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DIVERSITY OF MEDICINAL PLANTS AND ANTHROPOGENIC THREATS IN THE SAMBURU
CENTRAL SUB-COUNTY OF KENYA

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Abstract

Background: Traditional herbal medicine has been a constant source of substances for curing and preventing a variety of ailments. Biodiversity of medicinal plants and effects of human activities on availability of traditional herbal medicine have continuously received just a cursory treatment. This study sought to determine the biodiversity of medicinal plants and evaluate the effects of human activities on availability of traditional herbal medicine among the Samburu pastoral community in Kenya.

Materials and Methods: A questionnaire survey was addressed to 195 randomly stratified household respondents in four villages in Samburu Central Sub-county. Transect walks were carried out in the four villages to determine the diversity of the medicinal plants. Voucher specimens of the medicinal plant species were deposited at Kenyatta University Herbarium.

Results: The species richness comprised of 19 medicinal plants, majority of which grew in the wild but were threatened by human activities. 56% of the households reported that fire incidences highly affected availability of traditional herbal medicine, 50% reported that grazing of livestock moderately affected availability of traditional herbal medicine, 46% reported that building and construction activities moderately affected availability, while 43% and 40% reported that firewood collection and growing of crops respectively lowly affected availability of traditional herbal medicine among the Samburu people.

Conclusion: Most of the Samburu people use traditional herbal medicine. However, majority of the medicinal plants are threatened by anthropogenic factors. This has led to the continued decline of traditional herbal medicine. There is, therefore need to adopt management strategies that enhance the conservation of these valuable natural resources.

Keywords: medicinal plant, traditional herbal medicine, Kenya, Samburu

Introduction

Medicinal plants have been used since the history of mankind (Meaza et al., 2015; Odhiambo et al., 2011). Due to the efficacy of traditional herbal medicine, approximately 60-70% of the people in rural areas depend on it for their immediate medical care (WHO 1978, 2013). Many people use traditional medicine derived from plants because of existence of poor health facilities and conventional medicinal services especially in the rural areas (Omwenga et al., 2009; Tene et al., 2007). In Africa, people have continued to rely on medicinal plants because of the belief that traditional therapies are the most efficient ways of treating different ailments (Joshi and Joshi 2000). But there are also an increasing number of studies on their effectiveness following the scientific principles (Ogol et al., 2012).

In Kenya, availability of allopathic healthcare is still generally a problem, and 85-90% of the population has used traditional herbal medicine for the treatment of different diseases (Nagata et al., 2011). Due to lack of knowledge on drivers of medicinal plant species biodiversity and the current status of availability of traditional herbal medicine, many African governments lack a clear policy on use of traditional herbal medicine. However, the Kenyan government has attempted to sustain and increase the availability of traditional herbal medicine to rural communities. The government through National Environmental Management Authority (NEMA) and other law enforcement agencies has implemented laws that ensure conservation of medicinal plants in their wild habitats and encourage ex situ conservation. Unfortunately, these efforts have not yielded the expected results. In order to develop policies to maintain this valuable resource, research on its current availability and particularly potential causes of a declining availability need to be intensified.

The primary medical challenge experienced by most African countries include transferable diseases such as tuberculosis, measles, malaria, pneumonia, gastroenteritis, and diarrhea (Kariuki and Njoroge, 2011). According to Okello et al. (2010), 107 plants apportioned in 102 genera and 56 botanical families are of medicinal value to eg the Sabao community in Kenya. *Agave sisalana* and *Ziziphus abyssinica* were used to treat burns. Moreover, among the Nandi community in Kenya, common colds and flu are treated by plants such as *Schefflera volkensii* and *Nuxia congesta* whereas malaria is treated by *Terminalia spinosa* (Jeruto et al., 2008). In the Samburu community (Fratkin, 1996) there are many medicinal plants species used for treatment of human and livestock diseases (Bussmann 2006). Among them are species of the family *Mimosaceae*, largely used to cure ailments such as diarrhoea while *Vetaceae* family is used to treat wounds and malaria (Omwenga et al., 2009).

Majority of these medicinal plants in Samburu are found in shrubs that grow in the wild. The distribution of these medicinal plants in the landscape influences the availability of traditional herbal medicine. Currently, biodiversity of medicinal plants has been reported to be on the decline in several studies (Nadembega et al., 2011). This is because most medicinal plants are destroyed due to environmental degradation. Overgrazing of livestock and use of fire to clear the vegetation could lead to the destruction of most medicinal plants among the Samburu people. Samburu District in northern part of Kenya has a rich archive of flora but detailed studies on biodiversity and conservation have not been conducted in the area (Omwenga and Okemo 2014). A crucial point of focus on enhancing availability of traditional herbal medicine might therefore be to conserve biodiversity with particular focus on medicinal plants. The question on the status of biodiversity of medicinal plants needs to be answered.

The increased demand for medicinal plants in Kenya can be attributed to increasing human population and increasing poverty levels (NCAPD 2007). This is coupled with observed decreasing availability (Okello et al., 2010; Omwenga et al., 2015). As main threats, over-exploitation and land use change have been identified. (Mesfin et al., 2013) concurs by asserting that in Northern Ethiopia, pressures from agricultural activities, collection of plants for firewood, grazing of livestock and seasonal drought led to depletion of the medicinal plants and reduction in availability of traditional herbal medicine. Similarly, (Khan et al., 2012) reported that in the mountainous regions of Naran Valley in the Western Himalayas, over-exploitation through clearing of forests, livestock grazing and continuous collection of plants with medicinal value puts the natural ecosystem at risk thereby leading to decline in traditional herbal medicine. The redundancy concept where ecosystem functions are supported by many different species and the local extinction of one species will likely increase the abundance of other species normally comes into play to reduce local extinction (de Albuquerque and de Oliveira, 2007).

Livestock grazing is among the most significant human influences of plant biodiversity and vegetation structure. Light and moderate grazing brings about increased plant biodiversity (Tilman, 1997), whereas low grazing intensity decreases biodiversity (Willoughby and Alexander 2007), according to the intermediate disturbance hypothesis. (Noy-Meir, 1995) supports the argument that moderate grazing increases plant species richness and abundance. Grazing has several effects on the ecosystem depending on the intensity of the livestock grazing. Sustainable management of livestock grazing ensures availability of vegetation and litter on the soil which reduces erosion of the top soil, thereby increasing plant diversity (Fakhimi et al., 2011). Browsing may lead to an increase in shade tolerant plant species by opening up areas that were previously under shade (Bhattarai et al., 2004). Furthermore, browsing pressure may lead to the increase of some browsing tolerant plant species thereby reducing beta diversity of the other plant species (Mouquet and Loreau, 2003). According to Shanley and Luz (2003), fire has also led to the continued decline of plants used for medicinal purposes in Eastern Amazonia. The degree to which fire affected medicinal plant species depends on the characteristics of the plant. Fire tolerant species will not be severely affected by fire.

The Samburu nomadic pastoralists use fire to burn the old vegetation at the start of the rainy season so as to enable the grass to regenerate as they move to other areas. This will enable healthier grass to re-grow. In case of attacks by the neighboring communities, they also use fire to burn the surrounding vegetation so as to drive away bad omen. Fires in Samburu district are also instigated by honey-hunters during the process harvesting, especially during the dry season (Bussmann et al., 2006). Therefore, fire plays a major role in populated savanna ecosystems and its influence on medicinal plants needs to be studied.

Besides grazing and prescribed fires, firewood collection and deforestation are considered to be an important cause of the destruction of medicinal plants used by the Samburu people (Nanyingi et al., 2008). The Samburu people depend on firewood as a source of energy due to absence of an elaborate electric supply in the area. However, there is still uncertainty on the impact of anthropogenic activities on availability of traditional herbal medicine. This is because human activities vary in scale and intensity in different areas as a result of differences in technological development and degree of economic activities. Thus, the question arises on how human activities influence the availability of traditional herbal medicine.

This study aimed to evaluate the biodiversity of medicinal plants and assess perceived threats to the availability of traditional herbal medicine in a rural community in Kenya. The Samburu community in northern Kenya served as an example because they are a nomadic pastoralist community that depends on traditional herbal medicine in the treatment of both human and livestock diseases. We carried out transect walks to determine the biodiversity of medicinal plants. Furthermore, we conducted a questionnaire survey in the Samburu community and focused on human land use and its influences on availability traditional herbal medicine. We assessed 1) the species richness of medicinal plants among the Samburu community, 2) the percentage of people using traditional medicine and 3) the impact of human land use on the availability of traditional herbal medicine or medicinal plants

Research site

A case study of Samburu Central Sub-county in Kenya was chosen (Latitudes 30°-50° N, Longitudes 24°-34° E). The area had very few public health centers and therefore served as a good example to assess the availability of traditional herbal medicine. Approximately 80%-90% of the people in the area use traditional herbal medicine derived from higher plants for medicinal purposes (Fratkin, 1996; Bussmann, 2006).

The Samburu Central Sub-county falls within the arid and semi-arid lands (ASALS) biogeographic area and covers an altitudinal gradient of between 860 m to 1250 m. The area receives a mean yearlong rainfall of 500-600 mm with a bimodal rainfall distribution, whereby from March to May the area receives long rains and from July to September it experiences the short rains. The dry season extends from December to February. The mean annual temperature of the area study area is 30°C (Nanyingi et al., 2008). Due to the arid and semi-arid climate, savanna and few scattered forests form the natural vegetation. Most of the vegetation is present during the rainy seasons, while they decrease during the dry season and periods of frequent fire. The vegetation in Samburu Central Sub-county comprises scrubs, herbs, shrubs and forests. Scrubs cover much of the district and the most common are *Acacia hockii*, *Acacia tortilis* and *Salvadora persica*. Few scattered forests are found in Poroo and Kirisia.

Due to a population density of about 26 people per km², most of the area is in use (KNBS, 2009). The Samburu people who dominate the area engage in pastoralism as their main economic activity with grazing stocks of about 300 animals per household (sheep, goats, camels and cattle). A few of the Samburu people practice crop cultivation because the soils in the area are infertile (Bussmann, 2006).

Materials and Method

Sampling design

The target population in this study was that in Samburu Central Sub-county (n=105,052) and the medicinal plants in the area. Four villages were selected by purposive sampling to cover all typical characteristics (Lpartuk, Loosuk, Suguta Marmar and Pooro). The villages were identified due to differences in their environmental, social and economic attributes especially variation in vegetation type, availability of healthcare facilities and level of income. Additionally, snowball sampling was used to sample specialized herbalists from an established list provided by the District Medical Officer. The specialized herbalists sampled comprised of three old women and two young men. These specialized herbalists agreed to accompany us during the transect walks so as to help identify plants commonly used as traditional herbal medicine in the area. Two specialized herbalists were sampled in Suguta Marmar while one was sampled in each of the other three villages. To assess human land use and its negative and positive influences on the availability of traditional herbal medicine, household heads were considered in the survey. Within these villages, households were stratified based on the manner of construction of the houses, which represent different levels of income. This resulted in 3 classes: round, squared and rectangular houses. Households were then selected by stratified random sampling for the household questionnaire survey. Questionnaires were administered to the household heads since they are known to make important decisions with regard to use of traditional herbal medicine from plants for treating minor illnesses at home and their authority is often acknowledged by all the members of the family. They were therefore in a position to provide adequate information that explained availability of traditional herbal medicine.

For this research, it was necessary to provide questionnaires in English as well as in Samburu language. Therefore, we relied on the help of 2 native Samburu speakers for the translation.

Transect walks

Transect walks were carried out throughout the region in order to determine biodiversity of medicinal plants. Four transects were carried out in each village resulting in 16 transect walks. This was done with the aid of specialized herbalists who helped in the identification of the medicinal plant species. During these transect walks species richness, abundance, habitat of occurrence and status of the medicinal plants were recorded on a transect data sheet.

The abundance of the medicinal plants was determined (Chaudhuri and Sarkar, 2003). The abundance was categorized as: S= Sporadic, i.e. growing scattered, thus need careful monitoring (three species of medicinal plants in a quadrant); T= Threatened, i.e. the species are decreasing in number (two species of medicinal plants in a quadrant); PS= Presently safe i.e. The species are present but need efforts to protect them (five or more species in a quadrant); D= Dont Know ie doubtful presence (one species in a quadrant) and V= Vulnerable, i.e. are easily destroyed (three species of medicinal plants in a quadrant with likelihood of being easily destroyed by encroaching human activities). Based on these estimates, abundance of the medicinal plants was determined. Quadrants were laid out on open vegetation and used to categorize the abundance. A quadrant size of 30 × 30 m² was laid on open vegetation. The number of the medicinal plants in the quadrant and their growth attributes were used to categorize the abundance of the medicinal plant species.

Household questionnaire

Household heads comprising 109 men and 86 women were asked to provide some background information such as age, sex and level of income. They were asked if they had used traditional medicine during their lifetime. Furthermore, they were asked to rate the influence of 5 different land use types (Table 2) on availability of traditional herbal medicine on a five point Likert attitudinal scale. Human activities such as building and construction, grazing of livestock, fire, growing of crops and firewood collection were considered.

Botanical identification

The medicinal plant specimens were deposited at the Kenyatta University Herbarium for scientific identification.

Results and Discussion

Diversity of medicinal plants

16 transect walks showed that species richness of the medicinal plants used by the Samburu people comprised of 19 plants (Table 1). The species richness of medicinal plant ($n = 19$) appear to be rather low compared to those in other studies in Eastern Africa (Giday et al., 2003; Nanyingi et al., 2008). In former studies with similar methodology 56 medicinal plant species are recorded for the Samburu county with an area of 21,000 km² (Nanyingi et al., 2008) and (Fratkin, 1996) named about 120 plant species. A recent ethnobotanical survey recorded 25 species (Omwenga et al., 2015). For Ethiopia, 33 species are found in an area of 434 km² (Giday et al., 2003). Species numbers are thus not directly comparable due to the lack of standardization of sampling effort (e.g number of questionnaires, number and length transect walks and search time) and reference area. In order to derive comparable estimates for medicinal plant species richness and prevalence in time and space, a common methodology needs to be applied (Gotelli and Colwell, 2001; Whittaker et al., 2001). The status of plant species was derived from their abundance estimates. From our transect walks, 46% of the medicinal plants were considered to be threatened while only 23% were presently safe (Table 1).

Table 1: Medicinal plant species recorded during transect walks with specialized herbalists ($n = 19$). Disease that is treated by the plant was mentioned by the specialized herbalists. Abundance was used to assign classes of status.

Medicinal plant species	Samburu name	Disease	Status by abundance
<i>Carissa edulis</i>	Lamuriai	Malaria	Threatened
<i>Croton megalocarpus</i>	Lmargwet	Skin disease	Sporadic
<i>Dovyalis abyssinica</i>	Lmoroo	Stomach ache	Threatened
<i>Teclea nobilis</i>	Lgilai	Colds	Threatened
<i>Psiadia punctulata</i>	Labaii	Wounds	Presently safe
<i>Albizia anthelmintica</i>	Lmugutan	Asthma, Diarrhoea	Not known
<i>Psiadia arabiea</i>	Ltuanta	Tick control	Vulnerable
<i>Aloe secundiflora</i>	Sukuroi	Diarrhoea, Eyes	Threatened
<i>Olea africana</i>	Lmusigio	Diarrhoea	Sporadic
<i>Ipomoea spathulata</i>	Lokitenge	Eye problem	Threatened
<i>Warburgia ugandensis</i>	Sokorioi	Intestinal worms	Sporadic
<i>Cadaba farinosa</i>	Lumuriai	Tuberculosis	Presently safe
<i>Ramnus prinoides</i>	Loitaakine	Colds	Threatened
<i>Leonotis nepetifolia</i>	Sekuta	Diarrhoea	Vulnerable
<i>Olea europaea</i>	Lchingei	Dental hygiene	Presently safe
<i>Acacia nilotica</i>	Ikiloriti	Diarrhoea	Not known
<i>Acacia senegal</i>	Ltapes	Sore throat	Threatened
<i>Myrsine africana</i>	Seketet	Malaria, STIs	Threatened
<i>Sansaviera robusta</i>	Idupai	Wounds	Presently safe

Most (46%) of the medicinal plants found among the Samburu people were shrubs, 42% were trees, 8% were herbs and 4% were creepers. Majority of the medicinal plants were shrubs because they are the life form that can deal best with the environmental conditions in the study region (Omwenga et al., 2009). Under very dry conditions, these shrubs cannot survive anymore. Some of the medicinal plants were found in trees because the Samburu people did not cut down many trees for the construction of their simple temporary houses (manyattas), hence these medicinal plants from trees were conserved. A few medicinal plants were found in herbs because the goats and cattle that form a large majority of the

livestock kept by the Samburu people fed on the palatable herbaceous vegetation thereby reducing the number of medicinal plants found in herbs. However, only very few medicinal plants were found in creepers. This might be due to trampling by livestock and man causing low numbers of creepers in the vegetation. These findings are consistent with that of (Nanyingi et al., 2008) who established that shrubs formed the largest number of medicinal plants among the Samburu people, followed by trees, herbs and lianas respectively. Most medicinal plant species were present in the wild i.e. they grew on their own in their natural habitats without the influence of the people. Pakistan is a good example of a country where cultivation of medicinal plants has continuously led to increase in medicinal plant species (Alam et al., 2011). The Samburu people indeed made efforts to cultivate medicinal plants, but the nurseries were later deserted. The low number of cultivated medicinal plants outside the Samburu manyattas can be attributed to infertility of the soil in the area. It is also likely that most medicinal plants grew in the wild because the Samburu people do not practice crop cultivation as their main economic activity. Some of such species include *Acacia senegal*, *Teclea simplicifolia*, *Warburgia ugandensis*, *Salvadora persica* and *Olea africana* among others. On the other hand, only *Aloe secundiflora* was found in cultivated land. Therefore, most medicinal plants in Samburu Central sub-county grew in the wild and there is low probability that this might change in the near future. Of all the species found in the study area, *Psiadia punctulata* was the most common medicinal plant species that can be used to treat wounds. However, most of the collected medicinal plant species can be used to treat diarrhea. High diversity of medicinal plants not only in terms of taxonomy and life forms but also in terms of their purpose of use ensures the availability of traditional medicine for treatment of various frequent diseases. For diarrhea, 4 species are recorded (Omwenga and Okemo, 2014). This provided some redundancy and therefore increases safety of supply (Walker, 1992). Against tuberculosis, only one medicinal plant species was found during the transect walks (*Carissa edulis*) (Tabuti et al., 2010). This species can also be used to treat e.g. herpes (Tolo et al., 2006). Fortunately, this species occurred rather frequently and could be considered as presently safe. However, for the treatment of eye problems, only one species, *Ipomoea spathulata*, was found during the survey. The status of *I. spathulata* was categorized as threatened, posing the assessment of the development of distribution of this species and alternative species used for the same purpose as a priority. For most of the diseases, there were only one or two species used for their treatment. One could argue, that there exist probably more plant species in the region than recorded during our transect walks, that actually provide higher redundancy for disease treatment (Fratkin, 1996; Giday et al., 2003; Meaza et al., 2015; Nanyingi et al., 2008). Nevertheless, the species need to be collected by herbalists. Scientific collection trips show that some plant species are already difficult to find in the wild (Omwenga et al., 2015). High abundance of species in the landscape ensures that the species can be collected regularly and medicine is continuously available. If plants grow in a dispersed way and in low abundances, collection effort increases and medicine for treatment of a certain disease might not be available when needed.

Questionnaire: Use and threats

A majority of the households surveyed were males (56%). Of the 195 household respondents, 42% were above 49 years of age; 27% were aged between 40- 49 years; while 19% were aged between 30-39 years. However, only 12% of the household heads were below 30 years. Moreover, 70% of the household heads earned less than 1 dollar day. Samburu Central Sub-county is a relatively dense region (population density in Samburu County: 413.2 people per km²; mean population density of Kenya: 401.1 people per km²; source: KNBS, 2010) compared to many parts of Kenya the majority of people in the area are young (Republic of Kenya, 2010). The number of people who used traditional herbal medicine derived from plant species was very high (96%). More females than males used traditional herbal medicine while many older people compared to the young used the medicine. Use of traditional medicine was less among the younger people. This is because many young people lack sufficient traditional medicinal knowledge on the use of traditional herbal medicine (Bussmann, 2006). However, more women than men used traditional herbal medicine because they have many complications during pregnancy and childbirth (Omori et al., 2012). Compared to other parts of the country, many people use traditional herbal medicine in the treatment of human and livestock diseases (96%). For example, in South Nandi district in Kenya only 50% of the people resort to traditional medicine as primary healthcare (Jeruto et al., 2008). This can be attributed to the very weak health care infrastructure in the area and very low income of the population compared to other regions.

Impact of land use on medicinal plants

The questionnaire survey revealed that out of the main land used practices in the region, periodic fires were rated as the activity with the most important negative influence on availability of traditional herbal medicine in the area (Table 2).

Table 2: Considered as most important threat to medicinal plants in the Samburu region was fire followed by grazing and building & construction.

Human activities	Very high	High	Moderate	Low	Very low
Building & construction	1%	29%	46%	20%	5%
Grazing of livestock	1%	28%	50%	21%	1%
Fire	29%	56%	12%	3%	0%
Growing of crops	4%	12%	38%	40%	6%
Firewood collection	2%	11%	26%	43%	17%
TOTAL	37%	136%	172%	127%	29%

Fire is frequently used to clear vegetation so as to enable the grass to regenerate. The Samburu people also cleared land using fire to drive away bad omen after cattle raids by the neighboring communities. In addition, fire was also lit by honey harvesters. The clearing of vegetation using fire destroyed the fire intolerant medicinal plants commonly used as traditional herbal medicine thereby reducing availability of the medicine. Grazing was named as the second important anthropogenic factor. Some medicinal plants were destroyed by browsing while others were boosted by the disturbance. The browsing tolerant medicinal plants increased with grazing activities. Most of the Samburu people are nomadic pastoralists, hence at moderate population density medicinal plants sensitive to grazing were still conserved because the movement of the people and their herds to other regions creates a patchy pattern of different disturbance frequency and intensity. Some of the Samburu people also reduced the number of their livestock due to seasonal droughts thereby reducing the negative effect of livestock grazing on medicinal plants commonly used as traditional herbal medicine. Building and construction was also named as the second most important human activity that moderately affected availability of traditional herbal medicine because building and construction were taking place in areas where medicinal plants did not occur at all. Thus, in such regions people might not mention it. Moreover, firewood collection affected availability of traditional herbal medicine because some of the plants commonly used as firewood were at the same time of medicinal value. Hence, collection of firewood decreased the availability of plants used for medicinal purposes. Contrary to finding of (Mesfin et al., 2013) (Northern Ethiopia) growing of crops was considered to lowly affected medicinal plants in Samburu. This was because a few of the Samburu people grow crops since the soil in the area is infertile. Land use was considered as a threat to medicinal plants by the local population in Samburu Central sub-county. These findings agree with (Nanyingi et al., 2008) who reported that many medicinal plants among the Samburu people are under decline due to human activities such as construction activities, firewood collection, expansion of crop cultivation and livestock grazing. Considering that medicinal plants are not cultivated but collected from the wild, land use practices and their impact on medicinal plant species distribution becomes an important field of research.

Conclusions

This research described the diversity of medicinal plants and anthropogenic threats to the use of traditional medicine among the Samburu people in Kenya. Almost all of the people who took part in the questionnaire survey used traditional medicine indicating the high relevance of this field of research. Our survey showed that the majority of medicinal plant species in the Samburu County grew in the wild. Due to poor soil fertility, attempts of cultivation failed indicating that people will have to rely on their occurrence in the wild in the near future.

The abundance of many medicinal plants was low; thus, the species were considered as threatened. Perceived threats by anthropogenic activities were prescribed fires and livestock grazing. The influence of these factors on the distribution of medicinal plants in the landscape and their influence on the availability of this natural resource need to be assessed quantitatively to be able to develop sustainable land use strategies. Most importantly, species for which few alternatives exist in curing specific diseases need much attention.

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Declaration: Authors declare that this research presents no conflict of interests.

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