

Research Article

Traditional Medicinal Vegetables in Northern Uganda: An Ethnobotanical Survey

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Received 25 January 2021; Revised 1 June 2021; Accepted 22 June 2021; Published 15 July 2021

Academic Editor: Severino Matias de Alencar

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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 a cross-sectional ethnobotanical survey in Northern Uganda in order to document traditional medicinal vegetables and their uses. **Methods.** Qualitative and quantitative approaches of data collection and analysis were employed using semistructured, interviewer-administered questionnaires as well as key informant interviews following international ethical codes. Fidelity levels and informant consensus factors were also calculated. **Results.** 13 traditional vegetables belonging to 10 families were reported to serve as folk medicines. The most dominant families were Fabaceae (23.08%) and Solanaceae (15.38%). The most often used vegetables were *Corchorus* spp., *Hibiscus* spp., and *Asystasiagangetica* for musculoskeletal (51%), gastrointestinal (34.3%), and malaria (31.8%). The vegetables were cultivated in the backyard and the leaves stewed for the different ailments. The informant consensus factor was the highest for *Corchorus* spp., in the treatment of joint pain/stiffness (0.92-1) while the highest fidelity level was (60.42%) for *Amaranthus* spp., in the management of anemia. **Conclusions.** Northern Uganda has numerous traditional vegetables with medicinal benefits. Diseases treated range from gastrointestinal to reproductive through musculoskeletal abnormalities. The community obtains vegetable leaves from the backyard and stews them regularly for the medicinal purposes with no specific dosage. Therefore, we recommend studies to verify in laboratory models the efficacy of these vegetables and standardize the dosages.

1. 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 as well as desire for personalized health care coupled to 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] while 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 utterly 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 (*Portulacaoleracea* L.), headache (*Smithiasensitiva* Ait.) and diarrhea (*C. mimosoides* L.) [13] rheumatism and cough (*Marsileaminuta* Linn), and helminthes infestation (*Spinaciaoleracea* 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 folk as well as soil/climate types [15]. Some of these traditional vegetables have been domesticated, whereas others grow and are gathered as wild or semiwild flora [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) and 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), *Solanumaethiopicum* (Nakati), *Manihotesculenta* (cassava leaves), and *Ipomeabatatas* (sweet potato leaves). On the other hand, vegetables like *Solanumindicum* subsp. *distichum* (Katunkuma) are believed to control high blood pressure [17]. 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]. 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]. 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]. Therefore, in this study, we set out to document the traditional vegetables with their medicinal uses in Northern Uganda through an ethnobotanical survey.

2. Methods

2.1. Study Site and Setting. Data was collected from the Lango subregion, Northern Uganda. Northern Uganda as a region is divided into 5 subregions: 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 subsistence farmers. They mostly grow maize, soya beans, simsim, cassava, millet, ground nuts, and beans. The residents typically eat starchy foods that 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 *Cleome 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] (Figure 1).

2.2. Study Design and Sampling. A descriptive mixed method employing both quantitative and qualitative approaches of data collection and analysis was used to describe the traditional medicinal vegetables in Northern Uganda in an ethnobotanical survey [22, 23]. This was done to enable comprehensive data collection. A multistage simple random sampling technique [24] was used to select the units (i.e., subregion, district, subcounties, 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. A piece was picked, its name noted down in a book and replaced in the pool. The process was repeated until all the units were identified. One subregion, one district, four subcounties, 2 parishes per subcounty 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

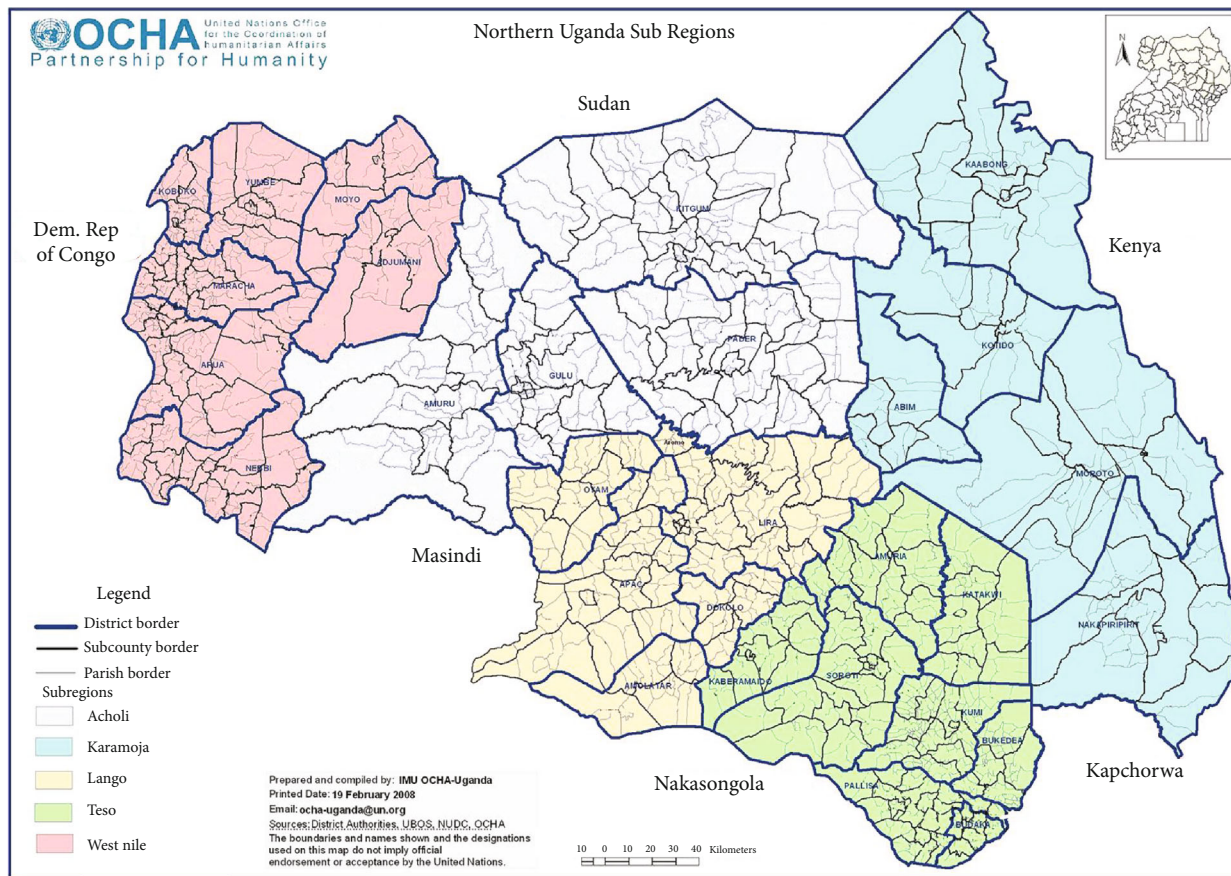


FIGURE 1: Map of Northern Uganda.

a formula by methodology [25]. However, two [2] of the questionnaires were invalid leaving a total of 244 which are reported in this paper. Of these, five herbalists were selected using purposive and snowball techniques [24] for qualitative data.

2.3. Ethnobotanical Data Collection. Quantitative and qualitative data was collected using a semistructured, 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 subcounty, parish, and village name; participant biodata; 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 246 persons were interviewed but during analysis, two were invalid. Therefore, 244 are reported in this paper.

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-HS2589). The scientific names were obtained from previous studies in the study location [15, 31] with some of the samples identified by a botanist at Makerere University, Botany Department.

2.4. 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. Further, the informant consensus factor (ICF) was calculated to describe the effectiveness of the vegetable for each disease

[32, 33] using the formula: $ICF = (n - nt)/(n - 1)$, where n is the number of individual reports of a plant use for a particular illness while nt 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]. There was no major difference between the reports of the key informants and the general community. Therefore, the information obtained from the key informants was incorporated in that of the general community and reported as a whole.

3. Results

3.1. Participant Sociodemographics. A total of 244 participants' responses were valid in the current study. 239 were community members while 5 were herbalists. Majority (59.8%) were aged 45-49; 68% were females; 96.3% belonged to the Lango tribe; 56.9% were Roman Catholics; 51.6% had primary level education; while 91.4% were subsistence farmers [Table 1].

3.2. Traditional Medicinal Vegetables and Their Uses in Northern Uganda. 13 traditional vegetables, namely, *Hibiscus spp*, *Cleome gynandra*, *Corchorus spp*, *Crotalaria ochroleuca*, *Vigna unguiculata*, *Brassica oleracea*, *Cucurbita maxima D*, *Amaranthus spp.*, *Capsicum spp.*, *Solanum nigrum L.*, *Acalypha bipartite M.*, *Cassia obtusifolia L.*, and *Crassocephalum rubens*, were reported as folk medicines. They belonged to 10 families including Malvaceae (7.69%), Cleomaceae (7.69%), Tiliaceae (7.69%), Fabaceae (23.08%), Brassicaceae (7.69%), Cucurbitaceae (7.69%), Amaranthoideae (7.69%), Solanaceae (15.38%), Euphorbiaceae (7.67%), and Asteraceae (7.69%) [Table 2].

3.3. Vegetables Most Often Used for Traditional Medicinal Purposes. Out of the 13 vegetables used for medicinal purposes in the region, the most often used as reported by the participants were *Corchorus spp* (24%), *Hibiscus spp* (17%), and *Crotalaria ochroleuca* (16%) (Figure 2).

3.4. Most Effective Medicinal Vegetables. Reports on the most effective medicinal vegetable by the study participants indicated *Corchorus spp* (Figure 3).

3.5. Plant Part Used and Method of Preparation. For all of the medicinal vegetables, the leaves (>95%) were stewed (>98%). The leaves and/or young shoots are harvested, chopped into small pieces, and boiled. Groundnuts/simsim paste often added. Sometimes, the paste is not added. This is done to improve effectiveness of the vegetable in the disease condition being treated. In most cases, the sauce is eaten as a whole. In some of the conditions, only the soup is drunk. In a few instances, however, raw leaves were chewed, for example, *Acalypha bipartite M* and *Crotalaria ochroleuca* in the treatment of tooth decay (0.8%) and malaria respectively. The roots plus the stem of *Cleome gynandra* were also crushed raw and the juice obtained used in prolonged labor

TABLE 1: Participants' sociodemographic 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 |

and placental expulsion (3.4%). In addition, the leaves of *Hibiscus spp*. were heated and placed on the wounds for healing purposes (0.4%).

3.6. Mode of Administration. The most applied route of administration was oral (99%). For eye/ear infections as well as toothaches, administration was topical (Table 2).

3.7. Cultivation of Medicinal Vegetables in Northern Uganda. Most of the medicinal vegetables in the current study were cultivated in the backyard (Figure 4).

3.8. Informant Consensus Factor (ICF). Using the reports of the study participants, the ICF for the 8 most commonly used traditional medicinal vegetable was calculated in order to highlight species that have healing potential for specific major purposes based on the homogeneity of informant's knowledge. The highest ICF value was 1 for *Corchorus spp*. (joint stiffness), *Hibiscus spp*. (poor lactation), and *Brassica oleracea* (cancer) (Table 3). Values close to 1 indicate a high rate of informant agreement on a plant.

3.9. 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 the findings, the highest fidelity level value was 60.42% (Table 4).

TABLE 2: Traditional medicinal vegetables in Northern Uganda.

| Vegetable (local name/scientific/family name) | Diseases treated | Plant part used | Mode of preparation, administration |
|---|--|--|---|
| Amalakang/ <i>Hibiscus spp</i> /Malvaceae | Poor appetite (31%) | Leaves | Stewed or soup drunk, 2× a day or week |
| | Nausea (0.8%) | Leaves | Stewed without extracting soup 2× daily |
| | Low saliva secretion (0.4%) | Leaves | Stewed as above once a week |
| | Low blood level (1.7%) | Leaves | Stewed (but not pasted for better results) once a day |
| | Sickle cell disease (0.8%) | Leaves | Stewed regularly |
| | Post-partum abdominal pain (0.4%) | Leaves | Stewed once a day |
| | Low milk production during lactation (10.8%) | Leaves/seeds | Stewed 3× a day for 1 week after delivery while seeds are roasted, ground, and eaten 3× a week |
| | Oral thrush (0.8%) | Leaves | Stewed 2× daily for a week |
| | Wounds (0.4%) | Leaves | Roasted/heated and placed on the wound 2× daily until recovery |
| | Malaria (1.7%) | Leaves | Stewed 2× daily for 3 days |
| | Ulcers (2.1%) | Leaves/seeds | Leaves stewed 2-3 times a week lifelong while seeds are grounded and mixed with other foods regularly |
| | Akeo/ <i>Cleome gynandra</i> /Cleomaceae | Body swellings-esp. stomach swellings (1.3%) | Leaves |
| Poor vision (1.7%) | | Leaves | Mixed with apuruk, boiled, and soup drunk 2× a day |
| Mouth sores with pus (0.8%) | | Leaves | Stewed 2× a day |
| Cough (2.1%) | | Leaves/roots | Rough surface of raw leaves used to scrub sores until cleared |
| Cold, flu (0.4%) | | Leaves | Leaves may be stewed or 3-4 raw leaves chewed 2× a day while 2-3 raw roots can also be chewed |
| Cannibalism (0.4%) | | Leaves | Stewed as required |
| Toothache (0.4%) | | Leaves | Boiled together with other herbs and eaten once a day for 1 week |
| Bone strength (1.3%) | | Seeds | Half boiled and placed on gum as required |
| Waist pain (0.8%) | | Leaves | Dried, fried, pounded, and stewed mixed with other foods |
| Painful eyes (0.4%) | | Leaves | Crushed to obtain juice and dropped into the eye 2× daily |
| Poisoning (0.8%) | | Leaves | Boiled-without salt and eaten or soup drunk 3× a day until recovery |
| Akeo/ <i>Cleome gynandra</i> /Cleomaceae | | Poor appetite (4.6%) | Leaves |
| | Bloating (0.4%) | Leaves | Stewed once a week |
| | Abdominal pain (14.2%) | Root/leaves + stem | Raw roots are chewed or pounded, juice extracted, and drunk 3× daily for 3days or roasted, stewed, and eaten at the time of pain while raw leaves are chewed or stewed 1-3× a day/3× a week; leaves also boiled, soup extracted, and drunk 3× a day for 4days |
| | Constipation (0.4%) | Leaves | Stewed regularly |
| | Ring worm+ skin rashes (9.6%) | Leaves | Crushed and applied (rubbed) on the affected area 2-3× a day for 1 week or until recovery |

TABLE 2: Continued.

| Vegetable (local name/scientific/family name) | Diseases treated | Plant part used | Mode of preparation, administration |
|---|--|---------------------|---|
| | Improve sexual activity in men (0.4%) | Leaves | Stewed regularly |
| | Extreme headache (3.3%) | Leaves | Pound, tied in a cloth, and wrapped around the head for 1 hour twice a day or cooked, soup drained, and eaten 3× a week |
| | Hypertension (0.4%) | Leaves | Stewed for one month |
| | Eye infection (1.7%) | Leaves | Crushed to obtain juice which is applied to the eye once during infection or 2× a day for 3 days |
| | Painful eyes (0.4%) | Leaves | Rubbed and placed closer to the eyes for the vapor to enter, 3× a day |
| | Otitis media (0.4%) | Roots | Pounded, water added, and filtered and dropped in ear 2× a day |
| | Removing blood clots from eyes (0.4%) | Leaves+stem | Stewed alone and eaten 3× a day |
| | Worm infestation (1.3%) | Leaves | Crushed and the juice rubbed on affected area once a day for 2 weeks |
| | Visual impairment (4.2%) | Leaves/roots | Leaves stewed 3× a day/week while roots are pounded, juice extracted, and drunk 3× a day |
| | Malaria (5%) | Leaves | Raw leaves chewed 3× a week or boiled, soup extracted, and drunk 3× a day for 3 days |
| | Diabetes (0.4%) | Leaves | Stewed daily |
| | Peptic ulcers (0.8%) | Leaves | Boiled, soup removed, and eaten 3× a day |
| | Difficulty in delivery (0.8%) | Root | Raw roots chewed once a day |
| | Prolonged labor (0.8%) | Leaves | Boil, juice extracted, mixed with tea leaves, and drunk once |
| | Removal of placenta after delivery (0.8%) | Leaves +stem +roots | Raw-washed and crushed to obtain juice and drunk in small quantities frequently |
| | Postpartum abdominal pain (0.5%) | Leaves + stem | Stewed, pasted and eaten 3× a day |
| | Miscarriages (0.4%) | Leaves | Stewed regularly |
| | Sickle cell (0.4%) | Leaves/seeds | Leaves stewed and mixed with avocado while seeds are pounded, water added, juice removed, and drunk (~150 ml) 3× a day |
| | Fever-in children (0.8%) | Leaves | Crushed, mixed with water and the child bathed 3× a day |
| | Scorpion bite (1.6%) | Leaves | Cooked and soup removed and drunk for 3 days |
| | Toothache (0.8%) | Roots | Crushed to obtain juice which is applied to teeth 2× a day for 3days |
| | Joint pain and stiffness (33.9%) | Leaves/seeds | Leaves stewed (alone for better results) and eaten regularly while seeds are stewed with other foods 2-3× a week lifelong and frequently for HIV patients |
| Otigo/ <i>Corchorus spp/Tiliaceae</i> | Waist pain during menstruation (0.4%) | Leaves | Stewed (+/- paste) regularly |
| | Prevent bone fracture in case of accident (1.3%) | Leaves | Stewed (+/-other foods) 2× a day |

TABLE 2: Continued.

| Vegetable (local name/scientific/family name) | Diseases treated | Plant part used | Mode of preparation, administration |
|---|---|-----------------|--|
| | Joint lubrication and strength (9.2%) | Leaves | Stewed regularly |
| | Heartburn (0.8%) | Leaves | Raw or stewed (but not pasted) 2× a day |
| | Poor appetite (10.9%) | Leaves | Stewed, 1-2 a day/week |
| | Ulcers (2.5%) | Leaves/seeds | Leaves stewed 2× a day for 2 weeks while seeds ground and mixed with other foods/also as tea 2× a day for 1 week |
| | Purgation (2.5%) | Leaves/fruits | Stewed 2-3× a day |
| | Flatulence (0.4%) | Leaves | Stewed regularly |
| | Bone pains (3.7%) | | |
| | Fasten fracture healing (1.3%) | Leaves | Cooked + silver fish |
| | Muscle rigidity (contractures) (0.8%) | Leaves | Stewed 2× daily |
| | Weak muscles (0.4%) | Leaves | Stewed 3× a day |
| | Engorged blood vessels (0.4%) | Leaves | Stewed 3× daily |
| | Constipation (5.9%) | Seeds | Cooked and eaten once after constipation or twice a week |
| | Malnutrition (0.8%) | Leaves | Stewed and pasted, 2× a day |
| | Scabies (0.8%) | Leaves | Dried, pounded, mixed with petroleum jelly, and applied to the skin 2× a day |
| | Anemia (1.7%) | Leaves | Stewed regularly |
| | Rough voice (smoothing) (0.4%) | Leaves/seeds | Stewed 3× a day |
| | Mental problems (0.4%) | Leaves | Stewed daily |
| | Poisoning (0.4%) | Leaves | Stewed 2× a week |
| | Sickle cell disease (0.4%) | Leaves | Stewed regularly |
| | Vision (0.4%) | Leaves/seeds | Stewed daily |
| | Hemorrhoids (0.4%) | Seeds | Stewed regularly |
| | Abdominal pain (0.4%) | Leaves | Stewed as required |
| | Enhance recovery from sickness (0.4%) | Leaves | Stewed alone |
| | Improve fetal health and ease birthing (0.8%) | Leaves | Stewed alone |
| | Low immunity esp TB patients (0.4%) | Fruit | Stewed 2× a week |
| | Painful swallowing, GI obstruction (0.4%) | Leaves | Stewed as required |
| | Poor digestion (0.8%) | Leaves | Stewed regularly |

TABLE 2: Continued.

| Vegetable (local name/scientific/family name) | Diseases treated | Plant part used | Mode of preparation, administration |
|---|---------------------------------------|-----------------------------------|---|
| Alaju/ <i>Crotalaria ochroleuca</i> /Fabaceae | Anemia (0.8%) | Leaves | Stewed regularly |
| | Malaria (31.8%) | Leaves | A hand full of raw leaves chewed once a day, or leaves are boiled (not pasted) and eaten or soup drunk (children) 2-3× a day for 2-4 days |
| | Abdominal pain (6.7%) | Leaves | A half of a handful of raw leaves chewed 2× a day or leaves are boiled (+ salt only) 2-3× a day for 1-2 days |
| | Chest pain (0.4%) | Leaves | Stewed daily |
| | Body aches (2.9%) | Leaves | Stewed without paste daily |
| | Visual impairment (2.5%) | Leaves | Stewed daily |
| | Cough (0.8%) | Leaves | Raw leaves chewed 2× daily |
| | Poor appetite (1.3%) | Leaves | Stewed 1-3× a day |
| | Ulcers (3.8%) | Leaves | Stewed 2× daily |
| | Heart burn (0.8%) | Leaves | Stewed regularly |
| | Fever (0.8%) | Leaves | Stewed as required |
| | Epilepsy (0.4%) | Seeds | Pounded and mixed with other herbs and drunk 2× a day for 3 days |
| | Headache (0.8%) | Leaves | Stewed (+ salt only) 2× a day frequently |
| | HIV symptoms (1.6%) | Leaves | Stewed 3× a day, 2× a week life long |
| | Malnutrition (1.3%) | Leaves | Boiled, soup extracted and drunk 3× during childhood |
| | Brucella (0.4%) | Leaves | Stewed until recovery |
| Eye infections-itching (0.8%) | Leaves | Stewed 2-3× a day | |
| Hypertension (1.3%) | Leaves | Raw leaves chewed or stewed daily | |
| Diabetes (0.8%) | Leaves | Raw leaves chewed or stewed daily | |
| Bojo/ <i>Vigna unguiculata</i> /Fabaceae | Anemia (1.3%) | Leaves | Stewed regularly |
| | Low vitamins (7.9%) | Leaves | Stewed 4× a day or raw leaves chewed 2× a day for 2 days or 2× a week |
| | Poor appetite (5.9%) | Leaves | Raw/stewed 2× a week |
| | Visual impairment (5%) | Leaves | Stewed 4× a week regularly |
| | Immune boosting (3.8%) | Leaves | Stewed and pasted 2× a day |
| | General body weakness (0.4%) | Leaves | As above |
| | Hernia (0.4%) | Leaves | Stewed with Otigo regularly |
| | Poorlactation (1.6%) | Leaves | Stewed at least 4× a day |
| | Cancer (0.4%) | Leaves | Raw leaves chewed regularly for 3 months |
| | Improve sexual activity in men (1.6%) | Leaves | Stewed |

TABLE 2: Continued.

| Vegetable (local name/scientific/family name) | Diseases treated | Plant part used | Mode of preparation, administration |
|---|---|-----------------|---|
| | Malaria (4.2%) | Leaves | Stewed 3 × a day, 3 × a week |
| | Appendicitis (0.4%) | Leaves | Stewed regularly |
| | Abdominal aches (0.4%) | Leaves | Raw leave eaten 3 × a day for 2 days |
| | Ulcers (2.9%) | Leaves | Raw leaves chewed 2-3 × a day or stewed once a day |
| | Wounds (0.8%) | Leaves | Crushed and applied to the wound |
| | Diabetes (1.7%) | Leaves | Mixed with acacia (Garcia), crushed to extract juice, and drunk 2 × a month stewed (+ paste) once daily or raw leaves chopped and eaten daily |
| | Hemorrhoids (1.7%) | Leaves | 3-4 raw leaves chewed once daily for 1 week |
| | Heart burn (2.1%) | Leaves | Stewed regularly |
| | Cancer (2.1%) | Leaves | Stewed twice a day |
| | Ulcers (10.9%) | Leaves | Half cooked + ground nuts 3 × a daily |
| | High blood pressure (+garlic) (2.1%) | Leaves | Raw leaves chewed frequently |
| | Constipation (1.3%) | Leaves | Raw/half cooked eaten 2x daily |
| | Drowsiness (0.8%) | Leaves | Raw/half cooked eaten 2 × daily |
| | Epilepsy (0.4%) | Leaves | Raw leaves eaten 3 × a daily |
| | Malaria (0.4%) | Leaves | Raw leaves eaten as required |
| | Sore throat (0.8%) | Leaves | Stewed or raw, eaten 2 × a day |
| | Poor appetite (1.3%) | Leaves | Stewed |
| <i>Kabici/Brassica oleracea/Brassicaceae</i> | Malaria (6.7%) | Leaf/seeds | Leaves stewed while seeds are roasted, coat removed, and eaten 3 × daily for 3 days |
| | Improves health during pregnancy (0.8%) | Leaves | Stewed and pasted regularly |
| | Abdominal pain (1.7%) | Leaves | Stewed daily |
| | Hepatitis B (1.3%) | Leaves | Stewed (+ salt+ red pepper) 2 × daily |
| | (+cabbage) coronary artery disease (0.4%) | Leaves | Raw leaves chewed 3 × a day as required |
| | Poor vision (0.8%) | Leaves | Stewed, not pasted |
| | Improve sexual activity in men (0.8%) | Leaves/seeds | Stewed or raw seeds chewed 2 × a day |
| | Poor appetite (4.6%) | Leaves/seeds | Stewed regularly |
| | High blood pressure (1.7%) | Seeds | Uncoated and eaten raw frequently |
| | Immune boosting (2.5%) | Leaves | Stewed |
| | Urinary tract infections (0.4%) | Leaves | Stewed 2 × a day |
| <i>Ocwica/Cucurbita maxima/Cucurbitaceae</i> | | | |

TABLE 2: Continued.

| Vegetable (local name/scientific/family name) | Diseases treated | Plant part used | Mode of preparation, administration |
|---|--------------------------------------|-----------------|---|
| | Memory enhancement (0.4%) | Fruits/seeds | Fruit-boiled and seeds-dried, fried, and coat removed before eating |
| | Ring worm (0.4%) | Leaves | Crushed, juice extracted, and applied to affected area 3× a day for 1 week |
| | Anemia (12.1%) | Leaves/seeds | Leaves stewed, seeds put in water, add sugar, and ~300 ml drunk 1-2× a day |
| | Poor child growth (0.4%) | Leaves | Stewed |
| | Poor appetite (7.1%) | Leaves | Stewed 2× a week |
| | Hepatitis B (0.4%) | Leaves | Stewed 2× daily |
| | Malnutrition (0.4%) | Leaves | Stewed 2× a week |
| | Hypertension (0.8%) | Leaves | Stewed (+ paste) regularly |
| | Poor vision (0.8%) | Leaves/fruit | Leaves stewed regularly; ripe fruit eaten daily |
| | Stomach aches (1.6%) | Leaves | Stewed once a week |
| | Hemorrhoids (0.4%) | Leaves | Stewed regularly |
| | Stomach aches (1.7%) | Leaves | Stewed (+salt only) 2× a day for 4 days or raw leaves are crushed to obtain juice which is drunk (~250 ml) 3× a day |
| | Peptic ulcers (0.8%) | Leaves | Stewed alone 2× a day |
| | Skin infections (0.4%) | Leaves | Stewed once daily |
| | Visual problems (1.7%) | Fruit/leaves | Ripe fruit eaten once daily for 4 days while leaves are stewed 2× a day |
| | Malaria (2.1%) | Leaves | Stewed once a day for 3 days |
| | Eye infection (0.4%) | Leaves/fruits | Leaves stewed 2× a week lifelong while ripe fruits are eaten regularly |
| | Weak bones (0.8%) | Leaves | Stewed 2× daily |
| | Immune boosting (0.4%) | Leaves | Stewed regularly |
| | (+Ayyu) malnutrition (0.8%) | Fruit/leaves | Ripe fruit eaten regularly while leaves are half cooked and eaten 3× a day until wellbeing |
| | Tooth decay (0.8%) | Leaves | Raw leaves chewed 2× a day for 4 days |
| | Skin infections (0.4%) | Leaves | Pounded, allowed to dry and mixed with petroleum jelly, and applied to skin daily |
| | Leptosy (0.4%) | Leaves | As above |
| | Stomach aches (0.4%) | Leaves | Mixed with alaju and stewed 2× a day |
| | Diarrhea (1.3%) | Leaves | Stewed and eaten once after diarrhea |
| | Constipation (0.4%) | Leaves | Stewed once a week |
| | Facilitate growth in children (0.8%) | Leaves | Stewed regularly |

TABLE 2: Continued.

| Vegetable (local name/scientific/family name) | Diseases treated | Plant part used | Mode of preparation, administration |
|--|--|------------------|---|
| Oyado/ <i>Cassia Obtusifolia</i> L./Fabaceae | Diarrhea (0.4%) Headache (0.4%) | Leaves Leaves | Stewed (+paste) 3 × a day Stewed 3 × a week |
| Apuruk/ <i>Crassocephalumubens</i> /Asteraceae | Bad oral smell (0.4%) Weak bones (0.4%) | Leaves Leaves | Stewed, soup drained, and eaten once a week Stewed 2 × daily |

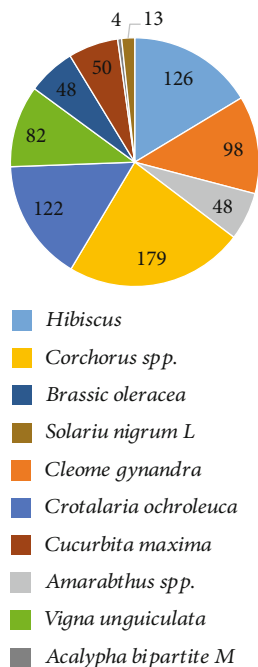


FIGURE 2: Vegetables most often used for medicinal purposes.

4. Diseases Treated per Body Systems

The traditional medicinal vegetables were used to treat diseases associated with diverse body systems. The disease treated was categorized into 10 categories as indicated in Table 5.

4.1. Source of Information. According to our findings, the study participants obtained information regarding traditional medicinal uses of the vegetables from (1) parents/guardians (69.5%), (2) friends (23%), (3) relatives (13.8%), (4) Radio (15.9%), and (5) neighbor (7.1%). Other sources included experience (13.4%), church (0.8%), and market (2.9%).

5. Discussion

Not only are traditional vegetables useful as food sources, they also provide a wide range of medicinal benefits. In our study, the participants were required to mention the vegetable, conditions treated, parts used, modes of preparation and administrations, and amount. 13 vegetables were reported to be used as traditional medicines (Table 2). The most mentioned were *Corchorus spp.* (77.4%), *Hibiscus spp.* (59.8%), *Cleome gynandra* (47.3%), and *Crotalaria ochroleuca* (55.2%). *Corchorus spp.* was reported the most effective in this study (Figure 3). 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 2). Meanwhile, the most commonly used parts included leaves which were stewed for the medicinal applications with no specific dosage for most of the conditions treated (Table 2). Some of the vegetables were administered a number of times per day while others per week or as required (Table 2). The most com-

monly used and effective traditional medicinal vegetables were often cultivated especially in the backyard (Figure 4). Most of the participants obtained information regarding the medicinal uses of the traditional vegetables from their parents or guardians. Some of the traditional vegetables' medicinal applications documented in the current study relate to earlier findings [15] but a number of them do not. For instance, *Hibiscus spp.* was used for poor appetite, nausea, low saliva secretion, anemia, postpartum abdominal pain, poor lactation, oral thrush, skin swellings, wounds, ulcers, body swellings –esp. stomach swellings, poor vision, mouth sores with pus, cough, cold, flu, toothache, bone strength, painful eyes, and poisoning in the current study. These findings agree with those of Qi and Aziz [34, 35] in which the plant was found to treat sores and wounds, along with the findings of Mahadevan and Kamali [36, 37] where the plant was found to be useful as an antihelminth, antibacterial, and for cough. In addition, *Hibiscus spp.* is reported to be lactogenic [38, 39], in agreement with the current study. *Cleome 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, and eye/ear infections including removal of blood clots. These findings could be explained by the antimicrobial activity of the plant as reported by Ajayiyeoba and Amanirampa [40, 41] where the plant was reported to exhibit antibacterial and antifungal activity. In addition, Scippers and Kamatenesi [42, 43] found *Cleome gynandra* useful in migraine headaches, ear infections, and abdominal pains coupled to acceleration of labor and reduction of postpartum hemorrhage just as the current study findings. *Corchorus spp.* was used to treat joint pain and stiffness as well as weak joints. It was also found to strengthen bones and thus prevent fractures 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 the plant which activates differentiation of osteoblasts, enhances bone mineralization, and reduces osteoclast activity [45, 46]. In Zimbabwe, *Corchorus spp.* is used for backaches [47] which is in agreement with the current study findings since the study participants reported using the plant for body aches. On the contrary, *Corchorus spp.* is used in Benin for cardiac insufficiency, fever, malaria, female fertility, ulcerations, and gastrointestinal problems [48]. The plant was also reported to be useful as an antiulcer, laxative/purgative in the current study probably due to its richness in fiber [49], and its gastroprotective effects [50, 51]. *Crotalaria ochroleuca* was found by the current study to treat malaria, abdominal pain, ulcers, epilepsy, chest pain, body aches, hypertension, and diabetes (Table 2). These findings agree with those of Anywar and Ashuraduzzaman [31, 52] where the plant was found to treat malaria and relieve bronchospasms which could be responsible for the chest pain in the current study. According to 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. *Vigna unguiculata* was reported to alleviate poor appetite, abdominal pains, ulcers, and visual impairment in the current study. The

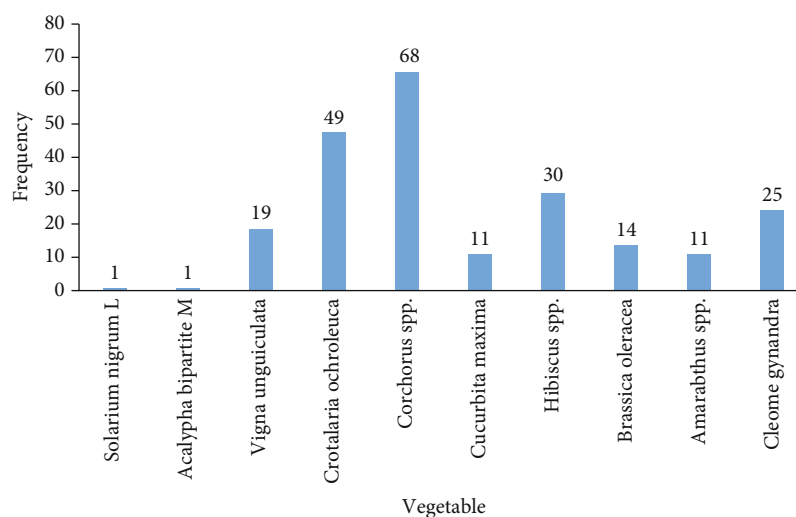


FIGURE 3: The most effective medicinal vegetables in Northern Uganda.

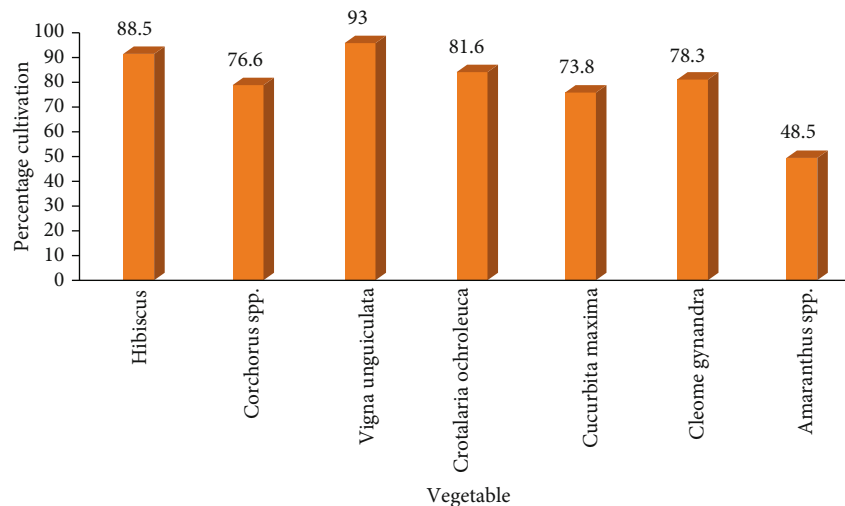


FIGURE 4: Cultivation of medicinal vegetables in Northern Uganda.

findings of Kritzinger et al. and Sayeed et al indicated that the plant had antimicrobial activity [54] [55]. These findings support the current use of the plant for abdominal pains. In addition, this is a green leafy vegetable rich in vitamin A which is well known for improving sight [56]. *Brassica oleracea* was used for ulcers, hypertension, malaria, constipation, epilepsy, and sore throat in the current study. This could be partly explained by the fact that the plant is bioactive [57] and fiber rich [58]. *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 hepatoprotective activity [59]. The plant was found by Solomon et al. to have antimicrobial activity [60] justifying the wound healing effect in the current study. *Amaranthus* spp. has been reported to boost blood levels [61] while *Crota-*

laria ochroleuca as an antimalarial agent [31]. These findings coincide with the current reports. The most frequent plant part used in the current study was the leaves. This was in agreement with other related studies [13, 62, 63]. The informant consensus factors (ICF) were calculated for the most commonly used traditional medicinal vegetables to ascertain the consistency of informants' ethnopharmacological knowledge (table 3). Usage of a variety of vegetables for a particular disease greatly reduced the ICF while for conditions where only a few vegetables were used, the resultant ICF was higher. High ICF values indicated wide usage (informant agreement) of a vegetable for a particular disease and hence calling for further pharmacological and phytochemical investigations. The vegetable and conditions with the highest ICF were *Corchorus spp.* for joint stiffness, joint weakness, and pain (ICF = 1); *Hibiscus spp.* for poor lactation; *Crotalaria ochroleuca* for malaria and body aches (ICF > 0.83); and *Cleome gynandra* for ringworm and abdominal pain (ICF > 0.75).

TABLE 3: 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 = $(n - nt)/(n - 1)$ |
|------------------------------|---------------------|---|--|--------------------------|
| <i>Corchorus spp.</i> | Joint stiffness | 67 | 1 | 1 |
| | Constipation | 14 | 4 | 0.77 |
| | Poor appetite | 26 | 9 | 0.68 |
| | Purgation | 6 | 1 | 1 |
| | Joint pain | 14 | 2 | 0.92 |
| | Joint weakness | 22 | 1 | 1 |
| | Weak bones | 7 | 2 | 0.83 |
| <i>Hibiscus spp.</i> | Poor appetite | 74 | 10 | 0.88 |
| | Cough | 5 | 2 | 0.75 |
| | Poor lactation | 26 | 1 | 1 |
| | Ulcers | 5 | 6 | -0.25 |
| <i>Crotalaria ochroleuca</i> | Malaria | 76 | 8 | 0.91 |
| | Body aches | 7 | 2 | 0.83 |
| | Poorhealth | 5 | 2 | 0.75 |
| | Poor vision | 6 | 9 | -0.6 |
| | Abdominal pain | 16 | 8 | 0.53 |
| | Ulcers | 9 | 6 | 0.38 |
| <i>Cleome gynandra</i> | Malaria | 12 | 8 | 0.36 |
| | Poor vision | 10 | 9 | 0.1 |
| | Headache | 8 | 4 | 0.57 |
| | Poor appetite | 11 | 10 | 0.1 |
| | Ring worm | 21 | 2 | 0.95 |
| | Abdominal pain | 34 | 8 | 0.79 |
| <i>Vigna unguiculata</i> | Poor appetite | 14 | 10 | 0.31 |
| | Poor vision | 12 | 9 | 0.27 |
| | Immune boosting | 9 | 4 | 0.63 |
| | Malaria | 10 | 8 | 0.22 |
| | Ulcers | 7 | 6 | 0.17 |
| <i>Cucurbita maxima</i> | Malaria | 16 | 8 | 0.53 |
| | Poor appetite | 11 | 10 | 0.1 |
| | Poor health | 6 | 3 | 0.6 |
| <i>Amaranthus spp.</i> | Anemia | 29 | 7 | 0.79 |
| | Poor appetite | 7 | 10 | -0.5 |
| <i>Brassica oleracea</i> | Heart burn | 5 | 3 | 0.5 |
| | Ulcers | 26 | 6 | 0.8 |
| | High blood pressure | 5 | 6 | 0.25 |
| | Cancer | 5 | 1 | 1 |

The high ICF for *Corchorus spp.* contradicts findings of other studies within and without the region [64–68]. Thus, the uses in the current study (joint pain/stiffness) differ from the uses elsewhere (muscle spasms, wounds). The ICF findings for *Hibiscus spp.* and *Crotalaria ochroleuca* as well as for *Cleome gynandra* agree with other studies in the region [31, 39–41]. On the other hand, the fidelity levels (FL) for vegetables with ICF values ≥ 0.5 were calculated to quantify their importance

to treat a disease (Table 4). The FL values were the highest for *Amaranthus spp.* (Anemia, 60.4%) and *Crotalaria ochroleuca* (malaria, 57.6%). This is supported by previous findings in the country [31, 61]. However, the current findings for *Hibiscus spp.* (poor appetite, 51.8%) and *Corchorus spp.* (joint pain and stiffness, 43.8%) contradict previous studies in other regions [39, 68]. High FL values indicate a high cultural significance for the vegetable. In a bid to strengthen conservation,

TABLE 4: Fidelity levels of the most common medicinal vegetables.

| Vegetable | Condition | No of participants report on condition (I_p) | Total No. of reports for any use (I_u) | FL = (I_p/I_u) × 100 |
|------------------------------|--------------------------|---|---|--------------------------|
| <i>Corchorus spp.</i> | Joint pain and stiffness | 81 | 185 | 43.78 |
| | Constipation | 14 | 185 | 7.57 |
| | Poor appetite | 26 | 185 | 14.05 |
| | Joint weakness | 22 | 185 | 11.89 |
| | Weak bones | 7 | 185 | 3.78 |
| <i>Hibiscus spp.</i> | Poor appetite | 74 | 143 | 51.75 |
| | Cough | 5 | 143 | 3.50 |
| | Poor lactation | 26 | 143 | 18.18 |
| <i>Crotalaria ochroleuca</i> | Malaria | 76 | 132 | 57.58 |
| | Body aches | 7 | 132 | 5.30 |
| | Poor health | 5 | 132 | 3.79 |
| | Abdominal pain | 16 | 132 | 12.12 |
| | Headache | 8 | 113 | 7.08 |
| | Ring worm | 21 | 113 | 18.58 |
| | Abdominal pain | 34 | 113 | 30.09 |
| <i>Vigna unguiculata</i> | Immune boosting | 9 | 82 | 10.98 |
| <i>Cucurbita maxima</i> | Malaria | 16 | 56 | 28.57 |
| | Poor health | 6 | 56 | 10.7 |
| <i>Amaranthus spp.</i> | Anemia | 29 | 48 | 60.42 |
| <i>Brassica oleracea</i> | Hemorrhoids | 4 | 56 | 7.14 |
| | Heart burn | 5 | 56 | 8.9 |
| | Ulcers | 26 | 56 | 46.43 |
| | Cancer | 5 | 56 | 8.93 |

TABLE 5: Diseases treated by traditional vegetables in Northern Uganda per body system.

| System | Diseases treated |
|------------------------|--|
| 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 |
| Reproductive system | Postpartum abdominal pain, poor lactation, sexual difficulties, prolonged labor, placenta removal, pregnancy, miscarriages |
| Endocrine system | Diabetes, goiter |
| Musculoskeletal system | Waist and backaches, joint pain and stiffness, joint weakness, bone fractures, muscle rigidity, tooth decay |
| Respiratory system | Cough, flu/cold |
| Renal system | Urinary tract infections |
| Cardiovascular system | Hypertension, anemia, headache, coronary artery disease, blood vessel engorgement |
| Nervous system | Poor vision, mental illnesses, memory enhancement, drowsiness, epilepsy |
| Integumentary system | Skin rashes and infections, leprosy, ring worm, scabies, wounds |
| 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 |

several ethnobotanical studies are being conducted in the country [64, 65, 69]. However, these studies major on documentation of medicinal plants and their uses rather than engaging the communities to actively participate in the conservation process at family levels. As such, community sensitization with these studies' findings is highly called for if these medicinal plants are to be conserved and preserved for the generations to come.

6. Conclusion

Northern Uganda has numerous traditional vegetables with medicinal benefits. Diseases treated range from gastrointestinal to reproductive through musculoskeletal abnormalities. The community obtains vegetable leaves from the backyard and stews them regularly for the medicinal purposes with no specific dosage. Therefore, we recommend studies to verify in laboratory models the efficacy of these vegetables and standardize the dosages.

Data Availability

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

Ethical Approval

The study was approved by the Research Ethics Committee of Mbarara University of Science and Technology and the Uganda National Council for Science and Technology (UNCST-HS2589). In addition, informed consent was obtained from the study participants who signed a consent form following explanation of the study aims and procedures.

Disclosure

Data was collected for academic purposes, as a requirement for the award of the degree of Doctor of Philosophy of Mbarara University of Science and Technology, Mbarara, Uganda.

Conflicts of Interest

The authors declare that there are no competing interests.

Authors' Contributions

NR performed the conception of idea, methods, data collection, and first manuscript draft. SBA and MKA performed the research design, data collection, and manuscript review. CDS and FB performed the research design and manuscript review. JOK and PA performed the general oversight and manuscript review. All authors read and approved the final manuscript.

Acknowledgments

The authors thank the leaders and community of the Lango subregion, Northern Uganda, and also the data collection

team: Mr. Opii Didan Jacob, Mr. Opio Ojok Innocent, Mr. Oleke Felix, Mr. Beja Humphrey, and Mr. Odong Alex.

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