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Indigenous knowledge and antibacterial activity of selected herbs used locally to treat common cold in Central Uganda

Joel Walugembe[1], Jacob S. Iramiot[2] and Esther Katuura[3]*

[1]Department of Biological Sciences, Kyambogo University, P. O. Box 1, Uganda.
[2]Department of Microbiology and Immunology, Faculty of Health Sciences, Busitema University, P. O. Box 1460 Mbale, Uganda.
[3]Department of Plant Sciences, Microbiology and Biotechnology, Colledge of Natural Sciences, Makerere University, P. O. Box 7062 Kampala, Uganda.

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The study documented the medicinal plants used in the treatment of influenza and common cough and established efficacy of some plants locally used against bacteria causing upper respiratory tract infections in Uganda. It involved an ethnobotanical survey and laboratory experimental investigation to determine the bioactivity against selected bacteria that cause upper respiratory tract infections. Data on medicinal indigenous knowledge was collected with the aid of questionnaires, direct observations, key informant interviews and field excursions and voucher specimen collection. The plants were identified by a botanist at Makerere University Herbarium (MHU), Department of Biological Sciences and voucher specimen were deposited in the herbarium. Methanol and diethyl ether extracts of the commonly used plants were screened for antibacterial activity against *Streptococcus pneumonia* and *Klebsiella pneumonia* using agar well diffusion and agar well dilution methods. Ethno botanical survey showed that 43 plants were commonly used and the most commonly used plant was *Momordica feotida*. Three out of four extracts assayed had activity against *S. pneumonia* and *K. pneumonia,* while one showed activity against *K. pneumoniae*. Hence, plants extracts showed broad spectrum antimicrobial activity. There is need for further development and standardization of products to treat respiratory diseases at household level in the study area.

Key words: Indigenous knowledge, medicinal plants, bioactivity, minimum inhibitory concentration (MIC), upper respiratory infections.

INTRODUCTION

Upper respiratory tract infections contribute highly to the disease burden in Uganda, particularly, in children under5 years and the immune-compromised individuals (Mbonye, 2004; Uganda Ministry of Health, 2010). Allopathic medicine is the national mainstay in treatment of these infections. However, due to poor infrastructure and distribution of health care services, particularly in the rural communities'; majority of the population lack

accessibility of these medicines. In addition allopathic medicines are costly and sometimes cause severe side effects to patients; hence some people have resorted to the use of herbal medicine which is thought to be safe, cheaper, available and sometimes due to lack of alternatives.

The use of plants to treat various diseases includes use of plants' seeds, berries, roots leaves, bark and flowers (Izzo and Ernst, 2009). The World Health Organization (WHO) estimates that 4 billion people globally presently use herbal medicine for some aspect of primary health care (Uganda Ministry of Health, 2010). WHO notes that of 119 plant-derived pharmaceutical medicines, about 74% are used in modern medicine in ways that correlated directly with their traditional medicinal uses by indigenous and local communities. It is estimated that about 80% of the population living in developing countries including Uganda use Traditional Medicine (TM), although, the % varies from country to country (Uganda Ministry of Health, 2010). For instance 90% in Ethiopia, 70% in Rwanda and 60% in Uganda and Tanzania use TM for their Primary Health Care (PHC) (Tabuti et al., 2012).

Majority of Uganda's population depends on herbal medicine because it is accessible, affordable and culturally familiar. With an estimated one health traditional practitioner for every 200 to 400 Ugandans compared to one western medicine trained doctor per 20,000 people, it is deduced that herbal medicine is more widely used compared to allopathic medicine. Herbal medicine has long been used to manage a range of common conditions including malaria, digestive and respiratory problems, tooth aches, skin diseases, reproductive health-related complications and upper respiratory infections (The Cross-Cultural Foundation of Uganda, 2008).

The use of allopathic medicine in Uganda, have led to various problems associated with the use of chemotherapeutic agents. Such problems include the pathogenic agents developing resistance to the drugs, for example the cough suppressants such as codeine or dextromethorphan are frequently prescribed but organisms have demonstrated resistance to the compounds, side effects of agents, for example expectorants have side effects of nausea and vomiting, inaccessibility due to high cost and limited treatment centers especially in rural areas.

Although the proportion of people living within 5 km of a health care facility in Uganda rose to 72% in 2010 from 49% in 2000 (Uganda Ministry of Health, 2010; The Uganda Ministry of Health, 2012) access to facilities is still limited by poor infrastructure, lack of medicine, lack of accommodation at facilities, shortage of medical human resource among other factors that constrain access to quality service delivery in rural areas (Kitula, 2007). Due to limited access to drugs, most people especially in rural areas in Uganda resort to use of herbal medicine to treat diseases such as respiratory infections. However, for most herbal medicine, their efficacy has not been validated (Ernst et al., 2006). This research documented the medicinal plants used in the treatment of respiratory tract infections and also established the efficacy of some plants used against the common bacteria causing upper respiratory infections in humans.

MATERIALS AND METHODS

Study design

This was a cross-sectional study involving both the ethno botanical survey to document the plants used in treatment of respiratory tract infections and experimental investigation to determine the bioactivity against selected bacteria that cause upper respiratory tract infections. The study was carried out between January and June, 2014.

Study area

The study was done in Luweero district in central Uganda (Figure 1). Luweero was chosen because it is accessible and also communication with local people was easy since majority of the people are Baganda. It is bordered by Nakasongola district to the north, Kayunga district to the east, Mukono district to the southeast, Wakiso district to the south and Nakaseke district to the west. The district headquarters at Luweero are located approximately 75 Km (47 miles), by road, North of Kampala, Uganda's capital and largest city. The coordinates of the district are: 00 50N, 32 30E (Latitude: 0.8333; Longitude: 32.500). The 2002 national census estimated the population of the district at about 336,600 with an annual population growth rate of 3.2%. It is estimated that the population of the district in 2010 was about 433,100 (City population.de, 2014).

The study was carried out in Katikamu Sub County in Musaale parish. This parish was chosen because it is far from Luwero town and hence the people do not easily access health facilities. Most people therefore resort to use of herbal medicine. In the parish, 4 villages were studied; Kakakala, Nnongo, Nsawo and Kakinga. Kakakala was the first village moved through, the first family was identified by the help of the local council chairperson, and then snowball method was used to identify other families and respondents that were interviewed. In each village, consent of the chairperson was first sought before interviewing the people. At least 25 people in each village were interviewed, making a total of 100 people.

Instruments for data collection

Data collection was aided by the use of questionnaires, direct observations, key informant interviews and field excursions which involved moving with the herbalist to the field to see the medicinal plants and also collect voucher specimen. Observation involved actual participation to learn how the local people process the

*Corresponding author. E-mail: katuurae@gmail.com.

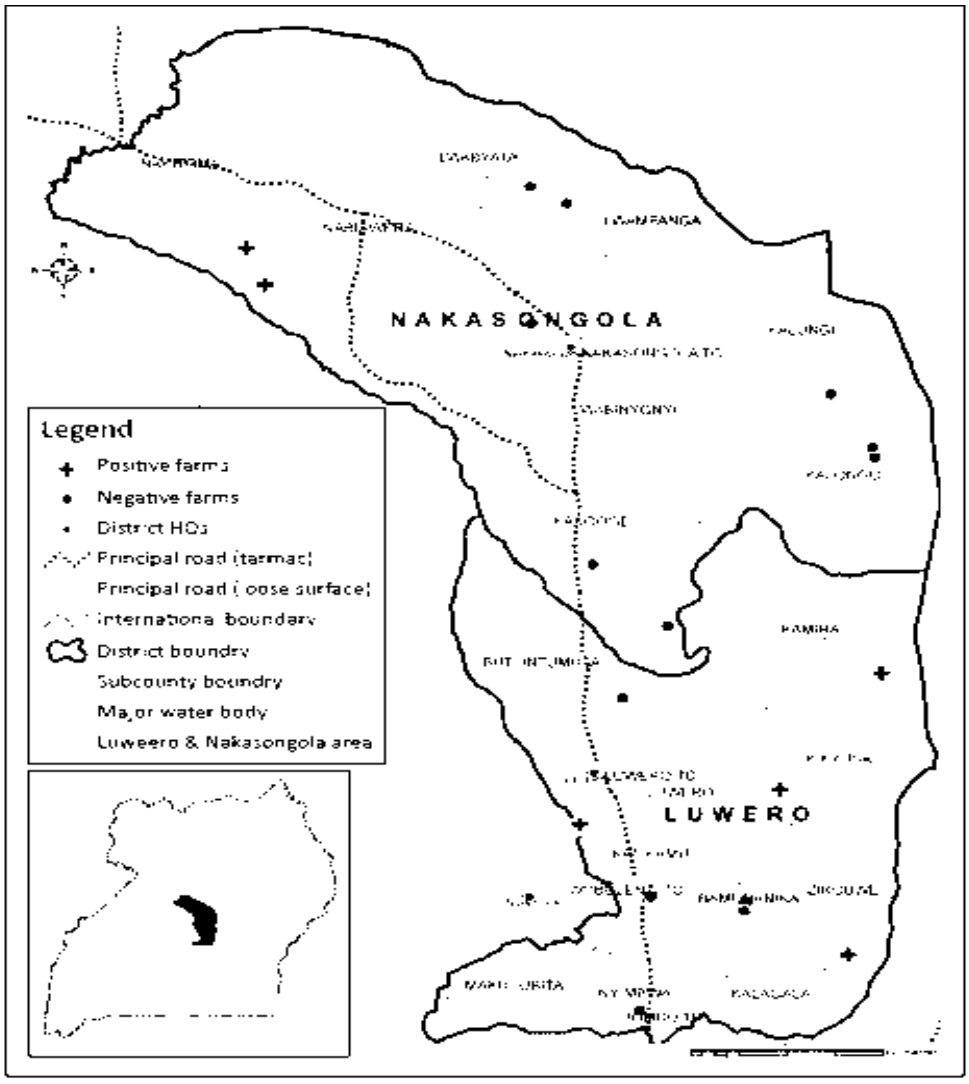

Figure 1. Map of Uganda showing location of Luwero district and the study villages.

medicinal plants and the actual plants/ plant parts used.

Identifying and documenting plants used in treating of upper respiratory tract infections

Sought information included; an inventory of plants used in the treatment of cough, part of used plant, preparation method, administration mode and dosage. A list of used plants was obtained, the most commonly used plants by the local people were determined based on the frequency of use and the priority plants which have not been worked on were chosen based on literature search. The plants were identified by a botanist at the Makerere University Herbarium (MHU), and a voucher specimen was deposited in the herbarium for future reference.

Collection and preparation of sample materials for laboratory analysis

The plants for laboratory analysis were collected from Luweero district in the early morning hours before sunrise, where plants/parts of plants were collected depended on the use information given by the respondents. Leaves were collected for *Momordica foetida,* and *Vernonia amygdalina,* stem bark was collected for *Acacia comphylacantha* and roots were collected for *Solanum macrocarpon.* These plant specimens were then cleaned by washing them and they were then air dried for a week at room temperature. They were then oven dried for 30 min, ground to powder with the grinding machine. The powder was weighed and then packed in air tight containers ready for extraction.

Laboratory analysis

This included extraction and microbiological testing carried out at Natural Chemotherapeutic Research Institute (NCRI) and Kyambogo University Microbiology laboratory/ Faculty of Science.

Extract preparation

Preparation of the plant crude extracts was carried out at NCRI. Extracts were obtained sequentially by maceration using non polar

diethyl ether followed by polar methanol. The extracts were then filtered and the filtrate were concentrated by evaporation using a rotary evaporator (BUCHI scientific equipments), weighed and reconstituted in Dimethyl sulfoxide (DMSO) to a concentration of 1 g/ml. These samples were then stored in a refrigerator at 4°C and later were used in the proceeding of antibacterial tests.

Determination of the antibacterial properties of the selected plants

The antibacterial assays were carried out using agar well diffusion method and agar dilution techniques. The antimicrobial activity of the plant extracts were tested on 2 standard bacteria species namely; *S. Pneumonia* a gram positive bacterium and *K. Pneumonia* a gram negative bacterium.

Inoculums' preparation

A colony of the organism was obtained using a wire loop; it was then emulsified in normal saline to make a suspension which is adjusted using 0.5 McFfarland standards so that its colour matches with that of the standard. This was to ensure that there is the right population cell per millimetre of normal saline. The adjusted cell suspension was inoculated on media by swabbing under aseptic conditions.

Antibacterial screening

The media of Mueller Hinton agar was prepared and treated according to manufacturer's guidelines, where 35 g of media was mixed with one litre of distilled water and enclosed in a container and autoclaved at 121°C for 15 min. The media was later dispensed into 90 mm sterile agar plates (Oxford, UK) and left to set. The agar plates were incubated for 24 h at 37°C to confirm their sterility.

Absence of growth after 24 h showed that the plates were sterile. The sterile Mueller Hinton agar plates were inoculated with the test culture by surface spreading using sterile wire loops and each bacterium evenly spread on the entire surface of the plate to obtain uniformity of the inoculum. The culture plate then had wells of 6 mm diameter and 5 mm depth made into it using a sterile agar glass borer. Ceftriaxone was used as a positive control, while normal saline was used as a negative control. Approximately 0.2 ml of the bioactive test plant crude extracts of concentration 1 g/ml was suspended in the wells and thereafter inoculated, plates/culture were incubated for 24 h at 37°C. The plates/cultures were examined for the presence of bacterial inhibition zones around each well. Antibacterial activity was determined from the zone of inhibition around the wells. Single readings were carried out. Non-active compounds did not show any inhibition zone. The zones of inhibition were measured using a ruler and a pair of divider (Picfare) and results were reported in millimeter. All zone diameters were considered important since the extracts from the plants were still crude.

The agar well diffusion method as described by Esimone et al. (1998) was adopted for antibacterial screening of plant extracts. In this method, 15 ml of Mueller Hinton agar was seeded with 1.0 ml of a broth culture of the test organism. This was done by introducing the culture into sterile petri dishes, followed by adding molten agar to incorporate the broth culture and swirling gently to ensure uniform distribution of the microorganisms in the gel and then finally allowing the agar to solidify on a flat surface. Wells were made in the agar plates (about 5.0 mm diameter using a sterile agar borer) into which equal volumes of the extract were transferred using micropipettes. The plates were allowed to stand for one hour for pre-diffusion of the extract to occur and then incubated at 20 to 25°C for 1 to 2 days. Dimethyl Sulfoxide (DMSO) was set in a different well alongside the test to serve as a negative control and Ceftriaxone was used as a positive.

Minimum inhibitory concentration (MIC)

The MIC was determined by agar dilution technique. A set of 5 test tubes were dispensed with 1 ml of sterile normal saline. An equal volume (1 ml) of the test plant extract was added to the first test tube and the 2 were mixed thoroughly well. Then I ml of the solution in the first tube was transferred to the second tube and the 2 mixed well. This was repeated until the last tube and the last aliquot 1 ml was discarded so as to have uniform volume. This constituted a twofold dilution whereby each step moved to the right reduced the concentration by a factor of 2. This procedure was done for all extracts individually. A bacterial culture adjusted using 0.5 McFarland solution was inoculated on sterile media. Agar wells were bored into the inoculated plates and the samples from the extracts were impregnated into the wells and incubated for 24 h. The different dilutions for a particular extract were impregnated on the same plate. Control plates inoculated with standard drug and DMSO (Dimethylsulfoxide) were set as positive and negative controls, respectively. After 24 h incubation, the plates were examined for antibacterial activity and the results were recorded.

Data analysis and presentation

The data was analyzed by Microsoft excel and the results presented as tables, pie chart and bar graphs, while qualitative interpretations were made for qualitative data.

Ethical considerations

The proposal was presented to the Department of Biological Sciences, Kyambogo University for approval. Before entry into any village, permission to interview the people was sought from the chairperson of the village. Also, consent of the individual was sought before beginning the interviews. For children under the consenting age, a guardian or parent signed on their behalf. For laboratory investigations, standard strains of bacteria whose sensitivity to antibacterial agents is known were used in the study. Also, the experiments were conducted in standard laboratories.

RESULTS AND DISCUSSION

Demographic data

From the survey, demographic information characterizing human population (age, sex, marital status among others) was obtained. The information is summarized in Table 1.

According to the obtained results, majority of the respondents were peasant farmers (80%), while only 20% had a formal employment. Almost all the local people were Baganda (97%); this made it easy to get as much information from them as possible since the interviewer was fluent in the spoken language. Most of the people were not well educated, more than half (62%) of the respondents had not made it to secondary school.

Table 1. A summary of social demographic characteristics of the study participants.

Characteristic	Category	Frequency
Gender	Male	56
	Female	44
Age	Below 35	46
	36-65	31
	66-75	18
	Above 75	5
Marital status	Single married	20
	Divorced	69
	Widow	10
	Divorced	1
Education	No formal	8
	Primary	54
	Secondary	35
	Tertiary	3
Occupation	Peasant	80
	Teacher	1
	Business	9
	Others	10

N=122.

Majority of the respondents were below 35 years of age, the proportion of the aged (above 75 years) was only 5%. Thirty five years and below is the reproductive age in Uganda, since the study was targeting children below five years of age, probably that is why most respondents were falling into this age bracket. However this may be an indication that the African traditional extended family structure is giving way to the nucleated family structure. The elderly people have been known to be the custodians of indigenous knowledge including traditional medicine (United Nations Environment Programme, 2008). Hence the small proportion of aged people in this study is an indication that the older people who have knowledge on medicinal plant use and preparations are dying off; hence, necessitating documentation of medicinal plants so that the knowledge is not lost with the people. It is important that a comprehensive study on indigenous systems and knowledge in Uganda done in order to transfer this knowledge to modern innovations and technologies to match the current trends amongst the younger generations.

Medicinal plant use

The gathered information from the local people about these plants included parts of the used plants in the treatments, preparation methods, route of administration and dosage. Forty three used plants by local people to treat influenza and common cough in Luweero districts were documented (Table 2). These were mostly given personally by the respondents or in consultation with other community members.

The most commonly used plants were *Momordica foetida, Callistemon Citrinus (Curtis), Psidium guajava* and *Mangifera indica,* respectively. Others that were used by many households included; *Azadirachta Indica, Syzygium cumminii, Persea Americana, Euclyptus globules, Albizia coriaria, Physalis peruviana, Tetradenia riparia* and *Acacia Compylacantha.* The family that contained most of the plants mentioned by respondents was Myrtaceae, while the most commonly used plant part was the leaves. Majority of the respondents used the oral mode of administration and boiling was the most preferred form of preparation of the medicine. The mode of administration for all the plants was oral.

Results from laboratory analysis

The dry plant crude extracts obtained at Natural Chemotherapeutic Research Institute (NCRI) and the antibacterial analyses were done at Kyambogo University

Table 2. Species scientific name, family, local name, local medicinal plant use and dosage of the reviewed plants.

Species scientific name, (Family), Local name	FREQ	Part	Preparation method	Dosage	
				Child	Adult
Momordica foetida Schumach (Cucurbitaceae), Bombo[D]	53	L	Chew the leaves or squeeze, take juice	NA	NA
Mangifera indica, L. (Anacardiaceae), muyembe[D]	50	L and S	Boil, leave to cool filter	2spoons×3 daily	1 cup
Callistemon citrinus, Curtis (Myrtaceace) Nyambalabutonya[D]	19	L and S	Boil, cool, filter	2spoons×3 daily	1/4 cup×2 daily
Psidium guajava L(Myrtaceae), Mapeera[D]	18	L	Boil with mango leaves, filter	2spoons×3 daily	1 cup
Vernonia amygdalina Delile (Asteraceae), Mululuuza[D]	10	L	Boil with 8, leave to cool	1spoons×3 daily	1/8cup×3 daily
Azadirachta indica, A. Juss (Meliaceae), Niimu[D]	8	F and L	Boil leaves and fruit	1spoon×3 daily	2spoons×3 daily
Synzigium cuminii L. (Myrtaceae),.Jjambula[D]	8	S	Boil them with 9 and 10, cool, filter	2spoons×3 daily	1/4cup×3 daily
Persea americana Mill. (Lauraceae), Ovakedo[D]	7	L	Boil with 9, leave to cool	2spoons×3 daily	1/4cup×3 daily
Eucalyptus globules Labill (Myrtaceae), Kalitunsi[D]	5	L	Boil, leave to cool	2spoons×3 daily	1/2 cup×3 daily
Albizia coriaria Welw (Mimosoideae, Omugavu[D]	5	S	Boil with 2, 4, 8, 9 and 15, cool	1spoon×3 daily	1/8cup×3 daily
Physalis peruviana L. (Solanaceae), Ntuntunu[D]	4	L	Squeeze, drink fluid	NA	NA
Tetradenia riparia (Hochst.) Codd. (Lamiaceae) Kyewamala[D]	4	L	Smoke, crush and lick or squeeze fluid for child or mix with 8 and 20 and squeeze	NA	NA
Acacia comphylacantha Hochst.ex.(Fabaceae), Kibeere[D]	4	S	Boil with 8,9 and 18 cool	2spoons×3 daily	1/2cup×3 daily
Solanum marcrocarpon L. (Solanaceae), Akatengotengo[L]	3	R	Clean, get bark crush dry add H_2O and salt	NA	NA
Ocimum basilicum L. (Lamiaceae) Kakubansiri[D]	3	L	Boil with 9,10 and 6, allow to cool	1spoon×3 daily	4spoons×3daily
Canarium schweinfurthii, Engl (Burseraceae) Miwafu[D]	3	S	Boil with 8,10 and 13, cool	1spoon×3 daily	2spoons×3 daily
Combretum molle R. Br. G. Don (Combetaceae) Endagi[D]	3	L	Boil, leave to cool	NA	NA
Dracaena steudneri, Schweinf (Dracaenaceae), Kajjolyenjovu[L]	2	L	Dry, burn add ash and salt, mix and lick	NA	NA
Rubia cordifolia, L. (Rubiaceae), Kasalabakesi	2	L		NA	NA
Markhamia lutea Denth K Schum (Bignoniaceae), Musambya[D]	2	S	Boil, leave to cool	2spoons×3 daily	1/4cup×3 daily
Spathodea campanulata P Beauv (Bignoniaceae), Kifabakazi[D]	2	S	Boil, leave to cool	2spoons×3 daily	1/4cup×3 daily
Ocimum suave Willid (Lamiaceae), mujaaja[D]	2	L	Boil with 9,19and24, cool	1/8 cup×3 daily	1/2cup×3 daily
Artocarpus heterophylus, Lam (Moraceae), ffene[D]	2	L	Dry leaves with 9 and17, sieve and lick	NA	NA
Lantana camara L. (Verbenaceae), Kayukiyuki[D]	2	L	Squeeze with 8and28 and take liquid	NA	NA
Piliostigma thonningii, Schum (Caesalpiniaceae), Kigaali[D]	2	S	Boil with 4,6,9 and13 cool	2spoons×3 daily	1/2cup×3 daily
Symphonia globulifera, L. f (Clusiaceae), Omusaali[D]	2	S	Boil with 6,8and9 leave to cool and cool	1spoon×3 daily	2spoons×3 daily
Zingiber officinale, Roscoe (Zingiberaceae) Ntangawuzi[C]	1	R	Crush and add warm H_2O	2spoons×3 daily	1/2cup×3 daily
Imperata cylindrical, P. Beauv (Poaceae) Olusenke[D]	1	R	Boil the roots	2spoons×3 daily	1/4 cup×2 daily
Asparagus africanus Lam (Asparagoideae) Kadaali[D]	1	S and L	Boil, cool, filter	1/4cup×3 daily	1/2cup×3 daily
Hoslundia opposite Vahl (Lamiaceae) Kamunye[D]	1	W	Boil, leave to cool	1/8 cup×3 daily	1/2 cup×3 daily
Brideria micrantha (Hochst.) Baill. (Euphorbiaceae) Katazamiti[D]	1	R	Boil with 18 and 8, leave to cool	2spoons×3 daily	1/4cup×3 daily
Sapium ellypticum (Euphorbiaceae) Musasa[D]	1	S	Boil with 8, 18, 21 and 22 cool	2spoons×3 daily	1/4cup×3 daily
Albizia coriaria (Fabaceae) Nongo[D]	1	S	Boil with 4, 9 and 22 leave to cool	2spoons×3 daily	3spoons×3 daily
Vangueria apiculata K. Schun (Rubiaceae) Matugunda[D]	1	L and S	Boil with 6, 9 and10, leave to cool	1spoon×3 daily	2spoons×3 daily

Table 2. Cont'd.

Ipomoea hildebrandtii, Vatke (Convolvulaceae) Nalongo[D]	1	L	Boil with 18, leave to cool	1/8 cup×3 daily	1 cup
Ficus exasperate Vahl. (Moraceae) Luwawu[D]	1	L	Dry, crush add cassava flour, salt and lick	NA	NA
Ageratum conyzoides, L. (Asteraceae) Namirembe[D]	1	W	Boil with 8, 18, 39, leave to cool	1spoon×3 daily	2spoons×3 daily
Galinsoga parviflora, Cav. (Asteraceae) Kafumbe[D]	1	W	Boil with 8,18 38, leave to cool	1spoon×3 daily	2spoons×3 daily
Aristolochia elegans, Mast (Aristolochiaceae) Akasero[D]	1	L	Boil them with 8, 18 and 43, leave to cool	2spoon×3 daily	1/2cup×3 daily
Aloe vera, Burm.f (Xanthorrhoeaceae) Kigaji[D]	1	L	Boil them with 8, 18 and 42, leave to cool	1/2 spoon×3 daily	2spoons×3 daily
Loranthus sp. (Loranthaceae) Nzirugaze[D]	1	L	Boil, leave to cool	1spoon×3 daily	2spoons×3 daily

Plant part: L- Leaves, S- stem bark, R- roots, W- whole plant, F- fruit; Mode of administration: [D]- drinking; [L]- licking; [C]- chewing.

Microbiology Laboratory in Uganda. All the 4 methanol plant extracts had activity against *Klebsiella pneumoniae*, while all except the extract of *A. comphylacantha* showed activity against *S. pneumonia*. The highest activity was observed in *V. amygdalina* and *M. feotida* at 24 and 21 mm inhibition diameter respectively against S*. pneumonia.* Therefore, all methanol plant extracts (100%) were active on *K. pneumoniae* (a gram negative bacterium) and 75% of the methanol extracts were active on *S. pneumonia* (a gram positive bacterium) (Table 3).

Almost all the plant extracts showed activity against the test pathogens. Of the four diethly ether plant extracts, 2 (*V. amygdalina* and *M. foetida*) had activity on both bacteria (Table 4). *Solanum macrocaporn* was only active *against K. pneumoniae,* while *A. comphylacantha* was only active against *S. pneumoinae* and 2 were active only on one bacterium. The biggest zone of inhibition was observed in both *S. macrocarpon* and *V. amygdalina* at 20 mm diameter against *K. pneumoniae* and *S. pneumonia*, respectively. Both methanol and diethyl ether extracts of *M. foetida* and *V. amygdalina* were active on both bacteria species. The most active, however, was *V. amygdalina.* Since plant medicines have many compounds in them, this makes parasites less prone to developing resistance to them. Hence an effective broad spectrum antibiotic could be formulated and developed from a combination of these plants.

Minimum inhibitory concentration (MIC)

The plants which were considered for minimum inhibitory concentration were those whose methanol or ether extracts showed activity against at least one bacterial species (Table 5).

DISCUSSION

Majority of the respondents were below 55 year of ages, this was an indication that the older people are the ones who have knowledge on medicinal plant use and the knowledge of preparations may disappear with time, hence necessitating documentation of medicinal plants so that the knowledge is not lost with death of the old people. Most of the respondents were peasant farmers; therefore, there income is low and hence they cannot afford the cost of allopathic medicine. So, they resort to the use of herbal medicine which is cheaper and readily available to them. This, therefore, calls for testing of the medicinal plants to determine their efficacy and safety to save the local people from taking 'non authenticated' and unsafe medications.

Majority of the respondents were married. This could be because the married people are the ones with children below 5 years and hence they use more herbs since URTIs mainly affect children below 5 years. Kibuule and Kagoya (2015) also reported that most of the affected are the children below 5 years. Very few of the people interviewed had attained tertiary education. This could be because most people who have reached that level do not use herbal medicine possibly since they can afford allopathic medicine possibly due to having better jobs.

Herbal remedies are prepared in several rather standardized ways which usually vary based upon the utilized plant, and sometimes, what condition is being treated. Many studies have reported use of leaves, oral administration and decoctions being highest in use compared to other plant parts (Tabuti et al., 2012). In this study, most commonly used plant parts were also leaves, while decoction was the most common form of preparation. All preparations were administered orally. The use of leaves encourages sustainable utilization and conservation of plants hence increased availability of the plants to the local people. The local communities can be encouraged to use the medicinal plants as alternatives, particularly those that have been proven efficacious and safe.

Table 3. Antibacterial screening on methanol plant extract against *K. pneumonia* and *S. pneumonia.*

Plant extracts	Inhibition diameter (to the nearest mm)	
	K. pneumoniae	***S. pneumoniae***
S. marcrocarpon	12	13
V. amygdalina	13	24
A. comphylacantha	15	Not active
M. foetida	12	21

Table 4. Antibacterial screening on diethyl ether extract against *K. pneumoniae* and *S. pneumonia.*

Plant extracts	Inhibition diameter (to the nearest mm)	
	K. pneumoniae	***S. pneumoniae***
S. macrocarpon	20	Not active
V. amygdalina	15	20
A. comphylacantha	Not active	14
M. foetida	13	12

Table 5. Minimum inhibitory concentration (MIC) of plant extracts against *K. pneumoniae.*

Methanol extracts	Minimum Inhibitory Concentration (MIC) ***K. pneumoniae***				
	1 g/ml	**0.5 g/ml**	**0.25 g/ml**	**0.125 g/ml**	**0.0625 g/ml**
S. marcrocarpon	12	0.0	0.0	0.0	0.0
M. foetida	11	0.0	0.0	0.0	0.0
A. comphylacantha	14	10	0.0	0.0	0.0
V. amygdalina	13	12	10	0.0	0.0
	Diethyl ether extracts				
S. marcrocarpon	18	15	10	10	0.0
M. foetida	12	0.0	0.0	0.0	0.0
V. amygdalina	14	11	10	0.0	0.0
	Minimum Inhibitory Concentration (MIC) *S. pneumoniae*				
	1 g/ml	0.5 g/ml	0.25 g/ml	0.125 g/ml	0.625 g/ml
S. marcrocarpon	11	10	10	0.0	0.0
M. foetida	20	17	15	13	10
V. amygdalina	23	20	18	15	10
	Diethyl ether extracts				
M. foetida	12	10	0.0	0.0	0.0
A. comphylacantha	13	11	10	10	0.0
V. amygdalina	19	17	14	11	10

It was found that the selected plants had antibacterial activity against at least one of the tested bacteria. In previous studies, both Vernonia amygdalina and M. feotida had showed antibacterial activities against E. coli and S. aureas (Lovet et al., 2015; Olukayode and Adebola, 2008). In this study, the plants showed activity on more test organisms including *K. pneumoniae.* The results of (MIC) also showed that the extracts were more active on gram positive bacterium. Generally, methanol extracts were more active than ether extracts. Therefore, probably the active ingredients in the plants were mostly the polar components since methanol extracts a larger proportion of polar compounds (Narhstedt, 2014). *V. amygdalina* and *M. foetida* had a broad spectrum activity for both di ethyl ether and methanol extracts. Amongst the 4 plants, *V. amygdalina* had the greatest activity and

hence has a great potential to be developed into a drug for URTIs. *S. marcrocarpon* had the greatest activity against *K. pneumoniae* and hence a standardized herbal medicine including a mixture of *S. marcrocarpon, V. amygdalina* and *M. foetida* could be further scientifically evaluated to standardize a medicine that would be used against URTIs at household level in the local communities.

A standard drug (antibiotic), ceftriaxone was also used to act as a positive control and sterile distilled water was used as a negative control. This was done to test the viability of the experiment. In the determination of MIC, the agar well dilution method was used because of its simplicity as compared to the broth dilution method. The concentrations of the different extracts were diluted by serial dilution method to the fifth dilution (0.0625 g/ml). It was observed that different concentrations of the extracts were the MIC for the different bacteria. The ether extract of *S. marcrocarpon* had the highest MIC (0.125 g/ml) against *K. pneumoniae*. *M. foetida* had the lowest MIC against *K. pneumonia* at 0.5 g/ml both in the diethyl ether and methanol extracts. This implied that *M. foetida* has good activity however it needs to be used in high concentrations. Hence it is essential to determine the safety profile of this plant. *M. foetida* and *V. amygdalina* had showed a low MICs for both extracts against *S. pneumoniae.* This is an indication that a formula consisting these two plants could lead to a more effective remedy against respiratory tract infections. We are making efforts to have a study on the combined or synergistic effects of these plants against the test pathogens in the near future. This could lead to an affordable alternative in management of upper respiratory infections. Generally, the 4 extracts had lower MIC for *S. pneumoniae,* a gram positive bacterium.

Conclusion

Plants extracts tested have antimicrobial activity against gram positive and gram negative bacteria and therefore can be of great medicinal function. Developing countries, like Uganda should therefore take advantage of such medicinal plants to formulate medications to treat upper respiratory infections especially in the rural areas. This further verifies that indigenous knowledge is important both in Primary Health Care and in Drug Development. There is need to intensify research in plant medicines/formulae that can be incorporated in the national health system.

Conflict of interests

The authors have not declared any conflict of interests.

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