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## Research paper

## Ethnobotanical survey of medicinal plants used in the management of cancer in Uganda



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## ABSTRACT

**Introduction:** Patients with cancer in Africa embrace the use of herbal medicine more than anywhere else in the world. This study identified and documented medicinal plant species used to manage cancer in ten (10) districts of Uganda.

**Methods:** An ethnobotanical survey was conducted between October 2021 and January 2022. In total, 18 (out of 55) traditional medicine practitioners (TMPs) having more than 10 years of experience in managing patients with cancer were interviewed using a semi-structured questionnaire. Data were analysed using descriptive statistics. The Relative frequency of citation (RFC) and Family importance value (FIV) indices were also computed.

**Results:** We identified 121 plant species, belonging to 55 families, with the most common families being the Fabaceae (20 species, FIV = 0.119), Asteraceae (13 species, FIV = 0.131), and Euphorbiaceae (eight species, FIV = 0.079). The plant parts most commonly used were leaves (39.3%) and roots (12.9%). The most frequently cited plants were: *Hoslundia opposita* Vahl (RFC = 0.44), followed by *Aspilia africana* (Pers.) C.D. Adams (RFC = 0.33), *Spathodea nilotica* Seem (RFC = 0.33), *Annona muricata* L. (RFC = 0.33), *Prunus africana* (Hook.f.) Kalkman (RFC = 0.28), *Acacia hockii* De Wild (RFC = 0.28), *Bidens pilosa* L. (RFC = 0.28), and *Carica papaya* L. (RFC = 0.22). The most common method of plant preparation and administration was the decoction (69.2%) and oral (86.7%) route, respectively.

**Conclusions:** Although most plants used by TMPs have the potential to generate leads for chemo-preventive cancer medicines, they remain unexplored. This study provides a lead to explore the potential of traditionally used plants for the management of cancer through pre-clinical and clinical research.

## Introduction

Among the various non-communicable diseases, cancer poses the most serious health challenge in sub-Saharan Africa. The recent Lancet

Oncology Commission indicated cancer rates and associated mortality were likely to double by 2040 (Ngwa et al., 2022). Between 1990 and 2010, Uganda recorded a rise in cancer incidence from 140 to 210 per 100 000 people (Stewart and Wild, 2014; Bray et al., 2018). Overall, 56

**Abbreviations:** TMPs, Traditional medicine practitioners; NACOTHA, National Council of Traditional Healers and Herbalists Association; FREC, Faculty of Medicine Research Ethics Committee; MUREC, Mbarara University Research Ethics Committee

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238 cancer cases were reported in 2018 (Bray et al., 2018). Among the 32 617 new cancer cases in Uganda in 2018, cervical cancer (19.7%), Kaposi sarcoma (13.1%), breast cancer (7.1%), and prostate cancer (6.4%) had the highest rates.

Compared to other world regions, most patients with cancer in sub-Saharan Africa, use herbal medicine (HM) to treat or ameliorate the symptoms of cancer (Asiimwe et al., 2021). The Uganda Cancer Institute (UCI) indicated patients used extracts from roots (25%) and leaves (45%) during cancer treatment (Mwaka et al., 2019). Another study reported that 22% of patients in Uganda used HM during cancer treatment (Kiwanuka, 2018). Advances in conventional cancer care have not deterred patients from using HM. Numerous influencing factors have been identified, including a rich culture and history of HM use, geographical factors (e.g., access to diverse/abundant medicinal flora), health system-related factors (e.g., high cost of conventional cancer care), and patient-/disease-related factors (e.g., a belief that HM is safe and effective against cancer) (Asiimwe et al., 2021).

The use of medicinal plant products among patients with cancer may have beneficial effects. Earlier studies have shown that some medicinal plants may prevent cancer initiation, progression, and metastasis (Ayaz et al., 2022; Lim et al., 2021). Studies conducted in Asia and Europe showed that the use of herbal medicines improved the quality of life of patients with cancer, increased the survival of patients with certain cancers, and had cancer chemo-toxic or preventive activities (Abdul Wahab et al., 2018; Dhanoa et al., 2014; Han et al., 2016; Kuo et al., 2018; Lee et al., 2021). In addition, population studies indicated that the consumption of medicinal plants reduced the risk of cancer (Gullett et al., 2010).

Although the use and possible benefits associated with medicinal plants in cancer are known, few studies have documented plants used to manage cancer by traditional medicine practitioners (TMPs) in Uganda (Omara et al., 2020). Although TMPs' role in cancer palliation is well documented (Kuteyi and Fazoranti, 2020), challenges around disclosure mean knowledge of the plants used in cancer typically remains confined to TMPs, which limits plant conservation and development of potent plant-derived chemotherapeutics in the African region. Therefore, this ethnobotanical survey aimed to identify, and document medicinal plants, and how they are used by TMPs in cancer management in selected districts of Uganda. Districts were selected purposively based on the presence of TMPs that use traditional medicine to manage patients with cancer and are inhabited by the Bantu ethnic groups.

## Methods

### Study design and area

This ethnobotanical survey involving ethnographic interviews and collection of medicinal plants was conducted among TMPs from 10 districts in Central, Eastern, and Western Uganda (Kiboga, Kampala, Buikwe, Mukono, Masindi, Hoima, Gomba, Wakiso, Kayunga, and Mayuge) (Fig. 1). These districts were selected purposively because of the presence of TMPs that use traditional medicine to manage patients with cancer (Omara et al., 2020). Most people living in these districts belong to the Bantu ethnic groups, which include the Baganda, Basoga, and Banyoro tribes. These tribes speak several languages including Luganda, Lusoga, and Runyoro. Plants were also collected from two major forest reserves (the Mabira and Budongo forests).

### Traditional medicine practitioners' selection

Before selection, TMPs were identified based on a recommendation by healers (healer-to-healer referral), local traditional associations, and local leaders. Purposive sampling techniques were used to select study participants based on specific inclusion and exclusion criteria. Specifically, the TMPs selected to participate in this study were herbalists and traditional healers (spiritualists) who: had relevant

knowledge about cardinal signs and symptoms of at least one cancer they managed, treated, or cared for patients with any type of cancer; had a minimum of 10 years of experience; known by the community, and consented to participate in the study. In total, 23 of the 55 TMPs that met our inclusion criteria were invited to participate in this study. However, only 18 participants provided consent, were interviewed, and revealed the plants they used to manage patients with cancer.

### Data collection/collection of plant specimens

The ethnobotanical survey was conducted between October 2021 and January 2022. Reconnaissance visits to identify TMPs were initially conducted in three districts (Kiboga, Kampala, and Mukono) where a previous review on cancer ethnomedicine reported the presence of TMPs that managed cancer (Omara et al., 2020). The selection of subsequent districts depended on the presence of TMPs who managed cancer. Potential participants were briefly interviewed about cancer and the types of cancer they treated and screened for eligibility. TMPs that met the study inclusion criteria were scheduled for in-depth interviews. Before these interviews, the questionnaire was pre-tested and adjusted as necessary. During subsequent visits, and after obtaining informed consent, in-depth interviews were conducted with participants in the local language. The semi-structured questionnaire contained questions on participants' socio-demographic profiles, plants used to treat cancer, how plants were harvested, plant parts used, and how they were prepared and stored. After each interview, plant specimens were collected and authenticated with the assistance of plant taxonomists using the procedure outlined by Martin (2010). Voucher specimens were pressed and deposited at the Makerere University Herbarium. Plant species were classified using an online plant list database (<http://www.theplantlist.org>) between January and October 2022.

### Data analysis

Quantitative data were entered in statistical package for social scientists (SPSS, version 20) and analysed using descriptive statistics. Comparisons were made on parameters including the plant parts used, families, modes of use, type of cancers managed, and plant habits. The ethnobotanical uses were further analysed using the Relative frequency of citation (RFC) and family importance value (FIV).

### Relative frequency of citation

The RFC was used to determine the relative importance of the plant (Ahmad et al., 2018). The RFC ranges from 0 ('nobody referred to a plant as useful') to 1 ('all informants referred to a plant as useful') (Faruque et al., 2018). This was obtained through dividing the frequency of citation (FC) by the total number of informants in the study (N):  $RFC = FC/N$ .

### Family importance value

The FIV indicates the importance of botanical families of species (El Hachlafi et al., 2022). This index evaluates the biological taxonomic value of species and was computed by dividing the sum of the RFC by the number of species in the family (Ns):  $FIV = RFC/Ns$ .

### Ethical considerations

The Faculty of Medicine Research Ethics Committee (FREC# 22/01-2021), Mbarara University of Science and Technology Research Ethics Board (MUREC/7#05/02-21), and The Uganda National Council of Science and Technology (Ref: HS1602ES) approved the study. The National Council of Traditional Healers' Association (NACOTHA) provided clearance to contact TMPs. All TMPs provided consent before participating in this study.

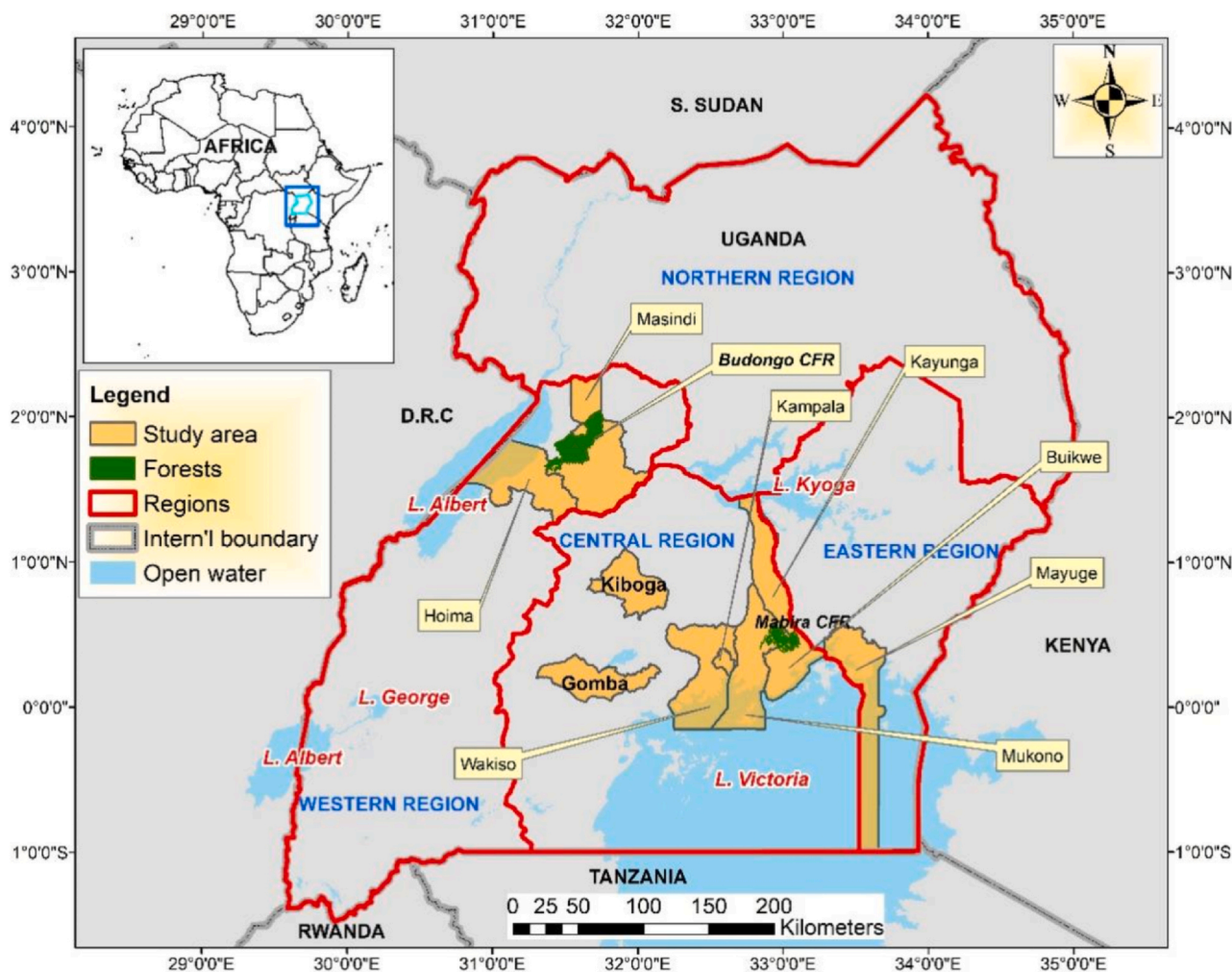


Fig. 1. Map of Uganda showing the study sites. Adopted from <https://doi.org/10.1371/journal.pgph.0001764>.

## Results

### Socio-demographic characteristics of TMPs

Eighteen (18) participants were interviewed and revealed the plants they used to manage patients with cancer. The majority of participating TMPs were male ( $n = 10$ ), with an average age of 53.6 years. Most TMPs ( $n = 11$ ) had not attended formal education. The majority of TMPs ( $n = 12$ ) described themselves as living and working in rural settings ( $n = 12$ ), with a median period of residence of 40 years (range 10–65 years). The majority of participating TMPs had spent approximately 25 years practicing traditional medicine, and half of them ( $n = 9$ ) were currently registered with their local or national umbrella organisation(s).

### Medicinal plant species used by TMPs to manage cancer

TMPs used 121 plants to manage cancer. The habits of the plants used by TMPs included: trees (37.2%), herbs (37.2%), and shrubs (17.4%) (Table 1). Most plants belonged to six families: Fabaceae (16.5%, 20 species, FIV = 0.119), Asteraceae (10.7%, 13 species, FIV = 0.131), Euphorbiaceae (6.6%, eight species, FIV = 0.079), Moraceae (4.1%, five species, FIV = 0.100), Rutaceae (3.3%, four species, FIV = 0.098), and Apocynaceae (3.3%, four species, FIV = 0.098). The most common plant parts used were leaves (39.3%), roots (12.9%), and stem bark (19.1%, Fig. 2). Commonly mentioned plants used to manage cancer were: *Hoslundia opposita* Vahl (RFC = 0.44), *Aspilia africana*

(Pers.) C.D. Adams (RFC = 0.33), *Spathodea nilotica* Seem (RFC = 0.33), *Annona muricata* L. (RFC = 0.33), *Prunus africana* (Hook.f.) Kalkman (RFC = 0.28), *Acacia hockii* De Wild (RFC = 0.28), *Bidens pilosa* L. (RFC = 0.28), *Carica papaya* L. (RFC = 0.22), *Entada abyssinica* A.Rich. (RFC = 0.22), *Canarium schweinfurthii* Engl. (RFC = 0.22), *Kalanchoe densiflora* Rolfe (RFC = 0.22), and *Callistemon citrinus* (Curtis) Skeels (RFC = 0.22). TMPs encouraged the use of plant foods such as *Persea americana* Mill (RFC = 0.28), *Cucurbita maxima* Duchesne (FC = 0.22), *Solanum nigrum* L. (FC = 0.17), and *Corchorus olitorius* L. (RFC = 0.17) as nutritional supplements.

Although TMPs used similar plants to manage all types of cancers (38.7%), specific plants were used to treat certain cancers. The most frequently treated cancers were skin (16.2%), cervical/uterine (10.4%), breast (6.9%), and prostate (5.8%) cancers (Fig. 3). Some plants such as *Cannabis sativa* L., *Kigelia africana* Lam and *Bidens pilosa* L. were used to manage cancer-related symptoms or conventional treatment-related side effects such as pain (17.5%), vomiting (12.7%), dehydration (12.7%), fever (14.3%), and other sore-related symptoms (44.4%). TMPs also used these plants to manage non-cancer-related illnesses, mainly sexually transmitted infections (STIs), especially syphilis, wounds (24.4%), and ulcers (7.6%, Table 2).

### Preservation, preparation, and administration of HM/plant products

Most plants were dried, crushed into powder, and stored in polythene bags/plastic bottles. The most common methods of plant preparation were decoction (69.2%) and squeezing (9.2%) (Fig. 4). After

**Table 1**  
Plants used by TMPs in the management of cancer.

Species name/Voucher number	Family name	Vern. name	Habit	Part used	Reported use in Cancer	FC	RFC	FIV
<i>Justicia betonica</i> L., JA21-01.	Acanthaceae	Nalongo [Lug]	H	L, B	All, cervical/uterine	2	0.11	0.140
<i>Acanthus pubescens</i> (Oliv.) Engl., JA21-16.	Acanthaceae	Amatojjo/matovu [Lug]	S	TU, R	All	3	0.17	0.110
<i>Allium cepa</i> L., JA21-02.	Amariyllidaceae	Ienga/Ekitungutu ekyelu [Lug]	Bu	TU	All	2	0.11	0.060
<i>Pseudospondias microcarpa</i> (A.Rich.) Engl., JA21-94.	Anacardiaceae	Bagambanimpayata [Ru]	T	L, R, B	Skin	1	0.06	0.330
<i>Annona muricata</i> L., JA21-18.	Annonaceae	Kutukiferi [Lug], emizabibu [Ru]	T	Se, L, F	All, cervical/uterine	6	0.33	0.170
<i>Centella asiatica</i> (L.) Urb., JA21-20.	Apiaceae	Kutukumwe*, kabakyala [Lug]	Cr	L	All	3	0.17	0.085
<i>Secamone africana</i> (Oliv.) Bullock, JA21-105.	Apocynaceae	Akateganende [Ru]	H	L	Vomiting in cancer	1	0.06	0.110
<i>Catharanthus roseus</i> (L.) G. Don, JA21-39.	Apocynaceae	Nil, Sekagya [Lug]	H	L	All, cervical/uterine	2	0.11	0.060
<i>Mondia whytei</i> (Hook.f.) Steels, JA21-05.	Apocynaceae	Mulondo [Lug]	Cl	R	All, skin	2	0.11	0.060
<i>Carissa edulis</i> (Forsk.) Vahl, JA21-72.	Apocynaceae	Omuyonza [Ru]	S	R	All	1	0.06	0.170
<i>Panax notoginseng</i> (Burkill) F.H.Chen, JA21-03;	Araliaceae	Nil, Giseng	H	TU	Prostate	1	0.06	0.170
<i>Phoenix reclinata</i> Jacq., JA21-17.	Araliaceae	Ekindu kundu [Lug]	T	Se, R	Cervical/uterine, prostate	7	0.36	0.060
<i>Cocos nucifera</i> L., JA21-29.	Araliaceae	Ekinazi [Lug]	T	Se	All	1	0.09	0.170
<i>Aristolochia elegans</i> Mast., JA21-57.	Aristolochiaceae	Nakasero [Lug]	Cl	Se, L, R, WP	All with fever	3	0.17	0.115
<i>Asparagus africanus</i> Lam., JA21-04.	Asparagaceae	Kadali [Lug]	H	L, R	Lung	1	0.06	0.131
<i>Dracaena steudneri</i> Engl., JA21-87.	Asparagaceae	Kajjolyenjovu [Lug]	T	L, B	Lung	3	0.17	0.060
<i>Bidens pilosa</i> L., JA21-89;	Asteraceae	Seere [Lug]	H	L	Cervical/uterine	5	0.28	0.170
<i>Boerhaavia longipes</i> (Oliv. & Hiern) N. E. Br., JA21-86.	Asteraceae	Etwatwa [Lug], ekisuura [Ru]	Sc	L, B	Cervical/uterine	3	0.17	0.060
<i>Dichrocephala integrifolia</i> O.Ktze, JA21-76.	Asteraceae	Omutubuza wamaizi*	H	F, L	All	1	0.06	0.060
<i>Aspilia africana</i> (Pers.) C.D.Adams, JA21-73.	Asteraceae	Makayi [Lug]	H	L, WP	Internals, skin, uterine	5	0.28	0.060
<i>Crassocephalum viellimum</i> (Benth.) S.Moore, JA21-78.	Asteraceae	Mukumbusa	H	L, WP	All, cervical/uterine	6	0.33	0.060
<i>Conyza sumatrensis</i> (S.F.Blake) Pruski & G.Sancho, JA21-11.	Asteraceae	Kafumbe omusajja [Lug]	H	L, R	Cervical/uterine	1	0.06	0.060
<i>Conyza pyrhopappa</i> Sch.Bip. ex A.Rich., JA21-95.	Asteraceae	Kafugankande [Lug]	H	L	All for pain	1	0.06	0.060
<i>Vernonia amygdalina</i> Delile, JA21-85.	Asteraceae	Omutuluza [Lug], Mubirizi [Ru]	S	L	All with fever	1	0.06	0.060
<i>Galinsoega parviflora</i> Cav., JA21-99.	Asteraceae	Mukasa [Lug]	H	L, WP	All	2	0.11	0.060
<i>Ageratum conyzoides</i> L., JA21-06.	Asteraceae	Namirembe [Lug]	H	L, WP	All	2	0.11	0.060
<i>Artemisia annua</i> L., JA21-25.	Asteraceae	Nil, Omugosera	S	L	All	1	0.06	0.060
<i>Silybum marianum</i> (L.) Gaertn., JA21-74.	Asteraceae	Nil, Marian thistle	H	L	Liver	1	0.06	0.060
<i>Kigelia africana</i> (Lam.) Benth. JA21-31;	Bignoniaceae	Musa [Lug]	T	F	Skin	2	0.11	0.060
<i>Spathodea nilotica</i> Seem. JA21-100.	Brassicaceae	Kifabakazi [Lug]	T	L, B	Breast, cervical/uterine	6	0.33	0.060
<i>Raphanus raphanistrum</i> L., JA21-49;	Brassicaceae	Radish, Nil	H	L	Liver	1	0.06	0.060
<i>Brassica oleracea</i> L., JA21-112	Brassicaceae	Red cabbage, embooga emyufu [Lug]	Ve	L, WP	All	2	0.11	0.060
<i>Canarium schweinfurthii</i> Engl., JA21-23.	Burseraceae	Muwafu [Lug]	T	B, Se	Cervical/uterine, Skin	5	0.28	0.060
<i>Cactus Opuntia</i> L. (prickly pear), JA21-22.	Cactaceae	Cactus, Engabo ya Kabaka [Lug]	Xe	L	All	1	0.06	0.060
<i>Warburgia ugandensis</i> Sprague, JA21-82.	Canellaceae	Omuya/Abasi	T	L	Skin, lung	3	0.17	0.170
<i>Cannabis sativa</i> L., JA21-79.	Cannabaceae	Njanyi, Njaaga [Lug]	H	L	All with pain, nausea, and vomiting	2	0.11	0.110
<i>Capparis erythrocarpus</i> Isert., JA21-10.	Capparaceae	Kirobo [Lug]	S	B	All	1	0.06	0.060
<i>Carica papaya</i> L., JA21-64.	Caricaceae	Paapali/Mupaapali [Lug, Lus, Gis]	T	Se, B, R, F	All, esp. bone and skin	4	0.22	0.220
<i>Maytenis senegalensis</i> (Lam.) Exell, JA21-42.	Celastraceae	Nyabuliko [Ru]	T	R, B	All, esp. throat, bone, and skin	3	0.17	0.170
<i>Chenopodium opulifolium</i> Koch & Ziz, JA21-12.	Chenopodiaceae	Omwetango [Lug]	H	L, R	Breast, throat	4	0.22	0.220
<i>Garcinia buchananii</i> Baker, JA21-60;	Clusiaceae	Omusali, Musali [Lug]	T	B	Skin	1	0.06	0.060
<i>Combretum molle</i> G. Don, JA21-62;	Combretaceae	Endagi [Lug]	T	B	Internal and external (e.g., bone, lung)	3	0.17	0.170
<i>Murdannia simplex</i> (Vahl) Brenan, JA21-113.	Commelinaceae	Lulira [Ru]	H	TU, L	All	1	0.06	0.085
<i>Commelina erecta</i> L., JA21-70.	Commelinaceae	Enanda/ekitezi, Enanda [Lug]	H	WP	Skin	2	0.11	0.060
<i>Ipomoea caritica</i> (L.) Sweet, JA21-15.	Convolvulaceae	Akacharugo, Kalanda lugo [Ru]	Cl	L	All esp. prostate, breast, and skin	1	0.06	0.060
<i>Ipomea batatas</i> (L.) Lam, JA21-69.	Convolvulaceae	Emikamba/enkora (potato leaves), Ebitakuri [Ru]	H	L	All	1	0.06	0.060

(continued on next page)

Table 1 (continued)

Species name/Voucher number	Family name	Vern. name	Habit	Part used	Reported use in Cancer	FC	RFC	FIV
<i>Kalanchoe densiflora</i> Rolfe, JA21-68.	Crassulaceae	Ekiyondo, Kiyondo-ekyeru [Lug]	H	L	All bleeding tumours	4	0.22	0.220
<i>Zehneria thwaitesii</i> (Schweinf.) C.Jeffrey, JA21-21.	Cucurbitaceae	Akaramata [Ru]	Cl	L, B	Cervical/uterine, skin	1	0.06	0.140
<i>Cucurbita maxima</i> Duchesne, JA21-96.	Cucurbitaceae	Obwongo (Ebisunsa ebito) Nsujju [Lug]	Sc	F, Se	All	4	0.22	
<i>Cupressus sempervirens</i> L., JA21-122.	Cupressaceae	Akakomera [Lug]	T	Se	Prostate	2	0.11	0.110
<i>Aletris moluccanus</i> (L.) Wild., JA21-65.	Euphorbiaceae	Kabaka Njagala [Lug]	T	Se	All	2	0.11	0.079
<i>Tragia brevipes</i> Pax, JA21-109.	Euphorbiaceae	Kamwe [Lug]/egyenyi [Ru]	Cl	R	Skin	1	0.06	
<i>Fluggea virosa</i> (Wild.) Voigt, JA21-110.	Euphorbiaceae	Olukandwa [Lug]	S	R	Breast, prostate	1	0.06	
<i>Jatropha curcas</i> L., JA21-97.	Euphorbiaceae	Ekilowalowa, Kiroowa [Lug]	T	L	Internal, skin	2	0.11	
<i>Manihot esculenta</i> Grantz, JA21-114.	Euphorbiaceae	Muhogo [Lug]	S	Sh	Internal, skin	1	0.06	
<i>Alchornea cordifolia</i> Muell. Arg., JA21-32.	Euphorbiaceae	Luzibaziba [Ru]	T	L	All internal	1	0.06	
<i>Shraklopsis elliptica</i> (Hochst.) Esser, JA21-35.	Euphorbiaceae	Omusasa/omuzanganda [Lug]	T	B	All	1	0.06	
<i>Ricinus communis</i> L., JA21-80.	Euphorbiaceae	Enyamasogoga [Ru], Esogasoga [Lug]	S	Se, R	Skin	2	0.11	
<i>Senna didymobotrya</i> (Fresen.) H.S.Irwin & Barneby, JA21-56.	Fabaceae	Muvuvumira [Lus]	S	L	Stomach, cervical	2	0.11	0.119
<i>Tylosmia fassoglenis</i> (Schweinf.) Torre & Hill, JA21-34.	Fabaceae	Ekiyugeyuge, Kiyugeyuge [Lus]	Li	TU, L	Breast, skin	2	0.11	
<i>Chamaecrista hirsuta</i> (L.) Lock (Syn. <i>Cassia hirsuta</i> L.), JA21-103.	Fabaceae	Kitonto, Enshununu [Ru]	H	Fl	All internal (e.g., blood, uterus/cervical)	3	0.17	
<i>Acacia constricta</i> A. Gray, JA21-46.	Fabaceae	Omwelamanyo [Lug]	S	L	All	1	0.06	
<i>Entada gigas</i> (L.) Fawc. & Rendle, JA21-90.	Fabaceae	Omutima gwensi [Ru]	Li	Se	All	1	0.06	
<i>Procarpus erinaceus</i> Poir, JA21-98.	Fabaceae	Omulema ngundu [Ru]	T	B	All	1	0.06	
<i>Cajanus cajan</i> (L.) Millsp., JA21-38.	Fabaceae	Enkuku [Ru], Enkolimbo [Lug]	le	L, Se	All	1	0.06	
<i>Indigofera arparocarpa</i> Taub., JA21-51.	Fabaceae	Sebazinga nkata [Lug]	H	L	All, lung	2	0.11	
<i>Entada abyssinica</i> A.Rich, JA21-55.	Fabaceae	Omwololola/omusambamadi [Lus], Mwolola [Lug]	T	Lor B or R	All internal, breast	5	0.06	
<i>Senna alata</i> (L.) Roxb, JA21-26.	Fabaceae	Omuchula	H	L	All esp. colon	1	0.06	
<i>Acacia hockii</i> De Wild, JA21-27.	Fabaceae	Akasana [Lug]	T	B	Internal and external, skin	5	0.28	
<i>Albizia cortaria</i> Oliv., JA21-28.	Fabaceae	Mugavu [Lug]	T	B	All esp., bone, throat, and lung	4	0.22	
<i>Albizia gummifera</i> (Gmel.) C.A.Sm., JA21-54.	Fabaceae	Nil	T	B	All	1	0.06	
<i>Acacia brevispica</i> Harms, JA21-115.	Fabaceae	Akawule	Li	B	All, lung	2	0.11	
<i>Piptadeniastrum africanum</i> (Hook.f.) Brenan, JA21-24.	Fabaceae	Epewere [Lug]	T	B	Skin	1	0.06	
<i>Acacia polyacantha</i> Wild. subsp. <i>campylacantha</i> (A. Rich) Brenan, JA21-61.	Fabaceae	Kibere [Lug]	T	B, L	All, esp., breast and skin	3	0.17	
<i>Albizia glaberrima</i> (Schumacher & Thonn) Benth., JA21-52;	Fabaceae	Nogo/enongo [Lug]	T	L	All internal esp., throat	2	0.11	
<i>Philenoptera laxiflorus</i> (Guill & Perr) Roberty, JA21-19.	Fabaceae	Omunyoroli [Ru]	T	R	All	1	0.06	
<i>Erythrina abyssinica</i> DC., JA21-44.	Fabaceae	Ejirikiti [Lug]	T	B	Internal of all types (advanced).	3	0.17	
<i>Indigofera arrecta</i> A.Rich, JA21-108.	Fabaceae	Kalegamaaliba, Kabamba Maliba [Lug]	H	L	Breast	2	0.11	
<i>Ribes inva-crispa</i> L., JA21-07.	Grossulariaceae	Entununu, Entuntunu [Lug]	S	L, Fs	All	1	0.06	0.060
<i>Ocimum gratissimum</i> L., JA21-53.	Labiatae	Omujaia [Lug]	S	L	Breast, prostate and intestinal	1	0.06	0.060
<i>Tetradenia riparia</i> (Hochst.) Codd., JA21-63.	Lamiaceae	Ekyewamala [Lug], Enyamansunsu [Ru]	S	L	All	3	0.17	0.260
<i>Leonotis nepetifolia</i> (L.) Ait.f., JA21-71.	Lamiaceae	Ekiyumumu [Lug]	H	L, Fr, Se	All, Uterine/throat	3	0.17	
<i>Hoslundia opposita</i> Vahl, JA21-30.	Lamiaceae	Kamunye/Orutoitoima [Ru]	S	L, Bs, Wp	Internal, skin, uterus/cervical	8	0.44	
<i>Persea americana</i> Mill., JA21-48.	Lauraceae	Ovacedo, Ovakedo* [Lug], Vakedo* [Lus, Gis]	T	L, B, Se	All (e.g., uterus/cervical, skin)	5	0.28	0.280
<i>Phragmites usitensis</i> (Oliv.) M. Gilb. subsp. <i>Usutensis</i> , JA21-13.	Loranthaceae	Enguklinzi [Ru]	Ep	Fls	All	1	0.06	0.060
<i>Artocarpus heterophyllus</i> Lam, JA21-75.	Moraceae	Fene [Lug]	T	Se	Breast	2	0.11	0.100
<i>Ficus sur</i> Forssk., JA21-33.	Moraceae	Omulukonyu	T	L	All	1	0.06	
<i>Ficus exasperata</i> Vahl, JA21-66.	Moraceae	Oluwawu [Lug], Omusomoro [Ru]	T	L, Se	All esp., uterine, prostate, and bone	2	0.11	
<i>Ficus natalensis</i> Hochst, JA21-59.	Moraceae	Omutuba [Lug], Mugaire [Lus]	T	B, R, L	All esp. Breast	2	0.11	
<i>Millettia excelsa</i> (Welw.) C.C.Berg, JA21-50.	Moraceae	Omwule, Mwule [Lug, Igb]	T	B, sap	Internal, skin	2	0.11	
<i>Musa acuminata</i> Colla, JA21-84.	Musaceae	Ekitooke ekimyufu [Lug]	H	F, shoots	All	3	0.17	0.170

(Continued on next page)

Table 1 (continued)

Species name/Voucher number	Family name	Vern. name	Habit	Part used	Reported use in Cancer	FC	RFC	FIV
<i>Myrica kandiana</i> Engl., JA21-08.	Myricaceae	Enkikimbo [Lug]	T	B, Fs	Internal, bone, skin	2	0.11	0.138
<i>Psidium guajava</i> L., JA21-106.	Myrtaceae	Amapera (guava), Mupeera [Lug], Ipeera [Ru]	S	Se and L	All esp. skin	2	0.11	
<i>Syzygium emini</i> Skeels, JA21-81.	Myrtaceae	Jambula [Lug]	T	B	Uterus/cervical.	2	0.11	
<i>Callistemon citrinus</i> (Curtis) Skeels, JA21-92.	Myrtaceae	Mwambala butonya, Mwabalabutonya [Lug]	S	L	All	4	0.22	
<i>Ximaria americana</i> L., JA21-37.	Olacaceae	Oruseka/ensekka [Ru]	S	R, Fs	All	1	0.06	0.060
<i>Justicia abyssinica</i> (A.Rich) Dandy & Brenan, JA21-91.	Onagraceae	Ekyamaizi [Ru]	H	L	Cervical	1	0.06	0.060
<i>Sesamum angustifolium</i> (Oliv.) Engl., JA21-83.	Pedaliaceae	Olutungotungo [Lug]	H	L	All	1	0.06	0.060
<i>Phyllanthus niruri</i> L., JA21-09.	Phyllanthaceae	Akabalira [Lug]	H	B	All	1	0.06	0.060
<i>Pitiosporium manni</i> Hook.f. subsp. <i>ripicola</i> (J. Leon) Cuf., JA21-14.	Pittosporaceae	Balwejilo [Lus], Abasi	T	R, B	Stomach, skin, bone	2	0.11	0.110
<i>Paspalum acuminatum</i> Raddi, JA21-119	Poaceae	Nil, Pascalum	Gr	R	All	1	0.06	0.060
<i>Coix lacryma-jobi</i> L., JA21-41.	Poaceae	Nil	Gr	L	All	1	0.06	
<i>Pennisetum purpureum</i> Schumacher, JA21-120.	Poaceae	Ebisagazi/Ekisagazi [Lug], olumuri [Ru]	H	R	Lung	1	0.06	
<i>Securida longipedunculata</i> Fresen., JA21-40.	Polygalaceae	Mukondwe [Lug, Lus]	T	R	Internal	1	0.06	0.060
<i>Prunus africana</i> (Hook.f.) Kalkman, JA21-67.	Rosaceae	Entasesa/gwabuzito, Ntasesa, Ngwabuzito [Lug, Ru]	T	L, B	All esp. prostate, bone, and throat	5	0.28	0.280
<i>Hallea robustipulata</i> (K. Schum.) J.F.Leroy, JA21-43.	Rubiaceae	Omunyamaizi [Ru]	T	R, L, B	Skin	1	0.06	0.060
<i>Zanthoxylum lepteurit</i> Guill & Perr, JA21-101.	Rutaceae	Omutatebwa [Ru]	T	B, R	All esp. skin, uterine	2	0.11	0.098
<i>Citropsis articulata</i> (Wild ex Spreng.) Swingle & M.Kellerm, JA21-47.	Rutaceae	Omunboro, Mubolo [Lug]	S	F	All	2	0.11	
<i>Citrus limon</i> (L.) Burm.f., JA21-117.	Rutaceae	Enimu [Lug, Ru]	T	Fs, L	All	1	0.06	
<i>Citrus sinensis</i> (L.) Osbeck, JA21-118.	Rutaceae	Omutungwa [Lug]	T	Fs	All, skin	2	0.11	
<i>Blighia unijugata</i> Baker, JA21-121;	Sapindaceae	Nkuzza nyana, Enkuzza nyana [Lug]	T	B	All	1	0.06	0.060
<i>Solanum nigrum</i> L., JA21-111.	Solanaceae	Eyobyoy/ejyoby [Lug], Enswiga esajja [Ru]	H	L	Liver	3	0.17	0.140
<i>Solanum abancayense</i> Ochoa, JA21-116.	Solanaceae	Engyagi oluteka [Ru]	H	Fl	All	2	0.11	
<i>Corchorus olitorius</i> L., JA21-104.	Tiliaceae	Ereke [Ru]	H	Se, L	All	3	0.17	0.170
<i>Fleurya aestuans</i> (L.), JA21-88.	Urticaceae	omunnyango, Munyango [Lug]	H	R, B	Skin, prostate	1	0.06	0.060
<i>Lippia javanica</i> (Burm.f.) Spreng., JA21-36.	Verbenaceae	Kisumuluzo [Lug]	S	L	All	1	0.06	0.060
<i>Clerodendrum myricoides</i> (Hochst.) Vatke, JA21-45.	Verbenaceae	Ekikonge [Lug]	S	WP, L, B	Skin and internal	1	0.06	0.060
<i>Lantana camara</i> L., JA21-58.	Verbenaceae	Nil	S	Se	Internal	1	0.06	
<i>Cyphostemma adenocaulis</i> (A.Rich) Wild. & Drummond, JA21-107.	Vitaceae	Akabombo akatono [Lug]	Cl	L, TU	All for pain	4	0.22	0.220
<i>Aframomum angustifolium</i> , (Sonn.) K.Schum. JA21-77.	Zingiberaceae	Anatehe [Ru]	H	Se, TU	Breast, prostate, and intestinal	2	0.11	0.110

FIV, family importance value; FC, frequency of citation; Lug, Luganda; Lus, Lusoga; Nil, no local name; RFC, relative frequency of citation; Ru, Runyoro/Rutooro/Rukiga/Runyakole/Runyaktiara; TMPs, traditional medicine practitioners.

Habit: Ba, bulb; Cl, climber; Ep, epiphyte; Gr, grass; H, herb; Le, legume; Li, liane; S, shrub; Sc, scrambler; T, tree; Ve, vegetable; Xe, xerophyte; All, all types of cancer.

Part used: B, bark; Fl, flowers; F, fruit; L, leaves; R, roots; S, seeds; TU, tuber.



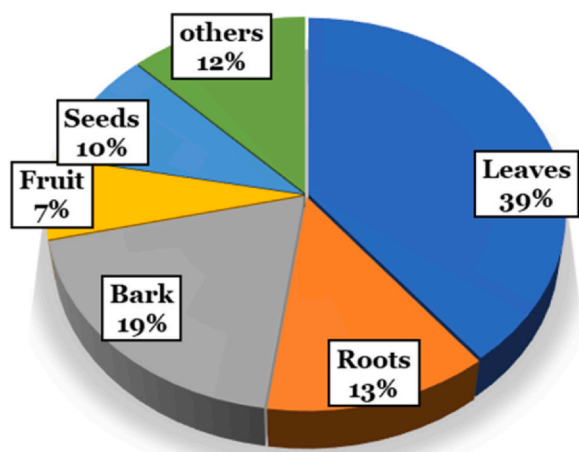


Fig. 2. Plant parts used.

harvesting plant parts, TMPs made decoctions by boiling them (fresh, dried, or powdered). Plants were boiled in combinations or separately (and mixed after boiling). In squeezing, multiple fresh herbs were ground by hand and mixed in water for administration. To treat the internal and external manifestations of cancer, TMPs preferred to administer HM using oral (86.7%) and topical routes (13.3%). Powder, plant saps, and other products were applied to the cancerous wound or sore, and patients took prepared remedies orally.

**Discussion**

This study identified and documented medicinal plants, and how they were used by TMPs in cancer management in Uganda. Similar to ethnobotanical studies conducted in Cameroon, Togo, Ethiopia, Egypt, and South Africa, most plants used to treat cancer in this study belonged to the Asteraceae, Euphorbiaceae, Fabaceae, and Apocynaceae plant families (Esubalew et al., 2017; Hassan et al., 2016; Kola et al., 2020; Sagbo and Otang-Mbeng, 2021a; Tchoundjeu et al., 2019). Species from the Asteraceae and Fabaceae families were also commonly used in cancer management in Morocco (El Hachlafi et al., 2022). The Fabaceae and Asteraceae families comprise territorial plants with secondary metabolites such as terpenoids, flavonoids, saponins, tannins, and phenols that may possess antineoplastic properties (Tariq et al., 2017). Euphorbiaceae are acclimatised to the worst weather conditions (i.e., dry), meaning the plants develop mutation loads and a range of secondary metabolites (e.g., terpenoids, alkaloids, and phenols) with known anticancer properties (Soladoye et al., 2010; Tariq et al., 2017).

In this study, the most common plant parts used were leaves and roots. Previous studies from Kenya and Nigeria indicated the leaves,

stem bark, and roots were commonly used (Ochwang’i et al., 2014; Tariq et al., 2017). Leaves may be commonly used because of the ease of harvesting, availability, and minimal harm to plant life (Tariq et al., 2017; El Hachlafi et al., 2022). Roots and bark are richer in metabolites, but have implications for plant conservation (Tariq et al., 2017), and their use may be related to perceived efficacy and a lack of knowledge about the impact of harvesting or conservation strategies of such plant parts (Mathew et al., 2021). Therefore, TMPs need training on plant conservation strategies, especially given the extinction of plant species in Uganda due to economic development activities, and stakeholders (government and non-government) need to invest in research related to the conservation of these medicinal species.

This study found TMPs tended to treat cancers that were familiar to them. As reported in studies from Kenya, India, and Nigeria, the most commonly treated cancers were skin, breast, prostate, uterine, cervical, and throat cancers, which corresponded to statistics for the national incidence of cancer in those countries (Ochwang’i et al., 2014; Tariq et al., 2017).

Consistent with studies from Morocco and Kenya, decoctions were the most common formulation method in this study (El Hachlafi et al., 2022; Ochwang’i et al., 2014). TMPs often combined multiple plants, which may have enhanced the efficacy of these plants against cancer but may also have posed risks for herb-to-herb and herb-to-drug interactions among patients with cancer receiving conventional treatment. Decoction allows for the extraction of active phytochemicals and reduces toxicity in multiple plant prescriptions (El Hachlafi et al., 2022). As reported in studies from Kenya, decoctions were taken orally, but occasionally herbal preparations were applied topically on the cancer sore (Ochwang’i et al., 2014; Tariq et al., 2017), which could reflect the belief that cancer originates within the body (Sophy and Mavis, 2008). Therefore, TMPs purportedly pulled cancer from the ‘inside’ to the ‘outside’ of the body using those routes of administration. In addition, the oral route was considered the most common and acceptable route of administration of traditional medicine (El Hachlafi et al., 2022).

In this study, commonly mentioned plants used by TMPs to manage cancer were *H. opposita*, *A. africana*, *S. nilotica*, *A. muricata L.*, and *P. africana*. Evidence from ethnobotanical studies conducted on the African continent indicated that about half of the plants (n = 67) used to manage cancer by TMPs in this study were used by TMPs elsewhere, especially for female-related cancers (cervical and breast), male-related cancers (prostate), and skin cancer (Table 2). Previous ethnobotanical surveys conducted in Nigeria, Uganda, Kenya, Ethiopia, Cameroon, Morocco, and Togo showed that the most common plants used by TMPs to manage cancer were *A. muricata* (Mohamed et al., 2022; Omara et al., 2020) followed by *K. Africana* (Tchoundjeu et al., 2019; Tembo et al., 2021), *C. roseus* (Nduche, 2019; Ochwang’i et al., 2014), *B. pilosa* (Tchoundjeu et al., 2019), *P. africana* (Ayele, 2018; Gumisiriza et al.,

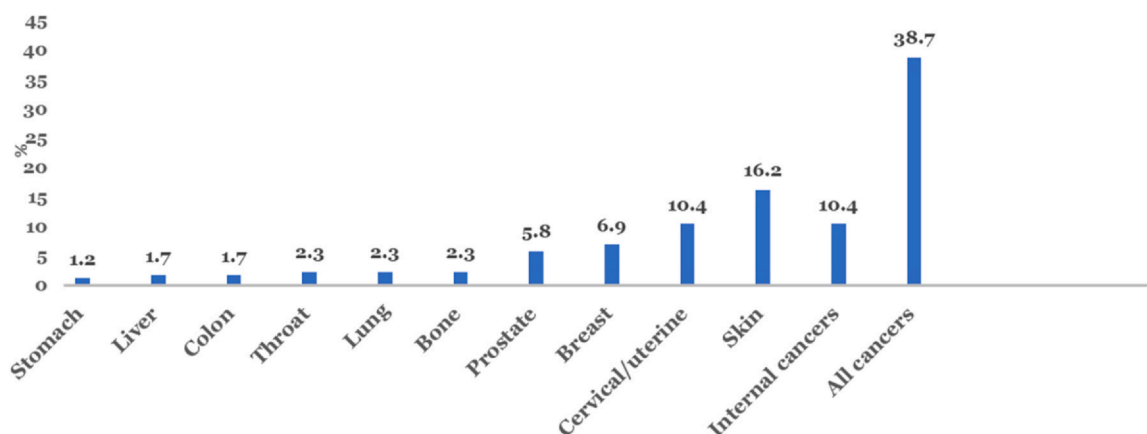


Fig. 3. Cancers managed.

**Table 2**  
Comparison of traditional uses of plants in this study with other previous published literature on cancer.

Species name	Reported use in cancer	Other diseases treated	Ethnobotanical studies/uses in cancer (cancer, country, and reference)
<i>Justicia betonica</i> L.	All, cervical/uterine	Skin cleanser, dead skin	Used for breast, skin, and colorectal cancer in Kenya (Ochwang'i et al., 2014)
<i>Acanthus pubescens</i> (Oliv.) Engl.	All	Vaginal warts, asthma, sexual virility	No reports
<i>Allium cepa</i> L.	All	Priapism, manpower, dog bites	Used for cancer in Nigeria and Turkey (Bozyel et al., 2019; Segun et al., 2018)
<i>Pseudospondias microcarpa</i> (A.Rich.) Engl.	Skin	HTN, kidney disease, cough, body weakness	No reports
<i>Annona muricata</i> L.	All, cervical/uterine	Manpower (roots), syphilis (leaves)	Used for nose cancer, gastric, breast, bone, and lung cancer in Gabon, Mexico, Uganda, Nigeria, Ecuador, Togo, and Ethiopia
<i>Centella asiatica</i> (L.) Urb.	All	Syphilis, brain memory booster	Used for cancer (e.g., skin) in Ethiopia and South Africa (Esubalew et al., 2017; Raimi et al., 2021; Tesfaye et al., 2020)
<i>Secamone africana</i> (Oliv.) Bullock.	Vomiting in cancer	Any fever associated with vomiting	No reports
<i>Catharanthus roseus</i> (L.) G. Don.	All, cervical/uterine	Poisoning, hernia	Used for throat, stomach, breast, ovary, cervix, lung, colon, rectum and prostate cancer, and esophageal cancer in Kenya, Ethiopia, Uganda, South Africa, and Nigeria (Esubalew et al., 2017; Nduche, 2019; Ochwang'i et al., 2014; Omara et al., 2020; Sagbo and Otang-Mbeng, 2021a, 2021b; Ukwubile et al., 2020)
<i>Mondia whytei</i> (Hook.f.) Skeels.	All, skin	Wound, abdominal pain	No reports
<i>Carissa edulis</i> (Forsk.) Vahl	All	-	Used for cancer in Nigeria (Saidu et al., 2015)
<i>Panax notoginseng</i> (Burkill) F.H. Chen	Prostate	Manpower	Used for lung cancer in Togo (Kola et al., 2020)
<i>Phoenix reclinata</i> Jacq.	Cervical/uterine, prostate	-	No reports
<i>Cocos nucifera</i> L.	All	-	Used for cancer in Nigeria (Afolayan et al., 2020).
<i>Aristolochia elegans</i> Mast.,	All with fever	Malaria, hernia (unstrangulated), eye twitching, high fever	Used for cancer in Nigeria (Saidu et al., 2015)
<i>Asparagus africanus</i> Lam.	Lung	-	Used for uterine, prostate, skin, and breast cancer in Nigeria, Zimbabwe, and Ethiopia (Ayele, 2018; Esubalew et al., 2017; Matowa et al., 2020; Saidu et al., 2015)
<i>Dracaena steudneri</i> Engl.	Lung	Joint pains, ulcers	No reports
<i>Bidens pilosa</i> L.	Cervical/uterine	Wounds, low blood cells, constipation	Used for breast, skin, liver, stomach, pancreas, brain cancer, throat cervical cancer in Gabon, Kenya, and Cameroon (Alonso-Castro et al., 2011; Clairet et al., 2019; Ochwang'i et al., 2014; Tchoundjeu et al., 2019)
<i>Bothriocline longipes</i> (Oliv. & Hiern) N. E. Br.	Cervical/uterine	Ulcers, genital cleaning after delivery	Used for cervical cancer in Uganda (Gumisiriza et al., 2019)
<i>Dichrocephala integrifolia</i> O.Ktze, JA21–76.	All	HIV	Used for breast, skin, liver, stomach, pancreas, lung, and brain cancer in Cameroon (Tchoundjeu et al., 2019)
<i>Siegesbeckia orientalis</i> L., JA21–93.	Internals, skin, uterine	Hernia, abdominal pain, sores	No reports
<i>Aspilia africana</i> (Pers.) C.D.Adams	All, cervical/uterine	Ulcers	Used for breast, skin, liver, stomach, pancreas, and brain cancer in Nigeria and Cameroon (Segun et al., 2018; Tchoundjeu et al., 2019; Ukwubile et al., 2020)
<i>Crassocephalum vitellinum</i> (Benth.) S.Moore	All	-	No reports
<i>Conyza sumatrensis</i> (S.F.Blake) Pruski & G.Sancho	Cervical/uterine	Excessive bleeding in women	Used for throat, breast, and squamous cell carcinoma of the gums in Kenya (Ochwang'i et al., 2014)
<i>Conyza pyrrhopappa</i> Sch.Bip. ex A.Rich.	All for pain	-	No reports
<i>Vernonia amygdalina</i> Delile	All with fever	-	Used in colorectal, breast, skin, stomach, and lung cancer in Gabon, Nigeria, Ethiopia, and Cameroon (Abebe, 2016; Ayele, 2018; Esubalew et al., 2017; Nduche, 2019; Ngoua-Meye-Misso et al., 2019; Saidu et al., 2015; Segun et al., 2018; Soladoye et al., 2010; Tchoundjeu et al., 2019; Ukwubile et al., 2020)
<i>Galinsoga parviflora</i> Cav.	All	-	Used for colorectal cancer in Kenya (Ochwang'i et al., 2014)
<i>Ageratum conyzoides</i> L.	All	Ulcers	Used for cancer in breast, skin, liver, stomach, and pancreas cancer in Cameroon and Nigeria (Afolayan et al., 2020; Segun et al., 2018; Tchoundjeu et al., 2019)
<i>Artemisia annua</i> L.	All	Malaria fever	Used for cancer in Uganda and Ethiopia (Anywar et al., 2020; Esubalew et al., 2017; Tesfaye et al., 2020)
<i>Silybum marianum</i> (L.) Gaertn.	Liver	-	Used for internal tumours in Brazil (De Melo et al., 2011)
<i>Kigelia africana</i> (Lam.) Benth	Skin	STIs, abdominal/back pain, fertility/ovulation.	Used for breast, skin, liver, stomach, pancreas, blood, cervical cancer, and uterine cancer in Kenya, Malawi, Togo, Uganda, Nigeria, Cameroon, and Zimbabwe (Afolayan et al., 2020; Matowa et al., 2020; Ochwang'i et al., 2014; Omara et al., 2020; Soladoye et al., 2010; Tchoundjeu et al., 2019; Tembo et al., 2021)

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Table 2 (continued)

Species name	Reported use in cancer	Other diseases treated	Ethnobotanical studies/uses in cancer (cancer, country, and reference)
<i>Spathodea nilotica</i> Seem	Breast, cervical/uterine	STIs (e.g., syphilis), vaginal fluids and woman's sexual power, ulcers, HTN, dysmenorrhoea	Used for cervical, bone, breast, colorectal, and skin cancer in Kenya and Nigeria (Ochwang'i et al., 2014; Soladoye et al., 2010; Ukwubile et al., 2020)
<i>Raphanus raphanistrum</i> L. <i>Brassica oleracea</i> L.	Liver All	Anaemia	No reports Used for gastric cancer in Uganda (Gumisiriza et al., 2019; Nakaziba et al., 2021)
<i>Canarium schweinfurthii</i> Engl.	Cervical/uterine, Skin	Cough, asthma, syphilis	No reports
<i>Cactus Opuntia</i> L.	All	DM, HTN, ulcers	Used for cancer in Uganda (Kyazike, 2021; Omara et al., 2020)
<i>Warburgia ugandensis</i> Sprague <i>Cannabis sativa</i> L.	Skin, lung All with pain, nausea, and vomiting	Sinusitis Pain, depression, cough	No reports Used for cancer in South Africa, Zimbabwe, and Uganda (Anywar et al., 2020; Matowa et al., 2020; Omara et al., 2020; Sagbo and Otang-Mbeng, 2021)
<i>Capparis erythrocarpos</i> Isert. <i>Carica papaya</i> L.	All All, esp. bone and skin	- -	No reports Used for skin, cervical, lung, colorectal, cervix, liver, pancreatic, and breast cancer in Gabon, Kenya, Nigeria, Togo, Uganda, and Morocco (Kola et al., 2020; Nduche, 2019; Ngoua-Meye-Misso et al., 2019; Ochwang'i et al., 2014; Omara et al., 2020; Samouh et al., 2019; Segun et al., 2018)
<i>Maytenus senegalensis</i> (Lam.) Exell	All, esp. throat, bone, and skin	Syphilis, skin/genital rashes/sores, UTI/STIs (candida), incompetent cervix, bone pain, (osteoarthritis)	Used for cancer in Nigeria and Ethiopia (Abebe, 2016; Saidu et al., 2015)
<i>Chenopodium opulifolium</i> Koch & Ziz <i>Garcinia buchananii</i> Baker <i>Combretum molle</i> G. Don	Breast, throat Skin Internal and external (e.g., bone, lung)	Tonsillitis, blessing - -	No reports No reports Used for cancer in Nigeria (Saidu et al., 2015)
<i>Murdannia simplex</i> (Vahl) Brenan	All	Vaginal fluids help in ejaculation/increase semen	No reports
<i>Commelina erecta</i> L. <i>Ipomoea cairica</i> (L.) Sweet	Skin All esp. prostate, breast, and skin	Wounds, abortion Syphilis, penile sores	No reports Used for breast, skin, and cervical cancer in Uganda and Kenya (Gumisiriza et al., 2019; Ochwang'i et al., 2014)
<i>Ipomea batatas</i> (L.) Lam	All	-	Used for colon, prostate, and breast cancer in Nigeria and Gabon (Nduche, 2019; Ngoua-Meye-Misso et al., 2019; Omogbadegun, 2013)
<i>Kalanchoe densiflora</i> Rolfe	All bleeding tumours	Cough, menstruation problems	No reports
<i>Zehneria thwaitesii</i> (Schweinf.) C. Jeffrey <i>Cucurbita maxima</i> Duchesne	Cervical/uterine, skin All	STIs -	No reports Used for cancer in Nigeria and Turkey (Bozyel et al., 2019; Ukwubile et al., 2020)
<i>Cupressus sempervirens</i> L. <i>Aleurites moluccanus</i> (L.) Wild. <i>Tragia brevipes</i> Pax	Prostate All Skin	Anal sores High blood sugar Penile erection, manpower, unoccluded Fallopian tubes	Used for cancer in Turkey (Bozyel et al., 2019) No reports Used for breast cancer and leukaemia in Kenya (Ochwang'i et al., 2014)
<i>Flueggea virosa</i> (Wild) Voigt	Breast, prostate	BPH in old men	Used for cervical cancer in Uganda and Nigeria (Gumisiriza et al., 2019; Onyancha, 2019)
<i>Jatropha curcas</i> L.	Internal, skin	Fibroids	Used for cervical cancer in Nigeria, Ethiopia, and Malawi (Abebe, 2016; Afolayan et al., 2020; Esubalew et al., 2017; Segun et al., 2018; Tembo et al., 2021)
<i>Manihot esculenta</i> Crantz	Internal, skin	HIV, dehydration, anaemia, high-grade fever	Used in prostate and breast cancer in Nigeria (Nduche, 2019)
<i>Alchornea cordifolia</i> Muell. Arg	All internal	-	Used in the treatment of cancer in Nigeria (Ohiagu et al., 2021)
<i>Shirakiopsis elliptica</i> (Hochst.) Esser	All	-	Used for colorectal and esophageal cancer in Kenya (Ochwang'i et al., 2014)
<i>Ricinus communis</i> L.	Skin	Constipation, high-grade fever, deworming	Used for breast, colon, liver, prostate, throat, neck, and face cancer in Nigeria and Ethiopia (Abubakar et al., 2020; Esubalew et al., 2017; Nduche, 2019)
<i>Senna didymobotrya</i> (Fresen.) H.S.Irwin & Barneby, <i>Tylosema fassoglensis</i> (Schweinf.) Torre & Hillc <i>Chamaecrista hirsuta</i> (L.) Lock (Syn. <i>Cassia hirsuta</i> L.)	Stomach, cervical Breast, skin All internal (e.g., blood, uterus/cervical)	Blessings, ulcers Splenomegaly (severe malaria), abdominal swelling, hernia Improving sight, allergies	Used for colorectal cancer in Kenya (Ochwang'i et al., 2014) No reports No reports
<i>Acacia constricta</i> A.Gray <i>Entada gigas</i> (L.) Fawc. & Rendle <i>Pterocarpus erinaceus</i> Poir, JA21–98.	All All All	- HTN, heart diseases or charms Syphilis	No reports No reports Used for breast, neck, and face cancer in Nigeria (Abubakar et al., 2020; Saidu et al., 2015; Segun et al., 2018)

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Table 2 (continued)

Species name	Reported use in cancer	Other diseases treated	Ethnobotanical studies/uses in cancer (cancer, country, and reference)
<i>Cajanus cajan</i> (L.) Millsp., JA21–38.	All	-	Used for liver and breast cancer in Nigeria (Afolayan et al., 2020; Nduche, 2019)
<i>Indigofera drepanocarpa</i> Taub., JA21–51.	All	-	No reports.
<i>Entada abyssinica</i> A.Rich, JA21–55.	All internal, breast	Syphilis, BPH	Used for breast, skin, liver, stomach, pancreas, and lung cancers in Cameroon (Tchoundjeu et al., 2019)
<i>Senna alata</i> (L.) Roxb. JA21–26.	All esp. colon	Colon cleanser	Used for cancer in Nigeria (Afolayan et al., 2020; Segun et al., 2018; Soladoye et al., 2010)
<i>Acacia hockii</i> De Wild, JA21–27.	Internal and external, skin	-	No reports
<i>Albizia coriaria</i> Oliv., JA21–28.	All esp., bone, throat, and lung	Syphilis, abdominal tumours, candidiasis	Used for breast, uterine, and skin cancer in Kenya, Uganda, and Nigeria (Anywar et al., 2020; Ochwang'i et al., 2014; Omara et al., 2020; Ukwubile et al., 2020)
<i>Albizia gummifera</i> (Gmel.) C.A.Sm.	All	-	Used for throat, breast, liver cancer, stomach, and skin cancer In Kenya (Ochwang'i et al., 2014)
<i>Acacia brevispica</i> Harms	All, lung	Toothache, dysmenorrhoea, toothache, jaundice with fever, manpower, dysmenorrhoea	No reports
<i>Piptadeniastrum africanum</i> (Hook.f.) Brenan	Skin	-	No reports
<i>Acacia polyacantha</i> Wild. subsp. <i>campylacantha</i> (A. Rich) Brenan	All, esp., breast and skin	Skin rashes in babies, neck swelling, or any swelling, internal wounds (e.g., ulcers)	No reports
<i>Albizia glaberrima</i> (Schumach & Thonn) Benth.	All internal esp., throat	-	No reports
<i>Philenoptera laxiflorus</i> (Guill & Perr) Roberty	All	Bleeding, dry one for syphilis	No reports
<i>Erythrina abyssinica</i> DC.	Internal of all types (advanced).	-	Used for cervical cancer in Uganda and Malawi (Anywar et al., 2020; Omara et al., 2020; Tembo et al., 2021)
<i>Indigofera arrecta</i> A.Rich	Breast	Syphilis, skin rashes (childbirth herbs), male and female sexual power (impotence)	No reports
<i>Ribes uva-crispa</i> L.	All	-	No reports
<i>Ocimum gratissimum</i> L.	Breast, prostate and intestinal	Cough and painful menses	Used for lung, brain, skin, liver, pancreas, stomach, oral, cervical, breast, and colorectal cancer in Kenya, Nigeria, Togo, Ethiopia, and Cameroon (Afolayan et al., 2020; Esubalew et al., 2017; Kola et al., 2020; Nduche, 2019; Ochwang'i et al., 2014; Segun et al., 2018; Tchoundjeu et al., 2019; Ukwubile et al., 2020)
<i>Tetradenia riparia</i> (Hochst.) Codd.	All	Cough, insomnia, hypertension	No reports
<i>Leonotis nepetifolia</i> (L.) Ait.f.	All, Uterine/throat	Colicky abdominal pain, COVID-19	No reports
<i>Hoslundia opposita</i> Vahl	Internal, skin, uterus/cervical	DM, ulcers, asthma, ulcers, mental health, removal of evil spirits or curses	Used for cancer in Nigeria (Segun et al., 2018)
<i>Persea americana</i> Mill.	All (e.g., uterus/cervical, skin)	Asthma, increases red blood cells, for manpower and body cleanser	Leaves used for stomach, colorectal, skin, and breast cancer in Kenya, Gabon, and Mexico (Afolayan et al., 2020; Alonso-Castro et al., 2011; Ngoua-Meye-Misso et al., 2019; Ochwang'i et al., 2014)
<i>Phragmenthera usuiensis</i> (Oliv.) M. Gilb. subsp. <i>Usuiensis</i>	All	-	No reports
<i>Artocarpus heterophyllus</i> Lam	Breast	-	Used for cancer in Nigeria (Ukwubile et al., 2020)
<i>Ficus sur</i> Forssk.	All	-	Used for cancer in Nigeria (Saidu et al., 2015; Segun et al., 2018)
<i>Ficus exasperata</i> Vahl	All esp., uterine, prostate, and bone	Body weight, swollen abdomen	Used for neck, throat, breast, and face cancer in Nigeria, (Abubakar et al., 2020)
<i>Ficus natalensis</i> Hochst	All esp. Breast	-	Used for cancer in Uganda and Nigeria (Afolayan et al., 2020; Omara et al., 2020)
<i>Milicia excelsa</i> (Welw.) C.C.Berg	Internal, skin	Wounds	Used for cancers such as cervical cancer in Gabon and Nigeria (Afolayan et al., 2020; Ngoua-Meye-Misso et al., 2019; Ukwubile et al., 2020)
<i>Musa acuminata</i> Colla	All	-	Used for cancer in Nigeria (Segun et al., 2018)
<i>Myrica kandiana</i> Engl.	Internal, bone, skin	Infertility, ulcers, abdominal discomfort: carrying away enemies, good luck, sinuses, cough	No reports
<i>Psidium guajava</i> L.	All esp. skin	-	Used for neck, skin, head, and face cancer In Nigeria, and Mexico (Abubakar et al., 2020; Alonso-Castro et al., 2011)
<i>Syzygium eminii</i> Skeels	Uterus/cervical.	Coughs, HTN, DM	No reports
<i>Callistemon citrinus</i> (Curtis) Skeels	All	Cough, fever, flue	No reports
<i>Ximenia americana</i> L.	All	Poisoning	No reports
<i>Jussiaea abyssinica</i> (A.Rich) Dandy & Brenan	Cervical	STIs, syphilis, sores of the penis and genitals, lungs	No reports
<i>Sesamum angustifolium</i> (Oliv.) Engl.	All	Dehydration	No reports
<i>Phyllanthus niruri</i> L.	All	-	No reports
<i>Pittosporum mannii</i> Hook.f. subsp. <i>ripicola</i> (J. Leon) Cuf.	Stomach, skin, bone	Poisoning, skin rash	No reports

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Table 2 (continued)

Species name	Reported use in cancer	Other diseases treated	Ethnobotanical studies/uses in cancer (cancer, country, and reference)
<i>Paspalum acuminatum</i> Raddi	All	Abdominal gas, back pain, muscle pain	No reports
<i>Coix lacryma-jobi</i> L.	All		No reports
<i>Pennisetum purpureum</i> Schumach	Lung	BPH, cough	Used for cervical cancer in Uganda (Gumisiriza et al., 2019)
<i>Securida longipedunculata</i> Fresen.,	Internal	-	Used for breast, bone, and brain cancer in Togo and Nigeria (Okunola, 2020; Nguld, 2015; Soladoye, 2010; Kola, 2020)
<i>Prunus africana</i> (Hook.f.) Kalkman	All esp. prostate, bone, and throat	BPH	Used for colorectal, breast, lung, skin, and prostate cancer in Kenya, Uganda, Cameroon, and Ethiopia (Anywar et al., 2020; Ayele, 2018; Gumisiriza et al., 2019; Ochwang'i et al., 2014; Tugume et al., 2016)
<i>Hallea robustipulata</i> (K. Schum.) J.F.Leroy.	Skin	Syphilis, kidney disease, skin wounds	No reports
<i>Zanthoxylum leprieurii</i> Guill & Perr	All esp. skin, uterine	DM, syphilis	No reports
<i>Citropsis articulata</i> (Wild ex Spreng.) Swingle & M.Kellerm	All	Manpower, bone, and back pain	No reports
<i>Citrus limon</i> (L.) Burm.f.	All	-	Used for lung and breast cancer in Togo and Nigeria (Kola et al., 2020)
<i>Citrus sinensis</i> (L.) Osbeck	All, skin	-	Used for neck, breast, head, and face cancer in Morocco and Nigeria (Abubakar et al., 2020; Segun et al., 2018)
<i>Blighia unijugata</i> Baker	All	-	Used for cervical cancer in Uganda (Omara et al., 2020; Tugume et al., 2016)
<i>Solanum nigrum</i> L.	Liver	Ulcers	Used for skin, prostate, cervical, liver, breast, and cancer in Ethiopia, South Africa, and Nigeria (Abebe, 2016; Ayele, 2018; Nduche, 2019; Raimi et al., 2021; Ukwubile et al., 2020)
<i>Solanum abancayense</i> Ochoa	All	-	No reports
<i>Corchorus olitorius</i> L.	All	-	No reports
<i>Fleurya aestuans</i> (L.)	Skin, prostate	BPH	Used for cancer in Nigeria (Ukwubile et al., 2020)
<i>Lippia javanica</i> (Burm.f.) Spreng.	All	-	No reports
<i>Clerodendrum myricoides</i> (Hochst.) Vatke	Skin and internal	Syphilis	No reports
<i>Lantana camara</i> L.	Internal	-	Used for blood, and skin cancer in Nigeria and Zimbabwe (Matowa et al., 2020; Segun et al., 2018)
<i>Cyphostemma adenocaula</i> (A.Rich) Wild. & Drummond	All for pain	HTN, reduces weight, heat in the body or scratching, skin scars, and boils.	Used for cervical cancer in Uganda (Gumisiriza et al., 2019)
<i>Aframomum angustifolium</i> , (Sonn.) K.Schum	Breast, prostate, and intestinal	-	No reports

STI, sexually transmitted infections; All, all types of cancer; DM, diabetes mellitus; HTN, high blood pressure or hypertension; BPH, benign prostatic hypertrophy; UTI, urinary tract infection; HIV, immunodeficiency virus.

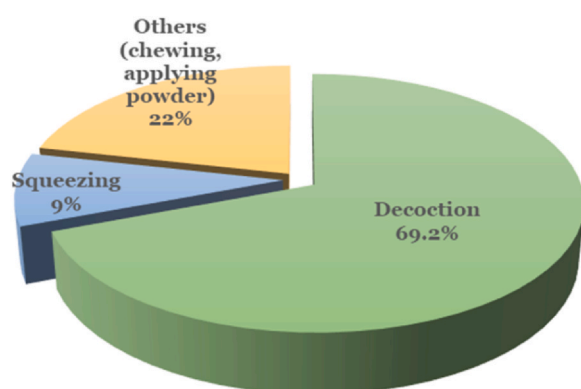


Fig. 4. Modes of preparation.

2019), *V. amygdalina* (Abebe, 2016), *A. coriaria* (Omara et al., 2020), and *A. africanus* (Ayele, 2018). Similar to this study, plants that may serve as nutraceuticals were commonly used by TMPs in Nigeria, Kenya, Togo, Cameroon, and South Africa to manage cancer, including *C. papaya* (Nduche, 2019; Ngoua-Meye-Misso et al., 2019) followed by *O. gratissimum* (Tchoundjeu et al., 2019), *S. nigrum* (Abebe, 2016; Ayele, 2018), and *P. americana* (Ngoua-Meye-Misso et al., 2019).

Some plants used by TMPs in this study to manage cancer (e.g., *A. muricata*, *C. sempervirens*, and *S. nigrum*) may contain anti-cancer properties with promising drug leads. Further exploration of these plants for pharmacological effects in cancer, including previously

unexplored plants, is warranted. Lastly, this study has limitations that may influence the conclusions made in this paper. Using a qualitative approach and a relatively small sample size, the findings of this study may not be generalised to other similar settings in sub-Saharan Africa.

### Conclusion

This study found that most plants used in cancer (N = 121) belonged to Fabaceae, Asteraceae, and Euphorbiaceae families, and were used to treat skin, cervical, prostate, and breast cancer. Fifty-one plant species were recorded as used for cancer management for the first time. Although these plants have the potential to generate anti-cancer medicines, they remain unexplored. More preclinical and clinical research is needed on plants used for cancer. This could start with appreciating and integrating traditional medical and conventional medical practice through frequent interaction. Currently, most medicinal plant research developments in Uganda are shared with the scientific community rather than TMPs; therefore, for patient safety and improvement in TMPs' knowledge, platforms and forums that engage scientists (including healthcare workers) and TMPs at local and national levels are needed to allow cross learning and sharing of scientific evidence on plants used to treat cancer. Such engagement will allow proper identification of documented plants in this study, further documentation of other medicinal plants used by TMPs for cancer and other diseases and demystify spiritual beliefs as often championed by TMPs. Such efforts will advance research by identifying the compounds or metabolites from the documented medicinal plants responsible for apoptotic induction *in vitro* and *in vivo* assays. Research could then be conducted to explore the actions

of the identified compounds (metabolites) on different cancer cell lines before pre-clinical and clinical testing (research) of the compounds. Studies may also explore the effects of some plants on relieving cancer-related symptoms or conventional treatment-related side effects (e.g., pain, vomiting, fever). Because of human activity, TMPs currently obtain their medicine (plants) for cancer care from distant places and some plant species are on the verge of extinction; therefore, research is needed on the conservation of these plant species. Furthermore, providing capital to buy and develop land or skills in medicinal species preservation is paramount.

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### Ethics approval

The Faculty of Medicine Research Ethics Committee (FREC#22/01-2021), Mbarara University of Science and Technology Research Ethics Board (MUREC/7#05/02-21), and The Uganda National Council of Science and Technology (Ref: HS1602ES) approved the study. The National Council of Traditional Healers' Association (NACOTHA) provided clearance to contact TMPs. All TMPs provided consent before participating in this study.

### Author contributions

John Baptist Asimwe participated in proposal writing and funding acquisition, interviewing, visiting the study area, collection of plant specimens, analysis, identification of the collected plant specimen, and manuscript writing. Ivan Kahwa, Clement Olusoji Ajayi, and Lina S. Mathew Alonga supported in interviewing, visiting the study area, and collection of plant specimens, analysis, identification of the collected plant specimen, and manuscript writing. Prakash B. Nagendrappa, Esther C. Atukunda, Maud M. Kamatenesi, Casim Umba Tolo, and Patrick E. Ogwang, assisted in funding acquisition, supervising the study, and manuscript writing and review.

### Declaration of Competing Interest

All the authors declare that they have no established conflicting financial interests or personal relationships that may have influenced the research presented in this paper.

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