



library@chuka.ac.ke; www.chuka.ac.ke

THENODIAGNOSTIC AND ETHNOTHERAPEUTIC SKILLS RELEVANT IN MALARIA MANAGEMENT: A CASE STUDY OF EMBU COUNTY, KENYA

Waiganjo, B.W., Githae, E.W., Warui, C.M. and Opiyo, E.A.

*School of Pure and Applied Sciences, Mount Kenya University, P. O. Box 3055-60200, Meru
Institute of Research and Graduate Studies, Gulu University; East African Herbarium, National
Museums of Kenya*

Department of Biological Sciences, Chuka University, P. O. Box 109-60400, Chuka

**Email: bwanja@mku.ac.ke; bibiannen2010@yahoo.com*

egithae@chuka.ac.ke

Citation: *Waiganjo, B.W., Githae, E.W., Warui, C.M. and Opiyo, E.A.(2014.)* The nodiagnostic and ethnotherapeutic skills relevant in malaria management: a case study of Embu county, Kenya.

In: Isutsa, D.K. and Githae, E.W. . *Proceedings of the Second Chuka University International Research Conference held in Chuka University, Chuka, Kenya from 28th to 30th October, 2015.*

ABSTRACT

Malaria tops the list of the most commonly encountered parasitic infections, and the most treatable disease by herbalists in Embu County. Indigenous knowledge relevant to disease diagnosis, treatment and prevention has not been documented in this region. The study was done between January and July, 2014 using a semi-structured questionnaire administered to herbalists who voluntarily shared information. A total of 48 herbalists (15 females and 33 males), aged between 25 and 92 years participated. Forty nine species (distributed in 27 families) were used in malaria treatment and eight species (distributed in seven families) were used to prevent mosquito bites. The herbs were administered in form of decoction or concoction. The mosquito repellants were burned, applied on the skin or hanged strategically in the house. The symptoms concurred with widely acceptable malaria signs and symptoms such as headache, vomiting, loss of appetite, joint pains and fever. While 83.3% of the herbalists were aware that malaria is spread by mosquitoes, 4.1% believed that it was caused by consuming mangoes injected by infected mosquitoes. Barks (41.6%) and roots (37.5%) were the most commonly harvested parts, while trees (57.7%) and shrubs (25.9%) were the most commonly used growth forms. Plant species believed to decline in number were *Caesalpinia volkensii* (52%), *Acacia tortilis* (31%), *Terminalia brownii* (21%) and *Strychnos henningsii* (18%). Their scarcity was attributed to human activities like overexploitation, clearing land for agriculture and cutting trees for charcoal and timber. Medicinal plants play a significant role in malaria treatment and control and indigenous knowledge relevant in malaria diagnosis and prevention is in harmony with the widely acceptable malaria signs and symptoms.

Keywords: Malaria, Diagnosis, Treatment, Prevention, Ethnodiagnostic, Herbalist

INTRODUCTION

Malaria is still the world number one killer especially among pregnant women and children below the age of five years (WHO, 2010). About 655, 000 people die from malaria and close to 216 million episodes of clinical illness that merit anti-malarial therapies occur annually (WHO, 2011). Ninety% of these deaths occur in sub-Saharan Africa (Boutin et al., 2005). In Kenya the highest incidences of the disease are in the Rift valley, Western, Central and Eastern provinces (Gitonga et al., 2010; Abdisalan et al., 2009; Snow et al., 1998). Embu County falls under the seasonal malaria transmission zone (MOH, 1994) with the disease being the leading cause of all outpatient visits (Kareru et al., 2007). Besides mortalities, malaria impedes socioeconomic development through cost of treatment and loss in work force productivity that translates to poverty and reduced economic growth (Sicuri et al., 2013; Sachs, and Malaney, 2002).

Traditional medicine is defined as practices, knowledge and beliefs that use minerals, plants, animal based remedies, spiritual therapies and exercises to prevent, treat and maintain wellbeing (WHO, 2003). It is one of the world's surest means of achieving total health (Antwi-Baffour et al., 2014). For a long time traditional medicine has been used to treat diseases in many parts of the world with approximately 80% of world's population relying on herbal medicine for their primary health care needs (WHO, 2003).

In Kenya herbalist play a significant role in treatment of malaria as well as malaria related fevers (Odhiambo et al., 2011, Kareru et al., 2007). Preference for medicinal plants is basically attributed to the fact that they are perceived as being cheap, accessible, with less or no side effects and to be more potent as compared to allopathic medicine (Ssegawa and Kasenene; 2007). Different plants species and parts are used against different stages of malaria parasite and vector. The plants are boiled and the concoction either drunk or used to bathe young children to reduce fever (Kareru et al., 2007). Others are bruised and hanged in the house or applied on the skin to prevent mosquito bites (Maia and Moore, 2011)

To diagnose, treat and prevent diseases herbalists have evolved unique indigenous knowledge (Nguta et al., 2011). This knowledge has been accumulated through instinct or observation of natural phenomenon such as feeding habits of other animals (Kareru et al., 2007). This knowledge is rarely documented and thus continual practice relies purely on the herbalist ability to remember. The knowledge is also highly guarded to an extent that it is only commonly transferred orally within family lines (Yirga, 2010). The practices therefore risk extinction in the event that the knowledge is not effectively transferred or the plants species used are depleted. This therefore calls for urgent documentation of the knowledge with an aim of promoting and preserving it.

MATERIAL AND METHODS

Study Site

Embu County is located in Eastern province of Kenya constituting of the following four constituencies Manyatta, Runyenjes, Gachoka and Siakago. The county borders the following counties; Tharaka Nithi to the North, Kitui to the East, Machakos to the South and Kirinyaga to the West. It covers 2,818 Km² and was formally subdivided into two districts i.e. Embu and Mbeere districts. The population in the county is estimated at 543, 221 (KPHC 2009).

herbalists claimed that they inherited the knowledge from a family a member either orally or from observation.

Table 1 Showing the disease treatable by herbalist (n=48)

Disease	No. of mentions	Disease	No. of mentions
Malaria	48	Diarrhea	4
Typhoid	32	Eye infection	4
Flu	28	Measles	4
Diabetes	19	Toothache	4
Asthma	18	Backaches	3
Blood pressure	17	Brucellosis	3
Gout/Joint pain	16	Cardiac problems	3
Pneumonia	16	Impotence	3
Intestinal parasites	15	Kidney problems	3
Joint pain	13	Wounds	3
Tuberculosis	11	Epilepsy	2
Sexually transmitted diseases	8	Allergy	1
Stomach aches	8	Heartburn	1
Cancer	7	Meningitis	1
Headache	7	Mental disturbance	1
Skin disease	6	Tonsil	1
Blood pressure	5	Anorexia	1

Causes of malaria

About 83% of the herbalists were aware that malaria is spread by mosquitoes. 37% of the herbalist mentioned stagnant water while 4.1% believed that consuming mangoes that are injected by infected mosquitoes as well as living in areas near bushy plantations could be the possible causes of malaria. 2% of the herbalist believed that malaria is caused by dirty water (Table 2).

Table 2: Mentioned causes of malaria (n=48)

Causes of malaria	No. of mentions	Percentage
Mosquitoes	40	83.3
Stagnant water	18	37
Mangoes injected by mosquitoes	2	4.1
Bushy plantations	2	4.1
Dirty water	1	2.0

Indigenous knowledge relevant to diagnosis of malaria

The herbalists were asked to mention signs that they look for when diagnosing malaria. Headache, vomiting, loss of appetite, joint pain and fever were the most commonly mentioned symptoms of malaria with at least 50% of the herbalist mentioning them. Cough, passing yellow urine, and drinking a lot of water were the least mentioned. (See table 3).

Medicinal plants used in malaria treatment

A total of 49 species distributed in 27 families were mentioned and scientifically identified by a taxonomist with the aid of the herbalist (Table 4). Plants belonging to family Fabaceae were the most commonly used in malaria treatment. Most of the plants mentioned were harvested from the forest by the herbalist and were harvested at night or early in the morning since this is the time they are assumed to have the highest concentration of the medicine. The herbal medicines were either used singly or in combination. Some of

the medicine was also administered with soap to make it more palatable. The dosage administered varied from one herbalist to another and between children and adults. All the interviewed herbalist avoided to treat pregnant women for fear of the drug being very strong to an extent of causing abortion. The medicine was prepared by gridding/cutting into small pieces, boiling and cooling after which the resulting concoction was administered by use of a spoon or a cup/glass. Some of the plants were also boiled and the concoction used to bathe young children. Treatment was repeated more than once in a day and was continued for between 3 days to one week. Medicinal plants used in malaria treatment in this region were popularly believed to be safe, more efficient as compared to conventional medicine, locally available and affordable. The medicine was preserved using honey and was considered safe for up to one month after preparation. In most instances the medicinal plants were stored in plastic containers or bag either in form of powder or cut in small pieces after they were thoroughly dried.

Table 3: Signs relevant in malaria diagnosis and the number of times each sign was mentioned (n=48)

Symptom	No. of mentions	Percentage
Headaches	33	68.8
Vomiting	29	60.4
Loss of appetite	28	58.3
Joint pains	26	54.1
Fever	24	50
Feeling cold	24	50
Restlessness	19	39.5
Shivering	18	37.5
Stomach aches	17	35.4
Body weakness	16	33.3
Fatigue	15	31.2
Diarrhea	15	31.2
Nausea	14	29.2
Excess sweating	14	29.2
Backaches	14	29.2
Feeling weak	13	27
Dizziness	11	22.9
Chest pain	11	22.9
Yellow eyes	6	12.5
Bitter taste in the mouth	4	8.3
Cough	3	6.25
Passing yellow urine	2	4
Drinking a lot of water	2	4

Table 4: Indicating the medicinal plants used to treat malaria in Embu County (n=48): T= tree; H= herbs; C= climbers; S= shrubs F: fruits)

Scientific name	Part used	No. of mentions	Family	Growth form
<i>Caesalpinia volkensii</i> Harms	Seeds/leaves	28	Caesalpinaceae	C
<i>Senna didymobotrya</i> (Fresen.) Irwin and Barneby	Leaves/fruits	24	Caesalpinaceae	S
<i>Tithonia diversifolia</i> (Hemsl.) A.Gray	Leaves/fruits	24	Compositae	S
<i>Schkuhria pinnata</i> (Lam.) Kuntze	whole plant	21	Asteraceae	H
<i>Terminalia brownii</i> Fresen.	Leaves/bark	20	Combretaceae	T
<i>Erythrina abyssinica</i> Lam. Ex DC.	bark/stem/roots	19	Fabaceae	T
<i>Azadirachta indica</i> A.Juss.	Leaves	17	Meliaceae	T
<i>Strychnos henningsii</i> Gilg	Stem/leaves	13	Loganiaceae	T
<i>Zanthoxylum chalybeum</i> Engl.	Leaves	11	Rutaceae	S
<i>Ajuga remota</i> Benth.	stem/leaves/roots	8	Labiatae	H
<i>Leonotis mollissima</i> Gurke	Leaves	8	Labiatae	H/S

Table 4 (Continued)

Scientific name	Part used	No. of mentions	Family	Growth form
<i>Aloe secundiflora</i> Engl.	whole plant	6	Aloaceae	H
<i>Olea europaea</i> L.	Leaves/stem	5	Oleaceae	T
<i>Vernonia lasiopos</i> O.Hoffm.	Leaves	4	Compositae	S
<i>Warburgia ugandensis</i> Sprague	leaves/bark	4	Canellaceae	T
<i>Fagaropsis hildebrandtii</i> Engl.) Milne-Redh.	Roots/bark	3	Rutaceae	T
<i>Lonchocarpus eriocalyx</i> Harms	Bark	3	Papilionaceae	T
<i>Solanum incanum</i> L.	Roots	3	Solanaceae	S
<i>Uvaria scheffleri</i> Diels	Roots	3	Annonaceae	S
<i>Zanha Africana</i> (Radlk.) Exell	Bark/roots	3	Sapindaceae	T
<i>Acacia ataxacantha</i> DC	Roots	2	Fabaceae	S
<i>Acacia drepanolobium</i> Harms ex Sjöstedt	Roots	2	Fabaceae	T
<i>Clerodendrum myricoides</i> (Hochst.) Vatke	Leaves	2	Verbenaceae	S
<i>Dombeya rotundifolia</i> (Hochst) Planch.	Stem	2	Sterculiaceae	T
<i>Harrisonia abyssinica</i> Oliv.	Bark/roots	2	Simaroubaceae	T
<i>Senna singueana</i> (Del.) Lock	Roots/bark	2	Caesalpiniaceae	T
<i>Toddalia asiatica</i> (L.) Lam.	Roots	2	Rutaceae	S
<i>Acacia mellifera</i> (Vahl) Benth.	Bark	1	Fabaceae	T
<i>Acacia nilotica</i> (L.) Willd. ex Delile	Bark	1	Fabaceae	T
<i>Acacia tortilis</i> (Forssk.) Hayne	Bark	1	Fabaceae	T
<i>Achyrothalamus marginatus</i> O.Hoffm.	Whole plant	1	Compositae	H
<i>Adansonia digitata</i> L.	Stem	1	Bombacaceae	T
<i>Albizia gummifera</i> (J.F.Gmel.) C.A.Sm.	Bark	1	Fabaceae	T
<i>Cissampelos pareira</i> L.	Tubers	1	Menispermaceae	C
<i>Croton dichogamus</i> Pax	Roots	1	Euphorbiaceae	S
<i>Dalbergia melanoxylon</i> Guill. and Perr.	Bark	1	Fabaceae	T
<i>Launaea cornuta</i> (Hochst. ex Oliv. and Hiern) C.Jeffre	Roots	1	Asteraceae	H
<i>Mangifera indica</i> L.	Roots \bark	1	Anacardiaceae	T
<i>Maytenus putterlickioides</i> (Oliv.) Exell and Mendonça	Bark/leaves	1	Celastraceae	T
<i>Maytenus senegalensis</i> (Lam.) Exell	Roots	1	Celastraceae	T
<i>Monanthes schweinfurthii</i> (Engl. and Diels) Verdc.	Roots	1	Annonaceae	S
<i>Newtonia hildebrandtii</i> (Vatke) Torre	Bark	1	Fabaceae	T
<i>Pappea capensis</i> Eckl. and Zeyh.	Bark	1	Sapindaceae	T
<i>Pentas parvifolia</i> Hiern	Bark/roots	1	Rubiaceae	S
<i>Plectranthus barbatus</i> Andr.	Leaves	1	Labiatae	S
<i>Premna resinosa</i> (Hochst.) Schauer	Roots	1	Verbenaceae	T
<i>Securidaca longipedunculata</i> Fresen.	Bark	1	Polygalaceae	T
<i>Steganotaenia araliacea</i> Hochst.	Bark	1	Umbelliferae	T
<i>Teclea simplicifolia</i> (Engl.) Verd.	Leaves	1	Rutaceae	T

Methods Used to Prevent Malaria

The most commonly mosquito repellent used in the region is *Tegetes minuta*. The plant is usually collected fresh and hanged in the house strategically to repel mosquito. Other plants used include *Allium sativum*, *Ocimum basilicum* and *Ocimum gratissimum* (See table 5). The plants are hanged in the house, applied on

the skin or burned to repel mosquitoes. 77 % of the herbalist mentioned that they use cow dung to repel mosquitoes. The cow dung was either dried and burned or freshly used to smear houses.

Table 5: Plants used to prevent mosquito bites (n=48): T=tree; H=herbs; C=climbers; S=shrubs

Scientific name	Local name	No. of mentions	Family	Mode of preparation
<i>Tegetes minuta</i> (W)	Mubagi	41	Compositae	The plant was bruised and hanged in the house
<i>Allium sativum</i> (F)	Kitunguu sumu	36	Amaryllidaceae	Crushing and applying on the skin
<i>Ocimum basilicum</i> (L)	Mataa	14	Labiatae	Burned
<i>Ocimum gratissimum</i> (L)	Makandu	8	Labiatae	Burned
<i>Azadirachta indica</i> (L)	Muarubaine	2	Meliaceae	The plant is bruised and hanged in the house
<i>Premna resinosa</i> (Hochst.) Schauer (L)	Mukarakara	8	Verbenaceae	The plant was bruised and hanged in the house
<i>Senna didymobotrya</i> (L)	Mwinu	7	Caesalpinaceae	The plant was bruised and hanged in the house

Parts Harvested

Roots are the most commonly harvested parts followed by bark, leaves, stem and whole plant. The least harvested parts were tubers, seeds and flowers. Some plants such as *Caesalpinia volkensii*, *Strychnos henningsii*, *Warburgia ugandensis* and *Erythrina abyssinica* had more than one part harvested.

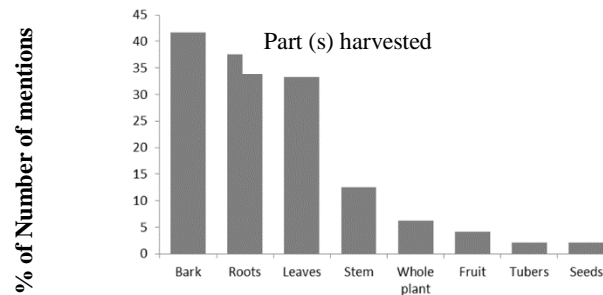


Figure 3: Showing the parts harvested

Growth forms of the parts harvested

The most frequently used growth forms for malaria treatment were trees 57.7%; shrubs 25.9%; herbs 12.9% and climbers at 7.4%

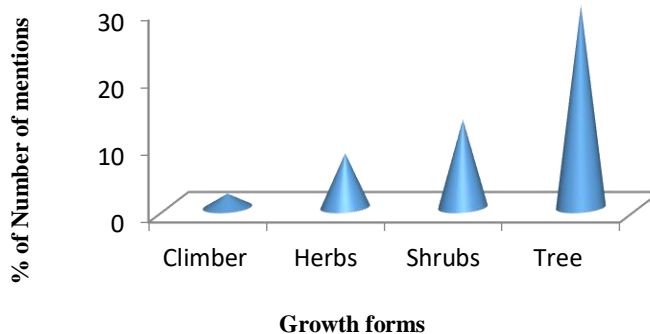


Figure 4: Indicating the growth forms commonly harvested

Species believed to be scarce

About 45% of the the plants used to treat and prevent mosquito bites were thought to be scarce. *Caesalpinia volkensii*, *Acacia tortilis*, *Terminalia brownii* and *Strychnos henningsii* were mentioned as the scarcest plants (See table 6). Among the mentioned species trees accounted tree were the most cited as being scarce 68.1% followed by shrubs 18.1%; herbs 9% and climbers 4.5%. 40.9% of these species had more than one harvested. Additionally bark/stem had the highestpercentage 59% followed by leaves 54.5%. The herbalist attributed the scarcity to overexploitation, clearing of land for agriculture purposes as well as cutting tree for use as charcoal and timber. Most of these plants are harvested from the forest since most of the herbalist did not on botanical gardens. The herbalist recommended that the best way to conserve the mentioned plants was to establish their own herbal gardens. This can be enabled through provision of seeds as well as training then in skills relevant in setting up herbal gardens at home.

Table 6: Showing the species believed to be scarce (n=48): T=tree; H=herbs; C=climbers; S=shrubs

Scientific name	Part used	No. of mentions	Family	Growth form
<i>Caesalpinia volkensii</i> Harms	seeds/Leaves	25	Caesalpinaceae	C
<i>Acacia tortilis</i> (Forssk.) Hayne	Bark	15	Fabaceae	T
<i>Terminalia brownii</i> Fresen.	Leaves/bark	10	Combretaceae	T
<i>Strychnos henningsii</i>	stem/leaves	9	Longaniaceae	T
<i>Albizia gummifera</i> (J.F.Gmel.) C.A.Sm.	Bark	8	Fabaceae	T
<i>Fagaropsis hildebrandtii</i> Engl.) Milne-Redh.	Roots	6	Rutaceae	T
<i>Senna didymobotrya</i> (Fresen.) Irwin and Barneby	Leaves	6	Caesalpinaceae	S
<i>Olea europaea</i> L.	Leaves/stem	5	Oleaceae	T
<i>Newtonia hildebrandtii</i> (Vatke) Torre	Bark	5	Fabaceae	T
<i>Securidaca longipedunculata</i> Fresen.	Bark	4	Polygalaceae	T
<i>Zanthoxylum chalybeum</i> Engl.	Leaves	4	Rutaceae	S
<i>Acacia nilotica</i> (L.) Willd. ex Delile	Bark	2	Fabaceae	T
<i>Adansonia digitata</i> L.	Stem	2	Bombacaceae	T
<i>Aloe secundiflora</i> Engl.	Whole plant	2	Alolaceae	H
<i>Azadirachta indica</i>	Leaves	2	Fabaceae	T
<i>Warburgia ugandensis</i>	leaves/bark/Leaves	2	Canellaceae	T
<i>Ajuga remota</i>	Roots/stem/leaves	1	Lamiaceae	H
<i>Erythrina abyssinica</i>	bark/stem/roots	1	Fabaceae	T
<i>Solanum incanum</i>	Roots	1	Solanaceae	S
<i>Teclea simplicifolia</i>	Leaves	1	Rutaceae	T
<i>Tithonia diversifolia</i>	Leaves	1	Compositae	S

DISCUSSION

Malaria tops the list of diseases treated by the herbal doctors in Embu County. This concurs with previous finding by Kareru et al. (2007). The study revealed that the interviewed herbalist relied on observation as well as information related to physiological processes such as feeding, digestion, urination, defecation and sleep among others to diagnose malaria. Symptoms such headache; vomiting; loss of appetite; joint pains; fever accompanied by excessive sweating; fatigue; stomachache; Nausea; and diarrhea among others were attributed to malaria infection. These are in concurrent with widely accepted malaria signs and symptoms (WHO, 1999). Over 80% of the respondents were aware that malaria is transmitted by Mosquitoes. However misconceptions on both the symptoms and the cause of malaria were documented in this study. For instance passing yellow urine was one of the symptoms attributed to malaria while some respondent believed that malaria is caused by feeding on mangoes injected by infected mosquitoes. It therefore implies that there is still need to educate the herbalist on malaria diagnosis and prevention methods.

Plants belonging to family Fabiaceae are most commonly used to treat malaria in Embu County. Plants from this family are commonly known to constitute some antimalarial compounds such as terpenoids and

tannins (Duker-Eshun et al., 2004; Ahmed et al., 1999). About 49 species are used to treat malaria while six species are used to prevent mosquito bites. While some of the plants mentioned in this study have been documented elsewhere for similar use others have been validated scientifically as possessing antiplasmodial activity either *in vivo* or *in-vitro* (Nguta et al., 2011; Muregi et al., 2007). This implies that the community knowledge toward plants used to treat and prevent malaria concurred with the scientific evidence already available. However some such as *Achyrothalamus marginatus*; *Dombeya rotundifolia* and *Monanthotaxis schweinfurthii* were documented for the first in regards to malaria treatment indicating that they were either indigenous to the Embu community or perhaps relevant reference could not be accessed in literature. The study also revealed that both indigenous and introduced species are used for malaria treatment and control in the region. This implies that traditional medicine in Embu County is dynamic a phenomenon linked to influence of information exchange between people. Factors contributing to use of medicinal plants in this region include claims that they are safer, affordable and are easily available. This support previous finding (Nguta et al., 2011) thus highlighting the need to appreciate the role played by medicinal plants in addressing human medical related problems.

There was inconsistency with both the dosage and in the prescription given by different herbalist. Additionally the dosages varied between children and adult. Plants were also used singly or in combinations. Water was the main media of all medicinal preparations and in some cases honey and soup were used alongside with the drug probably to enhance palatability. Concoctions were either administered orally by use of cups, glasses or spoons or used to bathe young children to relieve fever. Scientifically efficacy of plant extracts differ between different solvent for instance while methanol extracts of *Maytenus putterlickioides* were considered active against plasmodium in vitro those of water extracts were considered in active (Muthaura et al., 2007). This call for further study on validating the efficacy water extracts of the plants used in this region.

Although leaves were the most commonly harvested parts (Asase et al., 2005) this studies revealed that bark (41.6%) and roots (37.5%) were the most popularly harvested for malaria treatment. This is probably attributed to the fact that bark and roots have high partitioning for the photosynthates or exudates (Balick and Cox, 1996) which act as toxin for protection against intruders that would consequently confer protective to human diseases. There is danger in the use of roots and bark since there is a high risk of extinction to the individual plant. Other plants such as *Mangifera indica*, *Maytenus putterlickioides*, *Pentas parvifolia*, *Senna singueana* and *Strychnos henningsii* had more than one part harvested.

Trees and shrubs were the most commonly used in the study. This could probably be linked to the fact that they are available almost in all seasons since they are relatively drought resistance and not affected by seasonal variations (Bussman and Sharon, 2006). They are also the most abundant than other growth forms in the region (Oginosaka et al., 2002). *Caesalpinia volkensii* was ranked as the scarcest plant in the region. This plant was not only reported as the most commonly used plant in the region but also the seed are harvested endangering it. Some plants commonly used in ethnomedicine have been reported to be at risk of extinction a factor contributable to unsustainable harvesting (Jeruto et al., 2008). There is therefore urgent need to educate the herbalist on sustainable use of medicinal plants.

CONCLUSION AND RECOMMENDATIONS

In this study it is evident that the medicinal knowledge of Embu community is well articulated however with the change in lifestyle and increasing pressure on land due to population growth it is feared that the knowledge might get considerably limited or disappears in the unforeseen future. This is more evident since the knowledge is still transferred orally without written records. This study recommends that some of the medicinal plants reported in this study be assayed for efficacy and safety.

REFERENCES

- Abdisalan, M.N., Peter W.G., Victor, A.A., Anand, P.P., Simon, I.H., et al., 2009: The risks of malaria infection in Kenya in 2009. *Biomedical central infectious disease* 9: 180.
- Ahmed, El-Tahir., Gwiria, M.H.S. and Sami, A.K. 1999. Antiplasmodial activity of selected Sudanese medicinal plants with emphasis on *Acacia nilotica*. *Phytotherapy research* 13: 474-478
- Balick, M. J. and Cox, P.A. 1996. *Plants, people and culture: the science of ethnobotany*. W. H. Freeman and Company: Scientific American Li-brary, New York.
- Bussmann , R.W. and Sharon, D. 2006. Traditional medicinal plant use in Northern Peru: tracking 2000 years of healing culture. *Journal of Ethnobiology and Ethnomedicine* 2: 47.
- Engers, H.D., Bergquist, R. and Modabber, F. 1996. Progress on vaccines against parasites.
- Brooker, S. 2010: Implementing school malaria survey in Kenya: towards a national surveillance system. *Malaria Journal* 9:306.
- Gyllenhaal, C. Kadushin, M.R., Southavong, B., Sydara, K., Bouamanivong, S., Xaiveu, M.M. and Tsabang, N. 2010. Ethnobotanical uses of medicinal plants of two
- Kipkore, W., Wanjohi, B., Rono, H. and Kigen, G. 2014. A study of the medicinal plants used by the Marakwet Community in Kenya. *Journal of ethnopharmacology and ethnomedicine* 10:24.
- Kiringe, J.W. 2006 A survey of traditional herbal remedies used by the Maasai of Southern Kaijiado District, Kenya. *Ethnobotany research and application* 4:061-073.
- Kirira, P.G., Rukunga, G.M., Wanyonyi, A.W., Muregi, F.M., Gathirwa, C.N., Omar, S.A., Tolo, F., Mungai, G.M. and Ndiege, I.O. 2006. Anti-plasmodial activity and toxicity of extracts of plants used in traditional malaria therapy in Meru and Kilifi Districts of Kenya. *Journal of Ethnopharmacology* 106: 403-407.
- Koch, A., Tamez, P., Pezzuto, J. and Soejarto, D. 2005. Evaluation of plants used for antimalarial treatment by the Maasai of Kenya. *Journal of ethnopharmacology* 101 1-3: 95-9
- Kokwaro, J.O. 1976. *The medicinal plants of East Africa*. Kampala: East Africa Literature Bureau.
- Maia, M.F. and Moore, S.J. 2011. Plant-based insect repellents: a review of their efficacy, development and testing. *Malaria Journal* 10 Suppl 1:S11
- Makler, M.T., Palmer, C.J. and Ageri, A.L. 1998. A review of practical techniques for the
- Musa, S.M., Abdelrasool, F.E., Alsheikh, E.A., Ahmed, L.A.M.N., Mahmoud, A.L.E. and Yagi, S.M., 2011: Ethnobotanical study of medicinal plants in the Blue Nile State, South-Eastern Sudan. *Journal of Medicinal Plants Research* 517: 4287-4297.
- Muthaura, C.N., Rukunga, G.M., Chhabra, S.A., Omar, S.A., Guantai, A.N., Gathirwa, J.W., Tolo, F.M., Mwitari, P.G., Keter, L.K., Kirira, P.G., Kimani, C.W., Mungai, G.M. and Njagi, E.N.M. 2007. Antimalarial activity of some plants traditionally used in treatment of malaria in Kwale district of Kenya. *Journal of ethnopharmacology* 112:545-551
- Zirihi, G.N., Mambu, L., Guédé-Guina, F., Bodo, B. and Grellier, P. 2005. In vitro antiplasmodial activity and cytotoxicity of 33 West African plants used for treatment of malaria. *Journal of Ethnopharmacology* 98: 281–285.
