Tropical Journal of Pharmaceutical Research September 2014; 13 (9): 1527-1536
ISSN: 1596-5996 (print); 1596-9827 (electronic)

Available online at http://www.tjpr.org
http://dx.doi.org/10.4314/tjpr.v13i9.21

Original Research Article

Alternative Medicines for HIV/AIDS in Resource-Poor Settings: Insight from Traditional Medicines Use in Sub-Saharan Africa

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Received: 26 February 2014 *Revised accepted: 19 July 2014*

Abstract

Purpose: *To document the utilization of traditional medicines in managing human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) opportunistic infections in sub-Saharan Africa.*
Methods: *This study is based on a review of literature published in scientific journals, books, reports from national, regional and international organizations, theses and conference papers obtained from libraries and electronic search of Google Scholar, ISI Web of Science, MEDLINE, Pubmed, Scopus and Science Direct.*
Results: *A total of 79 medical conditions related to HIV/AIDS were treated using 74 plant species. The common diseases treated by herbal remedies were bacterial/fungal infections, boosting of appetite/immunity, cold/cough, cryptococcal meningitis, diarrhea, fever, herpes simplex/zoster, oral/oesopharyngeal candidiasis, skin infections/rash, tuberculosis and wounds. More than three-quarters of the documented plant species (63 species, 85.1 %) have anti-HIV active compounds.*
Conclusion: *This study reveals that traditional medicines are often used as alternative sources of medicines for HIV/AIDS opportunistic infections in sub-Saharan Africa. Further investigations are needed to explore the bioactive compounds of these herbal medicines, aimed at exploring the bioactive compounds that can be developed into anti-HIV drugs.*

Keywords: *Antiretroviral, HIV/AIDS, Sub-Saharan Africa, Traditional medicines*

Tropical Journal of Pharmaceutical Research is indexed by Science Citation Index (SciSearch), Scopus, International Pharmaceutical Abstract, Chemical Abstracts, Embase, Index Copernicus, EBSCO, African Index Medicus, JournalSeek, Journal Citation Reports/Science Edition, Directory of Open Access Journals (DOAJ), African Journal Online, Bioline International, Open-J-Gate and Pharmacy Abstracts

INTRODUCTION

The acquired immunodeficiency syndrome (AIDS), caused by infection with the human immunodeficiency virus (HIV) has become a devastating epidemic in sub-Saharan Africa [1]. Ethnobotanical studies conducted in the following sub-Saharan African countries indicated that traditional healers and local communities extensively use medicinal plants to manage the effects of HIV/AIDS in Cameroon [2], Namibia [3,4], Rwanda [5], South Africa [6-8], Sudan [9], Tanzania [1,10] and Uganda [11-13].

Despite the increasing acceptance of traditional medicines as an additional and alternative therapeutic strategy in the fight against HIV/AIDS opportunistic diseases in sub-Saharan Africa [1-4,7,8,10-13], this rich indigenous knowledge on traditional remedies is not adequately documented. Documentation of plants used for treating and managing HIV/AIDS opportunistic diseases in sub-Saharan Africa is urgent as there

is need to search for novel anti-HIV compounds. Moreover, an estimated 25 % of pharmaceutical drugs and 11 % of drugs considered essential by WHO are derived from plants; a large number of synthetic drugs obtained from precursor compounds originating from plants [14].

Medicinal plants used for treating and managing HIV/AIDS opportunistic diseases in sub-Saharan Africa are an integral part of a culturally accepted and holistic health care system that has been in existence for several generations. Therefore, traditional medicines are possible sources of complementary and alternative medicines for HIV/AIDS opportunistic diseases.

This review briefly examines the role of herbal medicines in the fight against HIV/AIDS opportunistic diseases in sub-Saharan Africa. It is hoped that this review will provide important and relevant information that will form a basis for further research to identify and isolate bioactive constituents that can be developed as drugs for the treatment and management of HIV/AIDS opportunistic diseases.

EXPERIMENTAL

In this study, the focus was on herbal plants that are used to treat or manage HIV/AIDS opportunistic diseases in sub-Saharan Africa, and also reported to have anti-viral bioactivity based on *in vitro* or *in vivo* studies. Only papers that included information on plant identity, the HIV/AIDS opportunistic diseases treated and plant part(s) used were included in this review.

The International Plant Name Index (www.ipni.org) and the Royal Botanic Garden and Missouri Botanic Garden plant name database (www.theplantlist.org) were used to validate plant scientific names, plant families and plant authorities. In addition to this, the anti-viral efficacy of the documented plant species, either *in vitro* or *in vivo* was also verified from published literature. Therefore, this review draws heavily on the results of ethnobotanical surveys undertaken in contemporary sub-Saharan Africa on traditional medicines used to treat or manage HIV/AIDS opportunistic diseases [1-13], as well as secondary data collected through a review of 60 research reports, policy documents, reports from national, regional and international organizations, and conference papers published in scientific journals (53), books (4), theses (2) and one as an abstract.

Literature was searched on international online databases such as ISI Web of Science, MEDLINE, Science Direct, Scopus and Google Scholar using specific search terms such as “herbal medicines used to treat HIV/AIDS opportunistic diseases”, “medicinal plants used to treat HIV/AIDS opportunistic diseases”, “traditional medicines used to treat HIV/AIDS opportunistic diseases”, and “anti-viral activity of [each documented plant species]”. References were also identified by searching the library collections of the National Herbarium and Botanic Gardens, Zimbabwe and University of Fort Hare, South Africa.

FINDINGS

This study recorded 74 plant species widely used traditionally in treating and managing HIV/AIDS opportunistic diseases in sub-Saharan Africa (Table 1. These medicinal plants were distributed among 37 families and 65 genera. The majority of medicinal plants (50, 67.6 %) used to treat and manage HIV/AIDS opportunistic diseases in sub-Saharan Africa were from 13 families (Table 2). Plant families with the highest number of medicinal plants were Fabaceae *sensu lato* (11 species), followed by Asteraceae and Euphorbiaceae (5 species each), Combretaceae, Lamiaceae and Myrtaceae (4 species each), Amaryllidaceae, Cucurbitaceae and Phyllanthaceae (3 species each), Apiaceae, Celastraceae, Clusiaceae and Xanthorrhoeaceae (2 species each). The rest of the families were represented by one species each (Table 1). The genera with highest number of species were Combretum with three species, followed by *Artemisia, Cucurbita, Euphorbia, Garcinia, Plectranthus, Senna* and *Syzygium* with 2 species each (Table 1).

Growth form and plant parts used

Trees (43.2 %) were the primary sources of the medicinal plants used for treating and managing HIV/AIDS opportunistic diseases in sub-Saharan Africa, followed by shrubs (27 %), herbs (24.3 %) and climbers (5.4 %) (Table 1). The plant parts used for making herbal preparations were the bark, bulbs, fruits, leaves, leaf sap, roots, stem, tubers and twigs (Table 1). The leaves (67.6 %) were the most frequently used, followed by roots (35.1 %), bark (31.1 %), bulb and seeds (5,4 % each), fruits, stem and twigs (2.7 % each), tubers and leaf sap (1.4 % each) (Table 1).

Table 1: Plant species used to treat and manage various HIV/AIDS opportunistic diseases in sub-Saharan Africa

Family, species name	Growth habit	Part(s) used	Condition treated, country and references in brackets	Pharmacological activities
Amaryllidaceae				
Allium sativum L.	Herb	Bulb	Aspergillosis, oesopharyngeal candidiasis (South Africa) [8], skin infections (Cameroon) [2]	HIV-1 reverse transcriptase inhibitory effect [15]
Crinum macowani Baker	Herb	Bulb	Acne, backache, blood cleansing, boils, cold, fever, glandular swelling, kidney and bladder diseases, rheumatism, wounds, tonic, tuberculosis, venereal diseases (South Africa) [8,16,17]	Anti-HIV activity [16]
Tulbaghia violacea Harv.	Herb	Leaves	Arthritis, asthma, cancer, cold, cough, cryptococcal meningitis, fever, intestinal worms, rheumatism, tuberculosis (South Africa) [8,16,17]	Anti-HIV activity [16]
Anacardiaceae				
Mangifera indica L.	Tree	Bark/leaves	Cough, diarrhea, tuberculosis (Tanzania, Uganda) [1,11-13]	Inhibits HSV-1 and 2 replication [18]
Apiaceae				
Alepidea amatymbica Eckl. & Zeyh.	Shrub	Bark/roots	Aspergillosis, boost appetite, cryptococcal meningitis, diarrhea, clean blood vessels, oesopharyngeal candidiasis (South Africa) [7,8]	Antiretroviral activity [19]
Daucus carota L.	Herb	Leaves	Skin infections (Cameroon) [2]	Inhibits HSV-1 replication [20]
Apocynaceae				
Cascabela thevetia (L.) Lippold	Shrub	Roots	Cough, tuberculosis (Uganda) [11]	HIV-I reverse transcriptase and HIV-I intrase inhibitor activities [21]
Asteraceae				
Artemisia afra Jacq. ex Wild	Shrub	Leaves	Oesopharyngeal candidiasis (South Africa) [8]	Anti-HIV activity [22]
Artemisia annua L.	Shrub	Leaves	Bacterial/fungal infections (Uganda) [11], skin infections (Cameroon) [2]	Anti-HIV activity [22]
Aspilia pluriseta Schweinf.	Herb	Leaves	Kwashiorkor, worms, wounds (Rwanda) [5]	Anti-HIV activity [5]
Tithonia diversifolia (Hemsl.) A. Gray	Shrub	Leaves	Ascariasis, diarrhea (Rwanda) [5]	Anti-HIV activity [5]
Vernonia amygdalina Del.	Shrub	Leaves/roots	Ascariasis, hepatitis, malaria (Rwanda) [5], diarrhea, herpes zoster (Tanzania, Uganda) [1,10,11], cryptococcal meningitis, herpes simplex (Cameroon, Tanzania) [1,2,10], skin infections (Cameroon) [2], boost appetite/immunity, stomach ache, fever (Cameroon, Uganda) [2,11,13], skin rash (Cameroon, Tanzania, Uganda) [1,2,10,13], backache, cough, headache (Cameroon, Uganda) [2,13], stomachache (Uganda) [13]	Anti-HIV activity [23]
Bignonaceae				
Kigelia africana (Lam.) Benth.	Tree	Bark/fruits	Herpes simplex (Namibia, Tanzania) [1,3,4], diarrhea (Namibia) [3], skin rash (Uganda) [12]	Inhibits HIV-1 reverse transcriptase [24]
Brassicaceae				
Raphanus sativus L.	Herb	Leaves	Skin infections (Cameroon) [2]	Antiviral activity [25]
Canellaceae				
Warburgia ugandensis Sprague	Tree	Bark/leaves/roots	Bacterial/fungal infection, cough, diarrhea, tuberculosis (Uganda) [11]	Inhibits HIV-1 reverse transcriptase [24]
Caricaceae				
Carica papaya L.	Tree	Leaves/roots/seeds	Cough, tuberculosis (Uganda) [11], oral candidiasis (Tanzania) [1,10]	Anti- HIV-1 activity [26]

Celastraceae				
Elaedendron transvaalense (Burtt Davy) R.H. Archer	Tree	Roots	Cold, dysmenorrhea, fever, skin rash (South Africa) [6]	Inhibits HIV-1 reverse transcriptase [6]
Maytenus senegalensis (Lam.) Exell	Tree	Bark/leaves/roots	Bacterial/fungal infections, cough (Uganda) [11], herpes simplex/zoster, oral candidiasis, skin rash, tuberculosis (Uganda, Tanzania) [1,10-12]	Inhibits HIV-1 replication and protease [24]
Cleomaceae				
Cleome gynandra L.	Herb	Leaves	Oral candidiasis (Tanzania) [1,10]	Anti-HIV activity [27]
Clusiaceae				
Garcinia buchananii Bak.	Tree	Bark/roots	Cryptococcal meningitis, diarrhea, herpes simplex/zoster, skin rash, tuberculosis (Namibia, Tanzania) [1,3,4]	HIV-1 protease inhibitory activity [28]
Garcinia livingstonei T. Anderson	Tree	Bark/roots	Cryptococcal meningitis, diarrhea, herpes simplex/zoster, skin rash, tuberculosis (Namibia) [3]	HIV-1 protease inhibitory activity [28]
Combretaceae				
Combretum hartmannianum Schweinf.	Tree	Bark/leaves/stem	Bacterial infections, febrile, jaundice (Sudan) [9]	Inhibits HIV-1 reverse transcriptase [10]
Combretum molle R. Br. ex G. Don	Tree	Bark/roots	Abdominal pains, convulsions, fever, leprosy, snake bites, worms (South Africa) [6], cough, tuberculosis (Uganda) [11]	Inhibits HIV-1 reverse transcriptase [6]
Combretum paniculatum Vent.	Tree	Leaves	Eye diseases, leprosy (Ethiopia) [29]	Inhibits HIV-1 replication [29]
Terminalia sericea Burch. ex DC.	Tree	Bark	Cryptococcal meningitis (Namibia) [4]	Inhibits HIV-1 reverse transcriptase [6]
Cucurbitaceae				
Cucurbita maxima L.	Climber	Leaves	Skin infections (Cameroon) [2]	Anti-HIV activity [30]
Cucurbita pepo L.	Climber	Leaves/roots	Skin infections (Cameroon) [2]	Inhibits HIV-1 reverse transcriptase [31]
Momordica foetida Schumach.	Herb	Leaves	Cough, diarrhea, fever, skin rash (Uganda) [13]	Anti-HIV activity [32]
Euphorbiaceae				
Croton lechleri Müll. Arg.	Tree	Bark	Anaemia, boost appetite, diarrhea (Namibia) [3]	Antiviral activity [33]
Euphorbia hirta L.	Herb	Leaves/roots	Bacterial/fungal infections, herpes zoster (Uganda) [11], dermatophytoses (South Africa) [8]	Inhibits HIV-1, 2 reverse transcriptase [34]
Euphorbia tirucalli L.	Shrub	Leaves	Cough, tuberculosis (Uganda) [11]	Anti-HIV activity [35]
Jatropha curcas L.	Shrub	Leaves	Herpes zoster (Uganda) [11], oral candidiasis, skin rash (Tanzania) [1,10]	Anti-HIV activity [36]
Ricinus communis L.	Shrub	Roots	Abortifacient, abscesses, antihelmentic, arthritis, asthma, dermatitis, diarrhea, fever, flu, toothache, tuberculosis, wounds (South Africa) [6], cough (Tanzania) [1,10]	Inhibits HIV-1 reverse transcriptase [6]
Fabaceae *sensu lato*				
Abrus precatorius L.	Climber	Bark/leaves/roots	Oral candidiasis (Namibia, Tanzania) [1,3,10]	Inhibits HIV-1 reverse transcriptase [37]
Albizia amara (Roxb.) B. Boiv.	Tree	Leaves	Stomach ache (Namibia) [3]	Inhibits HIV-1 reverse transcriptase [38]
Cajanus cajan (L.) Millsp.	Herb	Stem	Boost appetite/immunity (Uganda) [11], oral candidiasis (Tanzania) [1,10]	Antiviral activity [39]
Dichrostachys cinerea (L.) Wight & Arn	Shrub	Leaves	Oral candidiasis (Namibia) [3]	Inhibits HIV-1 reverse transcriptase [16]
Erythrina abyssinica DC.	Tree	Bark/root	Cough, tubeculosis (Tanzania) [1,10], diarrhea, herpes zoster (Uganda) [11]	Inhibits HIV-1 replication [24]
Peltophorum africanum Sond.	Tree	Bark/roots	Abdominal pains, cough, diarrhea, dysentery, dysmenorrhea, infertility, sore throat, toothache, tuberculosis, wounds (South Africa) [6]	Inhibits HIV-1 reverse transcriptase [6]
Piliostigma thonningii (Schum.) Milne-Redh.	Tree	Bark/roots	Cough (Namibia) [4]	Anti-HIV, HSV-1 and 2 activity [40]

Senna alata (L.) Roxb.	Tree	Leaves	Skin infections (Cameroon) [2]	Inhibits HIV-1 reverse transcriptase [37]
Senna occidentalis (L.) Link	Herb	Leaves/roots	Cough (Namibia) [3,4], diarrhea (Tanzania) [1,10], jaundice, malaria (Sudan) [9]	Inhibits HIV-1 reverse transcriptase [41]
Sutherlandia frutescens R. Br.	Shrub	Leaves/twigs	Backache, cold, chicken pox, diabetes, flu, physical and mental stress, piles, rheumatism, varicose veins (South Africa) [6]	Inhibits HIV-1 reverse transcriptase [6]
Hypoxidaceae				
Hypoxis hemerocallidea (Fisch.) Mey. & Avé-Lall	Herb	Tuber	Cancer, blood cleansing, boost appetite/immunity, oesopharyngeal candidiasis, tuberculosis, vaginal candidiasis, wounds (South Africa) [7,8,17]	Inhibits HIV-1 reverse transcriptase [42]
Lamiaceae				
Leonotis leonurus (L.) R. Br.	Shrub	Leaves/twigs	Asthma, boils, bronchitis, cold, constipation, cough, eczema, flu, hepatitis, high blood pressure, intestinal worms, itching, muscular cramps, skin infections (South Africa) [7,16,17]	Inhibits HIV-1 reverse transcriptase [16]
Ocimum basilicum L.	Herb	Leaves	Skin infections (Cameroon) [2]	Inhibits HIV-1 reverse transcriptase [43]
Plectranthus amboinicus (Lour.)Spreng.	Herb	Leaves	Bacterial/fungal infections, boost appetite/immunity, cough, tuberculosis (Uganda) [11]	Anti-HIV, HSV-1 and 2 activity [44]
Plectranthus barbatus Andr.	Shrub	Leaves	Herpes simplex/zoster, oral candidiasis, tuberculosis (Tanzania) [1,10]	Anti-HIV-1 activity [45]
Malvaceae				
Grewia mollis Juss.	Shrub	Leaves	Diarrhea (Uganda) [11]	Inhibits HIV-1 replication and protease [24]
Meliaceae				
Azadirachta indica A. Juss	Tree	Leaves	Bacterial/fungal infections (Uganda) [11]	Inhibits HIV-1 replication and protease [24]
Melianthaceae				
Bersama abyssinica Boyle	Tree	Bark/leaves/roots	Ascariasis, cholera, diarrhea, dysentery, malaria, rabies, ulcers, worms (Ethiopia) [29]	Inhibits HIV-1 replication [29]
Moringaceae				
Moringa oleifera Lam.	Shrub	Leaves/seeds/	Boost appetite/immunity (Uganda) [11], diarhea, skin infections, vomiting (Cameroon, Namibia) [2,3]	Anti-HIV activity [46]
Myricaceae				
Morella salicifolia (Hochst. ex A. Rich.) Verdc. & Polhil	Tree	Bark/roots	Boost appetite/immunity (Uganda) [11], cryptococcal meningitis, diarrhea, herpes simplex, tuberculosis (Tanzania) [1,10]	Inhibits HIV-1 replication and protease [24]
Myrisinaceae				
Maesa lanceolata Forssk.	Shrub	Seeds	Bacterial/fungal infections (Uganda) [11]	Inhibits HIV-1 replication [29]
Myrtaceae				
Eucalyptus globulus Labil.	Tree	Leaves	Cough, tuberculosis (Uganda) [11]	Anti-HSV-1 and 2 activity [47]
Psidium guajava L.	Tree	Bark/leaves	Cough, diarrhea (Namibia, Uganda) [3,11-13], tuberculosis (Namibia, Tanzania, Uganda) [1,3,4,11], vaginal candidiasis (South Africa) [8]	HIV-1 protease inhibitory activity [48]
Syzygium cordatum Hochst. ex Krauss	Tree	Bark/leaves	Diarrhea (Namibia) [3], herpes simplex/zoster, skin rash (Tanzania) [1,10]	Anti-HIV activity [49]
Syzygium guineense (Willd) DC.	Tree	Bark	Diarrhea (Namibia, Tanzania) [1,3,10]	Inhibits HIV-1 reverse transcriptase [50]
Olacaceae				
Ximenia americana L.	Shrub	Bark/roots	Contagious diseases, stomach ache, worms (Ethiopia) [29], oral candidiasis (Namibia) [4], skin rash (Tanzania) [1,10]	Inhibits HIV-1 replication [29]
Oleaceae				
Olea europaea L.	Tree	Bulb	Oesopharyngeal candidiasis (South Africa) [8]	Anti-HIV activity [51]
Papaveraceae				
Argemone	Shrub	Leaves/s	Cryptococcal meningitis (Tanzania) [1,10]	Anti-HIV activity [52]

mexicana L.		eeds		
Passifloraceae				
Passiflora edulis Sims	Climber	Leaves	Boost appetite/immunity (Uganda) [11]	Anti-HSV-1 activity [53]
Phyllanthaceae				
Bridelia micrantha Hochst.	Tree	Bark/roots	Abortifacient, diarrhea, sore eyes, stomach ache (South Africa) [6]	Inhibits HIV-1 reverse transcriptase [6]
Flueggea virosa (Robx.Ex.Wild)Voigt	Shrub	Leaves/roots	Cough, tuberculosis (Uganda) [11]	Anti-HIV-1 reverse transcriptase [54]
Phyllanthus reticulatus Poir.	Shrub	Leaves	Herpes simplex (Tanzania) [1,10]	Anti-HIV-1 reverse transcriptase [55]
Polygalaceae				
Securidaca longipedunculata Fres.	Tree	Bark/leaves/roots	Cryptococcal meningitis, oral candidiasis (Namibia, Tanzania) [1,3,10], gonorrhea (Namibia) [3], cough, syphilis (Ethiopia, Namibia) [3,29], diarrhea, rheumatism, stomach ache, tuberculosis (Ethiopia) [29]	Inhibits HIV replication [56]
Polygonaceae				
Rumex nepalensis Spreng.	Herb	Leaves	Boils, kwashiorkor, worms (Rwanda) [5]	Anti-HIV activity [5]
Rutaceae				
Citrus limon (L.) Burm.f.	Tree	Leaves/fruits/roots	Aspergillosis, cryptococcal meningitis, diabetes, high blood pressure (South Africa) [7,8], tuberculosis (Tanzania) [1,10]	Anti-HIV-1 activity [57]
Sapindaceae				
Dodonaea viscosa (L.) Jacq.	Shrub	Leaves	Cold, fever, malaria, piles, skin infections, sore throat, wounds (Ethiopia) [29]	Inhibits HIV-1 replication [29]
Solanaceae				
Solanum americanum L.	Shrub	Leaves	Boost appetite/immunity (Uganda) [11]	Antiviral activity [58]
Xanthorrhoeaceae				
Aloe vera (L.) Burm.f.	Herb	Leaf sap/leaves	Bacterial/fungal infections, boost appetite/immunity, cough, diarrhea, herpes zoster, tuberculosis (Uganda) [11]	Anti-HSV-2 activity [59]
Bulbine alooides (L.) Willd.	Herb	Leaves/roots	Burns, cracked lips, diarrhea, herpes simplex, itching, skin rash, ringworm, vomiting, wounds (South Africa) [16,17]	Anti-HIV activity [16]
Zingiberaceae				
Zingiber officinalis L.	Herb	Bulb	Aspergillosis (South Africa) [8], boost appetite/immunity, cough, tuberculosis (Uganda) [11], skin infections (Cameroon) [2]	Anti-HIV-1 activity [60]

Table 2: Families with the largest number of medicinal plants (more than 2 species) used to treat and manage HIV/AIDS opportunistic diseases in sub-Saharan Africa

Family	Number of medicinal plants	%
Fabaceae *sensu lato*	11	14.9
Asteraceae	5	6.8
Combretaceae	4	5.4
Lamiaceae	4	5.4
Myrtaceae	4	5.4
Amaryllidaceae	3	4.1
Cucurbitaceae	3	4.1
Phyllanthaceae	3	4.1
Apiaceae	2	2.7
Celastraceae	2	2.7
Clusiaceae	2	2.7
Xanthorrhoeaceae	2	2.7

Table 3: Major ailment and disease categories and plant species reported. Most species were reported in more than one ailment and disease category.

Ailment/disease	Number of species
Wounds	8
Bacterial/fungal infections	9
Fever	9
Boost immunity	11
Boost appetite	13
Cryptococcal meningitis	13
Oral/oesopharyngeal candidiasis	19
Herpes simplex/zoster	27
Tuberculosis	30
Skin infections/rash	31
Diarrhea	32
Cold/cough	33

HIV/AIDS opportunistic diseases and ailments treated with herbal medicines

A total of 79 medical conditions related to HIV/AIDS were treated using herbal remedies (Table 1). Bacterial/fungal infections, boosting of appetite/immunity, cold/cough, cryptococcal meningitis, diarrhea, fever, herpes simplex/zoster, oral/oesopharyngeal candidiasis, skin infections/rash, tuberculosis and wounds were treated with the highest number of medicinal plant species (Table 3).

DISCUSSION

The checklist in Table 1 provides baseline data on medicinal plants that are currently used to treat and manage HIV/AIDS opportunistic diseases in sub-Saharan Africa. This inventory is a crucial starting point in trying to assess the efficacy of traditional medicines in the management of HIV/AIDS opportunistic diseases as well as the development of effective drugs for the treatment of HIV/AIDS. One of the possible approaches to finding novel anti-HIV therapeutic agents is the screening of medicinal plants that are widely used in local communities to treat and manage HIV/AIDS opportunistic diseases.

Out of 74 medicinal plants widely used in sub-Saharan Africa to treat and manage HIV/AIDS opportunistic diseases, 63 species (85.1 %) have proven anti-HIV active compounds and known modes of action (Table 1). Among these is *Kigelia africana* used to treat diarrhea and herpes simplex in Namibia [3], herpes simplex in Tanzania [1] and skin rash in Uganda [12]. *Maytenus senegalensis* is used as herbal medicine for bacterial/fungal infections and cough in Uganda [11], and to treat herpes simplex/zoster, oral candidiasis, skin rash and tuberculosis in both Tanzania and Uganda [1,10-12]. Similarly, *Garcinia buchananii* has the same ethnomedicinal applications in Namibia [3] and Tanzania [1] as herbal medicine for chronic diarrhea, cryptococcal meningitis, herpes simplex/zoster, skin rash and tuberculosis [1,3,10].

Another noteworthy plant species used for treating and managing HIV/AIDS opportunistic diseases in sub-Saharan Africa are *Hypoxis hemerocallidea* and *Sutherlandia frutescens* (Table 1). These two species are currently recommended by the South African Ministry of Health for HIV management [6,17,42]. This is in accordance with the World Health Organization's recommendation that traditional medicines should be included in national responses to HIV/AIDS pandemic [14]. Some of these species can, therefore, be targeted for phytochemical and pharmacological studies with the aim of identifying active ingredients contained by such plants required for treating and managing HIV/AIDS. Such research is important, as there is need to search for improved antiretroviral agents which can be added to or replace the current drugs in use.

Despite the presence of anti-HIV activity in more than 85 % of the plant species in Table 1, these plant species have not been fully explored. Further investigations on phytochemical constituents and subsequent screening are needed for opening new opportunities to develop pharmaceutical drugs based on anti-HIV constituents shown by some of these plant species.

This study revealed that many people in sub-Saharan Africa use traditional medicines for the treatment and management of HIV/AIDS opportunistic diseases despite the increasing availability of antiretroviral therapy. People in sub-Saharan Africa, particularly the poor are still dependent on medicinal plants for the treatment of basic human ailments like backache, cold, cough, diarrhea, fever, headache, skin infections and wounds [14,17,24,44]. Therefore, traditional medicines remain the main source of primary health care available and accessible to all people in sub-Saharan Africa.

Although no plant-derived drug is currently in clinical use to treat and manage HIV/AIDS opportunistic diseases, knowledge on these plants is very important as this can serve as leads in the discovery of new anti-HIV agents. Medicinal plants may yield novel compounds that may be of interest for HIV/AIDS drug development particularly those medicinal plants characterized by anti-HIV activity (Table 1).

Limitations of the study

This study has taken a focused approach and generated extensive exploratory and qualitative data, however, the following limitations are acknowledged in relation to its findings. Detailed accounts of plants used to treat and manage HIV/AIDS opportunistic diseases are available from Cameroon, Namibia, Rwanda, South Africa, Sudan, Tanzania and Uganda only. Although, the results from these countries are diverse in nature, they may not apply directly to all countries in the sub-Saharan Africa. The

advantages of this limited sample size and sharp focus on detailed accounts on medicinal plants used to treat and manage HIV/AIDS opportunistic diseases in Cameroon, Namibia, Rwanda, South Africa, Sudan, Tanzania and Uganda resulted in a better and deeper understanding of traditional medicines useful for HIV/AIDS management in sub-Saharan Africa. Overall, while the study is useful in gaining an understanding of utilization of traditional medicines in managing HIV/AIDS opportunistic infections in sub-Saharan Africa and the value of traditional medicines in a wide spectrum of countries in the region, it is clear that more detailed national level studies should be undertaken. The present study provided a sample of preliminary data that could open up pertinent questions relating to the management of HIV/AIDS opportunistic infections using herbal medicines.

CONCLUSION

Correlation between the ethnomedicinal employment and the pharmacological activities have been duly observed and described in this study. In fact, this study suggests that some of the plant species have the potential to be developed as anti-HIV agents. While there are still gaps in the phytochemistry and pharmacological studies conducted so far, which need to be bridged in order to exploit the full medicinal potential of these species, it is still very clear that these plant species have tremendous potential for the future. This inventory will assist future workers on the selection of herbal plants to evaluate for phytochemical safety and pharmaceutical efficacy. There is also need for more research on the active compounds of these herbal medicines, some of which have already shown interesting pharmacological activities as shown in Table 1.

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