Medicinal plants used by herbalists in the treatment of snakebites envenomation in the Acholi, Teso and Karamoja sub-regions of Uganda

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Research

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Abstract

Background

There is high mortality and morbidity due to poisonous snakebites globally, with Sub Saharan African having one of the highest rates. However, Traditional Medicine Practitioners (TMP) have been treating snakebites in Uganda for long. However, few studies have been conducted to document such vital traditional indigenous knowledge before its lost. The aim of this study was to document the medicinal plant species used by experienced TMP in treating snake envenomation in selected post-conflict parts of northern Uganda.

Methods

An ethnopharmacological survey was conducted in Serere, Kaberamaido and Kaabong districts in Uganda. Twenty-five TMP with expertise in treating snakebites were purposively identified using the snowball technique, and interviewed using semi structured questionnaires. Data were analysed using simple descriptive statistics.

Results

Sixty plant species from 28 families were documented with high consensus among the isolated Ik community in Kaabong district. Most of the plant species used belonged to the Asteraceae and Fabaceae families with eight species each. Additionally, the genus *Echinops* was the most well represented with three species. The most commonly used plant species by frequency of citation were: *Steganotaenia araliaceae* (16), *Microglossa pyrifolia* (Lam.) and *Gladiolus dalenii* Van Geel (13), *Aframomum mildbraedii* Loes. (11), *Jasminum schimperi* Vatke, *Cyathula uncinulata* (Schrad) Schinz (10), *Crinum macowanii* Baker and *Cyphostemma cyphopetalum* (Fresen.) Desc. ex Wild & R.B.Drumm (10). *S. araliaceae* which was mentioned by all the TMP in the Ik community was used as first aid. Most of the plant species were harvested from the wild (68.75%) and were herbs (65.0%) and trees (23.3%). The most commonly used plant parts were roots (42.6%) and leaves (25.0%). Thirteen different methods of preparation and administration were used. Most of herbs were administered orally (61.2%), and topically (37.6%). The commonest methods of oral application were cold water infusions (32.5%) and decoctions (21.7%).

Conclusions

TMP widely use several medicinal plant species for treating snakebites envenomation in the selected post-conflict sub-regions of Acholi, Teso and Karamoja in Uganda

1.0 Background

Worldwide, more than five million people suffer snakebite every year leading to 25,000–125,000 deaths, while an estimated 400,000 people are left with permanent disabilities [1]. The World Health Organization (WHO) has classified snakebites as one of the most Neglected Tropical Diseases (NTD) in terms of incidence, severity, and clinical characteristics. This has served as a basis for advocacy for snakebite envenomation [2]. The burden of snake bite envenomation was eventually recognized in June 2017 and then enlisted as a NTD category A by WHO [2, 3].

Snakebite envenoming constitutes a serious medical condition that primarily affects residents of rural communities in Africa, Asia, Latin America and New Guinea [4]. It is an occupational, environmental and domestic health hazard that exacerbates the already impoverished state of these communities [1]. Venoms are mainly toxic modified saliva of poisonous snake. They consist of a complex mixture of enzymes, proteins, non-proteins and metalloproteinases [5]. The most important venom components that cause serious clinical effects are pro-coagulant enzymes, cytolytic or necrotic toxins, haemolytic and myolytic phospholipases A2, pre-synaptic and post-synaptic neurotoxins and haemorrhagins [6]. Broadly there are two types of toxins namely: neurotoxins, which attack the central nervous system and haemotoxins which target the circulatory system and kill victims very first. Snakes

with neurotoxic venom include cobras, mambas, sea snakes, kraits and coral snakes [5]. Snakes with haemotoxic venom include rattlesnakes, copper head and cottonmouths [7]. Snake venoms can be neutralized by antibodies obtained after immunizing domestic animals with them. This led to production of anti-venom called antisera. A major drawback of serum therapy is its prohibitive cost and chance that victims are often some distance away from medical care when bitten [8]. The search for novel venom inhibitors from natural products is therefore relevant because of their potential to complement serum therapy in neutralizing mainly the local damages of envenomation. Plants extracts constitute an excellent alternative with a range of anti-venom activities [7].

Africans have traditionally been treating poisonous snakebites using herbs [9–12]. For instance, 147 patients bitten by snakes were seen between November 1995 and October 1996 and 90% of them used herbs in KwaZulu-Natal, South Africa [13]. In Kenya, 32 medicinal plants have been documented for treatment of snakebites [14, 15]. In central Uganda, 36 plant species were documented for treating snakebites [10]. A total of 25 plants were documented for treatment of snakebites during survey of traditional herbal drugs of Bulamogi county, in Uganda [11]. Five other medicinal plant species were documented for treatment of snakebites in Northern sector of Kibale National Park in Western Uganda [16].

The current population of Uganda is over 45.3 million [17]. More than 80% of Ugandans are involved in agriculture and live in rural areas [18] where making the populace highly vulnerable to snake envenomation without access to antisera in health facilities. There is widespread use of medicinal plants for treatment of snakebites in Uganda although there are no statistics available snakebite treatment generally and the use of herbs to manage them, let alone their efficacy. Additionally, ethnopharmacological surveys of plants used for treatment of snakebites have not been done in many parts of Uganda. The aim of this study was to document the plant species used in the treatment of snakebites envenomation in the Acholi, Teso and Karamoja sub-regions of Uganda. These are post conflict regions were affected during the war led by Joseph Kony's Lord's resistance army rebel (LRA) outfit. The LRA war begun in 1986 and lasted over 18 years [19]. Anecdotal evidence seems to suggest a high prevalence snakebites envenomation experienced by returnees during the post-conflict resettlement in northern Uganda. This is because as many as 2 million people who had fled the fighting were forced into internally displaced people's camps in northern Uganda [20].

2.0 Methods

2.1 Study design and setting

An ethnopharmacological study was conducted in the districts of Soroti in Mukura/Asuret sub-counties (1.7229° N, 33.5280° E), Serere (4994° N, 33.5490° E), Kaberamaido, Anyara sub-county (1.6963° N, 33.2139° E) in the Teso sub region, Kitgum, Namukora & Orom sub-counties (3.3397° N, 33.1689° E, Acholi sub region) and Kaabong, Timu sub-county (3.5126° N, 33.9750° E, Karamoja Sub region) (Fig. 1). The data was collected between August and October 2017 using interviews with semi-structured questionnaires These areas have tropical and savanna type vegetation [21]. The study areas were selected because are recovering from protracted LRA war, they are remote. Additionally, these areas have limited access to modern health facilities with antisera and have been reported to have frequent snakebites [22, 23].

2.2 Characteristics of participants

Traditional medicine practitioners or herbalists with expertise in treating patients bitten by snakes were purposively selected and identified using the snowball technique [24].

2.3 Plant collection & identification

Voucher specimens of the plant species mentioned in the study were collected using standard procedures [25] and taken to Makerere University herbarium for identification. The scientific names of the plant species were identified based on the Kew database at http://www.theplantlist.org accessed on 4th January, 2018 at 18:09 local time. Plant families were verified using the angiosperm phylogeny group IV at http://www.mobot.org/MOBOT/research/APweb/

2.4 Data analysis

The data were analysed using simple descriptive statistics in Microsoft Excel 2019.

3.0 Results

Twenty-five TMP were purposively selected and interviewed. Only five were women, the rest were men. The average age of the respondents was 54.7 years and ranged from 36 to 95 years. The majority of the respondents (80%) were illiterate, with only 20% having attained primary education and were all peasant farmers.

Sixty plant species from 28 families and fifty-one genera were documented. The plant families with most species were Asteraceae (8), Fabaceae (7), Asparagaceae and Amaranthaceae with 4 species each and Euphorbiaceae, Meliaceae and Solanaceae with 3 species each (Table 1). The genus with the most plant species was *Echinops* (3). This was followed by: *Annona*, *Chlorophytum spp*, *Eucalyptus* and *Solanum* with two species each (Table 1).

Table 1
Medicinal Plant species used in the management of snakebites in Acholi, Teso and Karamoja sub-regions of Uganda

Family/Scientific name (Voucher Number)	Local name (Language)	PU	Hb	Mode of preparation & administration	W/D	FM	Documented use in treatment of snakebites envenomation elsewhere
Amaranthaceae							
1. *Cyathula uncinulata* (Schrad) Schinz (ODF 001)	Kulabakak (Ik)	R	H	Apply powder to bite area after making small cuts with razor blade.	W	10	No reports
Amaryllidiaceae							
2. *Allium cepa* L. (ODF 019)	Tungulu (Luo)	Blb	H	Decoction & drink	D	1	Externally applied for treatment of snake bite in Salem district of India [26] & Colombia [27]. Bulbs are chewed for snakebite in eastern and central Uganda [10, 11].
3. *Ammocharis tinneana* (Kotschy & Peyr.) Milne-Redh. & Schweick (ODF 025)	Joda (Luo)	L	H	Decoction & drink	D	1	No reports
4. *Crinum macowanii* Baker (ODF 20)	(Ateso)	B	H	Powdered & mixed with powder of *C. cyphopetalum* & applied topically. Powder also dissolved in & drink.		10	No reports
Annonaceae							
5. *Annona chrysopylla* (ODF 023)	Obolo (Luo)	L, R St	Sh	Decoction. Stems & leaves used for repelling snakes	W	4	No reports

Key: H=Herb, Sh=Shrub, T=Tree, Csh = Creeping shrub, Hb=Habit, PU- Parts Used, L=Leaves, R=Root, B=Blb, S= Stem bark, Sp = Sap, F= Fruit, Bb = Bulb WD= wild/domesticated, * = Local name adapted from English name, FM=Frequency of Mention

Family/Scientific name (Voucher Number)	Local name (Language)	PU	Hb	Mode of preparation & administration	W/D	FM	Documented use in treatment of snakebites envenomation elsewhere
6. *Annona senegalensis* Pers. (ODF 002)	Obolo (Acholi)	R/L	T	Pound & mix with water. Drink once/ chew root & apply on bitten area the next day. Stems barks used to repel snakes	W/D	9	Methanolic leaf extracts inhibited *Echis ocellatus* (Viper) venom activities [28]. Methanol root extract reduced hyperthermia & directly detoxified snake venom by 16–33% in rats against cobra (*Naja nigricotlis nigricotlis*) venom in rats [29].
Apiaceae							
7. *Steganotaenia araliaceae* Hochst. (ODF 003)	Segere (Ik)	L	S	Chew & swallow juice as first aid. Pound leaves, mix with water & wash out the venom from eyes to avert blindness.	W	16	Used in western Kenya for snakebite [14]
Asparagaceae							
8. *Albuca abyssinica* Jacq. (ODF 004)	Amujej (Ateso)	Blb/L	H	Crush leaves/bulbs, mix with water & drink as a purgative /Apply on bitten area/ Planted as a snake repellent	W	3	No reports
9. *Chlorophytum spp* 1 (ODF 022)	Emutungulu akwangan (Ateso)	Tb	H	Pound & apply on snake bite area	D	2	No reports
10. *Chlorophytum spp* 2 (ODF 024)	Eryau (Ateso)	Tb	H	Chew fresh roots	D	2	No reports
11. *Sansevieria trifasciata* Prain (ODF 036)	Tworo (Luo)	L	H	Pound & drink juice. Apply topically	W	3	Snake bites & poison antidote in southern Uganda [30]
Asteraceae							

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Family/Scientific name (Voucher Number)	Local name (Language)	PU	Hb	Mode of preparation & administration	W/D	FM	Documented use in treatment of snakebites envenomation elsewhere
12. *Echinops longifolius* A. Rich. (ODF 011)	Ofilifil (Ik), okeya (Luo)	L	H	Burn to make & apply on bitten site once only/rub directly on bitten part/ Mix 1 tsp with water.	W	9	No reports
13. *Echinops amplexicaulis* Oliv. (ODF 013)	Lukwang (Luo)	R	H	Pound, mix with water & drink once only/ Chew & apply on site the next day	W	3	Used in northern Uganda [31]. A novel crystalline caffeic acid from roots has anti-venom agents for hemolytic snake venoms [32].
14. *Echinops issphaerocephalus* L (ODF 005)	Okeya (Luo)	R	H	Pound, mix with water & drink once only/ Chew & apply on site the next day	W	2	No reports
15. *Erigeron floribundus* (Kunth) Sch.Bip. (ODF 021)	Ejut dolei (Ateso)	L	H	Squeeze juice & drink 3 times a day for at least 3 days	W	3	No reports
16. *Lactuca inermis* Forssk. (ODF 027)	Ekile (Ateso)	R	H	Mix powder with cold water & drink 3 times a day for at least 3 days	W	3	No reports
17. *Microglossa pyrifolia* (Lam.) Kuntze (ODF 006)	Ekiya Lo'emun (Ik), Etutum (Ateso)	R	H	Pound & mix with water & drink for 2 days/Mix powder with cold water & drink 3 times a day for at least 3 days	W	13	Used in Mukono district in central Uganda for snakebite treatment [10, 33]. An infusion is drunk for snakebite [11].
18. *Sigesbeckia orientalis* L. (ODF 035)	Yat twol (Luo)	L	H	Squeeze juice & drink/paste apply topically	W	5	No reports
19. *Vernonia biafrae* Oliv. & Heirn (ODF 030)	Ebwolibwol (Ateso)	R	H	Pound & mix with water & drink as a purgative	W	2	No reports
Colchicaceae							

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Family/Scientific name (Voucher Number)	Local name (Language)	PU	Hb	Mode of preparation & administration	W/D	FM	Documented use in treatment of snakebites envenomation elsewhere
20. *Gloriosa superba* L (ODF 007)	Lobon bong (Ik)	R	H	Powder sometimes mixed with powder of *G. dalenii* for various snake types, spider & scorpion stings.	W/D	8	No reports
Convolvulaceae							
21. *Astripomoe amalvacea* (Klotzsch) A. Meeuse (ODF 008)	Apom (Ateso)	R/St	H	Pound & mix with water & drink once a day for 2–5 day	W	3	A paste from the tuber is applied externally on snake bite wounds [26, 34].
Crassulaceae							
22. *Kalanchoe sp.* (ODF 032)	Ecucuka (Ateso)	L	H	Leave Juice/paste taken orally	W/D	2	No reports
23. *Bryophyllum delagoense* (Eckl. & Zeyh.) Druce (ODF 031)	Omucaga (Ateso)	L	H	Leave Juice/paste taken orally	D	2	No reports
Cucurbitaceae							
24. *Coccinia grandis* (L.) Voigt (ODF 033)	Bomo twol (Luo)	R	H	Decoction	W	2	No reports
Euphorbiaceae							
25. *Euphorbia hirta* L (ODF 029)	Acakacak (Acholi) Orurungo (Ateso)	B	H	Decoction	W	5	Roots eaten for snakebite in central Uganda [10].
26. *Euphorbia hypericifolia* L. (ODF 009)	Loje (Ik)	L	H	Pound/squeeze juice & apply directly to bitten part twice a day for 2 days	W	6	No reports
27. *Euphorbia tirucalli* L. (ODF 028)	Kilajok (Luo)	Sp	H	Drink sap & apply topically	D	2	Western Uganda [16]
Fabaceae							
28. *Canavalia ensiformis* (L) DC. (ODF 026)	Yat twol (Luo)	Sd	H	Chew seeds	D	2	No reports
29. *Glycine max* (L.) Merr. (ODF 037)	Soya (Luo)	Sd	H	Chew seeds	D	1	Seeds used in central Uganda [10].

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Family/Scientific name (Voucher Number)	Local name (Language)	PU	Hb	Mode of preparation & administration	W/D	FM	Documented use in treatment of snakebites envenomation elsewhere
30. *Indigofera arrecta* A.Rich. (ODF 040)	Eragwii (Ateso)	R		Decoction & drink or powder applied topically	W	5	Roots used for snakebites as a poultice [11]. A leaf infusion drunk for snakebites [35]
31. *Indigofera spicata* Forssk. (ODF 038)	Yat twol (Luo)	R, L & S	H	Pound & drink juice & apply topically	W	8	No reports
32. *Lonchocarpus laxiflorus* Guill. & Perr (ODF 059)	Eputon (Ateso)	R	T	Vomiting	W	1	No reports
33. *Piliostigma malabaricum* (Roxb.) Benth. (ODF 046)	Ogali (Luo)	T	L/B	Decoction	W	2	No reports
34. *Tamarindus indica* L.	Chwaa (Luo)	T	Sd	Chew/apply to snake bite area	W/D	7	Seeds are crushed & taken orally as anti-venom [36]. Seeds used for scorpion stings [37]
35. *Senna hirsuta* (L.) H.S.Irwin & Barneby (ODF 050)	Elekumare (Ateso)	R	T	Mix powder with cold water & drink 3 times daily for at least 3 days	W	3	No reports
Iridaceae							
36. *Gladiolus dalenii* Van Geel (ODF 014)	Lodokole (Ik)	B	H	Make small cuts around bitten area & apply powder once/mix powder with water & drink	W	13	Venomous stings & bites in Cameroon [38].
Lamiaceae							
37. *Hoslundia opposita* Vahl (ODF 010)	Etutu/Tutu (Ateso) Itutu (Kumam)	R	Sh	Crush in water & drink/ rub on bitten part/Powder & mix with about ¼ L of warm water & drink twice a day for 3 days	W	5	Root chewed and make poultice for snakebites [11].
Meliaceae							
38. *Azadirachta indica* A.Juss. (ODF 039)	Neem* (Acholi)	F	T	Decoction	D/W	6	A decoction or poultice used in central Uganda [10].

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39. *Pseudocedrela kotschyi* (Schweinf.) Harms (ODF 041)	Ekaka (Ateso)	R	Sh	Apply powder topically/make decoction & drink	W	5	No reports
40. *Toona ciliata* M. Roem. (ODF 012)	Yat bwoc/Yat luu pa coo (Luo)	R	T	Pound, mix with water & drink only once.	W	4	No reports
Moringaceae							
41. *Moringa oleifera* Lam. (ODF 056)	Moringa*	R/B	T	Decoction	D	2	Bark & root juice used in central Uganda [10].
Myrtaceae							
42. *Eucalyptus viminalis* Labill.(ODF 052)	Kalatuc (Luo)	R/L	T	Decoction	D	1	No reports
43. *Eucalyptus spp*. (ODF 053)	Kalatuc (Luo)	L	T	Decoction	D	2	No reports
Musaceae							
44. *Musa spp* (ODF 042)	Amemo (Luo)	L	R	Decoction	D	2	Juice from Musa *balbisiana* &*Musa* × *paradisiaca* in central Uganda [10].
Oleaceae							
45. *Jasminum schimperi* Vatke (ODF 057)	Ederut (Ateso)	R	H	Mix powder with powder from *C. cyphopetalum* & dissolve in water & drink/apply powder topically	W	10	No reports
Opiliaceae							
46. *Opilia amentacea* Roxb. (ODF 054)	Epolokiliok (Ateso)	R	CSh	Apply powder on cuts & also drink	W	1	Root paste is taken internally to cure snake bite by herbalists in India [26].
Pedaliaceae							
47. *Sesamum calycinum* subsp. *angustifolium* (Oliv.) Ihlenf. &Seidenst (ODF 015)	Abal/Emelerait (Ateso), Kilode (Luo)	R	H	Crush in water & drink/ rub juice on bitten part	W	2	No reports
Phyllanthaceae							

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48. *Phyllanthus ovalifolius* Forssk (ODF 043)	Elakas (Ateso)	R	Sh	Powder, mix with cold water & drink 3 times a day for at least 3 days/apply topically	W	3	Root chewed, followed by drinking lots of water to induce vomiting in the management of snakebites in Ethiopia [39]
Poaceae							
49. *Imperata cylindrica* (L.) Raeusch. (ODF 055)	Obiya (Ateso/Luo)	R	H	Chew	W	1	Root chewed for snakebite in eastern Uganda [10, 11].
50. *Sporobolus pyramidalis* P.Beauv. (ODF 001) (ODF 044)	Ajiki (Luo)	L	H	Decoction	W	1	No reports
Rubiaceae							
51. *Gardenia ternifolia* Schumach. & Thonn. (ODF 045)	Ekoroi (Ateso) Odwong (Luo)	R	T	Powder, mix with cold water & drink 3 times a day for at least 3 days/apply topically	W	6	A roots infusion is drunk for snakebite treatment [11].
Rutaceae							
52. *Citrus limon* (L.) Osbeck (ODF 047)	Lemun (Luo)	Fr	T	Squeeze out juice & drink	D	1	The juice is drunk [10].
53. *Zanthoxylum chalybeum Engl.* (ODF 048)	Eusuk (Ateso)	S R		Powder, mix with cold water & drink thrice daily for at least 3 days/apply topically	W	5	No reports
Sapindaceae							
54. *Zanha golungensis* Hiern (ODF 016)	Ekiya Lo'emun (Ateso)	R/St	T	Pound & mix with water & drink twice	W	4	No reports
Solanaceae							
55. *Capsicum annuum* L. (ODF 049)	Kamulari (Luo), Emulalu (Ateso)	F	H	Chew/ Powder, mix with cold water & drink 3 times a day for at least 3 days/apply topically	D	5	No reports

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56. *Solanum giganteum* Jacq. (ODF 017)	Ocok (Luo)	R/L	Sh	Drink ½ cup of decoction/Apply powder to small incisions made around the bite area/ Burn dry leaves & make victim inhale for severe cases & emergencies	W	2	No reports
57. *Solanum incanum* L. (ODF 056)	Ocok (Luo)	S	R	Decoction	W	3	Snakebite treatment in Lira district, northern Uganda [40]& Mukono in central Uganda [10].
Vitaceae							
58. *Cyphostemma adenocaule* (Steud. ex A.Rich.) Desc. ex Wild & R.B.Drumm. (ODF 058)	Anuno (Luo)	R	H	Decoction	W	5	No reports
59. *Cyphostemma cyphopetalum* (Fresen.) Desc. ex Wild & R.B.Drumm (ODF 034)	Anona (Kumam)	R	H	Pound & squeeze out juice& taken orally	W	10	No reports
Zingiberaceae							
60. *Aframomum mildbraedii* Loes. (ODF 018)	Acaet/Asawot (Ateso), Oceyo (Kumam), Ocayo (Luo)	Rh	H	Root juice is drink/Powdered & mixed with *C. cyphopetalum*. powder & water then drink/applied topically.	W	11	No reports
Key: H=Herb, Sh=Shrub, T=Tree, Csh = Creeping shrub, Hb=Habit, PU- Parts Used, L=Leaves, R=Root, B=Blb, S= Stem bark, Sp = Sap, F= Fruit, Bb = Bulb WD= wild/domesticated, * = Local name adapted from English name, FM=Frequency of Mention							

The most commonly mentioned plant species were: *Steganotaenia araliaceae* (16), *Microglossa pyrifolia* and *Gladiolus dalenii* both at 13, *Aframomum mildbraedii* (11), *Jasminum schimperi*, *Cyathula uncinulata*, *Crinum macowanii* and *Cyphostemma cyphopetalum* (10), *Annona senegalensis* (9) *Echinops longifolius* (9), *Gloriosa superba* and *Indigofera spicata* (8) *Tamarindus indica* (7) *S. araliaceae* was mentioned by all the TMP in the Ik community. It was used as first aid and is said to cause immediate vomiting only when used by someone bitten by a venomous snake.

Most of the plant species used were herbs (65.0%), followed by trees (23.3%) and shrubs (11.7%). The most commonly used plant parts were roots (42.6%), leaves (25.0%), stems (10.3%) and bark (7.4%). The least used parts were rhizomes and sap both at 1.5%.

3.1 Medicinal plant preparation & administration

The methods of preparation and administration were grouped into thirteen categories. Most of the herbal medicines were prepared for oral administration (62.5%). The rest were administered topically (32.5%) with the exception of inhalation of smoke from burnt plant material (1.2%). The commonest methods of oral application were cold water infusions (31.8%), decoctions (21.2%) and chewing or squeezing juice from the plant material and drinking it (5.9%). The commonest topical methods of application were poultices (9.4%) and direct application of powders to the bitten site or juice (8.2%), then application of powder to bite area after making small cuts with a razor blade (4.7%). Some of the plant species were used as snake repellents (3.6) and one specie was used for making an eye wash (1.2%) for cases of ocular envenomation by spiting cobras. One herbalist reported burning the plant material and making the patient to inhale the smoke in cases where they were unconscious (1.2%).

In the Ik community in Kaabong district, herdsmen, farmers and hunters usually moved with small quantities of *G. dalenii* powder as a quick remedy in case of being bitten by a poisonous snake. In case of a snakebite, small cuts are made at the site and the powder applied. Generally, the consensus among the TMP was high in the relatively closed and isolated Ik community. Additionally, the medicinal plant species they used were not used by the other communities interviewed elsewhere but only mentioned by the Ik community. These included *G. dalenii, E. longifolius*, *Cyathula uncinulata* and *Steganotaenia araliaceae*.

3.2 Knowledge acquisition and transfer

Most herbalists acquired their knowledge on the use of medicinal plants for snakebite management from their parents and grandparents (80%) other relatives (12%). Two unique cases (8%) involved field observation of self-medication in snakes. In the first case, one herbalist reported that he acquired knowledge on the use of *Microglossa pyrifolia* for treatment of snakebites by observing a snake wounded in a fight with another snake using it and reportedly recovering from its injuries. In the latter case, another herbalist who mainly uses the root of *Opilia amentacea* for all snakebite cases because of its perceived efficacy. The choice of this species was based on its whitish scaly stems which look line the scales of a snake.

3.3 Type of snakebites treated

Cyathula uncinulata, Astripomoe amalvacea, *Kalanchoe sp*. and *Hoslundia opposita* were specifically mentioned as being used for treating puff adder bites. *Euphorbia hypericifolia* was also used for treating scorpion and spider stings. *Microglossa pyrifolia* was used for treating all types of snakebites except puff adder. *Bryophyllum delagoense* and *Steganotaenia araliaceae* were used for treating cobra bites. In addition, *S. araliaceae* was used as first aid for all snakebites. Most of the plant species used are harvested from the wild (68.75%), 24.24% domesticated and 6.25% from both domesticated and wild. Thirty-seven (61.6%) of the documented plant species did not have any previous references about use in snakebite treatment in the literature.

3.4 Unidentified medicinal plant species used

An additional nine plant species were mentioned by the herbalists for treating snakebites envenomation in Kitgum district (Table 2). However, we were not able to collect voucher specimen for these species for identification for several reasons including wild fires that had destroyed some of their habitats, drought, insecurity near the Uganda Sudan boarder and difficulty in locating some of the species because they were naturally rare.

Table 2
Unidentified plant species used for snakebite treatment

Local name (Acholi)	Part used	Habit	Mode of preparation & administration
1. Obokoleb	T	R/B	Decoction
2. Abangabanga	H	Sd	Chew
3. Lalega dyel	S	R	Decoction
4. Acilo	S	R/L	Decoction
5. Amomo	S	R	Decoction
6. Lacer	S	F/L	Decoction / Bath
7. Ngili	H	R	Decoction
8. Te-okwero	S	R	Chew
9. Kokobelle mol	S	L/Sp	Decoction
Key: T = Tree, H = Herb, S = Shrub, R = Root, B = bark, L = leaves, F = Flowers, Sp = Sap			

4.0 Discussion

Even though most herbs were reportedly used singly, most of the herbalists prepared a polyherbal formulations for use. One of the TMP used powder consisting of *Pseudocedrela kotschyi, Gardenia ternifolia, Zanthoxylum chalybeum*, *Indigofera arrecta* and *Capsicum frutescens*.

Although we reported most of the plant species recorded in this study not having any previous documentation for use in snakebite treatment in the literature, some unique cases are presented as follows. We recorded for the first the use of species *Opilia amentacea* in the treatment of snakebite envenomation in Uganda. Interestingly, the same species is used in India for snakebite envenomation [26]. However, in Uganda, the single mention was one renowned traditional healer specialising in treating snakebites commonly known as “Dr. Snake” was associated with doctrine of signatures (DoS) or similarities. The selection of plant species for treatment of particular conditions because of their resemblance to particular organs is not a new concept. This DoS or similarities attributes the therapeutic properties of some plants to particular morphological characters or features they possess, i.e. “like treats like” [41]. This particular herbalist begun using this plant because of the scaly and dotted appearance of its bark and its creeping habit. This is the first report on the doctrine of signatures with *O. amentacea* with reference to snakebite. According to Bennett, [42], the Doctrine of Signatures is found throughout the world and has had a long history of use. He further argues that considering the DoS from the classical morphological perspective has rarely led to the discovery of medicinal plants and the approach is therefore unproductive and largely untestable. The DoS cannot therefore be considered scientific [41, 42], although parts of its utility lies in facilitating the process of understanding the subjective, psychological, and spiritual dimensions of nature [43].

Another interesting observation was the routine use of prayers during healing. One particular healer was observed to always began his plant collection routine in the field with prayers. He prayed to God beseeching him to give the plant species their healing power before he begun harvesting. He professed the catholic faith and attributed his success to his God. This particular healer had a medicinal plant garden and a special treatment room/hut in which he treated his patients. He got official recognition with a certificate from the ministry of culture in Uganda as early as 1986. The citation of prayers by herbalists who profess Christianity during healing rituals has previously been reported in western Uganda [44]. Prayers form an integral part of the belief system and are believed to make the treatment successful.

The transfer of traditional knowledge is by word of mouth. The TMP identify and train particular children on the identification, preparation and administration of the herbs. We report a unique case of self-medication in snakes. This proving an insight into the antivenom potential of *Microglossa pyrifolia*. Although previous studies have reported cases of self-medication especially in primates such as chimpanzees [45, 46] we have not come across previous reports of self-medication in snakes. However,

according to Shurkin, [47] some lizards are believed to survive venomous snake bites by eating roots of particular plants. It is therefore not farfetched to consider self-medication in snakes.

According to the in-charge of Timu health centre II in Kaabong district, there were relatively many reports of snake bites in the Ik community, but there were few cases reporting to the health facility health centre. Even those who reported to the health centre came several days after being bitten by snakes for supportive treatment after initially managing the snakebites with herbs. The health centre also did not have any antisera for treatment of snake bites.

Conclusion

TMP widely use several medicinal plant species for treating snakebites envenomation in the post-conflict sub-regions of Acholi, Teso and Karamoja in Uganda. There is a high consensus by herbalists in the Ik community on different plant species used. Most of the plant species are harvested from the wild, prepared as infusions and used orally. The knowledge on medicinal plant use is transmitted orally.

Declarations

Ethics approval and consent to participate

Ethical approval for the study was obtained from Gulu University research ethic committee (GUREC-003-20) prior to the study, and the Uganda National Council of Science & Technology (UNCST, No. SS 5207). Permission was also obtained from the local authorities to conduct the study in the respective sites. Written prior informed consent was obtained from each of the participants before every interview.

Consent for publication

All participants referred to in this study gave their consent for publication

Availability of data and materials

Supporting data to this article is publicly available in the Mendeley data repository: Data, V2, http://dx.doi.org/10.17632/g788hgn5t2.2

Competing interests

All the authors declare that they have n competing interests

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Authors' contributions

OFD conceptualised the study and wrote the protocol under the guidance of BR, NJ & AG. OFD & AG conducted the ethnopharmacological survey, analysed the data and drafted the manuscript under the supervision of BR & NJ. All authors read and approved the final manuscript.

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References

1. Gutiérrez JM, Warrell DA, Williams DJ, Jensen S, Brown N, Calvete JJ, Harrison RA, Initiative GS. The need for full integration of snakebite envenoming within a global strategy to combat the neglected tropical diseases: the way forward. PLoS Negl Trop Dis. 2013;7:e2162–2.
2. WHO.WHO guidelines. for the production, control and regulation of snake antivenom immunoglobulins. Switzeland: Geneva; 2010.
3. Chippaux J-P. Snakebite envenomation turns again into a neglected tropical disease! J Venom Anim Toxins Incl Trop Dis. 2017;23:38.
4. Warrell DA. WHO. Guidelines for the Prevention and Clinical Management of Snakebite in Afrika. Brazzav: Reg. Off. Africa; 2010.
5. Warrell DA. Snake bite. Lancet. 2010;375:77–88.
6. Gold BS, Wingert WA. Snake venom poisoning in the United States: a review of therapeutic practice. South Med J. 1994;87:579–89.
7. Oliveira CZ, Maiorano VA, Marcussi S, Sant'Ana CD, Januário AH, Lourenço MV, Sampaio SV, França SC, Pereira PS, Soares AM. Anticoagulant and antifibrinogenolytic properties of the aqueous extract from *Bauhinia forficata* against snake venoms. J Ethnopharmacol. 2005;98:213–6.
8. Shah K, Sherstha J, Thapa C. Snakebite management guideline. Kathmandu: Epidemiology and Disease Control Division, Department of Health Services, Zoonoses Control Sub-section, Government of Nepal; 2003.
9. Rajendran K, Shirwaikar A, Mehta M, Bharathi RV. *In vitro* and *in vivo* anti-snake venom (*Daboia russelli*) studies on various leaf extracts of *Acalypha indica* Linn. Int. J. Phytomedicine. 2010; 2.
10. Ntume R, Anywar UG. Ethnopharmacological survey of medicinal plants used in the treatment of snakebites in Central Uganda. Curr Life Sci. 2015;1:6–14.
11. Tabuti JR, Dhillion SS, Lye KA. Traditional medicine in Bulamogi county, Uganda: its practitioners, users and viability. J Ethnopharmacol. 2003;85:119–29.
12. Das K. Medicinal plants for snake bite treatment-future focus. Ethnobot Leafl. 2009;11.
13. Newman WJ, Moran NF, Theakston RDG, Warrell DA, Wilkinson D. Traditional treatments for snake bite in a rural African community. Ann Trop Med Parasitol. 1997;91:967–9.
14. Owuor BO, Mulemi BA, Kokwaro JO. Indigenous snake bite remedies of the Luo of western Kenya. J Ethnobiol. 2005;25:129–41.
15. Owuor BO, Kisangau DP. Kenyan medicinal plants used as antivenin: a comparison of plant usage. J Ethnobiol Ethnomedicine. 2006. .
16. Namukobe J, Kasenene JM, Kiremire BT, Byamukama R, Kamatenesi-Mugisha M, Krief S, Dumontet V, Kabasa JD. Traditional plants used for medicinal purposes by local communities around the Northern sector of Kibale National Park, Uganda. J Ethnopharmacol. 2011;136:236–45.
17. World Population Review. 2020; Accessed 29 March 2020.
18. Anderson J, Learch C, Gardner S. National Survey and Segmentation of Smallholder Households in Uganda. Underst. Their Demand Financ. Agric. Digit. Solut. 2016.
19. Van Acker F. Uganda and the Lord's Resistance Army: The new order no one ordered. Afr Aff (Lond). 2004;103:335–57.
20. Ministry of Health Uganda. WHO Health and mortality survey among internally displaced persons in Gulu, Kitgum and Pader districts, Northern Uganda. Uganda: Kampala; 2005.
21. Thomas AS. The vegetation of the Karamoja district, Uganda: An illustration of biological factors in tropical ecology. J Ecol. 1943; 149–177.

22. Wangoda R, Watmon B, Kisige M. Snakebite management: experiences from Gulu Regional Hospital Uganda. East Cent. African J. Surg. 2004; 9.
23. Nabatanzi V, Kamuli, Mbende. Gulu top in number of snakebites. New Vision,, New Vis. Daily: Ugand's Lead; 2018.
24. Browne K. Snowball sampling: using social networks to research non-heterosexual women. Int J Soc Res Methodol. 2005;8:47–60.
25. Martin GJ. Ethnobotany: A methods manual. London: Hall; 1995.
26. Alagesaboopathi C. Ethnomedicinal plants used for the treatment of snake bites by Malayali tribal's and rural people in Salem district, Tamilnadu, India. Int J Biosci. 2013;3:42–53.
27. Vásquez J, Alarcón JC, Jiménez SL, Jaramillo GI, Gómez-Betancur IC, Rey-Suárez JP, Jaramillo KM, Muñoz DC, Marín DM, Romero JO. Main plants used in traditional medicine for the treatment of snake bites n the regions of the department of Antioquia, Colombia. J Ethnopharmacol. 2015;170:158–66.
28. Emmanuel A, Ebinbin A, Amlabu W. Detoxification of *Echis ocellatus* venom-induced toxicity by *Annona senegalensis* Pers. J Complement Integr Med. 2014;11:93–7.
29. Adzu B, Abubakar MS, Izebe KS, Akumka DD, Gamaniel KS. Effect of Annona senegalensis rootbark extracts on Naja nigricotlis nigricotlis venom in rats. J Ethnopharmacol. 2005;96:507–13.
30. Okello J, Ssegawa P. Plants used by communities of Ngai sub county, Apac District, Northern Uganda. Afr J Ecol. 2007;45:76–83.
31. Kamatenesi MM, Acipa A, Oryem-Origa H. Medicinal plants of Otwal and Ngai Sub Counties in Oyam District, Northern Uganda. J Ethnobiol Ethnomed. 2011;7:7.
32. Agoro JW. Crystalline caffeic acid derivatives and compositions and method for treating snakebite.1978.
33. Hamill FA, Apio S, Mubiru NK, Mosango M, Bukenya-Ziraba R, Maganyi OW, Soejarto DD. Traditional herbal drugs of southern Uganda: Part III: Isolation and methods for physical characterization of bioactive alkanols from *Rubus apetalus*. J Ethnopharmacol. 2003;87:15–9.
34. Samy RP, Thwin MM, Gopalakrishnakone P, Ignacimuthu S. Ethnobotanical survey of folk plants for the treatment of snakebites in Southern part of Tamilnadu, India. J Ethnopharmacol. 2008;115:302–12.
35. Tugume P, Kakudidi EK, Buyinza M, Namaalwa J, Kamatenesi M, Mucunguzi P, Kalema J. Ethnobotanical survey of medicinal plant species used by communities around Mabira Central Forest Reserve, Uganda. J Ethnobiol Ethnomed. 2016;12:1–28.
36. Ushanandini S, Nagaraju S, Harish Kumar K, Vedavathi M, Machiah DK, Kemparaju K, Vishwanath BS, Gowda TV, Girish KS. The anti-snake venom properties of Tamarindus indica (leguminosae) seed extract. Phytother Res. 2006;20:851–8.
37. Anywar G, Oryem-Origa H, Kamatenesi Mugisha M. Wild plants used as nutraceuticals from Nebbi district, Uganda. European J Med Plants. 2014;4:641–60.
38. Ngoupaye GT, Bum EN, Ngah E, Talla E, Moto FCO, Taiwe GS, Rakotonirina A, Rakotonirina SV. The anticonvulsant and sedative effects of *Gladiolus dalenii* extracts in mice. Epilepsy Behav. 2013;28:450–6.
39. d'Avigdor E, Wohlmuth H, Asfaw Z, Awas T. The current status of knowledge of herbal medicine and medicinal plants in Fiche, Ethiopia. J Ethnobiol Ethnomed. 2014;10:38.
40. Oryema C, Bukenya-Ziraba R, Omagor N, Opio A. Medicinal plants of Erute county, Lira district, Uganda with particular reference to their conservation. Afr J Ecol. 2010;48:285–98.
41. Court WE. The doctrine of signatures or similitudes. Trends Pharmacol Sci. 1985;6:225–7.
42. Bennett BC. Doctrine of Signatures: An explanation of medicinal plant discovery or Dissemination of knowledge? Econ Bot. 2007;61:246–55.
43. Richardson-Boedler C. The Doctrine of Signatures: a historical, philosophical, scientific view (II). Br Homeopath J. 2000;89:26–8.
44. Kamatenesi Mugisha M, Asiimwe S, Namutebi A, Borg-Karlson A-K, Kakudidi EK. Ethnobotanical study of indigenous knowledge on medicinal and nutritious plants used to manage opportunistic infections associated with HIV/AIDS in western Uganda. J Ethnopharmacol. 2014;155:194–202.

45. Huffman MA. Chimpanzee self-medication: a historical perspective of the key findings. In: Hosaka K, Zamma K, Nakamura M, Itoh N, editors. Mahale Chimpanzees 50 Years Res. Cambridge: Cambridge University Press; 2015. pp. 340–53.
46. Huffman MA. Current evidence for self-medication in primates: A multidisciplinary perspective. Am J Phys Anthropol. 1997;104:171–200.
47. Shurkin J. News Feature: Animals that self-medicate. Proc Natl Acad Sci. 2014;111:17339–41.

Figures

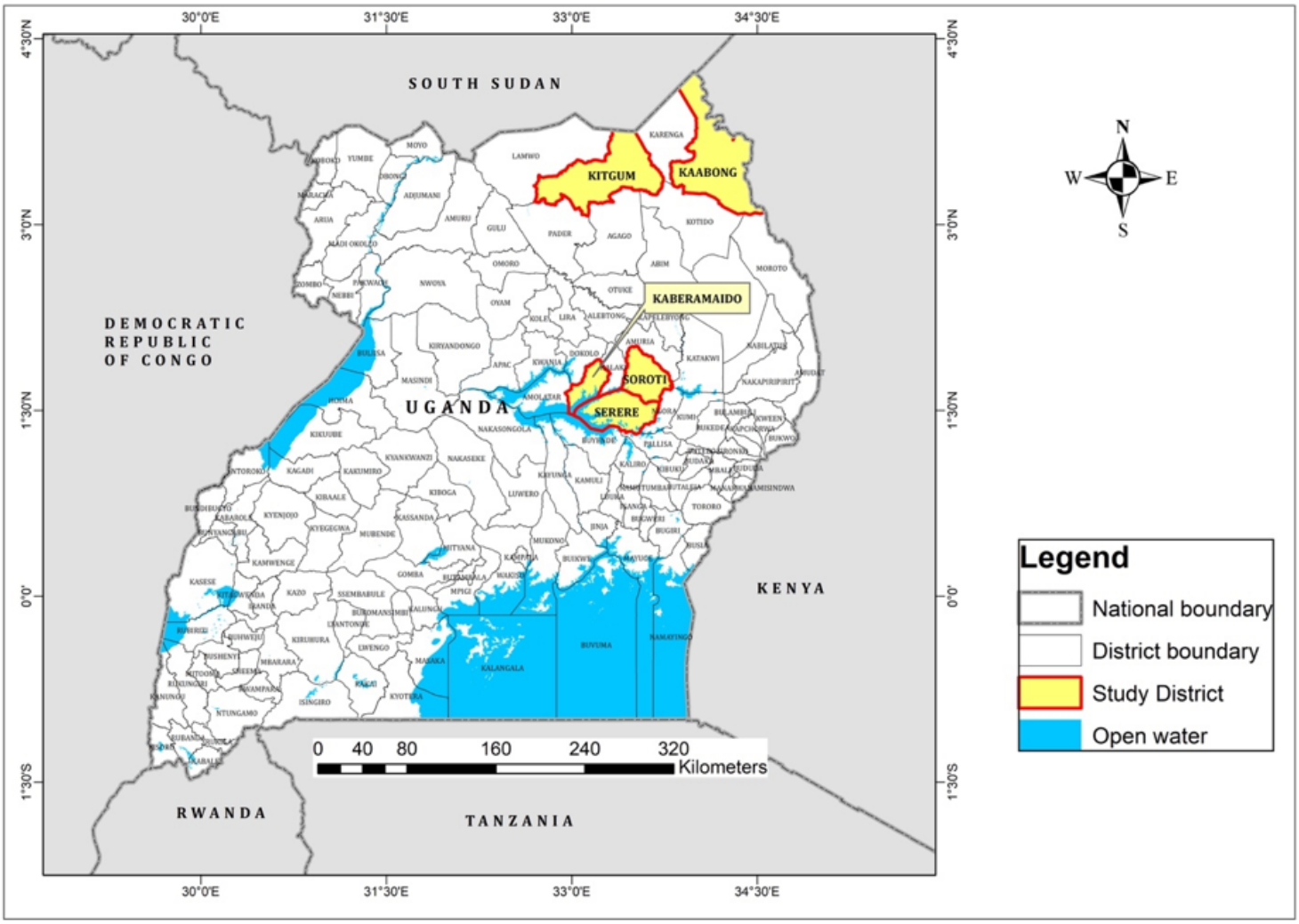

Figure 1

Map of Uganda showing study sites