Ecological Knowledge of indigenous plants among the Marakwet Community (Embobut Basin), Elgeyo Marakwet County (Kenya)

Bernard K. Wanjohi, Elizabeth W. Njenga, Vincent Sudoi, Wilson K. Kipkore, Henrietta L. Moore and Matthew I.J. Davies

Research

Abstract

Background: Sustainable utilization and conservation of indigenous plants requires information on the Indigenous Ecological Knowledge (IEK). This study assessed IEK on plant species identification, use and management of indigenous non-medicinal plants among the Marakwet Community in Embobut Basin in Kenya, which has a wealth of such knowledge.

Methods: Plant inventories for this study were done through interviews with seven elders from the Marakwet Community who are considered to have immense IEK. The same knowledge was also evaluated among 116 local community members using checklist-based questionnaires.

Results: There were 48 indigenous plant species inventoried by elders, where 4 plants (8.3%) had up to 3 indigenous names for the same plant while nine plant species (18.75%) had two names for the same plant among elders. The number of plant species that had a single and consensus name among the elders were 66.67%%. The average identification index of the species among the local was only 47.7%. Up to 58.3% of the local community members identified at least over 50% of the plant species, while 41.7% were able to identify below 50%.

Conclusions: This study demonstrates loss of IEK in the Marakwets Community of Kenya. The results of the study could be used to develop culture specific sustainable utilization and conservation strategies to preserve indigenous plants of cultural value to the rural communities. This may form the first strategy in co-management of plant resources for sustainable ethnobotanical and environmental management.

Key words: Traditional Ecological Knowledge, Indigenous plants, Kenya, Plant utilization

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Background

Plants are sources of food, fibers, firewood, shelter, medicine. Since majority of people have settled in area dominated by indigenous plants, there is increased utilization of the indigenous plants at the global scale (Shelef *et al.*, 2017; Kariuki *et al.*, 2018;

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Jiang *et al.*, 2015), which may fuel loss of indigenous plant species. Plant species loss both globally and in Africa is occurring at deadly speed. This loss is greatly reducing the store of genetic material available for future adaptation and likely involves the loss of medicinal, food and other useful plants that may be crucial to future generations (Agisho *et al.*, 2014; Kandari *et al.*, 2015; Dzerefos *et al.*, 2017).

The recognition of the local community knowledge, cultures, and the relationships with the indigenous plants species has been used by various stakeholders to enhance sustainable utilization and conservation of indigenous plant species (Hutton *et al.*, 2017; Wehi and Lord, 2017; Salako *et al.*, 2018). Rather than legislation and/or regulation, it is now widely accepted that suitable strategies to enhance sustainable utilization and management of indigenous plants should focus on local approaches involving traditional knowledge (Blanco and Carrière, 2016; Pieroni *et al.*, 2015). Here, traditional knowledge refers to the cumulative body of knowledge, innovations, practices and beliefs of indigenous and local communities that evolves through adaptive processes, shared and culturally transmitted across generations (Folke, 2004; Huntington, 2000). As a case in point, in developing measures for the use and protection of indigenous plants, the Convention on Biological Diversity (CDB) advocates for the enhancement of traditional knowledge to achieve this goal (Pilgrim *et al.*, 2009).

Most emphasis on traditional knowledge focuses on the respect and perpetuation of knowledge about the environment as espoused by Indigenous Ecological knowledge (IEK). Using IEK in stemming the tide of indigenous plant biodiversity loss, sustainable use and conservation recommend cataloguing knowledge of plants primarily in the tropical areas (Corlett, 2016). Although there are numerous published works on the plant diversity of tropical environments (Sosef *et al.*, 2017; Vellend *et al.*, 2017; Droissart *et al.*, 2018; Kimondo *et al.*, 2015; Kigen *et al.*, 2019), most of these are still based on purely scientific work that excludes the contribution of the local community members and does not reflect the IEK. Most studies so far done on plant inventories in developing countries largely focus on the taxonomic work with little emphasis on indigenous knowledge.

The effectiveness of IEK in the protection and conservation of biodiversity, rare species, protected areas and ecological processes is well recognized (Molnár and Berkes, 2018; Rana *et al.*, 2019; da Silva *et al.*, 2019; Negi *et al.*, 2018). However, changes in cultural norms, practices, westernization and globalization, particularly in Africa (Reese *et al.*, 2019), have led to the negation of IEK on plant species use and management in ongoing efforts to ensure sustainable management of plant resource. Although IEK beliefs have been applied in understanding the utilization and conservation of plant species (Irakiza *et al.*, 2016; Kariuki *et al.*, 2018; Sanoussi *et al.*, 2015), it still precludes vast areas with rich plant biodiversity. In Kenya, attempts have been made to recognize the importance of IEK in understanding the indigenous plant species among various stakeholders (Shiracko *et al.*, 2016; Tian, 2017). Nevertheless, there is still an obvious lack of practical recognition that IEK is central for identification, sustainable utilization and conservation of indigenous plants resources. This study was conducted to document the IEK of non-medicinal plants, their uses and conservation among the Marakwet Community of Kenya.

Materials and Methods

Study area

This study was conducted in the Embobut River Basin in the Elgeyo Marakwet County (Kenya) at latitude 0°58’ to 1°06’N and longitude 35°27’ to 35°33’E (Fig. 1). The Embobut forest covers an area of 21,655 hectares and is the source of Embobut River. The upper catchment is a hilly plateau with altitude ranging between 2200−3400 meters above sea level. The lower part of the study area has altitude ranging between 1000-2200 meters above sea level. The region has a mean annual rainfall of 1100 to 1500 mm. Rainfall in the region is unreliable and unevenly distributed but has two peaks in April to May and August to October and a drier spell from November to February (Rotich, 2019). The average temperature is 28°C during the wet season with a maximum of 35°C during the dry season and a minimum of 21°C in the coolest season. February is the hottest month, and June is the coolest. Soils in Embobut floodplain are ferrallitic, thick, freely draining, weakly acidic dominated by iron and aluminium sesquioxides with quartz sand and kaolinite clays. Based on vegetation cover and leaching, the soils characteristically contain no reserve of weatherable minerals rending them low in fertility (Matthew, 2014). Streams to the west of the watershed feed the Nzoia River system while to the east, it flow to Kerio River system. Human activities include livestock keeping, pastoralism, crop farming.

The main indigenous ethnic groups in the region are the Sengwer and Marakwet community. These ethnic groups have expanded into the forest and have increased the cultivation in the region leading to degradation and deforestation. This has culminated in multiple forced and contested evictions. Sadly these have not lead to regeneration of the forest and have damaged the ability to reach a negotiated settlment with an emphasis on community led conservation.

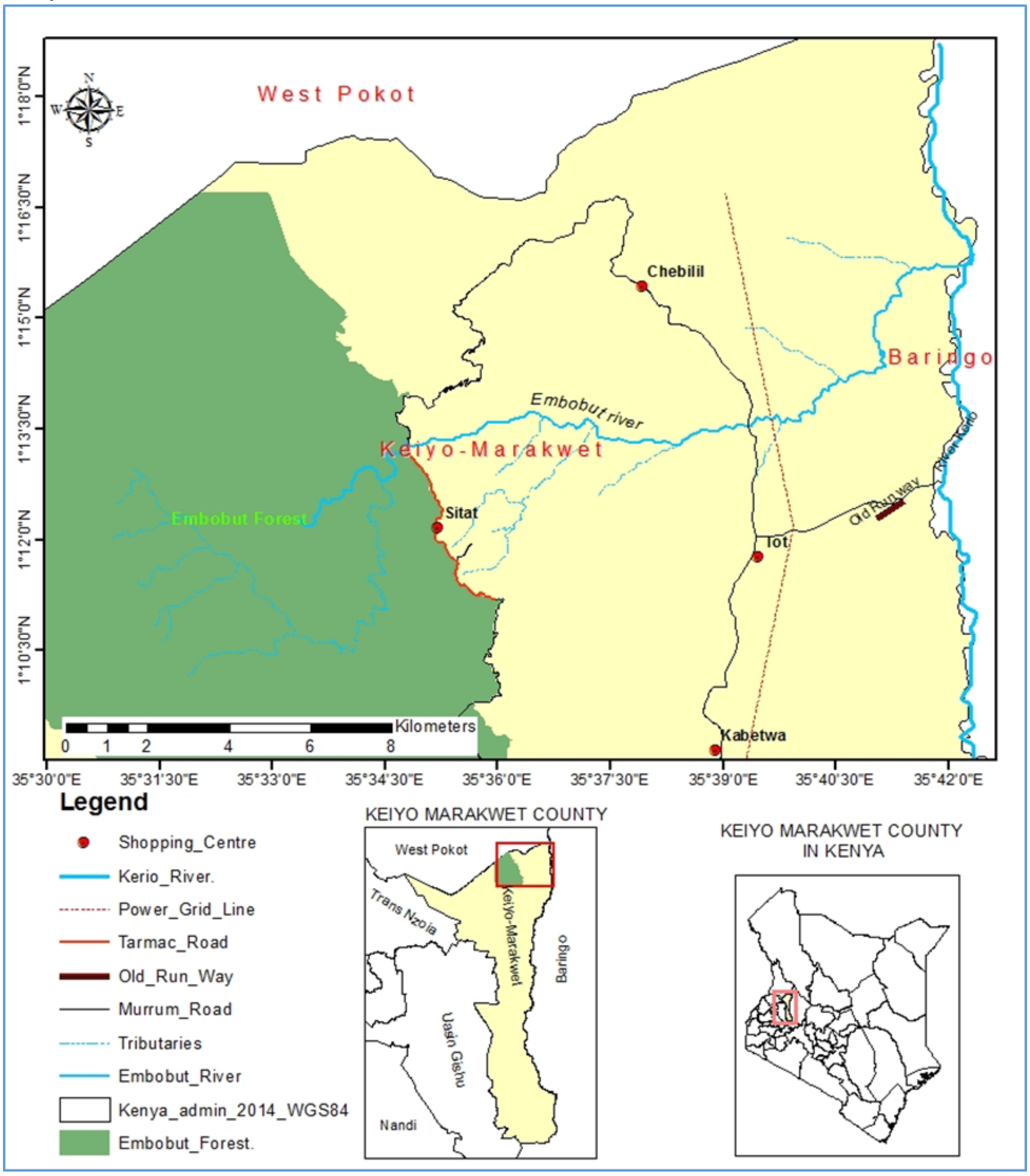

Figure 1. Map showing the study area

Research design

This study adopted an exploratory survey design, to determine information on the IEK among the Marakwet Community members. An exploratory design is carried out on a research problem when there exist few or no earlier studies to refer to or rely upon to predict an outcome. The design provided significant insight into a given situation where this is less research on the subject area, as the objective was to gather preliminary information on the IEK and help in designing measures aimed at sustainable use and management of the indigenous plant species. It was appropriate for this study since the area of IEK among the Marakwet Community has not been studied more clearly, despite knowledge that there exist large number of indigenous plants (Kipkore *et al.*, 2014).

Population, sample size and sampling

The target population are the inhabitants of Embobut Basin of Elgeyo Marakwet County. The population was approximately 26,772 (Kenya National Bureau of Statistics, 2010). From this population about 3123 people (11.6%) had access to the forest (Rotich, 2019). The sample size was determined by the formula: $n = z^2(\frac{pq}{d^2})$ (Omona, 2013).

Whereby: n = the desired minimum sample size, z = the standard normal deviation at set confidence interval, d = the acceptable range of error (0.05), p = the proportion of individuals accessing the forest

(11.6%), and q = the proportion of individuals not accessing the forest = 1−p (88.4%). Hence; d = 0.05, p = 0.116, z = 1.96 at 95% confidence level, q = 0.884.

Thus $n = 1.96^2(\frac{0.116 * 0.884)}{0.05^2}) = 157$

Therefore, the desired sample size was 157 local community members from the homesteads.

A total of seven elders from the community were sampled through snowballing technique. A total of 157 members of the local community members were selected through purposive sampling techniques. In purposive sampling, the participants were selected on the basis of some subjective criteria that was judged to be essential for the purpose of the research (Etikan *et al.*, 2016). From a total of 157 respondents, we used 116 questionnaires that were fully completed and had minimal bias (response rate of 73.9%). The socioeconomic profile of the sampled respondents is provided in Table 1. We sampled more men (71%) than women (29%) due to traditional dictates in the community. Most of the respondents were aged over 55 years (39%) followed those aged 46-55 years (29%) while those aged below 25 year were few. Most household heads sampled had no formal education (38%), which was followed by those with secondary levels of education (32%), then primary level of education (27%). Most respondents sampled practiced mixed farming (58%) followed by informal employment (16.2%). The majority of the households had stayed in the area for over 30 years (56.9%), followed by those who has have stayed in the area for 10-19 (22.4%) while those who have stayed in the region for less than 10 years were few in proportion.

Table 1. Elders and local community respondents' socio-economic and demographic characteristics

		Elders (n = 7)		**Locals (n = 116)**	
Socio-economic variables	**Characteristics**	**Frequency**	**Percent**	**Frequency**	**Percent**
Gender	Male	5	71.4	82	70.7
	Female	2	28.6	34	29.3
	Total	7	100	116	100
Age	<25	0	0.0	1	0.9
	26-35	0	0.0	11	9.6
	36-45	0	0.0	26	22.6
	46-55	0	0.0	33	28.7
	Above 55	7	100	45	39.1
	Total	7	100	116	100
Education level	None	5	71.4	44	37.9
	Primary	2	28.6	31	26.7
	Secondary	0	0.0	37	31.9
	College	0	0.0	4	3.4
	Total	7	100	116	100
Occupation	Crop farming	4	57.1	16	13.7
	Herder (Animals)	2	28.6	4	3.4
	Mixed farming	4	57.1	68	58.1
	Traditional herbalist	3	42.9	2	1.7
	Formal employed	0	0.0	3	2.6
	Business	0	0.0	3	2.6
	Technicians	0	0.0	2	1.7
	Informal employment	0	0.0	19	16.2
	Total	13*	-	117	100
Residence	Endo Sibou	3	42.9	30	25.9
	Endo Kibriem	1	14.3	30	25.9
	Embobut	2	28.6	30	25.9
	Kapiego	1	14.3	26	22.4
	Total	7	100.0	116	100.0
Duration of stay (years)	<10	0	0.0	3	2.6
	10-19	0	0.0	26	22.4
	20-29	0	0.0	21	18.1
	>30	7	0.0	66	56.9
	Total	7	100.0	116	100.0

*Total exceed the number sampled due to multiple socio-economic activities calculation is however based on number sampled

Instrumentation
Data were collected through interviews, questionnaires and observations. Interviews were conducted with the elders in the region identification of the plant species, knowledge on use and management. Later 157 members of the local community were provided with a questionnaire testing their knowledge of the same. The interviews and questionnaires were expected to answer four research questions vis:(1) which plant species do you know in the wild? (2) What are the plants used for? (3) Which plant parts are harvested for use? (4) knowledge of endangered nature of the plant. The names of the plants known by the participants were recorded in their vernacular names and a plant taxonomist identified their common and scientific names. Observation was also conducted as it has been regarded as more crucial in primary method in anthropological research, especially for ethnographic studies (Denzin, 2017). The aim of participant observation was to detect conservation methods and measures used in the study area.

Piloting
A reconnaissance visit was done to gain basic understanding of the potential respondents for the study. After the initial visit, a week was spent preparing questionnaires for the survey, and another week for training of research assistants on how to effectively administer the questionnaires and also iron out any challenges regarding translation of questions and responses (from English to the local languages and vice versa where applicable). The services of a translator were employed where necessary. A total of 20 questionnaires were piloted. The results of the pilot were used to improve the efficiency of the data collection instruments for the main survey.

Validity and reliability of research instruments
Validity is the degree to which results obtained from the analysis of the data actually represents the phenomenon under study. If such data is a true reflection of the variables, then inferences based on such data are accurate and meaningful. To test the validity of the research instruments, the questionnaire was prepared and submitted to the other ethnobotany researchers for cross checking and also to assess the reliance of the content.

Reliability of a test refers to the ability of that test to consistently yield the same results when repeated measurements are taken of the same individual under the same conditions (Kumar, 2019). Basically, reliability is concerned with consistency in the production of the results and refers to the requirement that, at least in principle, another researcher, or the same researcher on another occasion, should be able to replicate the original piece of researcher and achieve comparable evidence or results, with similar or same study population. Reliability of the research instruments was done during pilot through test-retest method and Cronbach alpha coefficient computed (Taber, 2018). The reliability of the items was based on the estimates of the variability of responses between the responses. In this study, the reliability coefficient was found to be 0.85 which was very good for the analysis.

Data Analysis
Data analysis comprised both quantitative and qualitative techniques. Quantitative data on the one hand were cleaned, coded and entered into Statistical Package for Social Science (SPSS) version 23 for analysis. Data were summarized using frequency and percentages.

Ethical considerations
This study adhered to the ethical standards required in research *vis-à-vis*: anonymity, confidentiality and informed consent. Prior to participation in the study, an informed consent of all participants was sought. The researcher acknowledges that many of the cultures from which traditional knowledge is collected are more endangered than the ecosystems in which they reside. When their local knowledge and information is published or supplied to databases, industry or the general public, a unique opportunity exists for these communities to receive economic or nonmonetary benefits from its use. If this opportunity is missed, their knowledge, once published, becomes part of the public domain and it is no longer their own to monitor and control. Anonymity was ensured by not collecting identifying information of individual subjects. Confidentiality was ensured by not divulging the identity of the respondents or their organizations.

Results

Traditional knowledge of the indigenous plant species in Embobut Basin
Interviews with the elders of the local community documented 48 indigenous plant species belonging to 24 families (Appendix 1, Local name checklist). Majority of the species belonged to the family Lamiaceae (6), followed by Asteraceae (4), Capparaceae (4) and Fabaceae (4). There were 4 plants (8.3%) with up to 3 indigenous names for the same plant. Nine plant species (18.75%) had two names for the same plant among elders. The number of plant species that had a single and consensus name among the elders were 66.67%%. Through questionnaires, the local community members identified the plant species based on the scheme of the elders, the result are presented in the same

Table 2 (Appendix 1). The average identification index of the species among the local was only 47.7%. Up to 58.3% of the local community members identified at least over 50% of the plant species, while 41.7% were able to identify below 50% where less than 20% of the local community members were able to identify 16.7% of the plants.

Knowledge of uses of indigenous plants
The sources of information for the IEK among the local community members are provided in Fig. 2. According to the participants, knowledge of the use of indigenous plant species identified during the interviews was obtained from their parents (46.7%), grandparents (39.3), relatives (11.5%) and friends (2.5%).

Among the 48 species identified, the elders were able to identify 30 use groups. These included 13 presented in Table 3 and Appendix 2 in addition to others such as boundary, brewing, broom, basketry, cleaning utensils, thatching, toiletry, gum arabica, making gutters, life fencing, mole traps, shade and walking sticks as well as for making soap. The indigenous knowledge on the use of firewood (86.2%), charcoal (73%) and timber (70.7%) elicited most responses. More than 50% of the respondents knew about the plant species used for fencing, building and ornamentals. Plant species for all the other use groups were known but the aggregate was less than 50%.

According to the elders the plants parts that were used were: roots, stems, branches, leaves, fruits, bark, canopy, thorns and flowers (Table 4). The researcher then determined the information concerning the same from the local community members (Table 4, Appendix 3). The traditional knowledge of the plant parts used was low and elicited less than 50% of the response except for leaves, branches and fruits.

Table 2. Indigenous Ecological Knowledge of plants species among the local community members in Embobut Basin (n = 116)

Attributes	Frequency	Percent
Number of species identified through TEK by elders	48	-
Number of respondents (LEK)	116	-
Number of species with 3 overlapping local names among elders	4	8.3
Number of species with 2 overlapping local names among elders	9	18.75
Number of species without overlapping local names among elders	35	50.5
Mean LEK knowledge index (%)	47.22	
Species known by 100% of the local community members	13	27.0
Species known by 90.1-99% of the local community members	8	16.7
Species known by 50.1-90% of the local community members	7	14.6
Species known by 25-50% of the local community members	12	25.0
Species known by <20% of the local community members	8	16.7

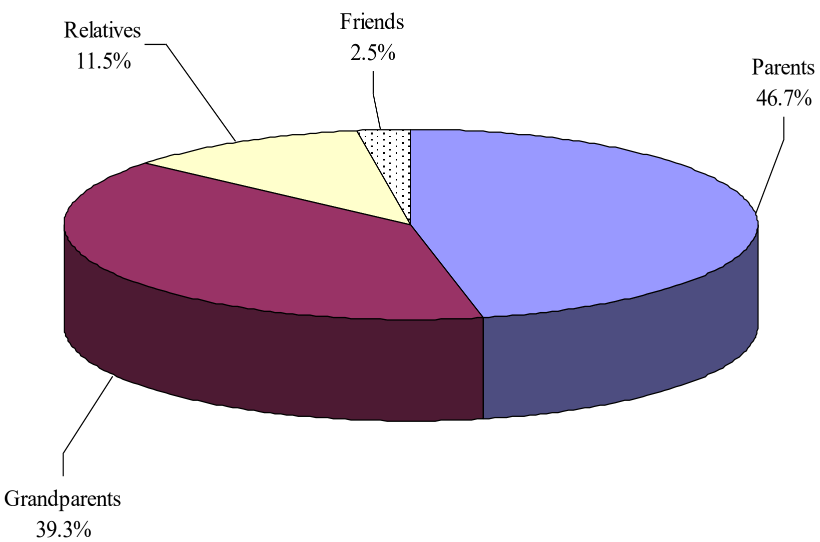

Figure 2. Sources of information on the use of indigenous plant species

Table 3. Indigenous Knowledge index of indigenous plant use among the local community members (n = 116)

Uses	Number of species used (elders)	Percent of local community members aware of the plant use
Fencing	20	51.9
Building	11	50.5
Charcoal	14	73.3
Firewood	25	86.2
Timber	6	70.7
Beehive	8	23.3
Fodder	34	27.6
Fruit	9	39.7
Handcraft	3	40.5
Nectar	9	21.7
Ornamentals	7	61.2
Rope	4	21.6
Vegetable	2	35.3

Table 4. Indigenous Knowledge of plant parts used for each of the identified species

Plant part used	Number of plant parts used (elders)	Knowledge index by local community members
Root	11	44.9
Stem	22	47.2
Branches	16	54.4
Leaf	29	56.3
Fruit	13	50.1
Bark	13	16.4
Canopy	16	23.2
Thorn	7	47.3
Flower	1	17.2

Conservation status of the indigenous plants

The IEK among elders and local community members in Embobut Basin is shown in Fig. 3. The results in the figure indicate low indigenous knowledge of the endangered species. During the study, our observation indicated several methods and measure adopted by the participants to preserve the indigenous plant species. First, strangers were not allowed to collect important plant species from the region. There is a taboo on striking fruits with a stick, as the plant will be destroyed when it loses some of its leaves and branches. During cutting of wood for timber and poles it was restricted to matured straight stems. Collection of wood for fuel, was confined to the dead woods only. Live species are not collected as firewood. Leaves to feeds goats were pruned from mature trees without allowing the animals to directly browse on the trees. The area chief, sub chief and village headsman together with selected youths were responsible for management of the local vegetation. The chief has laid down management rules governing the harvesting of indigenous plants. These include restrictions on the cutting of live species for fuel and harvesting of immature plant species. The youths discouraged members of the community from the indiscriminate felling of trees for fuel, food, fodder and collection of fruits.

Discussion

In this study, interviews held with the elders, who were considered the custodians of the IEK, there were 48 indigenous plant species belonging to 24 families which suggest occurrence of high diversity of indigenous species comparable to several parts of the tropical environment (Ojelel *et al.*, 2019; Abebe, 2019; Medley *et al.*, 2017). The high indigenous species diversity is not surprising since the area has favorable afro-montane type of environment for optimal growth of such plants. In the past, an understanding of the IEK have been called for (Kiprop *et al.*, 2017). Therefore, in this study we determined the IEK of the plant species, use and conservation among the elders and compared that knowledge among the local community members. In Kenya, the Marakwet sub-ethnic group have long history of using plants and therefore large numbers of studies have been conducted in the region (Kipkore *et al.*, 2014; Wanjohi *et al.*, 2020). The elders are custodian of the IEK in their communities while the local residents were supposed to positively identify to help in the preservation of the traditional knowledge. During the study we noticed that some of the elders could not agree on single name of several species and this was further exemplified by some elders suggesting different names for the different plants and therefore, it is clear that there may be some loss of IEK of plants. The study established that four plant species had three names by the elders; up to nine plant species had two names of a single plant species. This overlap could be an indication of loss of knowledge of these traditional plants. The loss of traditional ecological knowledge is not new and has been widely documented (Tang and Gavin, 2016). Wild plant knowledge is based on practices and oral transmission which may be vulnerable to decay and transformation through globalization. The local community members were not able to identify all the plant species based on the scheme developed by the elders, resulting in an average identification index of the species among the local being only 47.7%. Thus, it appears that the local community members either lacked IEK or simply lost the knowledge that they acquired from the parents and grandparents. The use of IEK has been used to assess the knowledge and beliefs in the utilization of important plant species (Irakiza *et al.*, 2016). The loss of IEK among local community members is now regarded as one of the threats in conservation of indigenous plant species (Gómez-Baggethun *et al.*, 2013; Gómez-Baggethun *et al.*, 2012; Reyes-García *et al.*, 2014; Tang and Gavin, 2016; Aswani *et al.*, 2018).

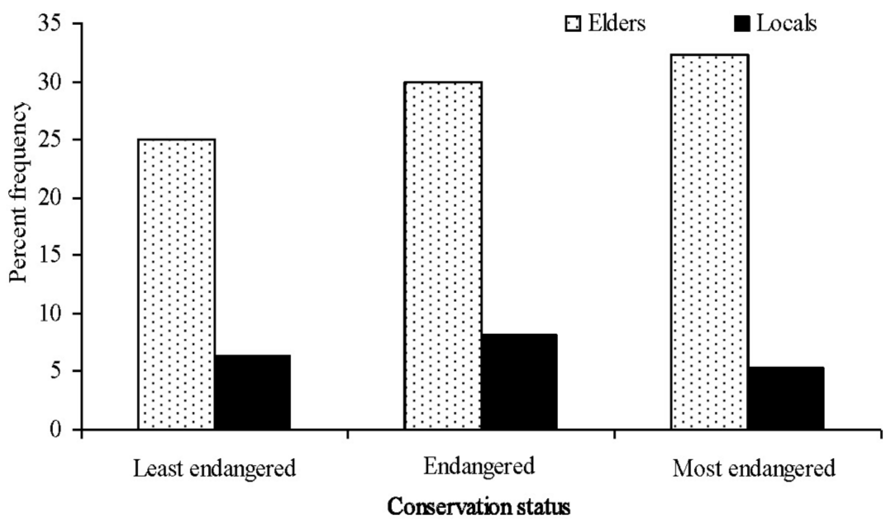

Figure 3. Indigenous Ecological Knoweldge of the conservation status of the indigenous plant species between the elders and local community members in Embobut Basin, Kenya

The IEK has been used to assess knowledge and beliefs in the utilization of important plant species (Irakiza *et al.*, 2016). Among the 48 species identified, the elders were able to identify 30 use groups. These include local uses such as fencing, building, firewood, timber, fodder, fruits, in addition to others such as boundary, brewing, broom, basketry, cleaning utensils, thatching, toiletry, gum arabica, making gutters, life fencing, mole traps, shade and walking sticks as well as for making soap. In Kenya, the plant resources provide important social and economic contribution to rural livelihoods (Otieno and Analo, 2012). The cultural uses of indigenous plants presented in the study are further supported by observations that the Marakwets use a great variety of wild species for a diverse range of purposes. The local community members obtain plants in which their livelihood depend on for such resources as fodder, fuel, fruits, vegetables, furniture, and roof thatching (Meragiaw *et al.*, 2016). The IEK for the use of firewood (86.2%), charcoal (73%) and timber (70.7%) were the most conspicuous. Indeed, more than 50% of the respondents knew about the plant species used for fencing, building and ornamentals due to the widespread use of the plant for these purposes. Therefore, despite the varied use of the plants it is clear that the local community members are not aware the exact uses of the plants which suggest that they have lost the traditional knowledge of the plant use.

Indigenous knowledge of plant parts used for various reasons indicated that leaf and branches recorded the highest knowledge on use at 56.3% and 54.4% respectively. The popularity of use of leaves was attributed to community naturally being livestock keepers. Thus, species like *Balanites aegyptica,* *Elaeodendron buchannaniii* and *Acacia elatior* are sources of the fodder for their animals especially during the dry season. In addition, fruits are also known to be source of nourishment during wet and dry season e.g. *Balanites aegyptiaca* fruits are boiled to reduce their bitterness during dry season and fed to children.

Structured interviews provided for three methods adopted by the participants to preserve the indigenous plant species to ensure their continued availability and use. It was observed that a paltry 19.7% of the respondents were aware that plants were threatened by their harvesting. Amongst the respondents they perceived local threats as 6.3% least threatened, 8.1% endangered and 5.3% most endangered. Some of the plants thought to have been most endangered included *Elaeodendron buchananii, Mystroxylon aethiopicum, Xymalos monospora* and *Commiphora mildbraedii*. This was attributed to their overuse, slow growth and their narrow ecological range. When interview for possible mitigation measures, they felt that harvesting sparingly, secrecy is applied when harvesting medicinal plants, collecting only dry wood for firewood, smearing soils when debarking was applied, to get fodder for animals only coppicing but not cutting of trees is allowed during dry season, putting signs where uprooting had been done and imposing some fines on felling some plants that were felt very useful to the community e.g. *Vachelia tortilis* and *Balanites* spp. where a goat fine was applied by council of elders when found guilty. Community imposed warning on cutting some plants like *Erythrina abyssinica* that anybody who contravened the rule would be hit by lightning when it rained.

Dependency on indigenous plant species necessitated the development of cultural practices to preserve the species. The harvesting of useful indigenous plant species from communal lands is regulated through observance of strict harvesting methods by all community members who collect the species to satisfy particular needs. Humans have shown tendency to manage plant resources according to their availability and value in households' subsistence (Leiper *et al.*, 2018). The management methods developed and used in the study included specific harvesting methods, making harvesting of some species a taboo or paying goats to the elders for cutting down some trees such as *Balanites aegyptiaca* and *Vachelia tortilis* and control of the use of plant species by the local chief.

Traditional knowledge of various communities is relevant to development in the short and long term, especially because these communities manage genetically important plant and animal biodiversity which may be significant in solving complex problems being experienced in this century. The importance of this body of knowledge is best explained by the African proverb:'when a knowledgeable old person dies, a whole library disappears' (Lalonde, 1993). This knowledge is orally passed from generation to generation, hence continuous disruption of cultural set-ups and younger people showing disinterest in learning local languages, traditional knowledge is on the verge of disappearance. The traditional medicinal plants, which may contribute greatly to trade in natural products in this century, are at risk due to habitat destruction and unsustainable rates of exploitation among other factors (Uchida *et al.*, 2018). Ethnobiologists have therefore gone a long way in securing traditional knowledge relevant for development by documentation and establishing innovative ways of integrating traditional and scientific knowledge systems for effective natural resource use and management. Research shows that integration of traditional knowledge into the market economy through economic activities based on utilization of natural resources could accelerate the acquisition and use of traditional ecological knowledge (Paneque-Gálvez *et al.*, 2018). A study in Amazon reveals that economic development that does not undermine traditional knowledge ends up contributing to preservation of traditional knowledge (Reyes-García *et al.*, 2019).

The chief in the study community extended his authority duties to monitor compliance to the rules of harvesting of indigenous plant species in his area of jurisdiction. He prevents over-exploitation of the indigenous plant resources by preventing the felling of live species for fuel and ensuring the harvesting of grass in the correct season. The indigenous plant collectors are monitored through effective leadership to apply sanctions and resolve conflicts over sustainability of the resources (Rankoana, 2016). It has been shown that the local authorities play a leading role in biodiversity conservation and management, and it is therefore commendable to include them in projects and programs for biodiversity conservation and management. This type of management method will ensure community participation in the conservation of useful species to safeguard their continued availability and use.

Members of the local communities possess knowledge of the local plants on which they are immediately and intimately dependent. The amount of traditional knowledge lost each year and means of salvaging and utilizing the knowledge needs to be considered. Majority of these plants are found in the biodiversity-rich countries such as tropical Africa including Kenya. Realization of the significant role that traditional ecological knowledge is likely to play a significant role in sustainable use and conservation of plant resources, which is reflected in various international, regional and national policies, including World Health Organization (WHO) traditional medicine strategy 2002-2005, Decade of the African traditional medicine African Unity 2001-2010 and Convention of Biological Diversity's (CBD) recognition of the need to respect, preserve and maintain knowledge and practices of traditional communities that are in favor of environmental protection.

Conclusions

The current study confirms that there exist several plant species as identified by the elders in their custody of the IEK. The species are harvested for purposes such as food, fuel and fodder for livestock fruits and vegetables. Majority of the local were unable to identify the plant species and did not correctly identify the use of the plants as well as the plant parts used by the local community members. Indeed, the identification of the conservation status of the local species was also poorly understood. This study has demonstrated that inhabitants of Embobut are losing the IEK. For this reason, the inventory generated by this study ought to be preserved for future use. Additionally, the study has shown that integrating new scientific knowledge with IEK can yield greater results in terms of sustainable utilization and management of the local indigenous flora.

The results of the study could be used to develop culture specific sustainable utilization and conservation strategies to preserve indigenous plants of cultural value to the rural communities. This may form the first strategy in co-management of plant resources for sustainable environmental management.

Declarations

List of abbreviations :BIEA: British Institute of East Africa; CBD: Convention for Biological Diversity; EAH: East African Herbarium; IEK: Indigenous Ecological Knowledge; NACOST: National Commission for Science, Technology and Innovation; SPSS: Statistical Packages for Social Sciences; UoEARF: University of Eldoret Annual Research Fund; WHO: World Health Organization

Ethics approval and consent to participate: The research team explained to the elders and the local community members the purpose of the study before data collection. The participants were asked to sign an informed consent form, as required by the Kenya's National Commission for Science, Technology and Innovation (NACOSTI). Ethical approval for this study was sought and obtained through University of Eldoret, Biological Sciences Ethics Committee (Approval 5/10/2017). The study is part of PhD project entitled "Anthropogenic and Environmental Influences of Plant Species of Embobut River Basin in Elgeyo Marakwet County, Kenya", which has already been approved by NACOSTI (Approval number NACOSTI/P/16/07860/10257).

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Availability of data and materials: The data was not deposited in public repositories.

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Authors' contributions: BKW carried out fieldwork, data analysis and drafted the manuscript. EWN and WKK configured the research project. The work was supervised by VS and MIJD. MIJD and HLM improved the manuscript. All authors read, reviewed and approved the final version of the manuscript.

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Appendix 1. Local name checklist, scientific name, common names and families of the plant species identified by the elders in Embobut Basin

Family	**Scientific Name**	**Local Name**	**Common English Name**	**Voucher No.**
Annonaceae	*Monanthotaxis buchananii* (Engl.) Verdc.	Murkuywo	Buchanan's dwaba-berry	WBK/7/16/043
Apocynaceae	*Adenium obesum* (Forssk.) Roem & Schult.	Konowarany	Desert Rose	WBK/7/16/054
Aspleniaceae	*Asplenium stuhlmannii* Hieron.	Lobchon		WBK/7/16/090
Asteraceae	*Senecio hadiensis* Forssk.	Arta (Orta)	Ragwort	WBK/7/16/148
	Mikaniopsis bambuseti (R.E.Fr.) C.Jeffrey	Chepteka (Cheptekaa)		WBK/7/16/143
	Crassocephalum montuosum (S.Moore) Milne-Redh.	Jepojompir	Rag leaf	WBK/7/16/114
	Psiadia punctulata (DC.) Vatke	Konocho	Blink Stefaans	WBK/7/16/146
Burseraceae	*Commiphora africana* (A.Rich.) Endl.	Chutwa	African Myrr	WBK/7/16/186
	Commiphora mildbraedii Engl.	Marsian		WBK/7/16/187
Campanulaceae	*Lobelia giberroa* Hemsl.	Sekekwa (Segekwa)	Giant Lobelia	WBK/7/16/190
Capparaceae	*Crateva adansonii* DC.	Kolowo	Garlic pear	WBK/7/16/199
	Cadaba farinosa Forssk.	Miskin	African ebony	WBK/7/16/195
	Boscia angustifolia A.Rich.	Sekon	Rough-leaved shepherds tree	WBK/7/16/192
	Boscia coriacea Graells	Sorukwo (Serekwo/Sorukwa)	Shepherd's-tree	WBK/7/16/193
Celastraceae	*Elaeodendron buchananii* (Loes.) Loes.	Eburwo		WBK/7/16/207
	Mystroxylon aethiopicum (Thunb.) Loes.	Kelwo (Kelyo)	Spoon wood	WBK/7/16/209

Cucurbitaceae	*Momordica rostrata* A. Zimm.	Kokocha		WBK/7/16/247
	Lagenaria siceraria (Molina) Standl.	Silangwa	Bottle gourd	WBK/7/16/244
Euphorbiaceae	*Euphorbia heterochroma* Pax.	Arukus		WBK/7/16/278
Fabaceae	*Acacia elatior* Brenan	Atat	River acacia	WBK/7/16/290
	Senegalia senegal (L.) Britton	Bilil (Belel/Pilil)	Sudan gum arabic	WBK/7/16/322
	Acacia gerrardii Benth.	Chesamis	Grey haired acacia	WBK/7/16/291
	Acacia brevispica Harms	Korniswo (Korniswa/Parnyirit)	Prickly thorn	WBK/7/16/289
Lamiaceae	*Clerodendrum johnstonii* Oliv.	Chesakau	Tinder woods	WBK/7/16/357
	Plectranthus kamerunensis Gürke	Lonwo		WBK/7/16/379
	Leucas calostachys Oliv.	Ng'eng'echwo		WBK/7/16/364
	Tetradenia riparia (Hochst.) Codd	Olonwo	Nutmeg Bush	WBK/7/16/391
	Salvia merjamie Forssk	Sakition	Sage	WBK/7/16/387
	Plectranthus laxiflorus Benth.	Simamat	Citronella spur flower	WBK/7/16/381
Malvaceae	*Abutilon mauritianum* (Jacq.) Medik.	Jeptur (Jeptula)	Velvet-leaf Indian mallow	WBK/7/16/399
	Grewia similis K.Schum.	Marsitet	African black wood	WBK/7/16/402
	Grewia bicolor Juss.	Sitet (Sitot)	White raisin	WBK/7/16/401
Menispermaceae	*Tinospora cordifolia* (Willd.) Miers	Kimukuku (Kimugugu)	Heart-leaved moonseed	WBK/7/16/422
Monimiaceae	*Xymalos monospora* (Harv.) Baill.	Kiptasi	Lemonwood	WBK/7/16/424
Moraceae	*Ficus sycomorus* L.	Mokong'wo	Faroh's tree	WBK/7/16/426
Myrtaceae	*Syzygium cordatum* Hochst. ex Krauss	Reperuo	Water-berry tree	WBK/7/16/434
Poaceae	*Pennisetum stramineum*	Kipkanerwa	Crimson fountain grass	WBK/7/16/501
	Eleucine jaegeri Pilg.	Sarkut (Sekut)	Goose grass	WBK/7/16/482
Rhamnaceae	*Zizyphus mucronata* Willd.	Nonoiwo (Nonowo)	Buffalo thorn	WBK/7/16/550
Rosaceae	*Alchemilla ellenbeckii* Engl.	Aririyo	Creeping lady's mantle	WBK/7/16/552
	Rubus pinnatus Willd.	Momon	Blackberry	WBK/7/16/559
Rubiaceae	*Pentas longiflora* Oliv.	Jepkore		WBK/7/16/574
	Keetia gueinzii (Sond.) Bridson	Tilam	Climbing Turkey berry	WBK/7/16/569
Solanaceae	*Solanum aculeatissimum* Jacq.	Kaplobotwo (Kaplopot/Kaplopotwo)	Dutch eggplant	WBK/7/16/613
	Solanum giganteum Jacq.	Kipkukai (Kipkutai)	Healing-leaf tree	WBK/7/16/614
Thymelaceae	*Gnidia glauca* (Fresen.) Gilg	Kiris	Fish Poison Bush	WBK/7/16/625
Urticaceae	*Urera hypselodendron* (Hochst. ex A.Rich.) Wedd.	Nyalya (Nyalian)		WBK/7/16/632
Zygophyllaceae	*Balanites aegyptiaca* (L.) Delile	Tuyunwo	Desert date	WBK/7/16/643

Appendix 2. Knowledge of the use of plants by the local community members (n = 116)

Scientific name	Fencing	Building	Charcoal	Firewood	Timber	Beehive	Fodder	Fruit	Handcraft	Nectar	Ornamental	Rope	Vegetable
Abutilon mauritianum				8.34			12.4						
Acacia brevispica	58.05		6.45	51.6		25.8	64.5	19.4					
Acacia elatior	90.2	82.3	89.5	67.8	54.5		90.2	58.1					
Acacia gerrardii	19.35	19.35	12.9	19.35			19.35						
Adenium obesum											12.9		
Alchemilla ellenbeckii							6.45						
Balanites aegyptiaca	99.2	219.3	90.2	90.2	6.45	58.05	87.5	187		38.7			19.35
Boscia angustifolia	12.9	6.45	19.35	12.9		12.9							
Boscia coriacea	19.35	12.9	19.35	25.8		6.45							
Cadaba farinosa				12.9			6.45						
Commiphora africana	12.9	12.9		6.45		12.9	12.9		32.25				
Commiphora mildebraedii							6.45		6.45				
Crassocephalum montuosum							6.45						
Crateva adansonii	34.5			19.35			19.35	19.4					
Elaedendron buchanannii	90.3	96.75	99.2	95.6	83.85	45.15	89.4			19.35			
Euphorbia heterochroma	12.9										19.35		
Ficus sycomorus					19.35			51.6			12.9		
Gnidia glauca			6.45	19.35			12.9			12.9			
Grewia bicolor			77.4	70.95			70.95			12.9		19.35	
Grewia similis				12.9			6.45						
Keetia gueinzii				19.35			19.35	19.4		25.8			
Lagenaria siceraria												12.9	
Leucus calostachys							6.45						
Lobelia giberroa							77.4				38.7		
Mikaniopsis bambuseti							19.35					19.35	
Momordica rostrata							12.9						
Monanthotaxis buchananii				12.9			12.9	6.45		19.35			
Mystroxylon aethiopicum			6.45	19.35			6.45						
Pennisetum stramineum							12.9						
Pentas longiflora							6.45						
Plectranthus laxiflorus							12.9						
Psiadia punctata				6.45									
Rubus pinnatus							6.45	6.45					
Senecio hadiensis	19.35						12.9				6.45		
Senegalia senegal	64.5	32.25	64.5	64.5			58.05	25.8	12.9	45.15			
Solanum aculeatissimum	6.45			6.45									
Solanum giganteum	6.45			6.45									
Syzygium cordatum	6.45	38.7	6.45	12.9	12.9	12.9	25.8	12.9		19.35			
Tetradenia riparia	12.9			6.45							19.35		
Tinospora cordifolia	6.45						6.45						
Urera hypselodendron	12.9						25.8				12.9	12.9	
Xymalos monospora	19.35	19.35	12.9	19.35	34.2	12.9	19.35	12.9		12.9			
Zizyphus mucronata	32.25	25.8	32.25	32.25			32.25						95

Appendix 3. Knowledge of the plant parts used for each of the identified species

Scientific name	Root	Stem	Branches	Leaf	Fruit	Bark	Canopy	Sticks	Thorns	Flower
Abutilon mauritianum				36.8						
Acacia brevispica		27.5	34.2	20.6					55.2	
Acacia elatior		90.5	75.9	100	89.7	12.8	5.8	28.9	92.5	
Acacia gerrardii	48.7	63.8	73.8	17.6	38.6				16.8	
Adenium obesum	26.7									
Asplenium stuhlmannii	26.5									
Balanites aegyptiaca		100	99.2	100	65.8	18.5	40.5		87.2	
Boscia angustifolia						20.6	6.8			
Boscia coriacea	67.9		64.6	11.5			16.5			
Cadaba farinosa		89.9	43.5	13.9						
Clerodendrum johnstonii	53.9	57.5								
Commiphora africana		20.6	26.8		52.6		20.5			
Commiphora mildebraedii							14.5			
Crateva adansonii		16.7		13.2	42.7					
Elaedendron buchanannii		68.6	68.8	96	46.7	13.8	49.4	14.5		27.24
Eleucine jaegeri				26.8						
Euphorbia heterochroma		15.6							29.8	
Ficus sycomorus		42.6	36.7	21.8	71.5		37.5			
Gnidia glauca		27.8	62.5	27.2			14.5			
Grewia bicolor		41.7	27.8	41.2			48.1	27.5		
Grewia similis		53.4	36.9							
Keetia gueinzii			46.1	36.9			7.1			
Lagenaria siceraria				13.8						
Lobelia giberroa				62.3						
Mikaniopsis bambuseti	24.5	66.7		13.8						
Monanthotaxis buchananii	58.9	25.6		36.9	43.8					
Mystroxylon aethiopicum							15.4			
Pennisetum stramineum				15.6						
Plectranthus kamerunensis						18.4				
Plectranthus laxiflorus				66.4						
Psiadia punctata		57.3		10.4						
Rubus pinnatus	38.9			15.4						
Salvia merjamie				32.5						
Senecio hadiensis				32.7						
Senegalia senegal		41.7	57.5	28.7	27.7	17.2	34.5		62.1	
Solanum aculeatissimum	68.9				6.8					
Solanum giganteum	45.6									
Syzygium cordatum					3.5		14.5			
Tetradenia riparia		10.3		36.7						
Urera hypselodendron		62.9		70.5		13.4				
Xymalos monospora		16.7	55.7	32.4	17.8		20.4			
Zizyphus mucronata	33.8	38.8	60.3	20.5	13.5		25.6			