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Ethnobotanical study of selected medicinal plants used against bacterial infections in Nandi county, Kenya

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Abstract
Background: Globally, medicinal plants have been used to treat different human ailments from time immemorial. In Kenya, various plants are used by local people in the treatment of various diseases. This is a common practice in Nandi county due to scarce health facilities in the region, traditional beliefs, cultural barriers and availability of medicinal plants. The objective of this study was to carry out an ethnobotanical survey to identify and document species of the medicinal plants that are used to treat bacterial infections, which are common in the region.
Materials and Methods: The survey was conducted during the period of June 2016 to December 2017 through oral interviews and using structured questionnaires. The plant materials cited by the traditional practitioners were collected, and further authenticated in the lab at the department of biological Sciences University of Eldoret, where voucher specimens were deposited at the herbarium.
Results: The result showed that thirty-three (33) medicinal plants distributed in twenty four (24) botanical families are used to treat bacterial infections. It was evident that majority of plants was used to treat Pneumonia 11 (33.3%), wounds 10 and diarrhea10 (30.3%). Other remedies used fewer plants. *Lactucca glandulifera* was recorded for the first time with ethnomedical uses while other species were previously reported.
Conclusion: The information gathered in this survey requires phytochemical analysis to validate the therapeutic potential of antibacterial compounds from promising plant species. This will therefore provide leads in the discovery and development of new Phytomedicine.

Keywords: Medicinal plants, infections and phytomedicine

1. Introduction
Medicinal plants is any plant which contain substance that can be used for therapeutic purposes in one or more of its organs or contain substance which are precursors for the synthesis of useful drugs. A plant become medicinal when its biological activities has been ethnobotanically or scientifically reported, (Regassa., 2013) [24]. Nandi people a subset of the Kalenjin community that occupy a large portion of the Nandi County in Rift valley of Kenya, they are believed to have lived in this region for over 400 years. These people use various plants for treating and curing diseases as an integral part of their routine health care systems. This is due to the high cost of imported conventional drugs and/or inaccessibility to western conventional health care system that has led to over reliance on traditional medicine, (Jeruto *et al.* 2015) [13]. On the other hand, even when conventional health care facilities are available, traditional medicine is viewed as an efficient and an acceptable system from a cultural perspective in treatment of various diseases (Borokini and Omatayo, 2012) [6]. This is in agreement with the studies of Gude that 80% of the people in the world depend on traditional medicine as primary health care, (Gude 2013, Ekor, 2013) [12].
An infection is a disease caused by microorganisms such as viruses, fungi, bacteria or parasites. However, the bacterial infections are very common in humans due to the emergence of the antibiotic resistant bacteria and this has remains a major concern to both researchers and the public (Marasini *et al.* 2015) [26]. Apart from resistance, bacterial infections are also common because of various factors such as, HIV/AIDS pandemic, poor hygiene, overcrowding, and resistance to conventional medicine. For example, water borne diseases, skin diseases, gastrointestinal worms, rheumatism, and respiratory disease are some of the common bacterial diseases treated using traditional medicine, (Tian *et al.* 2014).

Bacterial diseases such as tuberculosis, pneumonia, and dysentery are some of the infections that have been in increase in the recent years due to HIV/AIDS pandemic, (Kisangau *et al*, 2007) [16]. Therefore, it is important to carry out ethnobotany for bacterial diseases treated by medicinal plants because natural products obtained from higher plants may provide a new source of antimicrobial agents with possibly novel mechanisms of action. For example, traditional Chinese medicines are a valuable source for novel antibacterial agents. The use of plants extracts as antimicrobial activities could thus serve as a source for both traditional and conventional medicine. Plants synthesize diverse compounds called secondary metabolites, which contribute to their medicinal value. The most important bioactive constituents of the medicinal plants are alkaloids, anthraquinones, flavonoids, and phenolic compounds (Cushine *et al.* 2014) [9]. However, there is variation in the medicinal plants that exists in different ecological area and in most cases; the herbalists have species preferences among sites, partly due to the differences in the ecological niches within short distances and plant species, (Morshy, 2014) [19]. This makes the composition of the biologically active compounds of these medicinal plants to vary on their antimicrobial activities further screening on plants even those that has been screen elsewhere in the world.

2. Material and Methods

2.1The study area

Nandi county is situated in the western part of Kenya and borders uasin-Gishu county to the north-east, kericho county to the south-east, kisumu county of nyanza region to the south east, kakamega county of western region of Kenya to the north–west ((Anon, 2001, Kigomo, 2001) [5]. It comes into existence as a county in 2013 from the earlier Nandi district. The county is very rich in diverse flora being along near equator this make it suitable for studies related to medicinal plants.

2.2 Ethnobotanical surveys

Ethnobotanical survey was conducted during the period from June 2016 to December 2017. Twenty (26) herbalists consisting of 18 men and 8 women were interviewed during this period. All interviews were conducted in local languages. Research assistants acted as the translators during the conversations between the herbalist and the research team. After explaining the objectives of the research and seeking their consent, the herbalists were engaged.

Structured interviews and discussions were held with the herbalist on particular ailments by use of interview schedules for each respondent. Interviewed people were mainly the herbalists (both men and women). The time and place of interviews were arranged according to the schedules of the respondent. The meetings were held at the places of work such as the homes, farms, where they treat the patients. The Interviews were conducted in the local Nandi and kipsigis language except for a few cases where the respondents could understand Kiswahili. The information was recorded immediately or afterwards and appointments were made for more details at a more convenient place arranged with the respondent. The data collected were to supplement information regarding the local names of the plant species, parts used, preparation, administration, and the disease condition treated was documented (Table 1).

The herbalist or the botanists were used as guides during field trips to identify frequently cited plant species. The alleged antibacterial value of a particular plant was recorded as valid only if it was mentioned by at least 3 independent herbalist. Photographs of plants were also taken in the field.

2.3 Knowledge on bacterial infections

During the interviews, the symptoms of various bacterial infections were described to the healers for instances diarrhoea, coughing, chest pain, stomachache, indigestion, toothache, eye or hear itching, skin rashes, and sore throat (Simmers, 2003). The bacterial infections considered in the present study were Tuberculosis (TB), (chebuonit) and Pneumonia, locally called *kipkarasit*, Rheumatism (Chemurmukulelit), Tonsils (Mokwek), Wounds (mook), Typhoid (Miandat bek), syphilis (Takanet) and Gonorhoea (kipsununut). The symptomatic conditions include: Tonsils (mokwek), skin rashes locally called *kesir* and chronic diarrhea (*Madaet ab moo*) (Table 1).

3. Results and Discussion

3.1 Medicinal plants used in the treatment of bacterial infections

The plants' families, scientific names, vernacular names, part used, and medicinal use, are presented in Table 1. Thirty three (33) medicinal plants distributed in 24 botanical families were documented. The photographes of some of the commonly used medicinal plants/parts, in the region are shown below;

The roots were the most used parts 19 (57.57%), followed by barks 6 (18.18%) while leaves 5 (15.15%), and whole plant was 3 (9.09%). The roots and leaves were frequently used because they have high concentration of exudates stored in them being an excretory organ. They are also easy to prepare (Abera *et al.*, 2014) [1] (Table 1).

The medicinal plants mainly 45.5% and 40.9 were trees and shrubs respectively that were sourced from the wild. Trees and shrubs are the most frequent medicinal plant species because they are most abundant compared to other growth forms and people rely more on them. (Amuka *et al*, 2017, Teklay, 2013) [3, 28]. The main methods of preparation were decoction and infusion. However, some plants was prepared by more than one method. The most commonly use method of administration was oral especially for the internal ailments, dosages involved taking half or quarter of a cup twice a day or thrice a day depending on the efficacy of the drug and the nature of the ailment (Table 1). Leaves were the most widely used plant part (14 species, 50%) followed by roots (7 species, 25%) (Figure 2). It was evident that majority of plants was used to treat Pneumonia 11 (33.3%), wounds 10 and diarrhe10 (30.3%), followed by skin diseases 9 (27.3%). Other remedies used fewer plants, (Table 1). There was an extensive review of literature of the bacterial infections considered in the present study and medicinal plants of similar species on their ethno-medicinal use elsewhere in Kenya and the world as discussed below;

3.2 Tuberculosis (TB) (Chebuonit) was treated using the plants *Hoslundia opposita*, *Adenia gummifera, Zanthoxylum gillettii*. The fact that *Ficus sycomorus* roots are boil in water and taken for the management of tuberculosis in Nandi county, concoction of the roots are used in Zimbabwe to manage tuberculosis and other chest related conditions (Maroyi, 2013) [18]. *Adenia gummifera* is used in South Africa by the Kwa Zulu Natal people to manage HIV/AIDS (De Wet *et al*. 2012) [10].

The fact that *Zanthoxylum gilleti* bark is boil and taken for the management of tuberculosis by the Nandi community. It is also used for the management of related bacterial diseases such as cold, stomachache, rheumatism and urinary infections in Ivory Coast (kokwaro, 2003) [17].

3.3 Pneumonia (*kipkarasit*) was treated using a number of plants because it is a common diseases in the region that is cold this is in agreement with the studies of Amuka, (Amuka *et al*. 2014) [4]. Some of the plant that were used to treat pneumonia was *Plantago palmate, Zeheneria minutiflora, Acacia lahai, Leucas calastachys, Rubia cordifolia, Prunus africana and Erythrinia abyssinica* roots and bark are boiled and taken for the treatment of Tuberculosis in Nandi county as well as in Tanzania, (Kisangau *et al*. 2007) [16]. *Carisa edulis* roots are boiled and taken for the treatment of pneumonia in Nandi county while in Uganda the decoction from roots are used to treat measles and malaria, (Okullo *et al.* 2014) [20]. *Toddalia asiatica* boiled leaves are taken orally for the treatment of pneumonia in the county. It is also used in other parts of East Africa in the treatment of diseases caused by related bacteria and viruses (Orwa *et al*. 2008) [21]. *Zanthoxylum gillettii* bark is boil and taken for the management of pneumonia by the Nandi community. It is also used for the management of other bacterial infections such as stomachache, rheumatism and urinary infections in Ivory Coast (kokwaro, 2003) [17].

3.4 Rheumatism (Chemurmukulelit), was treated using the following plants in Nandi County, *Carisa edulis*, *Olinia rochetiana*, *Zanthoxylum gillettii* and *Cleodendrum myricoides*. The fact that *Zanthoxylum gilleti* bark is boil and taken for the management of pneumonia by the Nandi community. It is also used for the management of rheumatism and other bacterial infections in Ivory Coast (kokwaro, 2003) [17].

3.5 Tonsils (Mokwek) were treated using the plants *Cythula schimperiana, Conyza subscaposa, Plantago palmate, Terenna graveolens, Acacia lahai, Cleodendrum myricoides and Rubia cordifolia.*

3.6 Wounds (mook) were treated using a number of plants in Nandi County. These include; *Cythula schimperiana, Lactuca glandulifera, Asparagus racemosus, Vangueria volkensii, Toddalia asiatica, Zanthoxyllum gilletti, Solanum macrantha, Urtica mossaica and Hoslundia opposita.* The fact that *Hoslundia opposita* is used to treat wounds in Nandi County, it also used to treat the same in Burkina Faso due to the presence of coumarin, (Regina *et al.* 2015) [25]. *Toddalia asiatica* boiled leaves are also taken orally for the treatment of wounds in the county, and it is used in other parts of East Africa in the treatment of diseases caused by bacteria, (Orwa *et al*. 2008) [22]. *Asparagus racemosusis* also used in NePal for the treatment of Urinary troubles, diarrhea, as antidysenteric, (Singh, 2012) [27].

3.7 Typhoid (Miandat bek) in Nandi county is treated using the plants; *Croton macrostschys, Cleodendrum myricoides* and *Bersamma abyssinica* roots that are boiled and taken orally for typhoid, and other stomach infections. In Tanzania, it is also used for the treatment of abdominal disorders such as

abdominal pain, diarrhoea and amoebiasis (Zekeya *et al.*, 2014) [29].

3.8 STDI' s, For instance Syphilis (Takanet) and Gonorhoea (kipsununut) was treated using a number of plants, *Senecio discifolius, Cleodendrum myricoides, Carisa edulis, Ficus cycamorus, Solanum incunum* and *Erythrinia abysinicca.* The barks of *Erythrina abysinicca* is boiled and taken for the management of STDI's in the county. In other African folklore medicine, the bark is boiled with goat meat for treatment of gonorrhea, (Jeruto, *et al.* 2015) [13].

3.9 Diarrhoea was treated using the plants *Cythula schimperiana, Bersamma abyssinicca, Albicia coriaria, Cluttia abyssinica, Plantago palmate, Cuttia abyssinica, Senna didymobotya, Ficus cycomorus, Spermacose princeae, Rubia cordifolia, Syzygium cordatum. Albicia coriaria* is used to treat the same in Nyanza by the Luo community (Jeruto *et al.* 2015) [13]. In Northern Uganda the stem bark is crushed soaked in water and the extracts taken orally to cure dysentery (Kamatenesi *et al*. 2011) [14]. *Syzygium cordatum* root decoctions are used in Nandi County to treat and manage diarrhoea. It is also used in Ayurvedic medicine for the management of related gastrointestinal complaints. *Syzygium cordatum* root decoctions are used also in Nandi County to treat and manage diarrhoea. In Congo, the local communities use the bark concoction to manage related bacterial infections and amoebic dysentery (Otshudi *et al*., 2000). *Bersamma abyssinicca* barks are boiled and taken for the treatment of abdominal disorders such as diarrhoea and amoebiasis in Tanzania, (Zekeya *et al.* 2014) [29]. *Rubia cordifolia, Senna didymobotya, Hoslundia opposita, Croton macrostachyus, Clerodendrum myricoides* and *Bersama abyssinica* have been documented for use in treatment of diarrhoea in Ethiopia, (Bizuneh *et al*. 2018).

3.10 Skin diseases were treated using the plants *Lactuca glandulifera, Vangueria volkensii, Spermacose princeae, Syzygium cordatum, Cluttia abyssinica, Erithrinea abyssinica, Senna didymobotya and Olinia rochetiana. Syzygium cordatum* root decoctions are used in Nandi County to treat and manage Skin diseases, in Tanzania, roots and bark are boiled and taken orally for the treatment of the same, (Kisangau *et al*., 2007) [16]. On the other hand, *Cluttia abyssinica* leaves decoctions are used to treat skin diseases in Nandi County while in Ethiopia, the leaf extracts are also used to treat skin infections. *Erythrinea abyssinica* is used in Nandi County to treat skin diseases in human being but in other African countries the leaves are used to cure skin diseases in cattle (Orwa *et al*. 2009) [22]. *Senna didymobotrya* is used in Nandi County to control skin infections as well as diarrhea. It is also used to treat skin conditions in humans in meru.

Table 1: Medicinal Plants used for the treatment of bacteria

Family	Scientific name (Local name) Voucher number	Infections treated	Habit/Part Used	Method of reparation/Mode of administration
Amaranthaceae	*Cythula schimperiana*- (*Namgwet*) KN/Ndi/17/05/ 022	Diarrhoea and Wounds	Herb (R)	Fresh cleaned roots are boiled in water and half a cup taken orally twice a day
Apocyanaceae	*Carissa edulis* Vahl (Tamuryakiat/ Legetetiot) KN/Ndi/17/05/ 021	Pneumonia, rheumatism and STD'I's	Shrub (R)	Fresh cleaned roots are boiled in water and half a cup taken orally twice a day
Asclepiadaceae	*Curroria volubilis (Schltr.) Bullock* (Simatwet) KN/Ndi/17/05/ 023	Stomachache	Tree (B)	Fresh cleaned roots are boiled in water and quarter of a cup taken orally twice a day
Asteraceae	*Lactuca glandulifera* (Chebara) KN/Ndi/17/05/008	Skin diseases and wounds	Shrub (W)	whole plant is roasted and applied on the infected part of the body
	Conyza subscaposa O. Hoffm. (Chepng' ombet) KN/Ndi/17/05/ 024	Tonsils	Herb (R)	Cleaned Roots are pounded in water and a taken orally twice a day
Asparagaceae	*Asparagus racemosus* Willd.(Chesibaiyat) KN/Ndi/17/05/ 020	wounds, Sore throat and Pneumonia	Shrub (R)	Cleaned Roots are boiled in water and a full cup taken orally twice a day
Campanulaceae	*Plantago palmate* Hoof. (Masiririet). KN/Ndi/17/05/ 025	Tonsils, Pneumonia, diarrhoea, eye infections	Herb (R)	Cleaned Roots are boiled in water and a half a cup taken orally twice a day
Compositae	*Senecio discifolius* Oliv. (Chemamaiyat). KN/Ndi/17/05/ 026	Stomachache, syphilis and eye infections	Herb (W)	Whole plant is pounded and water added and taken or applied to the affected area
Cucurbitaceae	*Zehneria minutiflora* (cogn) c. Jeffrey (Manereriat). KN/Ndi/17/05/ 027	Pneumonia, toothache, eye infections	Liana (R)	Cleaned Roots are boiled in water and a full cup taken orally thrice a day
Euphorbiaceae	*Croton macrosthyus* (*Bissana*) (Tebeswet) KN/Ndi/17/05/ 002	Typhoid, measles	Tree (B)	Barks are boiled in water and half a cup taken orally twice a day
	Clutia abyssinica Jaud. Pach (Kurmanyat/Turmanyat) KN/Ndi/17/05/ 002	Diarrhoea, skin diseases and stomachache	Shrub (L)	Leaves are boiled in water and half a cup taken orally thrice a day or fresh leaves are roasted and quarter of a spoon of products taken thrice a day
Fabacea	*Albizia coriaria* Welw. Ex Oliv. (Musengertet) KN/Ndi/17/05/ 007	Diarrhoea and tonsils	Tree (R)	Fresh cleaned root are boiled in water and quarter of a cup taken orally thrice a day
	Acacia lahai Steud (Chebitet).KN/Ndi/17/05/ 010	Diarrhea and coughs, pneumonia	Tree (B)	Fresh bark is boil and quarter of a cup taken thrice a day
	Erythrinia abyssinica DC.(Kakaruet).KN/Ndi/17/05/ 011	Diarrhoea, Skin diseases Pneumonia and STDI's	Tree (B)	Fresh barks are boil in water and quarter of a cup taken thrice a day
	Senna didymobotya (Fresen) Irwin (Senetwet) KN/Ndi/17/05/ 003	Skin infections, Diarrhoea	Shrub (L)	Freshleaves are boiled in water and half a cup taken orally twice a day or leaves are pounded and applied on the skin as a paste
Labiataceae	*Leucas calostachys* Oliv. (Ngechepchiat). KN/Ndi/17/05/ 028	Ulcers, ,pneumonia, stomach-ache	Shrub (R)	Cleaned roots are boiled in water and an eight of a cup taken orally thrice a day
Lamiaceae	*Hoslundia oppositae* Vahl (cherungut). KN/Ndi/17/05/ 019	Wounds and TB	Shrub (L)	Fresh leaves are pound in water a and half a cup taken orally twice a day or applied on the wound
Melianthaceae	*Bersamma abyssinica* Fresen (Kipumetiet)	Cholera, typhoid,	Tree (R)	Fresh cleaned roots are boiled in water and half

	KN/Ndi/17/05/ 005	stomach infections		a cup taken orally thrice a day
Moraceae	*Ficus cycomorus* L. (Mogoiwet). KN/Ndi/17/05/ 018	Diarrhoea, Tuberculosis and STD'Is	Tree (R)	Fresh cleaned roots are boiled in water and quarter of a cup taken orally twice a day
Myrtaceae	*Szigium cordatum* Hochst. ex sond (Lamaiywet) KN/Ndi/17/05/ 006	Diarrhoea	Tree (R)	Cleaned roots are boiled in water and quarter of a cup taken orally twice a day
Oliniaceae	*Olinia rochetiana* (Museset) KN/Ndi/17/05/ 009	Rheumatism, bronchitis and Skin diseases	Tree (B)	Fresh cleaned bark is boil in water and quarter of a cup taken orally thrice a day
Rubiaceae	*Spermacose priceae* (S. Moore). Bremek. (Chemurguiwet). KN/Ndi/17/05/ 033	Dysentery, Skin diseases, diarrhoea	Tree (R)	Fresh cleaned root is boil in water and quarter of a cup taken orally thrice a day
	Tarenna graveolens (S. Moore) (Chepkurwet). KN/Ndi/17/05/ 029	Eye infections and Tonsillitis	Shrub (R)	Fresh cleaned root is boil in water and quarter of a cup taken orally twice a day
	Vangueria volkensii k. schum (Kimolwet). KN/Ndi/17/05/ 030	Wounds and skin infections	Shrub (R)	Cleaned roots are boiled in water and half of a cup taken orally twice a day
Passifloraceae	*Adenia gummifera* Harv (Hams) (Chepnyalildet) KN/Ndi/17/05/ 012	TB and leprosy	Liana (R)	Fresh cleaned roots are boil in water and quarter of a cup of products taken thrice a day
Rosaceae	*Prunus africana* (Hook f) Scweinf (Tendwet) KN/Ndi/17/05/ 013	Pneumonia and eye problems	Tree (B)	Fresh cleaned bark is boil in water and half a cup taken orally twice a day
	Rubus apetalus Poir (Momoniet) KN/Ndi/17/05/ 004	stomach ailment	Shrub (R)	Fresh cleaned roots are chewed twice a day
Rubiacea	*Rubia cordifolia* L. (Chepsaleitet) KN/Ndi/17/05/ 017	Pneumonia, tonsils, diarrhoeae	Liana (W)	Whole fresh plant is dried, burned and quarter of a spoon of products taken thrice a day
Rutaceae	*Toddalia asiatica* (L.) Lam. (Kipkoskosit). KN/Ndi/17/05/ 016	Pneumonia and Wounds	Shrub (L)	Fresh leaves are boiled in water and half a cup taken orally twice a day
	Zanthoxylum gillettii (De. wild) Westerman (Sagawatiet) KN/Ndi/17/05/ 014	TB and Pneumonia, Rheumatism and wounds	Tree (B)	Fresh bark is boiled in water and half a cup taken orally thrice a day
Solanaceae	*Solanum micranthum* Dunal (Sigowet). KN/Ndi/17/05/ 032	STD'Is and wounds	Shrub (R)	Roots are boiled in water and half a cup taken twice a day
Urticaceae	*Urtica mossaica* Mildbr (Siwot) KN/Ndi/17/05/ 015	Coughs, wounds	Herb (W)	whole plant is boiled in water and quatre of a cup taken orally thrice a day
Verbanaceae	*Cleodendrum myricoides* (Hochst.) Vatke (Kabetiot) KN/Ndi/17/05/ 001	Typhoid, Tonsils, Rheumatism, Gonorrhoea	Shrub (R)	Cleaned roots are boiled in water and quarter of a cup taken orally thrice a day

Key; **Used parts:** R-Roots, B-bark, L-leaves, and W-whole plant

The family with the highest number of species that are used by the Nandi community was Fabaceae with 4 species, (40.0%), followed by Rubiaceae with 3species, (30.0), Asteraceae, Euphorbiaceae, Rosaceae, Rutaceae each 2 representing (20.0%) while the remaining 18families had single species each representing (10.0%). (Figure 1). Most plants were used to treat more than one infection or symptom except *Szigium cardatum* that was used to cure diarrhoea only. Pneumonia was reported to be treated by highest number of plants followed by typhoid and STDI's with three plants each, (Table 1). Pneumonia is a one of the killer diseases in the county being in the highland, which is cold, and tuberculosis is due to the HIV/AIDS. It is, therefore, necessary to preserve this indigenous knowledge on traditional medicines by proper documentation, identification of plant species used, herbal preparation, and dosage. This will assist future studies on the selection of herbal plants to evaluate for phytochemical safety and efficacy.

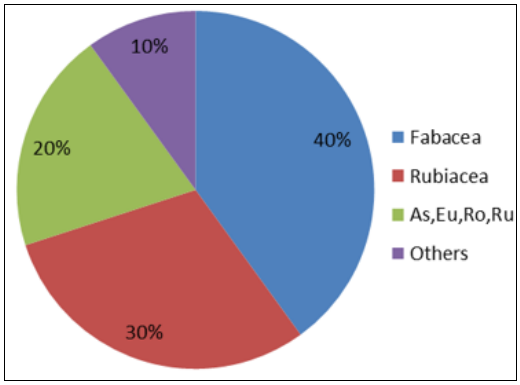

Fig 1: Percentage species distribution of medicinal plants within families

4. Conclusion and Recommendation

The study documented the indigenous knowledge of medicinal plants used commonly used for treatment of bacterial diseases in Nandi County, Kenya. In this Study, 33 medicinal plant species are reported that are used in the traditional treatment of bacterial infections by Kenyan people. The data gathered in this survey therefore, provide leads in the discovery and development of phytomedicine. Hence' there is a need to develop potentially effective drugs while noting dangerous drugs and practices that should be discarded.

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Conflicts of interest

There are no conflicts of interest

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