

Traditional Medicinal vegetables in Northern Uganda. An ethnobotanical survey.

Rebecca Nakaziba (✉ d2rebecca1@gmail.com)

Lira University <https://orcid.org/0000-0002-4361-8594>

Maxson Kenneth Anyolitho

Lira University

Sharon Bright Amanyanya

Lira University

Jasper Ogwal-Okeng

Lira University

Paul E. Alele

Mbarara University of Science and Technology

Research

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Abstract

Background A wide range of indigenous vegetables grow in Uganda especially during rainy seasons but scarcely during droughts, except those that are commercially grown. Although a number of these vegetables have medicinal values, they have not been satisfactorily studied besides conservation. Therefore, we conducted an ethnobotanical cross-sectional survey in Northern Uganda in order to document traditional vegetables and their medicinal values.

Methods An ethnobotanical survey was conducted in Northern Uganda using both qualitative and quantitative data collection approaches to data collection and analysis. Data was collected using semi-structured, interviewer-administered questionnaires following international ethical codes and key informant interviews using well developed key informant guides. A total of 244 individuals participated in the study.

Results The study documented forty five (45) traditional vegetables in Northern Uganda, out of which fifteen (15) also served as folk medicine. These included: Amalakwang (*Hibiscus sabdariffa*), Akeo (*Gynandropsis gynandra*), Alaju (*Asystasia gangetica*), Otigo (*Corchorus* spp.), Ocwica (*Cucubita maxima*), and Bojo (*Vigna unguiculata*) among others. The disease conditions managed using traditional vegetables in the study area included: gastrointestinal, reproductive, musculoskeletal complications as well as non-communicable diseases.

Conclusion Northern Uganda has numerous traditional vegetables with medicinal benefits such as gastrointestinal, reproductive and musculoskeletal abnormalities. The community obtains vegetable leaves from the backyard and stews them for the medicinal purposes. However, there was no specific dosage administered. Therefore, we recommend studies to standardize the dosages and verify in laboratory models the efficacy of these vegetables.

Introduction

Despite the aggressive rivalry from conventional medicines, natural products have remained drugs of choice for some individuals due to their safety and efficacy (1). Individuals prefer to use traditional medicines because of affordability and accessibility; desire for personalized health care and fear for adverse events associated with synthetic drugs (2, 3). Usage also surges when conventional medicines are ineffective in the treatment of diseases such as cancer, and in the face of new infectious diseases (4, 5). Traditional medicines of plant origin are used by about 80% of persons in the developed countries (6, 7). More than 30% of the modern pharmacological drugs have their origin directly or indirectly linked to plants (8, 9). An estimated 25% of the drugs prescribed worldwide are derived from plants (10) and out of the total 252 drugs in the World Health Organization's (WHO) essential medicine list, 11% are exclusively of plant origin (1, 11). Moreover, 80% of 122 plant derived drugs have their uses related to their original ethnopharmacological purposes (12).

Traditional leafy vegetables worldwide are a valuable and cheap source of nutrition for a balanced diet (13). In addition, these vegetables serve as folk medicines (13) for treating conditions such as toothache (*Amaranthus viridis* L.), acute abdominal pain (*Celosia argentea* L.), painful urination (*Portulaca oleracea* L.), headache (*Smithia sensitiva* Ait.) and diarrhea (*C. mimosoides* L.) (13); rheumatism and cough (*Marsilea minuta* Linn), and helminthes infestation (*Spinacia oleracea* Linn.) (14).

In Uganda, traditional vegetables are plant species which are either native or were introduced into the country a while ago and are presently being cultivated and their leaves used as a sauce to the staple foods (15, 16). Diverse species grow in all the geographical regions of the country. However, their level of cultivation and consumption differs depending on the local customs, beliefs, practices and staple foods of the folks as well as soil /climate types (15). Some of these traditional vegetables have been domesticated whereas others grow and are gathered as wild or semi-wild floras (15, 16). Domesticated vegetables are planted in home-based gardens (backyards) with trivial devotion in their production. The production of traditional vegetables is suitable for several families as they grow within a short time period shortly after the start of rains subsequent to dry seasons (15). Further, traditional vegetables are a major source of ascorbic acid and various micronutrients in the diet (16, 17) in Uganda. The vegetables contain: vitamins (A, B, and C); proteins and minerals such as iron, calcium, phosphorus, iodine and fluorine in varying amounts but adequate for normal growth and health (17). According to the FAO Food Balance Sheet for Uganda, traditional food plants supply about 90% energy, 76% protein and 63% fat, and most of vitamins A and C, iron and dietary fiber (15). These food values are vital necessities for normal growth and defense against protein/calorie malnutrition in humans (15). Traditional vegetables ensure a well-balanced diet in rural areas (13). In some cases, parts of traditional vegetable species serve as staple foods such as: the mature fruits of *C. maxima* and the tubers of *C. benghalensis*, *Ipomoea* spp., *M. esculenta* and *S. edule*.

Not only are these traditional vegetables a source of food, they are as well used for medicinal purposes. For example, prevention of blindness especially in children using vitamin A found in all dark green leafy traditional vegetables such as *Amaranthus* (dodo), *Solanum aethiopicum* (Nakati), *Manihotesculenta* (cassava leaves) and *Ipomea batatas* (sweet potato leaves). On the other hand vegetables like *Solanum indicum subsp. distichum* (Katunkuma) are believed to control high blood pressure (17). According to a study carried out at Mwana mugimu Nutrition Services, traditional vegetables were identified as a critical nutritional resource (especially in children) (18). The study suggested that families should make nutritious foods for young babies using locally available foods, including traditional vegetables in the fight against malnutrition (15). In addition, the leaves of *B. pilosa* are used for wounds and boils while the juice for various eye and ear problems and a decoction for rheumatism, stomach disorders and intestinal worms yet the roots for malaria treatment. Other important medicinal traditional vegetables include *C. obtusifolia*, *Celosia argentea*, *C. benghalensis*, *Corchorus* spp., *G. abyssinica*, *Hibiscus* spp., *L. siceraria*, *L. cylindrica*, *S. indicum*, *S. indicum subsp. distichum*, *T. indica* and *Tribulus* spp.(15). Traditional vegetables are also used to obtain various other products such as ornaments, dyes, tobacco and coffee substitutes, pipes, ropes, sacks, mats, containers, ladles, industrial oils including drug sponges, carriers, soil fertilizers and livestock feeds (15).

Whereas these traditional vegetables are easily accessible to the communities and would conveniently and cheaply be used in management of various disease conditions, studies regarding their medicinal uses are scanty in the country. Besides, there is poor and inadequate documentation of the traditional medicinal uses of most of these plants since it is often privately and verbally passed on from one generation to another. This leads to high risk of loss of information about these plants including their medicinal values (19, 20). In this study, we therefore set out to document the traditional vegetables in Northern Uganda with their medicinal uses through an ethnobotanical survey.

Methods

Study site and setting

Data was collected from the Lango sub-region, Northern Uganda. Northern Uganda as a region is divided into 5 sub-regions: Acholi, Karamoja, Lango, West Nile and Teso. There are several ethnic groups in the region such as Acholi, Langi and Ateso tribes. The region has a hot climate and the natives are majorly subsistence farmers. They mostly grow maize, soya beans, simsim, cassava, millet, ground nuts and beans. The residents typically eat starchy foods frequently accompanied by pasted green leafy vegetables of different kinds. They are fond of using plants including vegetables as traditional medicines for disease treatment. For instance, they use *Hibiscus spp* for the treatment of cough and the roots *Gynandropsis gynandra* to facilitate birthing. The northern region of Uganda has 30 districts with a total population of 7,188,139 and a total area of 85,391.7 km² (21).

Study design and sampling

A descriptive mixed method design was employed in the current study. Both quantitative and qualitative approaches of data collection and analysis were used to describe the medicinal uses of traditional vegetables in Northern Uganda in an ethnobotanical survey (22, 23). This was done to enable comprehensive data collection. A multi-stage simple random sampling technique (24) was used to select the units (i.e. sub region, district, sub-counties, parishes and villages) for quantitative data in order to properly portray the study area and be able to generalize the study outcomes. The sample units were selected by listing the names of all units (at each stage) on small pieces of paper which were mixed up. One piece was picked, its name noted down in a book and it was replaced in the pool. The process was repeated until all the units were identified. One sub-region, one district, four sub-counties, 2 parishes per sub-county and 6 villages from each parish and finally 5 households per village were selected. The study participants were selected based on the convenience sampling technique (24) for easy access. A sample size of 246 households (one person per household) was determined following a formula by methodology (25). Of these, five herbalists were selected using purposive and snowball techniques (24) for qualitative data. A total of 244 participants (one person per household) were interviewed.

Ethnobotanical Data Collection

Quantitative and qualitative data was collected using a semi-structured, interviewer-administered, questionnaires (26, 27) and key informant interviews (28) respectively. Interviews were conducted in the local language (Luo) using research assistants who were skilled undergraduates from the region (26). The data collection tool was designed to obtain details regarding the: sub-county, parish and village name; participant bio-data; commonly consumed vegetables (local names); vegetables with medicinal benefits; their therapeutic uses; plant part used; style of preparation; route of administration and quantity used (27). In addition, the participants were requested to mention the medicinal vegetables they most commonly used, the most effective (in their opinion) and the source of information regarding the medicinal value. This information was carefully recorded in the tool during the interviews. The data collection tool was pretested before use (29) to ensure content validity and the questionnaires were properly checked for completeness and correctness before leaving the field following data collection. A total of 244 persons were interviewed. Of these, 239 (165 female and 74 male) were community members while 5 (1 female and 4 males) were known herbalists (key informants). The herbalists were individually interviewed following a key informant interview guide generated for the study (28). The study participants were natives aged 45 years and above except for the key informants whose age was not regarded. Before conducting the interviews, the local area leaders were contacted to obtain permission for the study and informed consent was obtained from each participant. In addition, international ethical codes of conduct were ensured throughout the study (30). Further, the study was approved by Research and Ethics Committee (REC_{MUREC 1/7}) of Mbarara University of Science and Technology as well as the Uganda National Council for Science and Technology (UNCST). The scientific (botanical) names of the vegetables were obtained from previous studies of medicinal plants in the region.

Data analysis

The quantitative study responses obtained from the survey were coded and double entered into SPSS v.20 for a descriptive statistical analysis of frequencies and percentages. This was done in order to assess the significance of the vegetables in the study area. The information was summarized and reported in the form of figures and tables. Data obtained from key informants was grouped into themes and reported as quotations (31). In addition, the participants were tasked to mention the most common and therapeutically effective vegetable. Further, the informant consensus factor (ICF) was calculated to describe the effectiveness of the vegetable for each disease (32, 33) using the formula: $ICF = (n - n_t) / (n - 1)$, where n is the number of individual reports of a plant use for a particular illness while n_t is the total number of species used by all informants for this illness. Furthermore, the fidelity level FL for the 10 commonly used vegetables for medicinal benefits was calculated as follows: $FL = (I_p / I_u) \times 100\%$, where: I_p is the number of informants who suggested the use of a species for the same major use (therapeutic) and I_u is the total number of informants who mentioned the plant species for any use (33).

Results

Participant socio-demographics

A total of 244 participants were involved in the current study. 239 were community members while 5 were herbalists. Majority were aged 45–49 (59.8%); females (68%); 96.3% of the Lango tribe; Roman Catholics (56.9%); of primary level (51.6%) and farmers (91.4%) [Table 1].

Table 1
Participants' Socio-demographics profile

Variable	Description	Frequency	Percentage
Age	45–49 years	146	59.8
	50–54 years	38	15.6
	55–59 years	18	7.4
	60 and above	42	17.2
Gender	Female	166	68.0
	Male	78	32.0
Tribe	Lango	235	96.3
	Acholi	6	2.5
	Alur	1	0.4
	Bantu	2	0.8
Religious affiliation	Anglican	77	31.8
	Roman Catholic	139	56.9
	Moslem	2	0.8
	Pentecostal	25	10.5
	Other	1	0.4
Education level	Informal	77	31.6
	Primary	128	52.5
	Secondary	35	14.3
	Other	4	1.6
Source of income	Subsistence Farming	223	91.4
	Business	12	5.0
	Formal employment	6	2.5
	Other	3	1.2

Traditional Vegetables In Northern Uganda

There were a total of 45 traditional vegetables were documented in Northern Uganda. The list (local names) is provided in Table 2. The scientific names were obtained from previous studies.

Table 2
Traditional vegetables in Northern Uganda

S/N	Local name	Scientific/ family name	Frequency	Percentage
1	Amalakwang	<i>Hibiscus spp</i>	220	92.1
2	Bojo	<i>Vigna unguiculata</i>	225	94.1
3	Alaju	<i>Crotalaria ochroleuca G.Don /Fabaceae</i>	205	85.8
4	Acwica	<i>Cucurbita maxima D/ Cucurbitaceae</i>	190	79.5
5	Otigo	<i>Corchorus spp</i>	231	96.7
6	Birinyanya		10	4.2
7	Tula	<i>S. gilo</i>	12	5
8	Cabbage	<i>Brassica oleracea</i>	107	44.8
9	Nyanya		8	3.3
10	Akeo	<i>Gynandropsis gynandra/ Cleomaceae</i>	202	84.5
11	Ocuga	<i>Solanum americanum Mill. (Solanacea)</i>	67	28
12	Abuga	<i>Amaranthus spp</i>	175	73.2
13	Ocobo		7	2.9
14	Acwere		4	1.7
15	Aminatakara		20	8.4
16	Atiang tiang		9	3.8
17	Awica		90	37.7
18	Abura		25	10.5
19	Ayuu bap	<i>Acalypha bipartite M</i>	47	19.7
20	Opere	<i>Colocasia esculenta</i>	46	19.2
21	Adipakong		47	19.7
22	Burukula		1	0.4
23	Sukuma wiki		16	6.7
24	Agabo		1	0.4
25	Kamalala	<i>Capsicum spp.</i>	17	7.1
26	Apuruk		20	8.4
27	Amola		3	1.3

S/N	Local name	Scientific/ family name	Frequency	Percentage
28	Orono		2	0.8
29	Akukuna		1	0.4
30	Oyado		7	2.9
31	Akorobonyo		2	0.8
32	Cabit		3	1.3
33	Acwewangweno		12	5
34	Pot omogo	<i>Manihot esculenta</i> / <i>Euphorbiaceae</i>	13	5.4
35	Aquin		1	0.4
36	Oboke		1	0.4
37	Opwoo		2	0.8
38	Aconge		3	1.3
39	Ajanjala		1	0.4
40	Awin		1	0.4
41	Abita		1	0.4
42	Nakati	<i>Solanum aethiopicum</i>	5	2.1
43	Odwang		1	0.4
44	Alebe		1	0.4
45	Icok	<i>Ipomoea batatas</i>	1	0.4

(15, 34)

Cultivation Of Traditional Vegetables In Northern Uganda

From our study, most of the common traditional vegetables were cultivated especially in the backyard but the less common ones were obtained from the wild (Fig. 2).

Traditional Medicinal Vegetables In Northern Uganda

A number of traditional vegetables in the current study were used for medicinal benefits as well. The detailed information regarding traditional medicinal vegetables is provided in Table 3.

Table 3
Traditional medicinal Vegetables in Northern Uganda.

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
Amalakwang (<i>Hibiscus spp</i>)	Poor appetite	Leaves	Stewed or Soup drunk; 2x a day or week
	Nausea	Leaves	Stewed without extracting soup 2xdaily
	Low saliva secretion	Leaves	Stewed as above once a week
	Low blood level	Leaves	Stewed (but not pasted for better results) once a day
	Post-partum abdominal pain	Leaves	Stewed once a day
	Low Milk production during lactation	Leaves/ Seeds	Stewed 3x a day for 1 week after delivery while seeds are roasted, ground and eaten 3x a week
	Vitamins	Leaves	Stewed daily
	Oral thrush	Leaves	Stewed 2x a week
	Skin swellings	Leaves	Roasted and Rubbed on the affected part regularly until recovery
	Wounds	Leaves	Roasted/heated and placed on the wound 2x daily until recovery
	Ulcers	Leaves/ seeds	Leaves stewed 2–3 times a week lifelong while seeds are grounded and mixed with other foods regularly
	Body swellings – esp. stomach swellings	Leaves	Mixed with apuruk, boiled and soup drunk 2x a day
	Poor vision	Leaves	Stewed 2x a day
	Mouth sores with pus	Leaves	Rough surface of raw leaves used to scrub sores until cleared
	Cough	Leaves / Roots	Leaves may be stewed or 3–4 raw leaves chewed 2x a day while 2–3 raw roots can also be chewed
Cold, flu	Leaves	Stewed as required	

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
	(stop) cannibalism	Leaves	Boiled together with other herbs and eaten Once a day for 1 week
	Toothache	Leaves	Half boiled and placed on gum as required
	Bone strength	Seeds	Dried, fried, pounded and stewed mixed with other foods
	Painful eyes	Leaves	Crushed to obtain juice and dropped into the eye 2x daily
	Poisoning	Leaves	Boiled – without salt and eaten or soup drunk 3x a day until recovery
Akeo (<i>Gynandropsis gynandra</i>)	Poor appetite	Leaves	Stewed 2x a week
	Bloating	Leaves	Stewed once a week
	Abdominal pain	Root/ Leaves + stem	Raw roots are chewed or pounded, juice extracted and drunk 3x daily for 3days or Roasted, stewed and eaten at the time of pain while raw leaves are chewed or stewed 1-3x a day/ 3x a week; leaves also boiled, soup extracted and drunk 3x a day for 4days
	Ring worm + skin rashes	Leaves	Crushed and applied(rubbed) on the affected area 2-3x a day for 1 week or until recovery
	Improve sexual activity in men	Leaves	Stewed regularly
	Headache (extreme)	Leaves	Pound, tied in a cloth and wrapped around the head for 1 hour twice a day or cooked, soup drained and eaten 3x a week
	Hypertension	Leaves	Stewed for one month
	Eye infection	Leaves	Crushed to obtain juice which is applied to the eye once during infection or 2x a day for 3 days
	Painful eyes	Leaves	Rubbed and placed closer to the eyes for the vapor to enter, 3x a day
	Otitis media	Roots	Pounded, water added, and filtered and dropped in ear 2x a day
Removing blood clots from eyes	Leaves + stem	Stewed alone and eaten 3x a day	

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
	Worm infestation (helminthes)	Leaves	Crushed and the juice rubbed on affected area once a day for 2 weeks
	Visual impairment	Leaves / Roots	Leaves stewed 3x a day/week while roots are pounded, juice extracted and drunk 3x a day
	Malaria	Leaves	Raw leaves chewed 3x a week or boiled, soup extracted and drunk 3x a day for 3 days
	Diabetes	Leaves	Stewed daily
	Peptic ulcers	Leaves	Boiled, soup removed and eaten 3x a day
	Difficulty in delivery	Root	Raw roots chewed once a day
	Prolonged labor	Leaves	Boil, juice extracted, mixed with tea leaves and drunk once
	Removal of placenta after delivery	Leaves + stem + roots	Raw – Washed & crushed to obtain juice and drunk in small quantities frequently
	Postnatal abdominal pain	Leaves + Stem	Stewed, pasted and eaten 3x a day
	Miscarriages	Leaves	Stewed regularly
	Sickle cell	Leaves / Seeds	Leaves stewed and mixed with Avocado while seeds are pounded, water added, juice removed and drunk (~ 150 ml) 3x a day
	Fever – in children	Leaves	Crushed, mixed with water and the child bathed 3x a day
	Scorpion bite	Leaves	Cooked and soup removed and drunk for 3 days
	Toothache	Roots	Crushed to obtain juice which is applied to teeth 2x a day for 3days
Otigo (<i>Corchorus spp</i>)	Joint pain and stiffness	Leaves / Seeds	Leaves stewed (alone for better results) and eaten regularly while seeds are stewed with other foods 2-3x a week lifelong and frequently for HIV patients
	Waist pain during menstruation	Leaves	Stewed (+/- paste) regularly

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
	Prevent bone fracture in case of accident	Leaves	Stewed (+/-other foods) 2x a day
	Joint lubrication & strength	Leaves	Stewed regularly
	Heartburn	Leaves	Raw or stewed (but not pasted) 2x a day
	Poor appetite	Leaves	Stewed, 1–2 a day/week
	Ulcers	Leaves / Seeds	Leaves stewed 2x a day for 2 weeks while Seeds grounded and mixed with other foods/ also as tea 2x a day for 1 week
	Purgation	Leaves/fruits	Stewed 2-3x a day
	Flatulence	Leaves	Stewed regularly
	Fasten fracture healing	Leaves	Cooked + silver fish
	Muscle rigidity (contractures)	Leaves	Stewed 2x daily
	Weak muscles	Leaves	Stewed 3x a day
	Engorged blood vessels	Leaves	Stewed 3x daily
	Constipation	Seeds	Cooked and eaten once after constipation or twice a week
	Malnutrition	Leaves	Stewed and pasted, 2x a day
	Scabies	Leaves	Dried, pounded, mixed with petroleum jelly and applied to the skin 2x a day
	Anemia	Leaves	Stewed regularly
	Rough voice (smoothing)	Leaves/seeds	Stewed 3x a day
	Mental problems	Leaves	Stewed daily
	Poisoning (antipoison)	Leaves	Stewed 2x a week

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
	Sickle cell disease	Leaves	Stewed regularly
	Vision	Leaves/seeds	Stewed daily
	Hemorrhoids	Seeds	Stewed regularly
	Abdominal pain	Leaves	Stewed as required
	Enhance recovery from sickness	Leaves	Stewed alone
	Improve fetal health and ease birthing	Leaves	Stewed alone
	Low immunity esp TB patients	Fruit	Stewed 2x a week
	Painful swallowing, GI obstruction	Leaves	Stewed as required
	Poor digestion	Leaves	As above
Alaju (<i>Crotalaria ochroleuca</i>)	Anemia	Leaves	Stewed regularly
	Malaria	Leaves	A hand full of Raw leaves chewed once a day or leaves are boiled (not pasted) and eaten or soup drunk (children) 2-3x a day for 2-4 days
	Abdominal pain	Leaves	A half of a handful of raw leaves chewed 2x a day or leaves are boiled (+ salt only) 2-3x a day for 1-2days
	Chest pain	Leaves	Stewed daily
	Body aches	Leaves	Stewed without paste daily
	Visual impairment	Leaves	Stewed daily
	Cough	Leaves	Raw leaves chewed 2x daily
	Poor appetite	Leaves	Stewed 1-3x a day
	Ulcers	Leaves	Stewed 2x daily
	Heart burn	Leaves	Stewed regularly

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
	Fever	Leaves	Stewed as required
	Epilepsy	Seeds	Pounded and mixed with other herbs and drunk 2x a day for 3 days
	Headache	Leaves	Stewed (+ salt only) 2x a day frequently
	HIV symptoms	Leaves	Stewed 3x a day, 2x a week life long
	Malnutrition	Leaves	Boiled, soup extracted and drunk 3x during childhood
	Brucella	Leaves	Stewed until recovery
	Eye infections-itching	Leaves	Stewed 2-3x a day
	Hypertension	Leaves	Raw leaves chewed or stewed daily
	Diabetes	Leaves	Raw leaves chewed or stewed daily
Bojo (<i>Vigna unguiculata</i>)	Anemia	Leaves	Stewed regularly
	Low vitamins	Leaves	Stewed 4x a day or raw leaves chewed 2x a day for 2 days or 2x a week
	Poor appetite	Leaves	Raw/stewed 2x a week
	Visual impairment	Leaves	Stewed 4x a week regularly
	Immune boosting	Leaves	Stewed and pasted 2x a day
	General body weakness	Leaves	As above
	(+ Otigo) malaria	Leaves	Stewed together 3x daily for 3 days
	Hernia	Leaves	Stewed with Otigo regularly
	Milk production (lactation)	Leaves	Stewed at least 4x a day
	Cancer ('Alooti')	Leaves	Raw leaves chewed regularly for 3months
	Improve sexual activity in men	Leaves	Stewed

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
	Malaria	Leaves	Stewed 3x a day, 3x a week
	Appendicitis	Leaves	Stewed
	Abdominal aches	Leaves	Raw leave eaten 3x a day for 2 days
	Ulcers	Leaves	Raw leaves chewed 2-3x a day or stewed once a day
	Diabetes	Leaves	Mixed with acacia (Garcia), crushed to extract juice and drunk 2x a month stewed (+ paste) once daily or Raw leaves chopped and eaten daily
Cabbage (<i>Brassica oleracea</i>)	Hemorroides	Leaves	3–4 Raw leaves chewed once daily for 1 week
	Heart burn	Leaves	Stewed regularly
	Cancer	Leaves	Stewed twice a day
	Ulcers	Leaves	Half cooked + ground nuts 3x a daily
	(+ garlic) High blood pressure	Leaves	Raw leaves chewed frequently
	Constipation	Leaves	Raw/ half cooked eaten 2x daily
	Drowsiness	Leaves	Raw/ half cooked eaten 2x daily
	Epilepsy	Leaves	Raw leaves eaten 3x a daily
	Malaria	Leaves	Raw leaves eaten daily
	Sore throat	Leaves	Stewed or raw, eaten 2x a day
	Poor appetite	Leaves	Stewed
Ocwica (<i>Cucurbita maxima</i>)	Malaria	Leaf/ seeds	Leaves stewed while seeds are roasted, coat removed and eaten 3x daily for 3 days
	Improves health during pregnancy	Leaves	Stewed and pasted regularly
	Anemia	Leaves	Stewed daily
	Hepatitis B	Leaves	Stewed (+ salt + red pepper) 2x daily
	(+ cabbage) Coronary artery disease	Leaves	Raw leaves chewed 3X a day as required

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
	Poor vision	Leaves	Stewed, not pasted
	Improve sexual activity in men ('man power')	Leaves / Seeds	Stewed or raw seeds chewed 2x a day
	Appetizer	Leaves /seeds	As above
	Leaves	Stewed daily	
	High blood pressure	Seeds	Uncoated and eaten raw frequently
	Wound healing	Leaves	Stewed
	Urinary tract infections	Leaves	Stewed 2x a day
	Memory enhancement	Fruits/ seeds	Fruit- boiled; seeds – dried, fried, coat removed before eating
	Ring worm	Leaves	Crushed, juice extracted and applied to affected area 3x a day for 1 week
Abuga (<i>Amaranthus spp</i>)	Anemia	Leaves / seeds	Leaves stewed; seeds put in water, add sugar and ~ 300 ml drunk 1–2 x a day
	Poor child growth	Leaves	Stewed
	Poor appetite	Leaves	Stewed 2x a week
	Hepatitis B	Leaves	Stewed 2x daily
	Malnutrition	Leaves	Stewed 2x a week
Awica (scientific name missing)	Malaria (+ alaju)	Leaves	Stewed “+salt only and eaten or soup drunk 2-3x a day for 4 days
	(+ otigo) Fasten healing	Leaves	Stewed
	Ulcers	Leaves	Stewed 2x daily
	Stomach aches	Leaves	Stewed 2x a day; twice a week or full plate 1-2x a day for 4 days or crushed raw to obtain juice and ~ 200 ml drunk 3x a day

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
	Poor appetite	Leaves	Stewed 2x a day
	Anemia	Leaves	Stewed regularly
	Visual impairment	Leaves	Stewed (+ salt only) regularly
	Hypertension	Leaves	As above
	(+ Alaju) HIV symptoms	Leaves	Stewed (+ paste) regularly
	Goiter	Leaves	Crushed, juice extracted and drunk 3x a day for 2 weeks
	Worm infestation	Leaves	Stewed (+ salt only) 2x a week
	Joint pain	Leaves	Stewed 2x a week
Opele (<i>Colocasia esculenta</i>)	Appetizer	Leaves	stewed (+ raw simsim) regularly
Pot kamalara	Pressure	Leaves	Stewed (+ paste) regularly
(<i>Capsicum spp.</i> Red pepper)	Poor Vision	Leaves /Fruit	Leaves stewed regularly; Ripe fruit eaten daily
	Stomach aches	Leaves	Stewed once a week
	Hemorrhoids	Leaves	Stewed regularly
Ocuga (<i>Solarium nigrum L</i>)	Stomach aches	Leaves	Stewed (+ salt only) 2x a day for 4 days or Raw leaves are crushed to obtain juice which is drunk (~ 250 ml) 3x a day
	Peptic ulcers	Leaves	Stewed alone 2x a day
	Skin infections	"	Stewed once daily
	Visual problems	Fruit / Leaves	Ripe fruit eaten once daily for 4 days while leaves are stewed 2x a day
	Malaria	Leaves	Stewed once a day for 3 days
	Eye infection	Leaves / Fruits	Leaves stewed 2x a week lifelong while ripe fruits are eaten regularly
	Weak bones	Leaves	Stewed 2x daily

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
	Immune boosting (prevent infections)	Leaves	Stewed regularly
	(+ Ayuu) malnutrition	Fruit/ Leaves	Ripe fruit eaten regularly while leaves are half cooked and eaten 3x a day until wellbeing
Ayu bap (<i>Acalypha bipartite M</i>)	Tooth decay	Leaves	Raw leaves chewed 2x a day for 4 days
	Skin infections	Leaves	Pounded, allowed to dry and mixed with petroleum jelly and applied to skin daily
	Leprosy	Leaves	As above
	Stomach aches	Leaves	Mixed with alaju and stewed 2x a day
	Diarrhea	Leaves	Stewed and eaten once after diarrhea
	Constipation	Leaves	Stewed once a week
	Facilitate growth in children	Leaves	Stewed regularly
Amola	Diarrhea – esp. in children	Leaves	Roasted and ground to powder and eaten 3x a day
Oyado (<i>Cassia Obtusifolia L</i>)	Diarrhea	Leaves	Stewed (+ paste) 3x a day
	Headache	Leaves	Stewed 3x a week
Jagi (<i>Solarium gilo L</i>)	Stomach aches	Fruits	Raw, eaten in small quantities
Apuruk (<i>Crassocephalum rubens</i>)	Bad oral smell	Leaves	Stewed, soup drained, and eaten once a week
	Weak bones	Leaves	Stewed 2x daily
Adipa-kong	Waist & back pain	Leaves	Crushed and rubbed on affected part regularly for 1 month
	Bone weakness	Leaves	Stewed 2x a day
Aminotakara	Causes abortion	Leaves	Crushed to obtain juice and ~ 500 ml drunk
Nakati (<i>Solanum aethiopicum</i>)	Peptic ulcers	Leaves	Stewed regularly

Vegetable (Local name/ Scientific name)	Diseases treated	Plant part used	Mode of Preparation, Administration and Amount
	Heart burn	Leaves	As above
Ocwere	Diabetes	Fruit	Raw, chewed with salt, 2 fruits a day
	Blurred vision	Fruit	As above

Vegetables Most Often Used For Traditional Medicinal Purposes

A total of 15 vegetables were reported to be used commonly. Their extent of utility is represented in figure iii. The top 5 among the 15 were Otigo, Amalakwang, Alaju, Akeo and Bojo (Fig iii).

Most Effective Medicinal Vegetable

Reports on the most effective medicinal vegetable by the study participants are represented in figure iv. *Corchorus spp* was reported by most of the participants as most effective for its medicinal purposes.

Informant Consensus Factor (ICF)

Using the reports of the study participants, the ICF for the 15 most commonly used traditional medicinal vegetable was calculated. The least ICF value was found to be -7 while the highest was 1 (Table 4).

Table 4

ICF values for the diseases commonly treated by the traditional medicinal vegetables in Northern Uganda.

Vegetable	Condition	No of participants report on condition (n)	Total No of species for condition (nt)	ICF= (n-nt)/(n-1)
Otigo (<i>Corchorus spp</i>)	Heartburn	2	5	-3
	Joint stiffness	67	1	1
	Constipation	14	4	0.77
	Malnutrition	2	4	-2
	Anemia	4	7	-1
	Poor appetite	26	9	0.68
	Mental illness	1	1	0
	Purgation	6	1	1
	Joint pain	14	2	0.92
	Difficulty swallowing	1	1	0
	Poor vision	1	9	0
	Ulcers	6	6	0
	Headache	2	4	-2
	Engorged blood vessels	1	1	0
	Hemorrhoids	1	3	0
	Wounds	1	3	0
	Bone pains	2	1	1
	Child birthing	2	3	-1
	Joint weakness	22	1	1
	Weak bones	7	2	0.83
Fracture prevention	3	1	1	
Malaria	1	8	0	
Amalakwang	Poor appetizer	74	10	0.88
	Wounds	1	2	0
	Cough	5	2	0.75

Vegetable	Condition	No of participants report on condition (n)	Total No of species for condition (nt)	ICF= (n-nt)/(n-1)
	Poison antidote	2	2	0
	Malaria	4	8	-1.33
	Bone weakness	3	2	0.5
	Waist pain	2	3	-1
	Paralysis	1	1	0
	Sickle cell	2	2	0
	Poor lactation	26	1	1
	Anemia	4	7	-1
	Poor vision	4	9	-2
	Postpartum abdominal pain	1	1	0
	Ulcers	5	6	-0.25
	Abdominal swellings	3	1	1
	Alcohol reaction	2	1	1
Alaju (<i>Crotalaria ochroleuca</i>)	Malaria	76	8	0.91
	Headache	2	4	-2
	Bloating	2	1	1
	Joint pain	1	2	0
	Poor appetite	3	10	-3.5
	Anemia	2	7	-5
	Body aches	7	2	0.83
	Improve health	5	2	0.75
	Poor vision	6	9	-0.6
	Abdominal pain	16	8	0.53
	High blood pressure	3	6	-1.5
	Ulcers	9	6	0.38
	Akeo	Malaria	12	8

Vegetable	Condition	No of participants report on condition (n)	Total No of species for condition (nt)	ICF= (n-nt)/(n-1)
	Poor vision	10	9	0.1
	Difficulty in parturition	2	2	0
	Headache	8	4	0.57
	Sickle cell dse	1	2	0
	Constipation	1	4	0
	Man power	1	3	0
	Skin rash	1	2	0
	Poor appetite	11	10	0.1
	Ring worm	21	2	0.95
	Abdominal pain	34	8	0.79
	Poor health	2	3	-1
	High blood pressure	1	6	0
	Eye/ear infection	4	3	0.33
	Worm infestation (helminthes)	3	2	0.5
Bojo	Wounds	2	3	-1
	Headache	1	4	0
	Poor appetite	14	10	0.31
	Poor vision	12	9	0.27
	Anemia	3	7	-2
	Immune boosting	9	4	0.63
	Malaria	10	8	0.22
	Hemorrhoids	2	3	-1
	Diabetes	4	4	0
	Ulcers	7	6	0.17
Acwica	Pregnancy	2	3	-1
	High blood pressure	1	6	0

Vegetable	Condition	No of participants report on condition (n)	Total No of species for condition (nt)	ICF= (n-nt)/(n-1)
	Memory	1	1	0
	Hang over	2	1	1
	Male sexual enhancement (man power)	1	3	0
	Yellow fever	1	1	0
	Promotion of Labor	1	3	0
	Malaria	16	8	0.53
	Anemia	4	7	-1
	Poor appetite	11	10	0.1
	Poor vision	2	9	-7
	Poor health	6	3	0.6
	Ringworm	1	2	0
	Hepatitis B	3	2	0.5
	Abdominal pain	4	8	-1.33
Abuga	Anemia	29	7	0.79
	Appetite	7	10	-0.5
	Hepatitis B	1	2	0
	Abdominal pain	1	8	0
	Malaria	1	8	0
Cabbage	Hemorrhoids	4	3	0.33
	Hemorrhage	1	1	0
	Immune boosting	1	4	0
	Heart burn	5	3	0.5
	Ulcers	26	6	0.8
	Coronary artery disease	1	1	0
	High blood pressure	5	6	0.25

Vegetable	Condition	No of participants report on condition (n)	Total No of species for condition (nt)	ICF= (n-nt)/(n-1)
	Poor appetite	3	10	-3.5
	Cancer	5	1	1
	Constipation	3	4	-0.5
	Goiter	1	1	0

Fidelity Level (FL)

The FL for the traditional medicinal vegetables which treated diseases with ICF values 0.5 and above was also calculated. According to our findings, the fidelity level values ranged from 1.08 to 60.42% (Table 5).

Table 5
Fidelity levels of the most common medicinal vegetables

Vegetable	Condition	No of participants report on condition (lp)	Total No of reports for any use (lu)	FL= (lp/lu)*100
Otigo (<i>Corchorus spp</i>)	Joint pain and stiffness	81	185	43.78
	Constipation	14	185	7.57
	Poor appetite	26	185	14.05
	Purgation	6	185	3.24
	Bone pains	2	185	1.08
	Joint weakness	22	185	11.89
	Weak bones	7	185	3.78
	Fracture prevention	3	185	1.62
Amalakwang	Poor appetite	74	143	51.75
	Cough	5	143	3.50
	Bone weakness	3	143	2.1
	Poor lactation	26	143	18.18
	Abdominal swellings	3	143	2.1
	Alcohol reaction	2	143	1.4
Alaju	Malaria	76	132	57.58
	Bloating	2	132	1.52
	Body aches	7	132	5.30
	Poor health	5	132	3.79
	Abdominal pain	16	132	12.12
Akeo	Difficulty in parturition	2	113	1.77
	Headache	8	113	7.08
	Ring worm	21	113	18.58
	Abdominal pain	34	113	30.09
	Worm infestation (helminthes)	3	113	2.65

Vegetable	Condition	No of participants report on condition (lp)	Total No of reports for any use (lu)	FL= (lp/lu)*100
Bojo	Immune boosting	9	82	10.98
Acwica	Hang over	2	56	3.57
	Malaria	16	56	28.57
	Poor health	6	56	10.7
	Hepatitis B	3	56	5.36
Abuga	Anemia	29	48	60.42
Cabbage	Hemorrhoids	4	56	7.14
	Heart burn	5	56	8.9
	Ulcers	26	56	46.43
	Cancer	5	56	8.93
Awica	Malaria	13	29	44.8

Diseases Treated Per Body Systems

The traditional vegetables were used to treat diseases associated with diverse body systems. Examples include: the digestive system, the reproductive system and the cardiovascular system (Tables 6)

Table 6
Diseases treated by traditional vegetables in Northern Uganda per body system

System	Diseases treated	Traditional vegetables used
Digestive system	Poor appetite, nausea, low saliva production, oral thrush, peptic ulcers, abdominal pain, bloating, flatulence, purgation, heart burn, diarrhea, bad oral smell, constipation, hemorrhoids, sore throat, hernia	Amalakwang, Apuruk, Jagi, Oyado, Nakati, Amola, Ayuu, Ocuga, Kamalara, Opele, Awica, Abuga, ocwica, cabbage, Bojo, Alaju, Otigo, Akeo
Reproductive system	Postpartum abdominal pain, poor lactation, sexual difficulties, prolonged labor, placenta removal, pregnancy, miscarriages,	Ocwica, Bojo, Otigo, Akeo,
Endocrine	Diabetes, goiter	Ocwere, Awica, Bojo, Alaju, Akeo,
Musculoskeletal	Waist and backaches, joint pain and stiffness, joint weakness, bone fractures, muscle rigidity, tooth decay,	Otigo, Adipa-ikong, Otigo, Apuruk, Ayuu, Ocuga, Awica, Bojo, Alaju, Amalakwang
Respiratory	Cough, flu/cold	Alaju, Amalakwang
Renal	Urinary tract infections,	Ocwica,
Cardiovascular	Hypertension, anemia, headache, coronary artery disease, blood vessel engorgement, blood clotting,	Kamalara, Awica, Abuga, Ocwica, Alaju, Cabbage, Bojo, Otigo, Akeo
Nervous	Poor vision, mental illnesses, memory enhancement, drowsiness, epilepsy,	Ocwere, Ocuga, Kamalara, Awica, Ocwica, Cabbage, Bojo, Alaju, Otigo, Akeo, Amalakwang
Integumentary	Skin rashes and infections, leprosy, ring worm, scabies, wounds	Ayuu, Ocwica, Akeo, Otigo, Amalakwang
Others	Malnutrition, growth retardation, eye/ear infections, immune boosting, malaria, helminth infestation, HIV symptoms, Hepatitis B, wound healing, hang over, cancer, Brucella, fever, sickle cell disease, Poisoning, rough voice, scorpion bite	Ayuu, Ocuga, Awica, Akeo, Abuga, Ocwica, Otigo, Cabbage, Bojo, Alaju, Otigo, Amalakwang,

Source Of Information

According to our findings, the study participants obtained information regarding traditional medicinal uses of the vegetables from 1)- Parents/ guardians (166); 2)- Friends (55); 3)- Relatives (33); 4)-Radio (38) and 5)-Neighbor 17). Other sources included experience (32), health worker (19), sensitization (5), church (2) and market (7).

Selected Key Informant Reports

Common medicinal vegetables: usage

A 55 year old female herbalist

"The leaves of Otigo are used for low appetite. You can boil alone or mixed with other vegetables and serve in a juice form. Children, 1 teaspoon three times a day. Over 5 years, 1 table spoon. For adults, you increase the amount. The leaves of Otigo can also be used for difficulty in breathing. Mix with other vegetables but if chopped and put in water it is effective. For the roots, get the root, wash, pound and apply to the joints for joint pain. The roots are curative for hemorrhoids... The roots of Akeo are used to accelerate labor and to deliver stacked placenta. It is boiled and taken when hot. The flowers are used in treatment of allergy. Squeeze and apply drops into the nose".

A 73 year old male herbalist

"Alaju plus abuga to treat malaria; pound and squeeze juice after boiling. Give about a spoonful 3 times a day. The juice can stay for 1 week. Epilepsy mix icuru roots pounded plus apena kulu roots plus itutu roots with yellow flowers then pound. Icuru is very strong so pick small amount and mix and boil. Filter to extract juice. Give half a glass 3 times a day. Give every time the moon is appearing since epilepsy is seasonal. Follow the trends until epilepsy is eliminated".

Discussion

Not only are traditional vegetables useful as food sources, they also provide a wide range of medicinal values. In our study, the participants were required to mention the vegetable, conditions treated, parts used, modes of preparation and administrations and amount. A total of 45 traditional vegetables were documented in our study (Table 2). Out of the 45, fifteen were used as traditional medicines (Table 3). The most mentioned were *Corchorus spp*, *Hibiscus spp*, *Gynandropsis gynandra* and *Crotalaria ochroleuca* and *Corchorus spp*. was reported most effective (Figure iii and iv.). They were used for treating conditions which ranged from gastrointestinal complications such as abdominal pains and oral thrush through reproductive abnormalities like difficulty birthing and male sexual complications to musculoskeletal disturbances such as joint pain and stiffness (Table 3). Meanwhile the most commonly used parts included leaves which were stewed for their medicinal applications and there was no specific dosage for most of the conditions treated (Table 3). Some of the vegetables were administered a number of times per day while others per week or as required (Table 3). The most used traditional medicinal vegetables were often cultivated especially in the backyard (figure ii.). Most of the participants obtained information regarding the medicinal uses of the traditional vegetables from their parent or guardians.

Some of the traditional vegetables documented in the current study relate to earlier findings (15) but many of them are not revealed. The medicinal uses of the commonly used traditional vegetables in the current study relate to other findings as indicated below:

Amalakwang (*Hybiscus spp*) was used for Poor appetite, Nausea, Low saliva secretion, Low blood level, Post-partum abdominal pain, Low Milk production during lactation, Vitamins, Oral thrush, Skin swellings, Wounds, Ulcers, Body swellings –esp. stomach swellings, Poor vision, Mouth sores with pus, Cough, Cold, flu, to stop cannibalism, Toothache, Bone strength, Painful eyes and Poisoning. These findings agree with those of Qi and Aziz (35, 36) in which the plant was found to treat sores and wounds; along with the findings of Mahadevan and Kamali (37, 38) where the plant was found to be useful as an antihelminth, antibacterial and for cough. In addition, Okasha (39) found the plant to be lactogenic which also agrees with the findings of the current study.

Akeo (*Gynandropsis gynandra*) was used in the management of poor appetite, abdominal pain, scorpion bite, ringworm, difficult/prolonged labor, removal of retained placenta, postpartum bleeding, extreme headache, worm infestation, eye/ear infections including removal of blood clots among others. These findings could be explained by the antimicrobial activity of the plant as reported by Ajaiyoeba and Amanirampa (40, 41) where the plant was reported to exhibit antibacterial and antifungal activity. In addition, Scippers and Kamatenesi (42, 43) found the plant useful in migraine headaches, ear infections and abdominal pains coupled to acceleration of labor and reduction of postpartum haemorrhage which as well is in line with the findings of the current study.

Otigo (*Corchorus spp*) was found to strengthen weak joints coupled to improving joint flexibility. It was also found to strengthen bones and thus prevent fracture formation as well enhance fracture healing. This could be attributed to the fact that the plant is rich in calcium as reported by Idris (44) which favors mineralization thus strengthening the bones or due to the antioxidant activity of *C. olitorius* which activates differentiation of osteoblasts, enhance bone mineralization and reduce osteoclast activity (45, 46). In Zimbabwe, the plant is used for backaches (47) which is in agreement with the finding of the current study since the study participants reported using the plant for body aches. However, most of the findings of the current study about *Corchorus spp* are contrary to its uses in other places like Benin where the plant is used for cardiac insufficiency, fever, malaria, female fertility, ulcerations and gastrointestinal problems (48). This could be due to failure to recognize the effects of *C. Olitorius* in these conditions by Ugandans. The plant is reported to be useful as an anti-ulcer; laxative/ purgative in the current study probably due to its richness in fiber (49) and its gastro-protective effects (50, 51)

Alaju (*Crotalaria ochroleuca*) was found by the current study to treat malaria, abdominal pain, ulcers, epilepsy, chest pain, body aches, hypertension, diabetes among others (see Table 2). These findings agree with those of Anywar and Ashuraduzzaman (34, 52) where the plant was found to treat malaria and relieve bronchospasms which could be attributed to the chest pain in the current study. In a study conducted in Nigeria, the plant was found to have antibacterial and antifungal activity(53). This could explain its use for abdominal pains, brucella, cough and fever in the current study.

Boyo (*Vigna unguiculata*) was reported to alleviate poor appetite, abdominal pains, ulcers, visual impairment among other uses in the current study. In a study conducted by Kritzinger and friends, the plant was found to have antimicrobial activity (54) alongside the findings of Gupta (55). These findings

supports the use of the plant for abdominal pains in the current study. In addition, this is a green leafy vegetable rich in vitamin A which is well known for improving sight (56).

Cabbage (*Brassica oleracea*) was used for ulcers, hypertension, malaria, constipation, epilepsy and sore throat. This could be partly explained by the fact that the plant is bioactive (57) and that it possesses antihyperglycaemic properties (58)

Ocwica (*Cucurbita maxima*) was found to improve male sexual activity and fetal health, enhance wound healing, enhance memory and treat hepatitis B and coronary artery disease in the present study. On the contrary, a study by Dubey showed that the plant was used as a remedy for tape worms, as a sedative, a tonic, a diuretic, has anticancer, antidiabetic and hepato-protective activity(59). The plant was found by Solomon and others to have antimicrobial activity(60). This finding justifies the wound healing effect in the current study.

The most frequent plant part used in the current study was the leaves. This was in agreement with other related studies (13, 61, 62).

The informant consensus factor (ICF) for the most commonly used traditional medicinal vegetables ranged from - 3 to 1 (Table4). A variety of vegetables were used for the different ailments which greatly reduced the ICF. For conditions where only a few vegetables were used for management, the resultant ICF was higher. The vegetable and conditions with the highest ICF were Otigo for joint stiffness, joint weakness and pain (ICF = 1); Amalakwang for poor lactation; Alaju for malaria and body aches (ICF > 0.83); Akeo for ringworm and abdominal pain (ICF > 0.75). On the other hand, the fidelity levels (FL) were highest for Abuga (Anemia, 60.4%), Alaju (malaria, 57.6%), Amalakwang (poor appetite, 51.8%), Awica (malaria, 44.8%) and Otigo (joint pain and stiffness, 43.8%) (Table 5). Amaranthus spp is reported to boost blood levels (alleviate anemia) (63); Alaju is reported by Anywar to be an antimalarial agent (34). Hibiscus spp is also reported to be lactogenic (39, 64). These reports support the findings of this study.

List Of Abbreviations

ICF: Informant consensus factor, FL: Fidelity level

Declarations

Ethics approval and consent to participate

The study was approved by the IRB of Mbarara University of Science and Technology

Consent for publication

Not applicable

Availability of data and material

The datasets generated and/or analysed during the current study may be obtained from the corresponding author upon request.

Competing interests

The authors declare that there are no competing interests

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Authors' contributions

NR: Conception of idea, methods, data collection and first manuscript draft; SBA and MKA: research design, data collection and manuscript review; JOK and PA: general oversight and manuscript review

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Figures

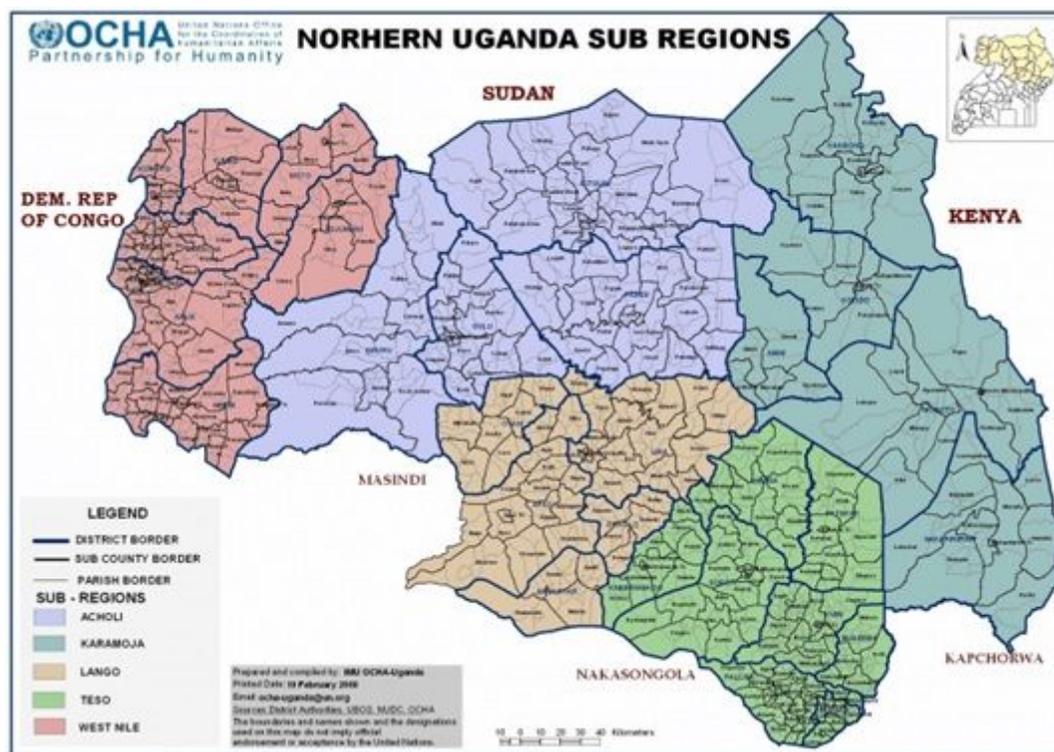


Figure 1

<https://reliefweb.int/map/uganda/northern-uganda-sub-regions> 11/08/2020

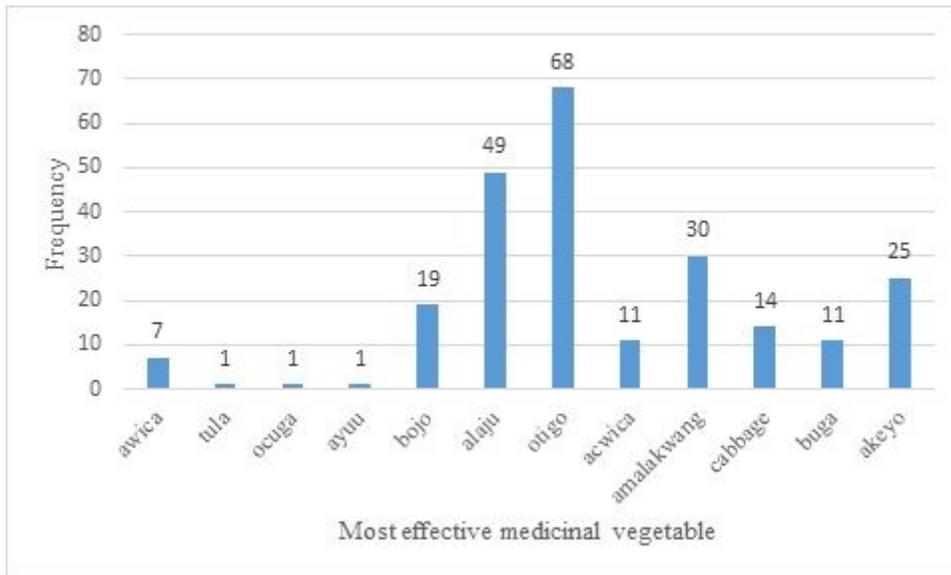


Figure 4

Most effective medicinal vegetable