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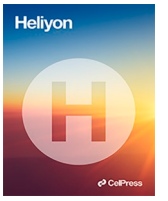

Research article

Ethnobotanical survey and phytochemistry of medicinal plants used in the management of HIV/AIDS in Eastern Uganda

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ABSTRACT

Currently, highly active antiretroviral therapy is unable to cure HIV/AIDS because of HIV latency. This study aimed at documenting medicinal plants used in the management of HIV/AIDS in Eastern Uganda so as to identify phytochemicals with HIV latency reversing potential. An ethnobotanical survey was conducted across eight districts in Eastern Uganda. Traditional medicine practitioners were interviewed using semi-structured questionnaires. Qualitative and quantitative phytochemical tests were respectively, performed to determine the presence and quantity of phytochemicals in frequently mentioned plant species. Data were analysed and presented using descriptive statistics and Informant Consensus Factor (ICF). Twenty-one plant species from fourteen plant families were reported to be used in the management of HIV/AIDS. Six plant species with the highest frequency of mention were: *Zanthoxylum chalybeum*, *Gymnosporia senegalensis*, *Warbugia ugandensis*, *Leonatis nepetifolia*, *Croton macrostachyus* and *Rhoicissus tridentata*. Qualitative phytochemical analysis of all the six most frequently mentioned plant species revealed the presence of flavonoids, tannins, terpenoids, alkaloids and phenolics. Quantitative analysis revealed the highest content of flavonoids in *L. nepetifolia* (20.4 mg/g of dry extract) while the lowest content was determined in *C. macrostachyus* (7.1 mg/g of dry extract). On the other hand, the highest content of tannins was observed in *L. nepetifolia*. (199.9 mg/g of dry extract) while the lowest content was found in *R. tridentata*. (42.6 mg/g of dry extract). Medicinal plants used by traditional medicine practitioners in Eastern Uganda to manage HIV/AIDS are rich in phytochemicals including flavonoids and tannins. Further studies to evaluate the HIV-1 latency reversing ability of these phytochemicals are recommended to discover novel molecules against HIV/AIDS.

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1. Introduction

Human immunodeficiency virus type-1 (HIV-1) is the etiologic agent of acquired immunodeficiency syndrome (AIDS). HIV/AIDS remains a global public health concern with 85.6 million people reportedly infected with the virus since the beginning of the epidemic over four decades ago [1]. While 40.4 million people have since died from AIDS-related illnesses, 39 million people were reported to be living with HIV globally and of these, Sub-Saharan Africa has always been an epicenter of the disease with over 68 percent of all global HIV infections [1]. In Uganda, as of 2021, an estimated 1.4 million people were reported living with HIV, and Eastern Uganda has the second highest disease burden with 4.2 percent prevalence [2].

With improved access and affordability of intensive highly active antiretroviral therapy (HAART), there has been a tremendous improvement in the life expectancy of people living with HIV/AIDS. However, HAART does not cure HIV/AIDS due to HIV latency [3–6] such that disruption or discontinuation of HAART leads to rebound in viremia [7–9]. Besides lack of cure, HAART has disadvantages with several studies reporting cases of toxicity [10–13], drug resistance [14–16] as well as other drug complications [17–19].

Due to the adverse side effects of conventional medicines including HAART and the limited access to medical facilities, the use of herbal medicines to manage ailments especially in rural areas of Uganda has been estimated at 60 percent [20]. In particular, the prevalence of people living with HIV/AIDS on HAART that use herbal medicines was reported to be 33 %, and this was especially used by patients experiencing adverse side effects of HAART [21]. Alternatives to HAART are being investigated and indeed there are medicinal plants which have shown efficacy against HIV/AIDS [22]. Phytochemicals in the class of diterpenes have been extensively investigated as latency reversing agents. Prostratin, a diterpene phorbol ester and a protein kinase C agonist first isolated from Pimelea prostrata (Thymelaceae) [23] exhibit HIV-1 latency reversal properties [24,25] providing a potential avenue for HIV cure. Other phytochemicals including ingenol (diterpene) [26], and procyanidin (flavonoid) [27] are being investigated as HIV-1 latency reversing agents.

In Uganda, studies on plant-based latency reversing agents are scanty yet the biggest population especially the poor depend on traditional medicines for their primary health care. Screening plants based on ethnopharmacological data increases the potential of finding novel compounds with HIV curative properties [28,29]. HIV/AIDS is a relatively new human disease with minimal ethnobotanical treatments. However, logical association of treatments for other likely viral infections and closely linked disease states or symptoms can increase the prospects of finding new phytochemical leads as potential *anti*-HIV or latency reversing agents [30]. In this study, an ethnobotanical survey was conducted in order to identify key medicinal plants used by traditional medicine practitioners (TMPs) in Eastern Uganda to manage HIV/AIDS. In addition, phytochemical analysis of the key medicinal plants was conducted with the aim of identifying the classes of natural products that can reverse HIV latency.

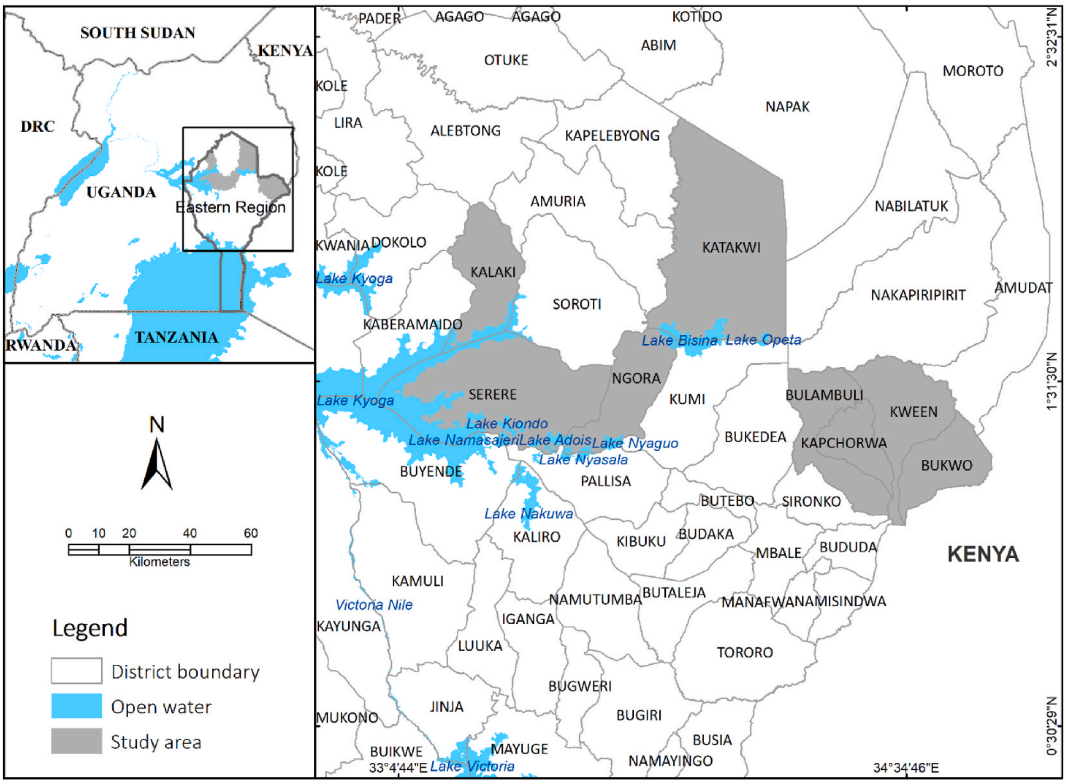

Fig. 1. Map of Uganda showing the study area in Eastern Uganda.

2. Materials and methods

2.1. Study design, setting and sampling

An ethnobotanical survey with cross-sectional study design was conducted across eight districts in Eastern Uganda including Bulambuli, Bukwo, Kalaki, Kapchorwa, Katakwi, Kween, Ngora and Serere (Fig. 1). The eight districts were purposely sampled on the basis of their location in rural areas, high poverty levels and long distance to access health services. The majority of the patients in these areas therefore, rely on the use of herbal medicines as the first or second option for management of HIV/AIDS. Furthermore, TMPs harvest the medicinal plants from these selected districts for preparation of herbal medicines.

Using the snowball sampling technique, a total of sixty-four TMPs were interviewed from the eight districts in Eastern Uganda. The TMPs were purposively selected on the basis of their reputation in the community in the management of HIV/AIDS using herbal medicines. In each of the districts, the first participant was identified either through the local council or leadership of the herbalist association. The first participant then helped us to identify the second who also helped us to identify the third until the last participant was identified.

2.2. Data collection

Ethnobotanical data were collected from the TMPs between June and July 2023 using a semi-structured questionnaire with the help of translators (research assistants) who were familiar with the local languages of the area. The questionnaire included items on the TMP biodata, knowledge on signs and symptoms of HIV/AIDS, names of medicinal plants used, details of plant parts harvested, preparation, administration, packaging and dosage of herbal medicine for managing HIV/AIDS. All the study participants were taken through the informed consent process prior to enrollment in to the study. Prior to commencement of the study, a pretest of the data collection tool was conducted among selected TMPs in Busoga sub-region. A focus group discussion was held with selected community members to complement the questionnaire survey particularly on issues of disease recognition and herbal medicine packaging. All the plants mentioned by TMPs used in the management of HIV/AIDS were identified and collected with the help of the TMPs in the field. At each sampling site, herbarium vouchers were collected and the collection points geocoded using a hand-held Global Positioning System (GPS). In total, 186 specimens were collected, pressed, dried and taken to Makerere University Herbarium (MHU) for name confirmation. This was guided by use of the Flora of Tropical East Africa (FTEA) for the different families of plants. For the six specimens that were included in the phytochemical analysis, herbarium specimens were prepared and mounted for future reference and these included; *Z. chalybeum* (MHU 51275); *L. nepetifolia* (MHU 51276); *C. macrostachyus* (MHU 51277); *Warbugia ugandensis* (MHU 51278); *G. senegalensis* (MHU 51279) and *R. tridentata* (MHU 512300).

2.3. Data analysis

Data were entered in Microsoft Excel spread sheet, coded, and exported to SPSS software Version 26 for analysis. Descriptive statistics were used to summarize ethnobotanical and participants socio-demographic data. The Informant Consensus Factor (ICF) was calculated to determine the homogeneity in the ethnobotanical information collected from the participants [31]. The ICF was computed using the formula below,

$$ICF = \frac{Nur - Nt}{Nur - 1}$$

Where "*Nur*" refers to the total number of use reports for each disease cluster and "*Nt*" refers to the total number of species in each use category. The ICF values range from 0 to 1. High ICF values (close to 1) indicate that participants use similar medicinal plants and thus there is agreement in the medicinal plants used to treat a particular disease while low ICF values (close to 0) indicate that participants use many different plant species to treat a disease.

2.4. Phytochemical analysis

2.4.1. Samples

The plant samples were roots of *Z. chalybeum*, aerial parts of *L. nepetifolia*, stem bark of *G. senegalensis*, stem bark of *C. macrostachyus*, stem bark of *W. ugandensis* and roots of *R. tridentata*. The plant samples were shade-dried and crushed into powder for analysis.

2.4.2. Sample extraction

The pulverized plant sample (10g) was extracted with 1L of 70 % ethanol and sonicated using GT sonic-D9 ultrasonic cleaner (China) for 30 min at 50 °C. The mixture was filtered through Whatman No. 1 filter paper (125 mm) and the filtrate was concentrated using rotary evaporator [32]. The dried extracts were stored in refrigerator until the analysis.

2.4.3. Qualitative phytochemical test

The profiling for presence of major phytoconstituents (flavonoids, terpenoids, tannins, alkaloids, steroids, saponin and phenolics)

were carried out using standard qualitative methods [33,34].

2.4.3.1. Detection of flavonoids (ferric chloride test). To each extract (0.2g of extract dissolved in 1 ml of ethyl alcohol and filtered) six drops of neutral ferric chloride solution was added. Formation of blackish red colour indicated the presence of flavonoids.

2.4.3.2. Detection of steroids (liebermann-burchard test). Each extract (0.2g) was dissolved in chloroform (1 ml) followed by 2 ml of concentrated sulphuric acid. Formation of reddish-brown colour at lower layer indicated the presence of steroids.

2.4.3.3. Detection of terpenoids. Each powdered plant material (0.5g) was treated with 5 ml of 1 % aqueous hydrochloric acid for 4 h. The extract obtained was treated with 1 ml of Trim-Hill reagent (10 ml of acetic acid, 1 ml of 0.2 % copper sulphate in water and 0.5 ml of concentrated hydrochloric acid) in a test tube followed by heating in a water bath. The appearance of a blue colour indicated the presence of diterpenoids while green colour indicated the presence of monoterpenoids.

2.4.3.4. Detection of tannins (ferric chloride test). Each extract (0.1g) was dissolved in distilled water (1 ml) and three drops of ferric chloride solution was added. Formation of blackish precipitate indicates the presence of tannins.

2.4.3.5. Detection of glycosides (Molisch's test). A mixture of Molisch's reagent (alpha-naphthol dissolved in ethanol) and concentrated sulphuric acid (1:1) was added to 1 ml of aqueous solution of each crude extract (0.1g of extract in 1 ml of distilled). Formation of the reddish-violet ring at the junction of two liquids indicates the presence of glycosides.

2.4.3.6. Detection of saponins. Each extract (0.5g) was mixed 15 ml of distilled water and then agitated in a graduated cylinder for 10 min. Foam formation that persisted for more 5 min indicated the presence of saponins.

2.4.3.7. Detection of alkaloids (Dragendorff's reagent test). Each extract (0.2g) was dissolved with 2 ml of 1 % diluted hydrochloric acid to the acidic solution followed by 2 ml of Dragendorff's reagent. An orange-red colour precipitate indicated the presence of alkaloids.

2.4.3.8. Detection of phenolics (ferric chloride test). Each extract (0.2g) dissolved 2 ml of ethyl alcohol and filtered followed by 1 ml of ferric chloride solution. Formation of an intense colour indicated the presence of phenols.

2.4.3.9. Detection of quinones. Each extract (0.2g) was dissolved in 2 ml of ethyl alcohol and followed by 2 ml of alcoholic potassium hydroxide solution. The appearance of a range of red to blue coloration indicated the presence of quinones.

2.4.3.10. Detection of phlobatannins. 2 ml of aqueous extract was added to 2 ml of 1 % hydrochloric acid and the mixture was boiled. Deposition of a red precipitate was taken as evidence for the presence of phlobatannins.

2.4.3.11. Detection of anthraquinones (Borntrager's test). Three ml of aqueous extract was shaken with 3 ml of benzene, filtered and 5 ml of 10 % ammonia solution was added to the filtrate. The mixture was shaken and the presence of a pink, red or violet colour in the ammonical (lower) phase indicated the presence of free anthraquinones.

2.4.4. Quantitative phytochemical analysis

2.4.4.1. Estimation of total flavonoid contents. The aluminium chloride spectrophotometric method was used to estimate total flavonoid content in the extracts using apigenin as the standard. 100 μl of each of standard solutions (2.81, 5.63, 11.25, 22.50 and 45.00 μg/ml) and extract (1.0 mg/ml) in duplicate were treated with 100 μl of 5 % $NaNO_3$, 150 μl of 10 % $AlCl_3$, 200 μl of 4 % NaOH and the absorbance was measured at 416 nm using single beam UV-VIS spectrophotometer (6705 Jenway, China). The total flavonoid content was expressed as mg/g quercetin equivalent (QUE) of dry extract [35].

2.4.4.2. Estimation of total tannin contents. Folin-Ciocalteu method was used to estimate the total tannin content in the plant extract using tannic acid as the standard. In 200 μl methanolic solution of the extract (1 mg/ml) was added to 200 μl of 10 % Folin-Ciocalteu reagent kept for 5 min before adding 100 μl of 35 % Na_2CO_3 and 5 ml of distilled water then incubated for 35 min in the dark. The absorbance was determined using a spectrophotometer (6705 Jenway, China) at λ_{max} 292 nm. The same procedure was repeated for the standard solutions (3.13, 6.25, 12.50, 25.00 and 50.00 μg/ml) of tannic acid for the calibration curve. The total phenol content in plant extracts was expressed in terms of ascorbic acid equivalent (mg of TCA/g of extract [36].

2.4.5. Statistical analysis

The experiments were performed in duplicate and the results expressed in the form of mean ± standard deviation. Data was analysed using descriptive statistics and presented as frequencies in figures (bar charts).

3. Results and discussion

In this study, the majority (39 %) of TMPs were aged between 40 and 59 years old while only few (2 %) were aged below 20 years. This finding is consistent with a recent study that investigated medicinal plants used to manage diabetes mellitus which reported similar age groups of TMPs in Eastern Uganda [37]. Similarly, the mean age of TMPs was 51 years in a study that investigated the traditional knowledge of medicinal plants for managing opportunistic infections among people with HIV/AIDS in Uganda [38]. The vast majority (96 %) of TMPs acquired traditional medicine knowledge from relatives and this is consistent with previous findings [37,38]. However, only few (42 %) had shared this knowledge with another person (Fig. 2). This is possibly due to the fact that many TMPs are illiterate [37,39] and others perceive sharing of traditional medicine knowledge as loss of intellectual property for which their livelihood depends.

A total of twenty-one plant species from fourteen families were documented (Table 1). The most reported plant family was Euphorbiaceae. Others include Asteriaceae, Celastraceae, Lamiaceae and Fabaceae. Meanwhile, three plant species with the highest frequency of mention including *Z. chalybeum* (Rutaceae), *G. senegalensis* (Celastraceae), and *W. ugandensis* (Cancellaceae), were also used in other parts of Uganda as medicinal plants for the management of opportunistic infections associated with HIV/AIDS [38]. Other plant species that were most frequently mentioned include *L. nepetifolia* (Lamiaceae), *C. macrostachyus* (Euphorbiaceae) and *R. tridentata* (Vitaceae) (Table 1). Most of the mentioned plant species were trees whereby, roots were the plant parts mostly harvested for preparation of herbal medicines and the majority of the plants were collected from the wild (Table 1), which is consistent with the previous findings [40–42]. In this study, the calculated informant consensus factor (ICF) was 0.47 implying that the TMPs use different medicinal plants to manage HIV/AIDS. In this region, there is limited sharing of knowledge with regards to herbal medicines for managing HIV/AIDS as the information is kept as a secret for economic gain by the TMPs. The ICF of 0.47 is similar to the one (0.54) reported by Obakiro et al. in an ethnobotanical study conducted to identify medicinal plants used in the management of diabetes mellitus in Eastern Uganda [37]. The difference between the ICF of 0.47 and 0.54 is 0.07 which is a 7 % difference. This difference is insignificant and therefore similar though not the same. Both HIV/AIDS and diabetes mellitus are diseases of economic importance to TMPs in Eastern Uganda because herbal medicines are the first- or second-line treatment option. To the contrary, Anywar et al.

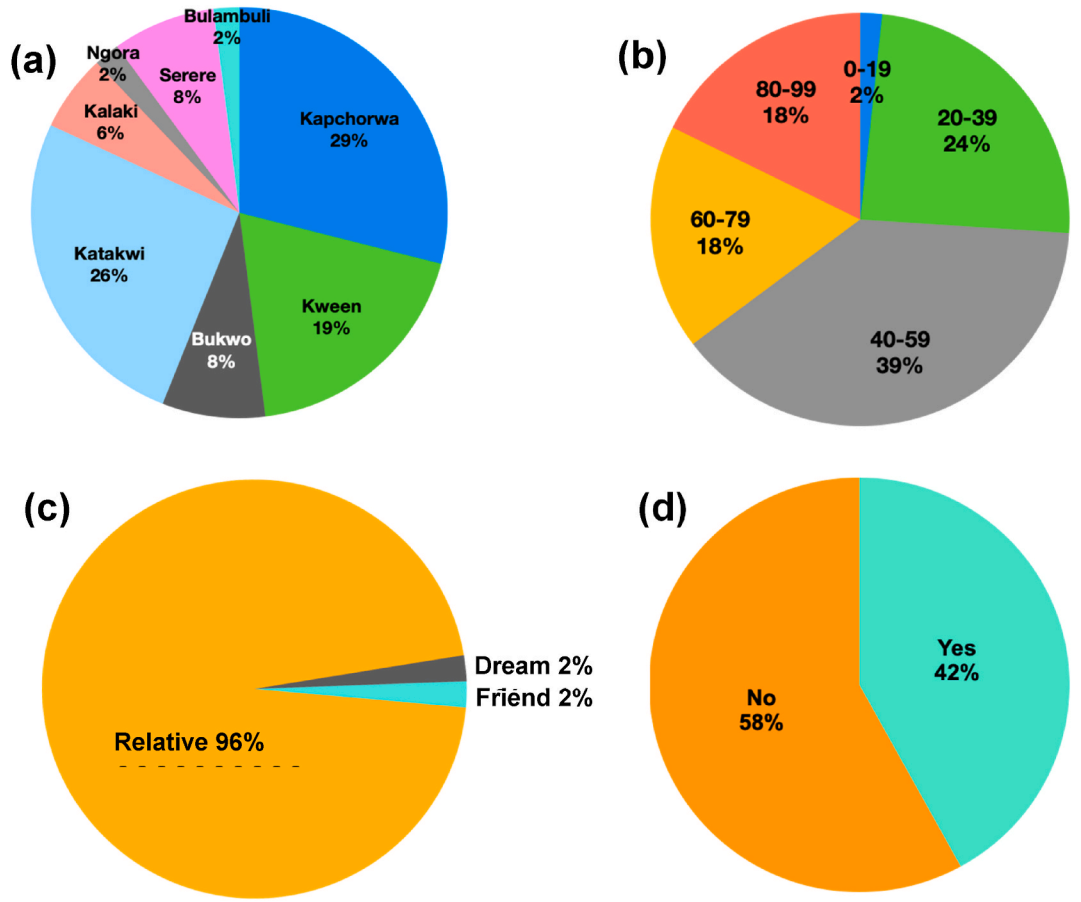

Fig. 2. Sociodemographic characteristics, source and transmission of traditional medicine knowledge by the study participants. (a) Districts surveyed and the distribution of sample size (b) Age group distribution of study participants (c) Source of knowledge and (d) Whether the participants have taught anyone.

Table 1
Medicinal plants used for HIV/AIDS management by the traditional medicine practitioners in Eastern Uganda.

S/N	Family	Scientific name	Local name	Voucher number	Habit	Habitat	Plant part used	Frequency of mention
1	Euphorbiaceae	*Ricinus communis* L.	Manuet*	JH001	Tree	Cultivated	Roots	1
2	Celastraceae	*Maytenus undata* (Thunb.) Blakelock	Chepkatet*	JH002	Tree	Low lands	Roots	1
3	Phyllanthaceae	*Phyllanthus amarus* Schumach. &Thonn.	Ngorinet*	JH003	Tree	Dry lands	Roots	2
4	Asteraceae	*Bidens pilosa*L.	Namugikong*	JH004	Herb	Cultivated	Whole plant	1
5	Euphorbiaceae	*Acalypha indica*Vell.	chepkwarerelong*	JH005	Herb	Wild	Leaves	1
6	Asphodelaceae	*Aloe vera* (L.) Burm.f.	Kigachi*	JH006	Herb	Rocky areas	Succulent parts	1
7	Moringaceae	*Moringa oleifera* Lam.	Muringa*	JH007	Herb	Rocky areas	Leaves and seeds	1
8	Rubiaceae	*Rytigynia umbellulata* (Hiern) Robyns	Lakatetwet*	JH008	Tree	Wild	Roots	2
9	Euphorbiaceae	*Euphobia hirta* L.	Otibolono**	JH009	Herb	Cultivated	Whole plant	1
10	Celastraceae	*Gymnosporia senegalensis* (Lam.) Loes	Eteba**	JH0010	Tree	Wild	Stembark	4
11	Vitaceae	*Rhoicissus tridentata* (L.f.) Wild & R.B.Drumm	Aremo***	JH0011	Creeper	Low lands	Roots	3
12	Bignoniaceae	*Kigelia africana* (Lam.) Benth.	Rootyonteet*, Edodoi**, Yago***	JH0012	Tree	Wild	Fruits	2
13	Rutaceae	*Zanthoxylum chalybeum* Engl.	Sonkoywet*, Eusuk**	JH0013	Tree	Wild	Roots	5
14	Lamiaceae	*Leonotis nepetifolia* (L.) R. Br.	Chechuju*, Ecikwa**	JH0014	Shrub	Wild	Whole plant	3
15	Cancellaceae	*Warburgia Ugandensis* Sprague	Abach**	JH0015	Tree	Wild	Stembark	4
16	Euphorbiaceae	*Croton macrostachyus* Hochst. Ex Delile	Toboswa*	JH0016	Tree	Cultivated	Stembark	3
17	Meliaceae	*Azadirachta indica* A. Juss.	Mwarubaine/Albaine*	JH0017	Tree	Cultivated	Leaves	2
18	Asteraceae	*Chromolaena odorata* (L.) R.M.King & H.Rob.	matipsorin*	JH0018	Shrub	Cosmopolitan	Roots	1
19	Ebenaceae	*Euclea divinorum* Hiern	Usuet*	JH0019	Tree	Low lands	Roots	1
20	Fabaceae	*Erythrina abyssinica* Lam.	Engocoro**, Owilakot***	JH0020	Tree	Wild	Stembark	1
21	Lamiaceae	*Plectranthus barbatus* Andr.	Angurwet*	JH0021	shrub	Low lands	Roots	1
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reported a higher ICF of 0.79 in a study that investigated the medicinal plants used for management of opportunistic infections among people lining with HIV/AIDS in the country [38]. This difference is attributed to the many TMPs' associations in other regions of the country such as central Uganda which have encouraged knowledge sharing and have done extensive training of TMPs in this region as compared to Eastern Uganda where every TMP is almost on his/her own.

Qualitative phytochemical investigation provides valuable information on the presence while quantitative phytochemical analysis enables determination of the total amounts of these compounds, thereby, allowing for a comprehensive understanding of their activity in the plant materials. Table 2 presents the results of qualitative analysis and confirmed the presence of flavonoids, alkaloids, phenolics, terpenoids and tannins in all the extracts (*Z. chalybeum*, *G. senegalensis*, *W. ugandensis*, *R. tridentata*, *L. nepetifolia* and

Table 2
Phytochemical composition of selected medicinal plants used for managing HIV/AIDS in Eastern Uganda.

Phytochemical	*L. nepetifolia*	*G. senegalensis*	*R. tridentata*	*C. macrostachyus*	*Z. chalybeum*	*W. ugandensis*
Flavonoids	+	+	+	+	+	+
Steroids	+	+	–	+	+	+
Terpenoid	+	+	+	+	+	+
Tannins	+	+	+	+	+	+
Glycosides	+	+	+	+	+	+
Saponin	–	+	+	+	–	+
Alkaloids	+	+	+	+	+	+
Phenolics	+	+	+	+	+	+
Quinone	+	+	+	+	+	+
Phlobatannins	+	+	+	+	+	+
Anthraquinones	+	+	+	+	+	+

Key: (+) represents present; (−) represents absence of a particular phytochemical

C. macrostachyus) analysed, which is consistent with previous reports [43–47]. However, saponin was absent in extracts of *L. nepetifolia* and *Z. chalybeum* while extracts of *R. tridentata* lacked steroids. Fig. 3 shows the quantitative analysis of flavonoids and tannins in selected plant samples. The flavonoid content in the selected plant samples ranged from 7.1 to 20.4 mg/g of dry extract. The highest content of flavonoids was found in the samples of *L. nepetifolia* (20.4 mg/g of dry extract). The lowest content was determined in the samples of *C. macrostachyus* (7.1 mg/g of dry extract). The amounts of tannins in the selected plant samples ranged from 42.6 to 199.9 mg/g of dry extract. The highest content of tannins was observed in the samples of *L. nepetifolia* while the lowest content of tannins was determined in samples of *R. tridentata*. (42.6 mg/g of dry extract). Certain groups of terpenoid, flavonoid, and tannin compounds, including prostratin, a terpene phorbol ester, and procyanidin, a flavanol-derived tannin found in plants, have been shown to possess latency-reversing properties [24,26,27]. It is therefore plausible that since the reported medicinal plants are used to manage HIV/AIDS, they could contain compounds with HIV latency-reversing properties or antiretroviral activities or immunomodulatory properties.

4. Conclusion

This study identified *L. nepetifoloa, Z. chalybeum*, *G. senegalensis*, *C. macrostachys, W. ugandensis* and *R. tridentata* as the most common medicinal plants used by TMPs to manage HIV/AIDS in Eastern Uganda. The identified medicinal plants are found to be highly rich in phytochemicals including flavonoids and tannins which contain bioactive compounds previously reported to reverse HIV-1 latency. While all the six plant species analysed contained flavonoids and tannins, the highest content of flavonoids and tannins were found in *L. nepetifolia and W. ugandensis.* However, the limitations of this study include lack of information regarding the TMPs dosage and when to administer the medication in relation to frequency was not recorded. Furthermore, this study is limited by the fact that it was not possible to confirm the exact identity of flavonoids and tannins that are plentiful in the six plant species analysed herein. Therefore, further analysis is required to identify the bioactive compounds in the extracts of these plants in order to identify compounds with HIV latency reversing properties.

Ethical statement

The study protocol was reviewed and approved by the Busitema University Faculty of Health Sciences Research Ethics Committee (Approval No: BUFHS-2023–77). All the respondents consented to participate in the study and had to sign a prior informed-consent form. The informed consent form was translated from English into three different languages including Ateso, Sabinya and Luganda. Permission to access the participants for this study was granted by the local area administration.

Funding

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Data availability statement

All the available data associated with this publication are included in the article. However, the six specimens that were included in the phytochemical analysis, herbarium specimens were prepared, mounted and deposited at the MHU with the following accession numbers; *Z. chalybeum* (MHU 51275); *L. nepetifolia* (MHU 51276); *C. macrostachyus* (MHU 51277); *Warbugia ugandensis* (MHU 51278); *G. senegalensis* (MHU 51279) and *R. tridentata* (MHU 512300).

CRediT authorship contribution statement

Richard Oriko Owor: Writing – review & editing, Writing – original draft, Investigation, Data curation, Conceptualization. **Carol Kawuma:** Writing – original draft, Investigation, Data curation. **Gauden Nantale:** Writing – original draft, Investigation, Data curation. **Kenedy Kiyimba:** Writing – original draft, Investigation, Data curation. **Samuel Baker Obakiro:** Writing – original draft, Investigation, Data curation. **Simple Ouma:** Writing – original draft, Investigation, Data curation. **Jalia Lulenzi:** Investigation, Data curation. **Yahaya Gavamukulya:** Investigation, Data curation. **Mercy Chebijira:** Investigation, Data curation. **Tonny Wotoyitide Lukwago:** Data curation. **Moses Egor:** Data curation. **Peter Musagala:** Data curation. **Moses Andima:** Data curation. **Dan Kibuule:** Writing – original draft, Data curation. **Paul Waako:** Writing – original draft, Data curation. **Joseph Hokello:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

We wish to submit our original research article by Owor et al. titled, **"Ethnobotanical survey and Phytochemistry of Medicinal Plants used in the Management of HIV/AIDS in Eastern Uganda"**, for publication in the Heliyon Journal. We confirm that this is original research article which has not been submitted or published elsewhere and that the contents of the manuscript fit within the

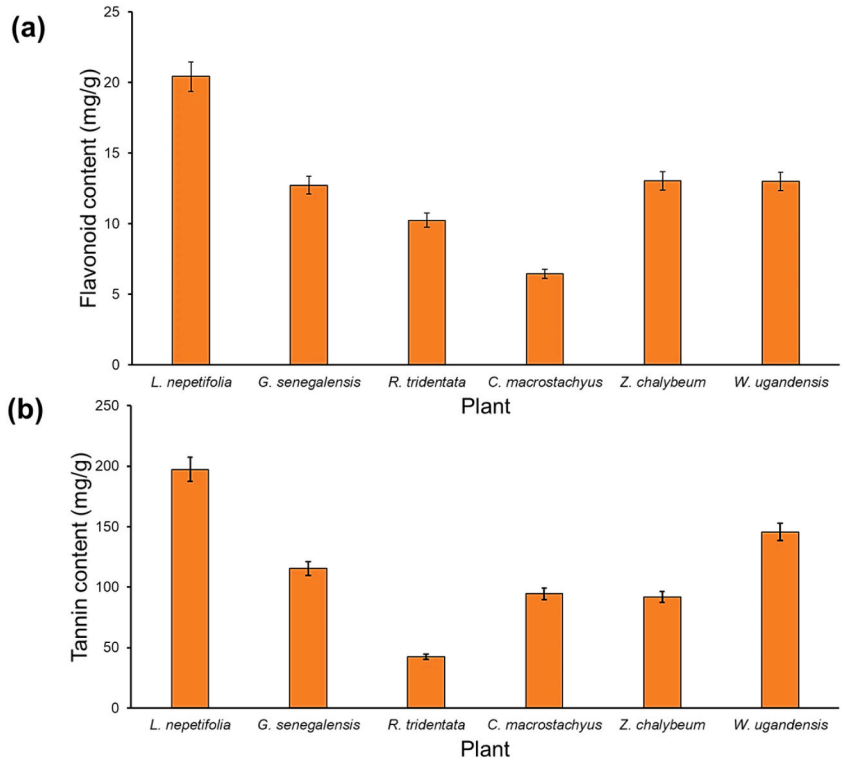

Fig. 3. Quantitative analysis of phytochemical contents of selected medicinal plant species most commonly used for managing HIV/AIDS in Eastern Uganda (a) Flavonoid content of selected medicinal plants and (b) Tannin content of selected medicinal plants. The bars represent the concentration in mg/g of the respective phytochemicals. The error bars represent the standard deviation of the mean.

aims and scope of your Journal. The authors of this manuscript declare that there is no conflict of interest and that all authors have approved the final manuscript for publication. Considering all the above facts, we believe the manuscript is relevant for publication in your highly esteem Journal. Correspondence should be addressed to Dr. Joseph Hokello, Department of Biology, Faculty of Science and Education, Busitema University, P.O Box 236, Tororo, Uganda. E-mail: josfrah4@gmail.com.mailto:josfrah4@gmail.com

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e31908.

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