubius* increase CD4 cell count.

3.9. Herpes zoster

The plant species used most in this category were *Jatropha curcas* and *Plumeria obtusa* each reported by 10.9% of respondents (Table 8). Research shows that 8% of patients with herpes zoster have HIV (Mitka, 2006).

3.10. Fidelity level of the commonly used plants

Fidelity level (FL) was calculated to analyse categories with major agreements to highlight the most important plants in each category (Table 9). Fidelity level shows the percentage of informants claiming the use of a certain plant species for the same major purpose (Ugulu, 2011). This is designed to quantify the importance of the species for a given purpose (Friedman et al., 1986).

Table 4
Medicinal plants used to manage cough and tuberculosis.

Species identity*	Growth habit	Parts used	Habitat	Mode of preparation & administration	Use reports (n=64)	PRK
Aloaceae <i>Aloe vera</i> L. Rukaka (Ru) Kikakaru-bamba (Ki) AS054	Herb	Leaf	C	Pound, add hot water and drink 2 table spoons 3 times daily	2	3.12
Anacardiaceae <i>Mangifera indica</i> L. AS025	Tree	Leaf, bark, root	C/W	Pound, boil, add honey drink 250 ml daily, one tea spoon for child	8	12.5
<i>Rhus natalensis</i> Bern ex. Krauss Omusheeshe AS067	Tree	Leaf	W	Boil and drink 500 ml daily; child; 1 teaspoon twice daily	2	3.12
<i>Rhus vulgaris</i> Meikle Obukanja (Ru) AS042	Shrub	Leaf, Root	W	Pound, steep, drink 500 ml	2	3.12
Apocynaceae <i>Thevetia peruviana</i> K. Schum Omusenene (Ru) AS022	Tree	Root	C	Boil with rock salt and give 3 table spoons daily	3	4.68
Asteraceae <i>Conyza bonariensis</i> (L) Cronquis Endaasha (Ru) AS068	Herb	Leaf /bark	W	Use powder in food/tea; or chew the bark	3	4.68
<i>Microglossa pyrifolia</i> Kuntze Omuvugankande (Ga) Omuhe (Ru) AS036	Shrub	Leaf/Flower	W	Chew leaf or boil & drink 250 ml twice a day	4	6.25
Canellaceae <i>Warburgia ugandensis</i> Sprague Omwiha (Ru) AS041	Tree	Bark	W/C	Use 1 tablespoon of powder in 500 ml water and drink 2 table spoons 3 times a day	8	12.5
Cannabaceae <i>Cannabis sativa</i> L. Enjaga (Ru) AS013	Herb	Leaf	C	Boiled with cow ghee and 1 teaspoon drunk 3 times a day	2	3.12
Caricaceae <i>Carica papaya</i> L. Amapapari (Ru) AS024	Shrub	Seeds/root	C	Mix root with leaves of <i>Mangifera indica</i> , <i>Psidium guajava</i> and <i>Eucalyptus grandis</i> , Boil drink 500 ml daily or boil seeds add rock salt drink	3	4.68
Celestraceae <i>Maytenus senegalensis</i> (Lam) Exell AS060	Tree	Leaf/bark	W	Decoction drunk 250 ml twice daily	4	6.25
Combretaceae <i>Combretum molle</i> R. Br. Ex. G. Don Omurama (Ru) AS015	Tree	Leaf (shoots)	W	Chew shoots or boil and drink 1 teaspoon 3 times a day	6	9.375
Euphorbiaceae <i>Euphorbia tirucali</i> L. Oruyenje (Ru) AS072	Tree	Leaf	W/C	Steam on fire and chew	7	10.93
Fabaceae <i>Acacia hockii</i> De Wild Obugando (Ru) AS032	Tree	Leaf/Bark	W	Chew or boil and drink 500 ml 3 times daily	3	4.68
<i>Albizia coriaria</i> Welw. Omusisa (Ru) AS005	Tree	Leaf/Bark/Root	W	Dry, boil and drink 500 ml daily; 3 teaspoons for child	18	28.12
<i>Flueggea virosa</i> (Robx. Ex. Wild) Voigt Omubwera (Ru) AS028	Shrub	Leaf/Root	W	Decoction drunk 250 ml 3 times a day	2	3.12
<i>Pseudarthria hookeri</i> Wight and Arn Omukongorani (Ru) AS058	Herb	Leaf	W	Decoction drunk, 1 tea spoon child; 500 ml adult, 3 times a day	3	4.68
Lamiaceae <i>Tetradenia riparia</i> (Hochst.) Codd umuravumba (Ki), Omuravunga (Ru) AS075	Herb	Leaf	C	Chew with rock salt	9	14.06
<i>Hoslundia opposita</i> Vahl. Esiteimwe (Ru) AS008	Shrub	Leaf/Flower	W	Decoction drunk ¼ glass 3 times daily	2	3.12
<i>Ocimum suave</i> Willd. Omwenyi (Ru) Umwenya (Ki) AS059	Herb	Leaf	W/C	Make tea or chew with rock salt	10	15.62
<i>Plectranthus amboinicus</i> (Lour.) Spreng. Akacuncu akakye (Ru) AS053	Herb	Leaf	C	Steam, drink 1 tea spoon	3	4.68
<i>Plectranthus kamerunensis</i> Gurke Kashenda (Ru) AS003	Herb	Leaf	C	Chew or steam and take extract	5	7.81
Myrtaceae <i>Callistemon citrinus</i> Stapf. Akatuusi AS074	Tree	Leaf/Bark	W	Decoction drunk 500 ml daily	4	6.25
<i>Eucalyptus globulus</i> Labil. Karutusi (Ru) AS047	Tree	Leaf	W	Chew; or drink decoction 500 ml daily	10	15.62
<i>Psidium guajva</i> L. Amapeera (Ru) AS066	Tree	Leaf	W	Decoction drunk 1/2 glass twice daily	3	4.68
Poaceae <i>Cymbopogon citratus</i> Stapf. Omuteete (Ru) AS050	Herb	Leaf	C/W	Chew	6	9.37
Polygonaceae <i>Rumex hymenosepalus</i> Torr Omwitsya (Ru) AS073	Herb	Root	C	Chew	3	4.68
Rhamnaceae <i>Guoania longispicata</i> Engl. Omufurura AS051	Climber	Leaf/Bark	W	Chew	3	4.68
Rutaceae <i>Citrus sinensis</i> L. Omucungwa (Ru) AS018	Shrub	Fruit/Leaf/Bark	C	Boil or squeeze fruit in hot water and drink as much	8	12.5
Verbenaceae <i>Lantana trifolia</i> L. Omuhukye (Ru), Umuhengeri (Ki) AS049	Shrub	Leaf	W	Chew or boil with rock salt, take ½ glass 3 times daily	8	12.5
Zingiberaceae <i>Zingiber officinale</i> Roscoe Entangahuzi (Ru) AS048	Herb	Tuber	C	Chew or add to hot water	2	3.12

Column 4: C – Cultivated, W – Wild; Column 7: PRK – Percentage respondent's knowledge.

* Column 1: identity includes family, species and local names; Ethnic language (Ru:Runyankore; Ki: Kinyarwanda), Voucher specimen code.

For this analysis, plants mentioned once were not considered. For the category of diarrhoeal infections, *Abutilon guineense* (FL=100) was found to be the most important species according to the Fidelity.

Dicliptera laxata, *Senecio hadiensis*, *Hibiscus sabdariffa*, *Eucalyptus globulus*, *Abutilon guineense*, *Plumeria obtuse* and *Jatropha curcus* scored the highest FL values. 100% indicates highest efficiency of the species in treating the ailments (Ugulu, 2011).

Table 5

Plants used for diarrhoeal infections.

Species identity*	Growth habit	Parts used	Habitat	Mode of preparation & administration	Use reports (n=64)	PRK
Aloaceae <i>Aloe vera</i> L. Rukaka (Ru) Kikaka-rubamba (Ki) AS054	Herb	Leaf	C	Steam and drink extract	2	3.12
Amaranthaceae <i>Amaranthus spinosus</i> L. Doodo y'amahwa (Ru) AS012	Herb	Leaf	W	Pound fresh, steep in hot water & drink 1 teaspoon 3 times daily	3	4.68
Anacardiaceae <i>Rhus natalensis</i> Bern ex. Krauss Omusheeshe AS067	Tree	Leaf	W	Boil and drink 250 ml daily	6	9.37
Asteraceae <i>Crassocephalum vitellinum</i> S. Moore Esunuunu (Ru) AS055	Herb	Leaf	W	Decoction drunk 250 ml daily	2	3.12
<i>Dichrocephala integrifolia</i> Kuntze Omubuzza (Ru) AS023	Herb	Leaf	W	Boil and use the hot water to make millet porridge, drink	2	3.12
<i>Erlangea tomentosa</i> S. Moore Ekyoganyanja (Ru) AS056	Herb	Leaf	W	Infusion drunk, 250 ml daily	2	3.12
<i>Vernonia amygdalina</i> Delile Omubirizi (Ru) AS062	Shrub	Leaf	W	Mix with leaves of <i>Persea Americana</i> , boil and drink 500 ml 3 times daily	4	6.25
Bigoniaceae <i>Markhamia lutea</i> K. Schum. Omushambya (Ru) AS070	Tree	Root/leaf	W/C	Decoction drunk 250 ml; 1 teaspoon child	3	4.68
Canellaceae <i>Warburgia ugandensis</i> Sprague Omwiha (Ru) AS041	Tree	Root/Bark	W/C	Boil fresh roots mix with beef soup and eat; pound fresh bark add honey and drink extract	2	3.12
Fabaceae <i>Erythrina abyssinica</i> Lam. Ekiko (Ru) AS080	Tree	Leaf/Bark/Root	W	Boil, add honey and take 2 table spoons 3 times a day	4	6.25
<i>Pseudarthria hookeri</i> Wight and Arn Oruhigura (Ru) AS058	Herb	Leaf	W	Mix and pound with rock salt add water and drink	2	3.12
<i>Rhynchosia resinosa</i> (A. Rich) Baker Akategansi/Kashaka ryoya (Ru) AS014	Herb	Leaf	W	Decoction drunk 500 ml 3 times daily	5	7.81
<i>Albizia coriaria</i> Welw. Omusisa (Ru) AS005	Tree	Root/Bark	W	Decoction drunk, 250 ml twice a day	3	4.68
Lamiaceae <i>Hoslundia opposita</i> Vahl. Esiteimwe (Ru) AS008	Shrub	Leaf	W	boil with rock salt & ghee, give 1/4 glass 3 times daily; 3 table spoons child	5	7.81
<i>Leonotis nepetifolia</i> (L.) R. Br Ekicumucumu (Ru) AS077	Herb	Leaf	W	Mix with leaves of <i>Carica papaya</i> and <i>Physalis minima</i> , steep in hot water, mix with sorghum porridge, give 500 ml 3 times; 5 Teaspoons to child	4	6.25
<i>Ocimum suave</i> Willd. Omwenyi (Ru) Umwenya (Ki) AS059	Herb	Leaf	W/C	Decoction drunk, 500 ml daily; 1 tablespoon for child	5	7.81
Malvaceae <i>Abutilon guineense</i> (Shumach.) Baker. F and Exell. Akanyashagama (Ru) AS045	Herb	Leaf	W	Infusion drunk, 500 ml	12	18.75
<i>Gossypium hirsutum</i> L. Pamba (Ru) AS021	Herb	Leaf	C	Infusion drunk, 500 ml daily	5	7.81
Myrtaceae <i>Psidium guajva</i> L. Amapeera (Ru) AS066	Tree	Leaf	W	Decoction drunk, 250 ml 3 times daily	5	7.81
Solanaceae <i>Physalis peruviana</i> L. Entuutu (Ru) AS077	Herb	Leaf	C/W	Infusion drunk, 500 ml daily	7	10.93
Tiliaceae <i>Grewia mollis</i> Juss Omukoma (Ru) AS001	shrub	leaf	W	Chew or boil and use extract to make millet porridge and drink; or boil, add ghee and drink 250 ml 3 times daily	6	9.37
Verbenaceae <i>Lantana trifolia</i> L. Omuhukye (Ru), Umuhengeri (Ki) AS049	Shrub	Leaf	W	Chew or drink infusion 3 tablespoons 3 times daily	4	6.25

Column 4: C – Cultivated, W – Wild; Column 7: PRK – Percentage respondent's knowledge.

* Column 1: identity includes family, species and local names; Ethnic language (Ru:Runyankore; Ki: Kinyarwanda), Voucher specimen code.

Table 6

Plants used for food.

Species identity*	Growth habit	Parts used	Habitat	Mode of preparation & administration	Use reports (n=64)	PRK
Amaranthaceae <i>Amaranthus graecizans</i> L. enyabutongo (Ru) AS026	Herb	Leaf	W	Steam and eat	1	1.56
Anacardiaceae <i>Mangifera indica</i> L. AS025	Tree	Fruit	C/W	Eat ripe fruits	4	6.25
Basellaceae <i>Basella alba</i> L. Enderema (Ru) AS035	Climber	Leaf	C	Steam and eat as vegetable	3	4.68
Capparaceae <i>Cleome gynandra</i> L. Eshogi (Ru) AS 017	Herb	Leaf	W/C	Steam and eat as vegetable	1	1.56
Caricaceae <i>Carica papaya</i> L. Amapapari (Ru) AS024	Shrub	Fruit	C	Eat ripe fruit	3	4.68
Convolvulaceae <i>Ipomea batatas</i> (L.) Lam Ebitakuri (Ru) AS064	Herb	Root	C	Cook and eat	8	12.5
Cucurbitaceae <i>Cucurbita maxima</i> Lam. Ebyozi (Ru) AS052	Climber	Leaf and fruit	C	Steam and eat as vegetable	5	7.81
Dioscoraceae <i>Dioscorea</i> spp Amayuni (Ru) AS011	Herb	Root/leaf	C	Boil and eat	5	7.81
Euphorbiaceae <i>Manihot esculenta</i> Crantz Muhogo (Ru) AS031	Shrub	Leaf/Root	C	Steam or boil and eat	5	7.81
Fabaceae <i>Cajanus cajan</i> (L.) Mills Entondeigwa (Ru) AS081	Shrub	Seeds	C	Boil and eat	5	7.81
Lauraceae <i>Persea Americana</i> Mill. Vakedo (Ru) AS063	Tree	Fruit	C	Eat ripe fruit	5	7.81
Myrtaceae <i>Psidium guajva</i> L. Amapeera (Ru) AS066	Tree	Fruit	W	Eat ripe fruit	4	6.25
Solanaceae <i>Solanum nigrum</i> L. Eshwiga (Ru) AS081	Herb	Leaf	W	Steam and eat as vegetable	4	6.25

Column 4: C – Cultivated, W – Wild; Column 7: PRK – Percentage respondent's knowledge.

* Column 1: identity includes family, species & local names; Ethnic language (Ru:Runyankore; Ki: Kinyarwanda), Voucher specimen code.

Table 7
Plants used to boost appetite and immunity.

Species identity	Growth habit	Parts used	Habitat	Mode of preparation & administration	use reports (n=64)	PRK
Acanthaceae <i>Asystasia gangetica</i> T. Anderson Eikinguura (Ru) AS065	Climber	Leaf	W	Mix and boil with leaves of <i>Conyza bonariensis</i> and <i>Mentha spicata</i> . 500 ml drunk daily	1	1.56
<i>Dicliptera laxata</i> C. B. Clarke, Omufooka (Ru) AS046	Herb	Leaf	C	500 ml of Decoction/infusion drunk 3 times daily	15	23.44
Aloaceae <i>Aloe vera</i> L. Rukaka (Ru) Kikakarubamba (Ki) AS054	Herb	Leaf	C	Decoction drunk, 250 ml daily	2	3.12
Amaranthaceae <i>Amaranthus dubius</i> Mart. Ex. Thell. Doodo (Ru) AS007	Herb	Seeds	C	Boil and eat as vegetable	1	1.56
Asteraceae <i>Artemisia absinthium</i> L. Akamuri (Ru) AS078	Herb	Leaf	C	Chew	1	1.56
<i>Bidens pilosa</i> L. Enyabarashana (Ru) AS069	Herb	Leaf	W	Infusion drunk, 500 ml daily	1	1.56
<i>Crassocephalum vitellinum</i> S. Moore Esunuunu (Ru) AS055	Herb	Leaf	W	Decoction drunk, 500 ml daily	4	6.25
<i>Plunchea ovalis</i> Omuneera (Ru) AS016	Shrub	Leaf	W	Decoction drunk, 500 ml daily	4	6.25
<i>Senecio hadiensis</i> Forssk Omuziranfu (Ru) AS039	Herb	Leaf	C	Decoction drunk, 500 ml daily; Powder eaten with food	11	17.18
<i>Vernonia amygdalina</i> Delile Omubirizi (Ru) AS062	Shrub	Leaf (shoots)	W	Chew leaf	4	6.25
<i>Erlangea tomentosa</i> S. Moore Ekyoganyanja (Ru) AS056	Herb	Leaf	W	Decoction drunk, 500 ml 3 times daily	2	3.12
Capparaceae <i>Capparis tomentosa</i> Lam. Kagyenzanda (Ru) AS040	Shrub	Root	W	Chew or use powder in food	2	3.12
Fabaceae <i>Cajanus cajan</i> (L.) Mills Entondeigwa (Ru) AS080	Shrub	Leaf	C	Decoction drunk, 1/4 glass 3 times daily	4	6.25
<i>Rhynchosia resinosa</i> (A. Rich) Baker Akategansi/Kashaka ryoya (Ru) AS014	Herb	Leaf	W	Decoction drunk 500 ml daily	1	1.56
Lamiaceae <i>Ocimum suave</i> Willd. Omwenyi (Ru) Umwenya (Ki) AS059	Herb	Leaf	W/C	Chew, or boil with milk, take 500 ml daily	8	12.5
<i>Plectranthus amboinicus</i> (Lour.) Spreng. Akacuncu akakye (Ru) AS053	Herb	Leaf	C	Decoction drunk, 500 ml daily	1	1.56
Lauraceae <i>Persea Americana</i> Mill. Vakedo (Ru) AS063	Tree	Leaf	C	Decoction, 500 ml drunk daily	5	7.81
Malvaceae <i>Hibiscus sabdarifa</i> L. Ekyeshagama (Ru) AS004	Herb	Leaf	C	Decoction drunk, 50 ml 3 times daily	15	23.43
Moringaceae <i>Moringa oleifera</i> Lam. AS057	Tree	Leaf	C	Leaves steamed and eaten as vegetable	6	9.375
Myricaceae <i>Myrica salicifolia</i> Omujeje (Ru) AS043	Shrub	Leaf/Bark	W	Powder added to food or tea	4	6.25
Passifloraceae <i>Passiflora edulis</i> Sims Obutunda (Ru) AS061	Climber	Leaf	C	Drink 1/2 glass of infusion 3 times daily	2	3.125
Rubiaceae <i>Hallea rubrostipulata</i> (K. Schum.) J. Fleroy Omuziko (Ru) AS071	Tree	Leaf, bark	W	Decoction drunk, 500 ml daily	3	4.68
<i>Tarenna pavettoides</i> (Harv.) Sim Omunywameizi (Ru) AS037	Shrub	Leaf	W	Powder added to food or tea	8	12.5
Solanaceae <i>Physalis peruviana</i> L. Entuutu (Ru) AS076	Herb	Fruit	C/W	Eaten ripe	7	10.94
<i>Solanum nigrum</i> L. Eshwiga (Ru) AS081	Herb	Leaf	W	Steam and eat as vegetable	4	6.25
Zingiberaceae <i>Zingiber officinale</i> Roscoe Entangahuzi (Ru) AS048	Herb	Tuber	C	Chew or add to hot water	1	1.56

Column 1: Species identity* includes family, species and local names; Ethnic language (Ru:Runyankore; Ki: Kinyarwanda), Voucher specimen code. Column 4: C – Cultivated, W – Wild; Column 7: PRK – Percentage respondent's knowledge.

3.11. Plant parts used, mode of preparation, dosage and administration

Leaves accounted for the largest percentage of plant parts used (71%), followed by roots (11%) and stem bark (8%). Whole plants, fruits, seeds, flowers and tubers contributed less than 3%. The use of leaves is less destructive to the plant unlike the use of roots and whole plant that involves digging up the plant which leads to plant death. Herbs (40 species) were the most used forms followed by trees (19 species), shrubs (18 species) and climbers (6 species). Contrary to our results, other studies reported that roots and shrubs were the commonly used parts and growth forms respectively (Kamatnesi et al., 2011; Maroyi, 2011).

Herbal remedies were prepared using either fresh plant material (81%) or dried material (7%). In some cases, a plant was used both in dry and fresh forms (16%). Plant remedies were prepared by boiling plant parts, pounding or squeezing the fresh material, cooking or steaming, roasting or smoking, and chewing. Herbal remedies were prepared mainly as water extracts using single

plant species (94%). A single plant species contains chemical compounds that curtail several infections, while a mixture (concoction) of plants is effective due to the additive and synergistic effects of a combination of plants that they have during treatment, as well as similar compounds acting on different pathogens.

The results of this study showed that using concoctions (6%) was not a common practice. However, it is a common practice to combine plants to create synergy, reduce toxicity and increase bioavailability and palatability (Tabuti et al., 2010; Bussmann et al., 2011; Namukobe et al., 2011). To enhance extraction of bioactive molecules, different additive substances like honey, fermented porridge, rock salt and milk are mixed with plant parts during preparation of remedies.

The medicinal plants preparations were administered through oral (87%) and topical /dermal (13%) routes. The high percentage of oral administration of remedies calls for more attention on testing for the safety, mainly toxicological properties of these herbal remedies. The recommended dosage for oral intake differs among informants for treating the same health problem. Informants

Table 8

Plants used to manage herpes zoster.

Species identity*	Growth habit	Habitat	Parts used	Mode of preparation & administration	use reports (n=64)	PRK
Acanthaceae <i>Hygrophila auriculata</i> (Schumach.) Heine Aganshongoreire (Ru) AS030	Herb	C	Leaf	Dry and apply powder on affected body area	3	4.68
Aloaceae <i>Aloe vera</i> L. Rukaka (Ru) Kikakarubamba (Ki) AS54	Herb	C	Leaf	Mix leaf powder with jelly and apply on affected area	2	3.12
Anacardiaceae <i>Rhus natalensis</i> Bern ex. Krauss Omusheeshe AS067	Tree	W	Leaf	Apply powder on affected area	3	4.68
Asteraceae <i>Guizotia scabra</i> Chiov. Ekitrankuba (Ru) AS033	Herb	W	Leaf	Apply powder	3	4.68
<i>Vernonia amygdalina</i> Delile Omubirizi (Ru) AS062	Shrub	W	Leaf	Apply extract on affected area	4	6.25
Apocynaceae <i>Plumeria obtusa</i> L. Omusikamori (Ru) AS029	Tree	C	Leaf	Apply leaf sap or powder on affected area	7	10.93
Celestraceae <i>Maytenus senegalensis</i> (Lam) Exell AS060	Tree	W	Leaf	Apply powder on affected part of body	3	4.68
Euphorbiaceae <i>Euphorbia hirta</i> L. Enkoninyabuto (Ru) AS027	Herb	W	Leaf	Apply extract; add powder to water drink 2 teaspoons for 14 days	3	4.68
<i>Jatropha carcus</i> L. Omuroowe (Ru), AS010	Shrub	C	Leaf	Apply sap on affected area	7	10.93
Fabaceae <i>Albizia coriaria</i> Welw. Omusisa (Ru) AS005	Tree	W	Bark	Apply powder on affected area	2	3.12
<i>Erythrina abyssinica</i> Lam. Ekiko (Ru) AS079	Tree	W	Bark	Apply powder on affected area	5	7.81

Column 3: C – Cultivated, W – Wild; Column 7: PRK – Percentage respondent's knowledge.

* Column 1: identity includes family, species and local names; Ethnic language (Ru:Runyankore; Ki: Kinyarwanda), Voucher specimen code.

Table 9

Fidelity level (FL) values of the frequently reported plants and their major uses.

Plant species	Family	Therapeutic uses	Use mention	Fidelity level (%)
<i>Abutilon guineense</i>	Malvaceae	Diarrhoea	12	100
<i>Dicliptera laxata</i>	Asteraceae	Appetite and immunity boosting	15	88
<i>Eucalyptus globulus</i>	Myrtaceae	Cough	10	77
<i>Hibiscus sabdariffa</i>	Malvaceae	Anaemia	15	100
<i>Jatropha curcus</i>	Euphorbiaceae	Herpes zoster	7	78
<i>Plumeria obtusa</i>	Apocynaceae	Herpes zoster	7	100
<i>Senecio hadiensis</i>	Asteraceae	Appetite and immunity boosting	11	92
<i>Albizia coriaria</i>	Fabaceae	Cough	27	67
<i>Hoslundia opposita</i>	Lamiaceae	Bacterial and fungal infections	17	58
<i>Ocimum suave</i>	Lamiaceae	Cough	25	40

indicated that the doses for liquid preparations were prescribed in terms of a full, half or one quarter of a mug or tea cup and a table spoon, depending on the age of the patient and type of disease being treated. Dosages varied between 100–500 ml (a mugful) for adults; 100–250 ml (half a mug) for older children above 5 years; and 1–3 tea spoons for children below 5 years. The drugs were taken 1–3 times a day for a period ranging from 1 to 30 days or until the patient's condition is improved, an anomaly that looks different from the conventional therapy medicines.

4. Conclusion

The results of the study revealed a high diversity of medicinal plants and traditional knowledge about the use, preparation, and administration of herbal remedies, which is still maintained among the local communities. The preservation of this knowledge appears to be the result of continued reliance on the medicinal plants by the local communities. Indigenous knowledge varies from respondent to another and among different age groups. In this study, we found that a large percentage (67%) of respondents with substantive knowledge was above 40 years of age, while mothers were found to have higher levels of plant use and knowledge. This is due to lack of interest among the youth. Utilisation of leaves and herbs for medicinal purpose preserves biological diversity. The high percentage of oral administration of the herbal remedies warrants more research on biosafety testing and toxicological factors to ensure its safety for human consumption. Domestication of medicinal plants is not taken seriously. The high informant consensus values for particular species indicates

that the species are used by a large proportion of informants and are worth searching for bioactive molecules. The present inventory of nutri-medicinal plants opens new avenues to scrutinise such a rich natural resource for further ethno-pharmacological studies in order to develop the potential of herbal medicine. The documented plants serve as a basis for future phytochemical and pharmacological studies.

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