

Medicinal Plants Used In Managing Diseases Of The Respiratory System Among The Luo Community: An Appraisal Of Kisumu East Sub-County, Kenya

James Kiamba Mailu (✉ jkmailu@gmail.com)

University of Nairobi <https://orcid.org/0000-0002-3236-3311>

Joseph Mwanzia Nguta

University of Nairobi College of Agriculture and Veterinary Sciences

James Mucunu Mbaria

University of Nairobi College of Agriculture and Veterinary Sciences

Mitchel Otieno Okumu

University of Nairobi College of Agriculture and Veterinary Sciences

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Abstract

Background

Respiratory diseases cause many deaths in children under 5 years of age particularly in Africa. The efficacy of current treatment differs among respiratory diseases and adverse effects may depend on dosage, duration of treatment, and the type of drug. Poor access to healthcare in rural areas makes many people in such communities to rely on traditional medicine. Most knowledge on traditional medicine makes use of indigenous remedies which are often undocumented and are at risk of being lost. Ethnobotanical data on medicinal plants used in managing diseases of the respiratory system may facilitate the search for new pharmaceutical agents.

Methods

Semi-structured questionnaires were used to collect information from 30 traditional medicine practitioners in Kisumu East Sub County. The sociodemographic characteristics of the informants, the local names of the plants used, their habit, active parts, indications, and methods of preparation, as well as routes of administration, scientific identity, and conservation status were recorded. A literature search was conducted via PubMed, Google Scholar, and Research Gate to identify other reported activities of the plants.

Results

Most practitioners were female (86.7%), were aged between 61 and 70 years (43.3%), had no formal education (56.7%), and had 21-30 years of practice (30%). A total of 45 plant species, belonging to 43 genera and 28 families were identified. Leguminosae and Rutaceae were the most dominant plant families, leaves were the most frequently used (33%), and trees were the most common habit (44.4%). Cough was the most common indication, decoction was the most common method of administration (68.8%), most preparations were taken orally, and most plants were collected in the wild (79.2%). Literature search established that at least 42/45 plant species had pharmacological activities.

Conclusions

Many plant species reported in this study have similar traditional uses in other communities. One plant; *Keetia gueinzii* (Sond.) Bridson was reported for the first time in the management of asthma, pneumonia, and cough. Documentation and preservation of ethno medicinal knowledge in the study area is of prime concern as most practitioners are advanced in age with little formal education. Plans to conserve some of the medicinal plants documented here should be initiated. Scientific validation of the traditional claims made is also needed.

Background

The global burden of respiratory diseases makes for daunting reading. Lower Respiratory Tract Infections (LRTI) and Chronic Obstructive Pulmonary Disease claimed approximately six million human lives in 2016 [1]. The situation is quite similar in Sub-Saharan Africa including Kenya where the burden of communicable diseases including those of the respiratory system is quite high [2].

Diseases of the respiratory system have a negative impact on individual productivity and are responsible for more than 10 percent of all disability-adjusted life years [3]. This statistic is second only to diseases of the cardiovascular system [3]. Moreover, with regard to the sum of years of life lost due to early death, acute respiratory diseases were ranked highly by the 2014 WHO Kenya Statistical profile [4]. Furthermore, according to a 2013 economic survey by the Kenya National Bureau of Statistics, pneumonia and tuberculosis were responsible for about 13.7 percent of all total deaths in the Nyanza region [5]. It is important to note that illnesses including those of the upper respiratory tract are the second leading cause of death in Kisumu County

Kisumu County Poor access to healthcare and scarcity of health resources in rural areas such as many parts of Kisumu East Sub County makes many inhabitants of such areas to rely on indigenous plant resources to manage common disease conditions such as those that affect the respiratory system. Remedies that make use of indigenous resources may hold the key concerning the future management of diseases of the respiratory system, and could potentially be integrated into mainstream healthcare [6]. However, their potential remains largely untapped owing to inadequate documentation among practitioners of traditional medicine.

The fact that the knowledge of traditional herbal medicine is by far and large an extension of people's culture [7], it is imperative that calculated steps are taken to protect the knowledge of these communities in the face of rapid infrastructural developments that are bound to lead to the loss of cultural lands and loss of plant resources [8]. In view of this, the aim of the current study was to collect ethnobotanical data on plants used in the management of respiratory diseases in Kisumu East Sub County.

Materials And Methods

Ethical approval and consent to participate in the study

Ethical approval for the study was obtained from the Biosafety, Animal Use and Ethics committee of the University of Nairobi (Ref: FVM BAUEC/2019/210). Approval was additionally sought from regional administrators (the area chief and assistant chief) who were also duly made aware of the study's objectives. The scope, possible benefits and risks of the study were explained to all willing participants (practitioners of traditional medicine) and consent forms were made available to them for signing.

Study area.

The study was conducted in Kisumu East Sub County in Western Kenya (Fig. 1). The study area is approximately 365 Kilometers from Nairobi (the administrative capital of Kenya) and covers an area of approximately 135.9 square kilometers. It lies within latitudes 0°20'South and 0°50'South and longitudes 33°20'E and 35°20'E and comprises of several administrative wards including Kolwa Central, Kolwa East, Manyatta B, Nyalenda A and Kajulu East and West [9]. Moreover, the population in this area is about 220,977 according to the 2019 Kenya Population and Housing Census [5]. It receives an annual relief rainfall of between 1200 mm and 1300 mm and annual temperatures range between 20°C to 35°C. The major economic activities of residents include fish farming, and agriculture (sugar, livestock and poultry farming)[9].

Data collection

The study was conducted between March and September 2019. Ethnobotanical data was obtained by using semi-structured questionnaire. The target respondents were local traditional medicine practitioners with good ethnobotanical knowledge of the plants used in managing respiratory diseases and related symptoms. Thirty local traditional medicine practitioners were selected for interviews which were conducted both in Kiswahili and Luo dialect with the aid of a botanist familiar with the language. Each of the respondents were interviewed individually to ensure confidentiality. The interviews sought to answer the following questions;

- Which plant parts are most commonly used in preparing the indigenous remedies indicated for respiratory illnesses?
- Which methods are adopted in preparing the indigenous remedies?
- Which respiratory illnesses are most commonly treated with medicinal plants in the study area?
- Which plant species are used in the preparation of the remedies?
- How are the indigenous remedies administered?

Collection and identification of plants specimen

Several trips were made to the homesteads of the herbalists to facilitate the collection of the specimens in the field. Voucher specimens were collected and pressed on site and later identified by a botanist and deposited at the University of Nairobi Herbarium. Information collected included the vernacular name, plant part used, plant habit, plant status, method of preparation, and route of administration.

Data analysis

Frequencies and percentages were used to analyze the collected sociodemographic data of the respondents. Frequency of citation was used as a parameter to evaluate the collected ethnobotanical data.

Relative Frequency of Citation (RFC)

This was done to determine the number of respondents who considered particular plant species as worth mentioning in the management of diseases of the respiratory system. The value was calculated using the formula described by Tardio and Santayana [10];

$$RFCs = \frac{FCS}{N} = \sum_{i=1}^{iN} URi / N$$

Where Fc is the number of respondents who cited a particular species and N is the total number of respondents.

Results

Socio-demographic information

The sociodemographic information of respondents is summarized in Table 1. About 86.7% of all respondents were female, and aged between 61 and 70 years of age (43.3%). The average age of the female traditional healers was 61.6 years while the average age of their male counterparts was 51.5 years of age. Seventeen of the herbalists (56.7%) had no formal education while only 1 had secondary education. It was observed that both sexes had extensive years of practices. The mean years of practice for male and female practitioners of traditional medicine in the study area was 27 years and 25 years respectively.

Table 1
Demographic characteristics of respondents (n = 30)

Variable (n = 30)	Frequency (percentage)
Gender	4 (13.3)
Male	26 (86.7)
Female	
Age	5 (16.7)
31-40	1 (3.3)
41-50	5 (16.7)
51-60	13 (43.3)
61-70	6 (20)
>70	
Education	17 (56.7)
None	12 (40)
Basic	1 (3.3)
Secondary	
Years of experience	5 (16.7)
1-10	8 (26.7)
11-20	9 (30)
21-30	4 (13.3)
31-40	2 (6.7)
41-50	2 (6.7)
> 50	

Diversity of medicinal plants identified and their use

Table 2 is a summary of the family, scientific name, local name, voucher No., habit, status, and part used, indication, method of preparation, route of administration and relative frequency of citation of medicinal plants used in managing respiratory diseases in Kisumu East Sub County.

Table 2

Plants used in managing diseases of the respiratory system among the Luo community of Kisumu East Sub County

Family	Scientific name	Local name	Voucher No.	Habit	Status	Part used	Condition managed	Mode of preparation/ Route of administration
Acanthaceae	<i>Acanthus polystachyus</i> Delile		JM2019/284/003	Shrub	Wild	R	Cough	D/O
Asphodelaceae	<i>Aloe kedongensis</i> Reynolds	Ogaka	JM2019/194/030	Shrub	Wild	L	Asthma, Pneumonia	C/O
Amaryllidaceae	<i>Allium sativum</i> L.	Otungu	JM2019/194/031	Herb	Cultivated	Bu	Allergies	Chew or C/O
Anacardiaceae	<i>Rhus natalensis</i> Bernh.	Sagla	JM2019/194/021	Shrub	Wild	R	Asthma	C/O
Apiaceae	<i>Steganotaenia araliacea</i> Hochst.	Nyaniang-liech	JM2019/118/006	Tree	Wild	R/ SB	Pneumonia	D/O
Apocynaceae	<i>Carissa edulis</i> (Forssk.) Vahl	Ochuoga	JM2019/194/022	Shrub	Wild	R	Common cold, pneumonia, asthma	D/O
Asteraceae	<i>Artemisia annua</i> L.	Nyumba	JM2019/269/001	Herb	Wild or cultivated	L	Asthma	D/O
	<i>Microglossa pyrifolia</i> (Lam.) Kuntze	Nyabung -odide	JM2019/194/006	Shrub	Wild	L/R	Cough	M, C/O
	<i>Tithonia diversifolia</i> (Hemsl.) A. Gray	Mafua/maua	JM2019/194/012	Shrub	Wild	SB/L	Asthma	C/O
Bignoniaceae	<i>Kigelia africana</i> (Lam.) Benth.	Yago	JM2019/194/003	Tree	Wild or cultivated	Fr/SB	Pneumonia	D/O
Burseraceae	<i>Commiphora africana</i> (A.Rich.) Engl.	Arupiny	JM2019/194/007	Tree	Wild	R	Pneumonia	D/O
Canellaceae	<i>Warburgia salutaris</i> (G.Bertol) Chiov	Abaki	JM2019/244/001	Tree	Wild or cultivated	SB	Asthma, allergy, chest pain, pneumonia	D/O
Caricaceae	<i>Carica papaya</i> L.	Apoyo	JM2019/269/002	Tree	Cultivated	R/L	Bronchitis	D/O
Combretaceae	<i>Terminalia brownie</i> Fresen	Minera/ Manera	JM2019//058/016	Tree	Wild or cultivated	SB	Asthma, pneumonia, common cold	D/O
Convolvulaceae	<i>Ipomoea kituiensis</i> Var	Obinju	JM2019/194/028	Shrub	Wild	L	Cough	D/O
Ebenaceae	<i>Euclea divinorum</i> Hiern.	Ochol	JM2019/194/023	Shrub	Wild	R	Pneumonia, asthma	D/O
Euphorbiaceae	<i>Croton megalocarpus</i> Del.	Ofunja muri	JM2019/194/015	Tree	Wild	L	Pneumonia	D/O
	<i>Croton dichogamous</i> Pax	Rachar	JM2019/178/001	Tree	Wild	R	Asthma	D/O
Hypericaceae	<i>Harungana madagascariensis</i> Lam. Ex Poir	Arema	JM2019/058/005	Tree	Wild	L	Cough	D/O
Iridaceae	<i>Gladiolus dalenii</i> Van Geel	Obuya	JM2019/284/001	Corm	Wild	Corm	Asthma, allergy	P/N
Lamiaceae	<i>Clerodendrum myricoides</i> (Hochst.) R.Br.ex Vatke	Okwerogweno/sangla	JM2019/058/021	Shrub	Wild	R/L	Pneumonia, asthma	D/O
	<i>Plectranthus barbatus</i> Andr.	Okita	JM2019/058/009	Shrub	Wild	L	Asthma, pneumonia, allergy	D/O

Family	Scientific name	Local name	Voucher No.	Habit	Status	Part used	Condition managed	Mode of preparation/ Route of administration
	<i>Vitex doniana</i> Sweet	Kalemba	JM2019/194/009	Tree	Wild	L/SB	Allergies, common cold	D/O
Leguminosae	<i>Acacia robusta</i> Burch.	Otiep	JM2019/214/001	Tree	Wild	SB/RB	Bronchial obstruction	C/O
	<i>Albizia zygia</i> (DC.) J.J.Macbr.	Oturbam	JM2019/224/002	Tree	Wild	SB	Pneumonia	D/O
	<i>Rhynchosia elegans</i> var. <i>elegans</i>	Jandarusi/Jandalusi	JM2019/284/002	Herb	Wild	Rt	Cough	C/O
	<i>Tamarindus indica</i> L.	Chwaa	JM2019/194/018	Tree	Wild or cultivated	Fr/SB	Cough, general body malaise	D/O
	<i>Tylosema fassoglense</i> (Kotschy ex Schweinf.) Torre & Hillec.	Ombasa	JM2019/194/016	Climber	Wild	R	Flu, pneumonia, asthma	D/O
Meliaceae	<i>Azadirachta indica</i> (L) Burm.	Mwarubaine	JM2019/269/003	Tree	Wild or cultivated	L	Cough	D/O
	<i>Khaya senegalensis</i> Desr. A. Juss	Tido	JM2019/194/019	Tree	Wild	SB	Common cold, cough	D/O
Molluginaceae	<i>Mollugo nudicaulis</i> Lam.	Ataro	JM2019/138/001	Herb	Wild	L	Cough	Chewed or D/O
Moringaceae	<i>Moringa oleifera</i> Lam.		JM2019/269/004	Tree	Cultivated	L	General body malaise	D/O
Myrtaceae	<i>Eucalptus camaldulensis</i> Dehnh	Bao	JM2019/269/005	Tree	Wild or cultivated	L	Common cold	D/O
	<i>Syzygium cumini</i> (L.) Skeels.	Jamna	JM2019/194/008	Shrub	Wild	SB	Cough	C/O
Olacaceae	<i>Ximenia Americana</i> L.	Olemo	JM2019/269/006	Shrub	Wild	R/SB	Cough	C/O
Ranunculaceae	<i>Clematis hirsuta</i> Guill. & Perr	Achogo	JM2019/269/007	Climber	Wild	L	Common cold	D/O
Rubiaceae	<i>Gardenia ternifolia</i> Schumach. & Thonn.	Rayudhi	JM2019/194/014	Shrub	Wild	R	Cough, Pneumonia	D/O
	<i>Keetia gueinzii</i> (Sond.) Bridson	Atego	JM2019/264/001	Shrub	Wild	RB	Asthma, pneumonia, coughing, allergy	P/N
Rutaceae	<i>Harrisonia abyssinica</i> Oliv.	Pedo	JM2019/194/001	Shrub	Wild	R	Cough, pneumonia, asthma	D/O
	<i>Teclea nobilis</i> Del.	Madat/midat	JM2019/194/024	Tree	Wild	R/L	Asthma, common cold	D/O
	<i>Toddalia asiatica</i> L.	Ajua/Nyalwet- kwach	JM2019/194/017	Shrub	Wild	L/R	Common cold, pneumonia, throat infection	C/O
	<i>Zanthoxylum chalybeum</i> (Eng) Engl.	Roko	JM2019/269/008	Tree	Wild	SB/RB	Pneumonia	D/O

Family	Scientific name	Local name	Voucher No.	Habit	Status	Part used	Condition managed	Mode of preparation/ Route of administration
	Zanthoxylum gillettii (De Wild.) P.G Waterman	Sogo-maitha	JM2019/224/001	Tree	Wild or cultivated	SB	Asthma, pneumonia, coughing, General body malaise	D/O
Vitaceae	Cissus rotundifolia (Forssk.) Vahl	Minya/katera	JM2019/194/026	Climber	Wild	L	Throat infection, pneumonia, coughing	D/O
	Rhoicissus revoilii Planch	Rabong'o	JM2019/269/009	Shrub	Wild	Rt	General body malaise	D/O

RFC: Relative Frequency of citation, SB: stem bark; R: roots; L: leaves; Rt: root tuber; RB: root bark; Fr: fruit; Bu: bulb; C: concoction (prepared by boiling plant part of different plants in water); D: decoction(prepared by boiling part in water); P: powdered (Plant part is dried and ground); M: macerate(Plant part is soaked in water); I: inhale; O: oral

Forty-five plant species belonging to 43 genera distributed among 28 families were reportedly used in herbal preparations for management of respiratory infections. Leguminosae and Rutaceae families were the most dominant with 5 species each, followed by Asteraceae and Lamiaceae families with 3 species each. Table 2. Euphorbiaceae, Meliaceae, Myrtaceae, Rubiaceae and Vitaceae family had 2 species each. Table 2. The other families had 1 species only. The identified 45 species comprised of trees (44.4%), shrubs (37.8%), herbs (8.9%), climbers (6.7%) and corms (2.2%). Table 2. A majority of the plants were sourced from the wild (79.2%) while some were grown in the homestead (20.8%). The most cited plants were Euclea divinorum, Tylosema fassoglensis, Carissa edulis, Harrisonia abyssinica, Zanthoxylum gillettii, and Warburgia salutaris with RFC values of 0.73, 0.67, 0.67, 0.6, 0.5, 0.47 and 0.47 respectively. Table 2

Figure 2 is an overview of the utility of different plant parts of the plants documented in this study. Leaves were the most frequently used parts (33%), followed by roots (28%) and stem bark (24%). Root bark, fruits, corms, bulbs and root tubers accounted for 15%. Roots, root bark, root tuber and stem bark accounted for 60% of plants parts used in management of diseases of the respiratory system.

Dosage, mode of preparation and route of administration

Various methods were used to prepare herbal medicine used for managing diseases of the respiratory system in the study area. Table 2. The most common method was decoction (68.8%), concoction (20.8%) and chewing (4.2%). Table 2. Other methods of preparation included cold maceration, powdering and crushing prior to instillation in the nostrils which accounted for 2.1% respectively. Table 2. The main route of administration of the indigenous remedies prepared by the traditional medicine practitioners was oral. Table 2.

Pharmacological reports on the medicinal plants documented in this study

About 42/45 of the plant species documented in this study have been tested for pharmacological activity. Table 3.

Table 3

Literature review of the plants used for management of respiratory infections among the Luo community of Kisumu East sub-County

Plant name	Previously reported traditional use	Reported pharmacological/chemical activity
<i>Acanthus polystachyus</i> Delile	Malaria [22], treatment of scorpion bite [23]	No previous report of biological activity
<i>Aloe kedongensis</i> Reynolds	Malaria [24]	Aqueous leaf extracts exhibited anti-plasmodial and leishmanicidal activity [25]
<i>Allium sativum</i> L.	Malaria, wound disinfectant, intestinal infections [26], treatment of colds [14], aphrodisiac [27]	Essential oil extracts exhibited possess antimicrobial properties [28], Allicin exhibited antibacterial, antifungal, anti parasitic and antiviral activities [29]
<i>Rhus natalensis</i> Bernh.	Diarrhea, influenza [30], respiratory disorders, malaria [31]	A 1:1 v/v, CH ₂ Cl ₂ /MeOH extract showed significant anti nociceptive activities in mice [32] and the aqueous extract exhibited antibacterial activity [30]
<i>Steganotaenia araliacea</i> Hochst.	Skin diseases [33], tuberculosis[34]	Methanol and aqueous root extract showed antibacterial properties [35], the aqueous, methanol and ethanolic stem bark extracts showed diuretic activity but were also reported to cause damage to vital organs [36]
<i>Carissa edulis</i> (Forssk.) Vahl	Respiratory infections [16] Chest pains [37, 38]	Pet-ether and ethanolic extracts were active against <i>Staphylococcus aureus</i> and <i>E. coli</i> [39], the presence of alkaloids, sterols and resins was also reported [39]
<i>Artemisia annua</i> L.	Fever [14]	Methanolic and ethanolic leaf extract possessed antimicrobial activity[40], artemisia ketone, 1,8-cineole and camphor [41], the methanolic leaf extract showed antioxidant properties [42]
<i>Microglossa pyrifolia</i> (Lam.) Kuntze	Ovarian cysts [26], malaria [26, 43]	Leaf extract have antioxidant activity [44], quercetin derivatives reported [44]
<i>Tithonia diversifolia</i> (Hemsl.) A. Gray	Diabetes, malaria [45], abscesses, snake bites [46]	Ethanolic extracts of aerial parts reported to have antiplasmodial activity [47], the aqueous and ethanolic extract of stem reported to possess antibacterial and antifungal activity [48], tagitinine C reported to have anti-plasmodial activity[49]
<i>Kigelia africana</i> (Lam.) Benth.	Pneumonia [50] Tuberculosis [34], measles in children [38]	Ethanolic extracts of stem bark and fruits possessed antibacterial [51], ethanolic extracts of stem bark exhibited antifungal activity [52], methanol and water fruit extracts showed antibacterial, antifungal and anti-giardial as well as anticancer properties [53]
<i>Commiphora africana</i> (A.Rich.) Engl.	Malaria, fever [54], swollen testicles and abdominal pains [38], pneumonia [30]	Ethanolic crude root extract had antifungal and antibacterial activity[55]
<i>Warburgia salutaris</i> (G.Bertol) Chiov	Chest complaints, cough, fever, pneumonia [15] Yellow fever [56], common cold, malaria [57], and Aspergillosis [58]	Acetone extract showed fungicidal activity against <i>Fusarium</i> species [59], antimycobacterial activity [60, 61]
<i>Carica papaya</i> L.	Malaria, liver disease [22], tuberculosis [34], malaria [62, 63], fever [14]	Methanolic extract of roots showed antibacterial activity [64], the presence of alkaloids, tannins, saponins, glycosides and phenols were detected [64]
<i>Terminalia brownie</i> Fresen	Cough [65], bronchitis [66], allergy, diabetes, malaria [30, 66], clotting agent, coughs and joint stiffness [67]	Ethyl acetate extracts had irreversible anti-fertility effect [68], the aqueous root bark extract showed antibacterial properties [30], the presence of saponins, flavonoids, triterpenoids, terpenoids and steroids was also reported [68]
<i>Ipomoea kituiensis</i> Var	Constipation (Stem), digestive disorders [67]	Leaf extracts prepared by using a 1:1 v/v ratio of methanol to DCM showed acaricidal activity [69]
<i>Euclea divinorum</i> Hiern.	Stomachache [70], bleeding [71], diarrhea, typhoid, stroke [17], toothache [67]	Aqueous and ethanolic root bark extracts showed contractile activity on isolated rabbit uterine strips [72]
<i>Croton megalocarpus</i> Del.	Influenza, pneumonia, wound healing, family planning, typhoid, over bleeding during menstruation cycle and birth [17]	Petroleum ether and aqueous leaf extract exhibited antibacterial and antifungal properties [73], and triterpenes, tannins, anthraquinones, flavanols/flavones, chalcones were found present [73], the methanolic leaf extract exhibited activity[74]
<i>Croton dichogamous</i> Pax	Chest congestion (wheezing) [75], polio like-symptoms, gonorrhea, chest pains [38], threatened abortion, infertility [76]	Pesticidal activity [77]
<i>Harungana madagascariensis</i> Lam. Ex Poir	Gastrointestinal disorders [78]	The aqueous extracts exhibited in vitro antibacterial activity against <i>S. typhi</i> , <i>S. paratyphi</i> , <i>S. paratyphi B</i> and <i>S. typhimurium</i> [79], astilbin or 3-O- α -L-rhamnoside-5,7,3',4' - tetrahydroxydihydroflavonol was found to have antibacterial activity [80], alkaloids, triterpenoids, phenols, anthraquinones, anthocyanins, tannins, saponins were found to be present [79]
<i>Gladiolus dalenii</i> Van Geel	Epilepsy, diarrhea, nasopharyngeal infection, intestinal spams [81]	95% ethanolic leaf extract exhibited antibacterial activity against <i>S. pyogenes</i> , <i>K. pneumoniae</i> [82], the crude 1:1 v/v dichloromethane/methanol extract showed antifungal activity against <i>Aspergillus niger</i> [83], and alkaloids, saponins, and cardenolides were found to be present [82]

Plant name	Previously reported traditional use	Reported pharmacological/chemical activity
<i>Clerodendrum myricoides</i> (Hochst.) R.Br.ex Vatke	Malaria [84], febrile convulsions, abdominal colic [84], respiratory infections [16], pneumonia [30]	Root extracts showed antibacterial and antifungal activity [85], the aqueous and methanolic leaf extract exhibited antibacterial activity [30], [86], the methanolic leaf extract showed anti-plasmodial activity [87]
<i>Plectranthus barbatus</i> Andr.	Abdominal pain, diarrhea [88], tuberculosis, [34], malaria, [89], wounds, swelling, joint pain, stomach problems, [90], asthma [91]	Eugenol, α -pinene and β -caryophyllene isolated from extracts of the plant were reported to have larvicidal properties [92], other compounds isolated include α -pinene and manool [93], the hydro-alcoholic leaf extracts exhibited anticonvulsant activity [94]
<i>Vitex doniana</i> Sweet	Hypertension, diabetes, ulcers [95] Malaria, measles [96], gastroenteritis, diarrhea [97], diuretic, diabetes [98]	The methanolic stem bark extract showed antimicrobial activity [99, 100], the aqueous leaf extract possessed antioxidant activity [101], alkaloids, saponins, tannins, anthraquinones, terpenoids, flavonoids were reported [101], and the hydroalcoholic stem bark extract was reported to have wound healing properties [102]
<i>Acacia robusta</i> Burch.	Malaria [103], fibroids [76]	The methanol root bark extract showed antifungal activity [104]
<i>Albizia zygia</i> (DC.) J.J.Macbr.	Antimalarial activity [65], anticancer [105] Cough, fever, aphrodisiac, counter female sterility [106] Bronchial disease, fever [107]	Methanolic and hexane extracts exhibited antimicrobial activity [106], alkaloids, saponins, glycoside, steroid, resin and reducing sugars were reported [106], the ethanolic stem bark extract showed in vivo anti-inflammatory and antioxidant activity [108]
<i>Rhynchosia elegans</i> var. <i>elegans</i>	Malaria, common cold, fever [22]	No reports
<i>Tamarindus indica</i> L.	Malaria [99, 109], constipation, jaundice [65], aphrodisiac, general wellbeing [14], sexually transmitted infections [67]	The acetone stem bark extract showed antibacterial activity against <i>Proteus mirabilis</i> [64], the aqueous pulp extract showed antibacterial activity against <i>S. aureus</i> , <i>E. coli</i> and <i>P. aureginosa</i> [110], tannins, phlobatamins, alkaloids, saponins, and sesquiterpenes were found present [64]
<i>Tylosema fassoglense</i> (Kotschy ex Schweinf.) Torre & Hillc.	Epilepsy, infertility in women, renal disease, cancer [88]	Methanol extracts reported to have antibacterial activity [111], ethyl acetate extracts showed antifungal activity [112]
<i>Azadirachta indica</i> (L) Burm.	Malaria [18] Scabies, control blood sugar levels [27], tuberculosis [34]	The n-hexane extract showed antibacterial against <i>Salmonella typhi</i> and antifungal activity against <i>Candida albicans</i> [113], the 50% ethanolic leaf extract exhibited antioxidant and antibacterial properties [114], the presence of saponins, triterpenoids, alkaloids, tannins, glycosides and steroids was also reported [114]
<i>Khaya senegalensis</i> Desr. A. Juss	Diabetes, hypertension [115], hepatic inflammations, sinusitis [65], malaria [63]	Antibacterial activity against <i>Salmonella enterica</i> subsp. <i>Enterica</i> serovar <i>typhi</i> [116], the ethyl acetate extract of the leaves showed hypoglycemic activity [117], the aqueous extract showed hepatoprotective effects [118], the ethanolic extract exhibited antioxidant activity [119], the presence of saponins, tannins, reducing sugars, carbonyl or aldehyde, phlobatannins, flavonoids, terpenoids, alkaloids, cardiac glycosides, anthraquinones has also been reported [116]
<i>Mollugo nudicaulis</i> Lam.	Whooping cough and jaundice [120]	Methanolic leaves extract exhibited antioxidant and antibacterial activity [121], the whole plant extract showed antidiabetic properties [122], the presence of alkaloids, steroids, flavonoids and reducing sugars was also reported [121]
<i>Moringa oleifera</i> Lam.	Malnutrition [54], tuberculosis [34], loss of memory, prostate cancer [17], flu, asthma, hypertension, malaria [123]	The fresh leaf juice and aqueous extracts from the seeds were reported to inhibit growth of <i>P. aeruginosa</i> and <i>S. aureus</i> [124], the hepatoprotective effects of the aqueous-methanol leaf extracts against antimalarial drug intoxication [125], and the phytochemical composition (phenolics, flavonoids, terpenoids, steroids) have been reported [126]
<i>Eucalyptus camaldulensis</i> Dehnh	Tuberculosis [34], malaria, liver disorders [54], respiratory tract congestion, chronic bronchitis, coughing, tuberculosis [127]	Essential oil from leaves possessed antibacterial activity [128], the n-hexane and chloroform leaf extracts exhibited activity against <i>Helicobacter pylori</i> [129] while the methanolic extracts reportedly had antimycobacterial activity against <i>M. tuberculosis</i> and <i>M. bovis</i> [130]
<i>Syzygium cumini</i> (L.) Skeels.	Asthma, bronchitis, sore throat [131], coughing, diabetes, dysentery, ringworm, inflammation [132], diarrhea, dysentery, wounds, constipation [27]	The ethanolic bark extract has been reported to have anti-inflammatory activity [133] while the aqueous bark extract has been reported to have hypoglycemic and anti hyperglycemic activity [134]
<i>Ximenia Americana</i> L.	Throat infection, amenorrhea, wound healing, pain [135]	Methanolic root and stem bark extract was reported to have antimicrobial activity [136], the methanolic stem bark extract was reported to have antioxidant activity [137] and tannins, cyanogenetic glycosides [138], terpenoids, glycosides, steroids, phenols and triterpenoids have been found present in extracts [68]
<i>Clematis hirsuta</i> Guill. & Perr	Colds, cleanser [17], common cold, chest problems [90]	Antifungal activity against <i>Candida albicans</i> [139]
<i>Gardenia ternifolia</i> Schumach. & Thonn.	Hypertension [115], dysentery, urinary tract infections [140]	The aqueous extract showed antimicrobial activity against <i>Campylobacter coli</i> , <i>Campylobacter jejuni</i> , and <i>S. aureus</i> [140], 80% methanolic root bark extract showed in vivo anti plasmodial activity [141], and the ethanolic root extract showed virucidal activity against the African Swine Fever Virus [142]

Plant name	Previously reported traditional use	Reported pharmacological/chemical activity
Keetia gueinzii (Sond.) Bridson	Malaria [18]	No reports
Harrisonia abyssinica Oliv.	Arthritis, Sexually transmitted infections [31], stomach ache, coughs, malaria [67]	Antifungal activity [143], antifungal, antibacterial and molluscicidal activity [144]
Teclea nobilis Del.	Antipyretic [145], malaria, headache, joint pains, common cold, pneumonia, intestinal worms, chest pain [90], pneumonia and arthritis [38]	The ethanolic leaf extract exhibited antipyretic and analgesic activities and was found to be weakly active against carrageenan induced edema [146], lupeol (a pure terpenoidal compound) was isolated from the leaves and possessed anti-inflammatory, analgesic and antipyretic activities [147] and the methanolic root crude extracts possessed anti-caseinolytic activity [148]
Toddalia asiatica L.	Sore throat, malaria [149], fever, and stomach ache [150], abdominal pains, gynecologic disorders including infertility, common colds, cancer, renal disorders [88], tuberculosis [34], common cold, fever, malaria, pneumonia, chest pain [90], asthma, chest pain, toothache [17], malaria and respiratory disorders [88]	Hexane, acetone and methanol leaf extracts showed larvicidal activity [151], the ethyl acetate leaf extracts showed antifungal activity against <i>Candida albicans</i> [152], the CH ₂ Cl ₂ /MeOH (1:1) root extract showed anti nociceptive and anti-inflammatory effects [153]
Zanthoxylum chalybeum (Eng) Engl.	Tuberculosis [34], malaria [18], pneumonia [90], cough, and cervical cancer [154]	Methanolic extracts showed activity against <i>S. aureus</i> [86], aqueous stem bark extract possessed significant anti hyperglycemic activity [155], the aqueous root bark extract showed antimicrobial activity against <i>B. cereus</i> and MRSA [156], and anti-plasmodial activity [157]
Zanthoxylum gillettii (De Wild.) P.G. Waterman	Malaria [43]	50% MeOH in CH ₂ Cl ₂ extract showed anti plasmodial activity against <i>P. falciparum</i> [158], the presence of (E)- β -ocimene, linalool and E-nerolidol was detected [159] as well as peroxysimulenoline, sanguinarine, fagarine I, norchelerythrine, Trans-fagaramide, 8-Methylnorchelerythrine, and dihydronitidine [160]
Cissus rotundifolia (Forssk.) Vahl	Threatened abortion/contraception [76], pain [86], malaria, liver disease and otitis, [161] malaria [99]	Antibacterial activity [162], the aqueous leaf extracts reported to have hypoglycemic activity [163]
Rhoicissus revoilii Planch	Pneumonia, tonsillitis [164]	The ethanolic extract has been reported to have good antifungal activity against <i>Candida albicans</i> [164]

Discussion

Sociodemographic information on traditional medicine practitioners in the study area

The majority of respondents in this study primarily belonged to the older age groups in society. Older members of the society are considered more experienced in key tenets of traditional medicine and are more likely to be custodians of traditional knowledge than the younger generation [159, 160]. Studies have also argued that inexperience among the younger generation in matters of traditional medicine significantly impairs their acceptance by their communities [159, 160].

A majority of the practitioners interviewed in this study had not received any formal education which is similar to what has been observed by other authors who have postulated that the practice of traditional medicine is usually restricted to the less educated members of the society [160]. It may also be suggested that young people in the study area may not be interested in preserving their cultural heritage by learning the tradecraft of traditional medicine from the older people. Both male and female practitioners of traditional medicine in the study area had extensive years of experience. It stands to reason that the more these practitioners are involved in their tradecraft, the richer their experiences and the sharper their expertise.

Diversity of medicinal plants identified and their use

Leguminosae was the most dominant plant family indicated for respiratory illnesses in the study area. This observation differs from that of a similar study by Alamgeer and colleagues who reported that Asteraceae was the most dominant plant family indicated for respiratory illnesses in Pakistan [161]. According to Christenhusz and colleagues, Leguminosae has a large global distribution and is the 3rd largest plant family in the world (after Orchidaceae and Asteraceae) [162]. It may be suggested that the metabolites present in this plant family and their worldwide distribution may have some bearing on the decision by the traditional medicine practitioners in the study area to consider using them in their indigenous remedies. Similar trains of thought have been advanced by other workers [161].

The predominance of trees as a source of herbal therapies in the study area may have something to do with their abundance, easy availability throughout the year, and resistance to drought and seasonal variations as has been reported by others [161, 163, 164]. Leaves were the most frequently used plant parts which is a similar observation to previous studies that have attributed this to the fact that leaves are considered as important photosynthetic organs [160, 161].

There were some practitioners that reported that *Warburgia salutaris* and *Zanthoxylum gillettii* were no longer available in some parts of the study area due to poor conservation practices. The practitioners reported that in the past, the roots of these plants were commonly used to prepare indigenous remedies for various illnesses including those of the respiratory system. Moreover, it was noted during sample collection that many of the other medicinal plants were being

collected by uprooting. According to Maroyi, it is not advisable to over use the roots and stem barks of plants for medicinal value as this may sabotage efforts aimed at conserving the environment and ensuring plant biodiversity [47]. However, it is important to note that some of the practitioners had been sensitized on the conservation of wild flora. It was therefore welcome to see that some of these practitioners only collected plant parts in quantities that were sufficient for their work and which would not hamper conservation efforts. It is also worth mentioning that a local name for *Acanthus polystachyus* was not available. Instead, it was agreed that 'Nyanandi' was the closest semblance to a name that this plant could be given on account that it may have originally have been brought in from Nandi County which happens to be a County that neighbours the larger Kisumu County.

Dosage, mode of preparation, and route of administration

Factors such as the condition being managed, its' severity, and the number of years the practitioner had practiced weighed heavily on the dosage of medicinal plants applied. It was also strongly recommended that those who sought treatment from these practitioners were to follow all the instructions provided to them. Teaspoons and tablespoons were primarily used in the measurement of the powdered medicinal plant materials. Those who sought treatment from these practitioners were advised to take concoctions and decoctions measured either as glassful or cupful. It was however observed that there was ambiguity on what cup/glass size was appropriate for use. Notwithstanding, cup sizes of 300 ml or 500 ml were common among the practitioners. This trend has also been observed in a previous report that surveyed some medicinal plants used for maternal healthcare in Katsina state, Nigeria [16].

Decoctions and concoctions were the most common method of indigenous remedy preparation and were done either by the herbalist or by the patient who was given instructions on how to make the preparation. The process often involved harvesting the plants, drying them in the sun or in the house for a period of several days, and crushing them into powder with the aid of a homemade mortar and pestle. The preparations would then be stored in plastic soda bottles that varied between 500 ml and 2 liters and sold to the patients directly or in the market. Powdered plant parts could be included in tea and administered orally.

The route of administration was majorly orally. In the case of *Eucalyptus camaldulensis*, decoctions were prepared by boiling the leaves in an earthen pot and the patient was advised to cover themselves with a blanket such that the emanating steam completely engulfed them. This was done over a period of time and the patient would later be advised to take 2 teaspoons of the decoction for the management of common cold. In the event that there was no recovery, the patient was to revert back to the herbalist for further directions.

The herbalists reported that their remedies rarely failed. In the event of failure, it was the opinion of the practitioner that the patients had not followed the instructions as provided. Furthermore, minimal side effects were reported by the herbalist regarding the use of such preparations. It is not clear whether these practitioners had the capacity to identify any adverse events or whether they had any mechanisms to report such cases whenever they occurred.

Pharmacological reports on the medicinal plants documented in this study

Various ethnobotanical studies have been carried out in Kenya in a bid to identify and preserve ethno medicinal knowledge among various communities in the country. Some of these studies include those conducted by Kokwaro, Johns, Orwa and their colleagues in Kisumu [165, 166], Mukungu and co-workers in Kakamega [160], Otieno and co-workers in the Lake Victoria region [167], and Nguta and others in Msambweni [82]. To the best of our knowledge, this is the first study to document the medicinal plants used in the management of respiratory illnesses in Kisumu East Sub County.

The plants identified in the study have previously been reported to be used by various communities for managing similar ailments as well as other ailments not captured in the present study. The most cited plants in this study were *Warburgia salutaris*, *Zanthoxylum gillettii*, *Carissa edulis*, *Tylosema fassoglensis*, and *Harrisonia abyssinica*. It is interesting to note that a previous study by Kariuki and colleagues in the Kibwezi area of Kenya reported the use of *Carissa edulis* and *Clerodendrum myricoides* in the management of lower respiratory tract infections [27]. This overlap in utility seems to suggest that there may in fact be a consensus among traditional practitioners from different communities with regard to the usefulness of some of the medicinal plants in their environment. The bark and leaves of *Carissa edulis* have been reported in the management of asthma, common cold and cough [64]. Previous studies have reported the use of roots and leaves of *Toddalia asiatica* in the management of cough and common cold [106]. The root bark of *Croton dichogamus* has been reported in the management of asthma while leaves of *Moringa oleifera* have been reported in the management of tuberculosis [167]. *Croton megalocarpus* has also been previously been reported for the treatment of colds, cough and respiratory diseases [168]. A study conducted in Loitoktok District, Kenya reported the use of the decoction of leaves of *Croton megalocarpus* in the management of some respiratory illnesses [169]. *Rhoicissus revouillii* root tuber has been reported in the management of pneumonia and tonsillitis [158]. A previous study reported the use of *Terminalia brownie* in the management of cough and bronchitis [58].

There is no pharmacological evidence in current literature on the use of *Acanthus polystachyus*, *Keetia guenzii* and *Rhynchosia elegans*. However, available literature suggests that *Acanthus polystachyus* is traditionally indicated for malaria [11], and in the management of scorpion bites [12] while *Rhynchosia elegans* has been reported to be traditionally used in ethnoveterinary practice in managing backleg, anthrax, amoebiasis, malaria, cold and fever [11, 170]. To the best of our knowledge, this study provides the first report of the medicinal use of *Keetia guenzii*. *Clerodendrum myricoides* and *Zanthoxylum chalybeum* have been reported to be used in the traditional management of pneumonia. However a study by Hayelom and colleagues has reported that the root extract of *Clerodendrum myricoides* is toxic [171]. In addition, root bark extracts of *Zanthoxylum chalybeum* (Eng) Engl. have also been reported to cause impaired renal function and intestinal neoplasms [172]. These studies exemplify the need to carry out pharmacological testing and toxicity evaluation of medicinal plants traditionally indicated for various uses.

Conclusions

Many plant species reported in this study have similar traditional uses in other communities. One plant; *Keetia guenzii* (Sond.) Bridson was reported for the first time in the management of asthma, pneumonia, and cough. Documentation and preservation of ethno medicinal knowledge in the study area is of prime

concern as most practitioners are advanced in age with little formal education. Plans to conserve some of the medicinal plants documented here should be initiated. Scientific validation of the traditional claims made is also needed.

Abbreviations

LRTI: Lower respiratory tract infections; COPD: Chronic obstructive pulmonary disease; WHO: World Health Organization; BAUEC: Biosafety animal use and ethics committee; RFC: Relative frequency of citation

Declarations

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Authors' contributions

JKM: Conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, visualization, writing original draft, and writing review and editing. **JMN:** Conceptualization, investigation, methodology, supervision, validation, writing review and editing. **JMM:** Conceptualization, investigation, methodology, supervision, validation, writing review and editing. **MOO:** Formal analysis, investigation, validation, visualization, writing original draft, writing review and editing.

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Availability of data and materials

All data generated or analyzed during this study are included in the text

Ethical approval and consent to participate

Ethical approval for the study was obtained from the Biosafety, Animal Use and Ethics committee of the University of Nairobi (**Ref: FVM BAUEC/2019/210**). Approval was additionally sought from regional administrators (the area chief and assistant chief) who were also duly made aware of the study's objectives. The scope, possible benefits and risks of the study were explained to all willing participants (practitioners of traditional medicine) and consent forms were made available to them for signing.

Consent for publication

Not applicable

Competing interests

The authors declare no conflict of interest

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Figures

Kisumu East Subcounty.

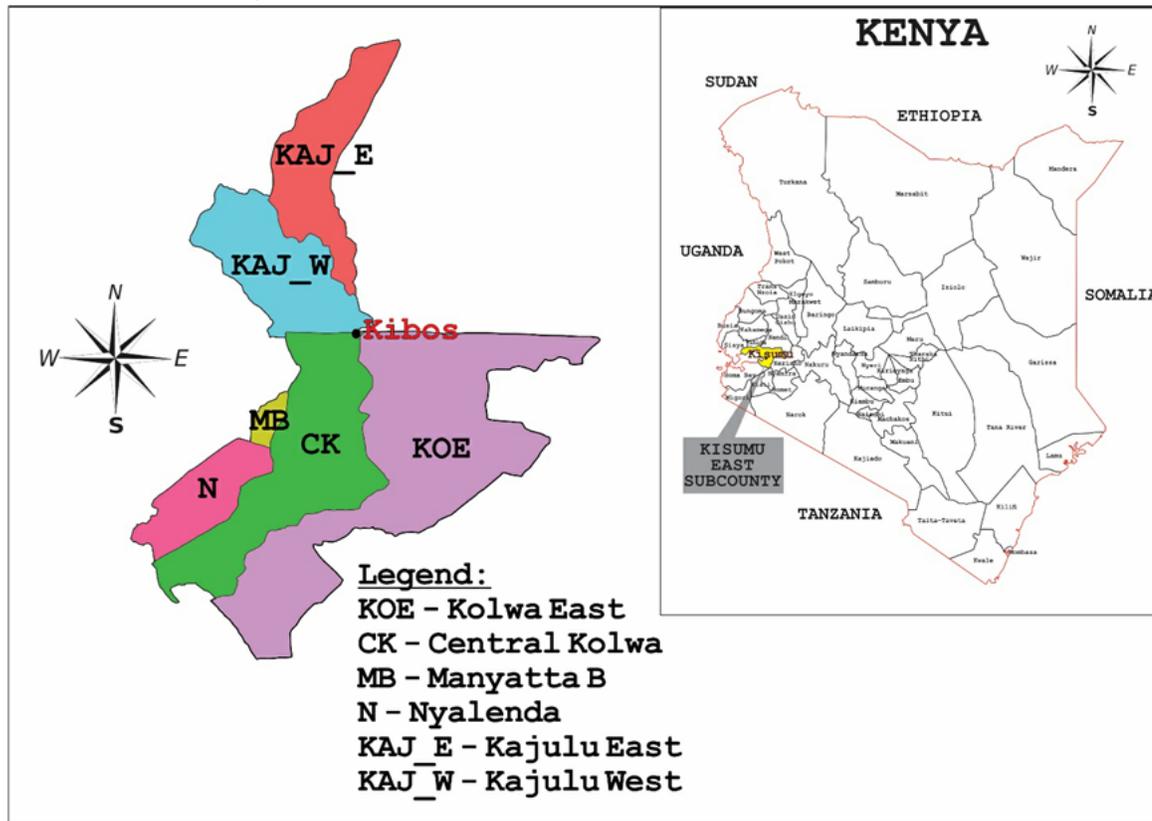


Figure 1

Map of Kenya showing Kisumu County and Kisumu East Sub County.

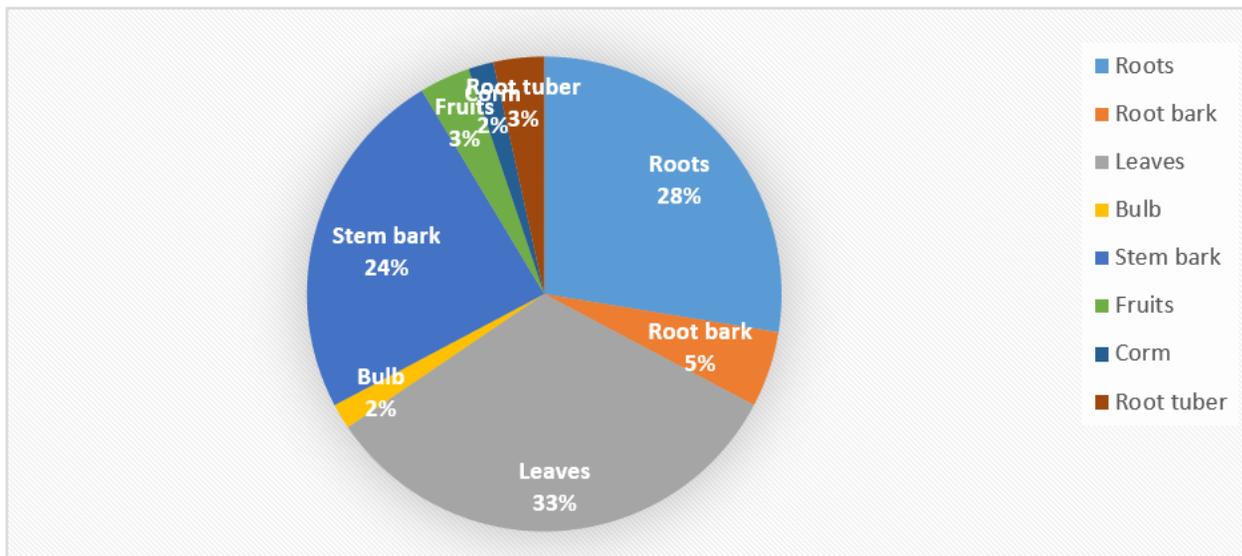


Figure 2

Plant parts used in managing diseases of the respiratory system in Kisumu East Sub County

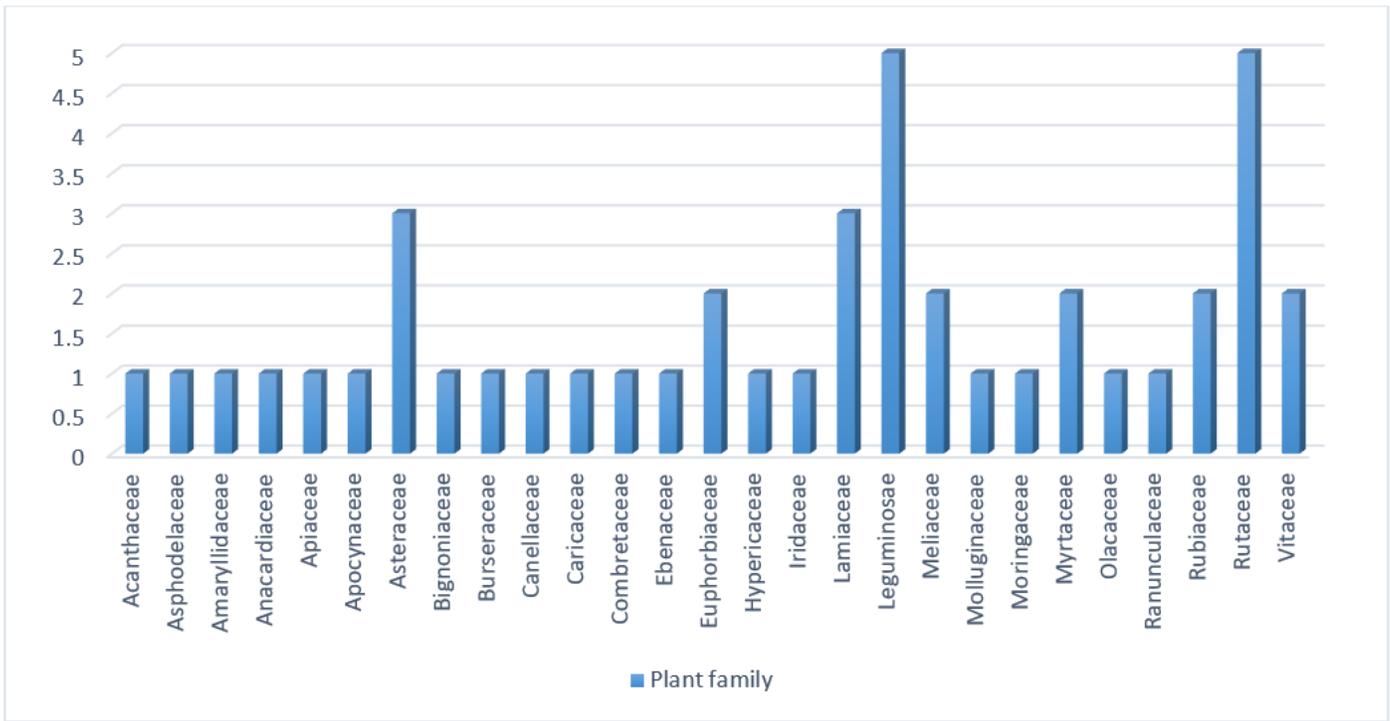


Figure 3

Distribution of medicinal plants used in managing diseases of the respiratory system in Kisumu East Sub County according to plant families.