ECOLOGY OF MEDICINAL PLANTS AND THEIR INTEGRATION INTO PRIMARY HEALTHCARE IN KAJIADO COUNTY, KENYA

BY

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A thesis submitted in partial fulfillment of the requirements for the award of the Degree of Master of Science in Biology of Conservation in the School of Biological Sciences,

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May 2013

Declaration

This thesis is my own original work and has not been submitted to any other university for the award of a degree.

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Dedication

I would like to dedicate this thesis for my families who sacrifice for my education.

Acknowledgement

I would like to express my gratitude to my supervisors, Prof. J.I. Kinyamario, Dr. Najma Dharani and Dr. Samuel Kiboi, for their prompt guidance and support throughout my thesis work and Dr. Najma who accepted me to provide financial support for the field work. I would also like to thank DAAD – NAPRECA (German Academic Exchange Service through Natural Product Research in Eastern and Central Africa) for covering the tuition fee and sponsoring me to undertake my postgraduate study in University of Nairobi. I am very much grateful to Prof. Dr. Mark van Kleunen and his research team, University of Konstanz, Germany for supporting me in statistical analysis, giving ideas in the whole research work and letting me know many aspects of plant ecology research. Moreover, my appreciation goes to Prof. Abiy Yenesew and Dr. Solomon Derese, Department of Chemistry, University of Nairobi, for their continuous support and advice. My acknowledgement should also go to Prof. Nathan Gichuki, Dr. Francis Mwaura and Dr. Isaiah Ang'iro Nyandega for their assistance and great effort to assist me during the research work. My thanks also go to Mr. Chalo Mutiso, University of Nairobi Herbarium, for his great assistance in identification of some species. I would also like to thank my field assistant Ezekiel Roimeno for his valuable support in the field work. My acknowledgement further goes to my friends both in School of Biological Sciences and the Department of Chemistry, University of Nairobi.

Abstract

The study was conducted with aim of assessing the composition, distribution, abundance and the community structure of local medicinal plants; and determining the modes of exploitation and contribution of these plants in primary health care and livelihoods of rural communities in Marble Quarry (KMQ), Mile 46 and Oltepesi at Central Kajiado, Kenya. Data were obtained using semi-structured forms to record topics related to the medicinal use of specific plants and through vegetation sampling in the field. The medicinal use value of plant species in the research sites did not reveal significance differences (df=2, F= 0.956, P=0.388, α=0.05). Relative abundances of species in the three research sites were highest for *Balanites aegyptiaca* (36.92%) in KMQ, *Commiphora africana* (28.41%) and *Balanites aegyptiaca* (27.27%) followed by *Acacia drepanolobium* (21.6%) in Mile 46, while in Oltepesi, *Balanites aegyptiaca* (39.4%) was the dominant species. This indicated that the area was dominated by only a few medicinal plant species. At Mile 46 and KMQ all the species had a contagious distribution while in Oltepesi, one species *Albizia anthelmintica* showed a regular distribution.

In Oltepesi research area, lower species diversity and evenness were recorded as compared to the other two sites, though no significant differences (df = 2, P=0. 259, α = 0.05) was noted between the sites. The species diversity in the area was of homogenous type. Oltepesi had the highest beta diversity (β) (2.52) followed equally by KMQ and Mile46 (0.846).

The medicinal use value index of a plant species was highly correlated with the sites and this indicated that the plant species had great contribution to primary health care and livelihood of the society. The main threats of medicinal plants in the area were deforestation, drought, lack of awareness, urbanization, ignorance and expansion of human settlements in the study areas but

didn't reveal significant difference statistically (df=2, F=0.564, P=0.571 and α=0.05). An integrated conservation strategy is required in the area to conserve many of the medicinal species.

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List of acronyms and abbreviations

ANOVA	Analysis of Variance
DBH	Diameter at Breast Height
GPS	Global Positioning System
IMP	Indigenous Medicinal Plant
IUCN	International Union of Conservation Nature
IVI	Importance Value Index
KMQ	Kenya Marble Quarry
PHC	Primary Health Care
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

Approximately 85% of the world's population relies on traditional medical treatments based on plant remedies, and around 25% of the world's pharmaceutical medicines demands are derived from plants (Rai *et al*., 2000). According to the World Health Organization, approximately 3.5 billion people in developing countries believe in the efficiency of plant remedies and use them regularly (Gera *et al*., 2003) and it has also been estimated that up to 90% of the population in developing countries rely on the use of medicinal plants to help meet their primary health care needs (WHO, 2002). As a result, the global market for medicinal plants increases by 7% annually, and generates approximately US$ 70 billion in revenues (Gera *et al*., 2003).

Apart from their importance in the primary health care system of rural communities, medicinal plants also improve the economic status of the people involved in their sales in markets all over the world. In Kenya, traditional medicine from medicinal plants has still continued to play a major role in Primary Health Care (PHC). More than 70% of the Kenyan population relies on traditional medicine as its primary source of health care, while more than 90% use medicinal plants at one time or another (Odora, 1997). For many local communities in Kenya, traditional medicine is less expensive, more locally available, and more culturally accepted than modern conventional medicine (Dharani and Yenesew, 2010). More than 1200 plants are described as medicinal plants from a flora of approximately 10,000 members (Kokwaro, 1993). The wide spread use and acceptability of the traditional medicinal value of plants in both urban and rural society in Kenya could be attributed to culture, efficacy against some diseases, accessibility and affordability as compared to modern medicine. This traditional medical system is characterized by variation in socio-cultural background, ecological diversity of the country as well as ethnic group and this knowledge of traditional medicine is usually passed from generation to generation through word of mouth (Muthee *et al.*, 2011).

The substantial contribution to human health and well being made by medicinal plant species is now widely appreciated and understood. In most developing countries, unmonitored trade of medicinal plant resources, destructive harvesting techniques, overexploitation, habitat loss, and habitat change are the primary threats to medicinal plant resources (IUCN, 2002; Dharani and Yenesew, 2010). In addition to habitat being a critical factor in determining species abundance, the plant parts used and the manner in which medicinal products are harvested also may affect population structure and availability. Primary forest tree products, including barks, roots, and exudates, are widely used, but little is known about the sustainability of harvesting strategies currently employed. Particularly vulnerable are those species occurring in low densities, those whose roots are harvested, and those whose bark or oil is extracted unsustainably (Cunningham, 2000). Determining sustainable harvesting strategies requires basic ecological information, but the ecology of even the most widely used species is poorly understood (Peters, 1994).

Increasing demands for medicinal plants internationally have resulted in the over-exploitation and indiscriminate over-harvesting of medicinal plants. The degree of disturbance to the species population and vulnerability to over-exploitation depends on the availability and need of part used, and the life form. Particularly vulnerable to over-exploitation are the slow growing forest species. The harvesting technique employed in the prevailing area is important in the conservation of medicinal plants as some of the practices may be destructive.

Most of the plants used in traditional medicine are collected from the wild, and only a few have been domesticated. There is, therefore, a real danger of genetic erosion, which in turn calls for the need for collection and conservation, research on propagation and cultivation, and investigation into possible modifications in the active ingredients due to changes in the growing environment. For conservation of rare plant species, cultivation is often considered an alternative to wild collection (IUCN, 2001).

According to Anyinam (1995), the conservation of African medicinal plant species is critical for local health as well as for international drug development. As much as 95% of African drug needs comes from medicinal plants, and as many as 5000 plant species in Africa are used medicinally (Taylor *et al*., 2001). One of the major concerns of our times, according to Gauto *et al.* (2011), is the loss of Earth's biological diversity. The world's flora and fauna are facing an alarming decline of its wild populations, mainly due to the loss of their natural existing habitats. A lack of ecological knowledge of these plants can seriously hinder the conservation and sustainable use of medicinal plant species, especially in the face of anthropogenic threats such as overexploitation and land use change.

The insufficient knowledge about the ecology of medicinal plants is a serious problem for resource managers. The creation of protected areas may facilitate the conservation of medicinal plant species by reducing habitat loss and, via restrictions on access and extractive use, reducing disturbance and overexploitation (On *et al*., 2001; Ndangalasi *et al*., 2007).

The land tenure regimes of ownership, control and management of land determine the level of conservation attainable for biotic conservation. Acquired rights on land influence the forms, intensity and efficiency of land use (Osemeobo, 1992). Rapid land use/cover changes, unprecedented in human history especially in developing countries are continuously altering ecosystems, thereby threatening sustainability and livelihood systems (Seno and Shaw, 2002). As human population increases, biodiversity is facing widespread competition with humanity for space and resources and as a result, there is increasing conflict between the need for biodiversity conservation and economic development. To determine the relative contribution of habitat specialization to the maintenance of diversity in tropical forests requires rigorous quantification of the relationships between species' distributions and habitat variables, as well as the identification of the causes underlying those patterns.

Apart from threatening the survival or existence of communities' knowledge on traditional medicine, changing lifestyles and practices (Kiringe, 2005) are also affecting the status of medicinal plants themselves. It is generally agreed that in the less developed countries like those of Africa, human activities are taking a serious toll on renewable resources including plant species that are valuable to rural communities (Southgate and Sanders, 1990). Deforestation is one of such activities that have led to tremendous loss of important plant resources in both the developed and developing countries. Land use changes have taken place in the recent past which have seen agriculture become popularized (Campbell *et al*., 2000), and this had the potential to undermine the conservation of important plant resources to the community.

The growing demand for many of the species and an increasing interest in their use combined with continued habitat loss and erosion of traditional knowledge, are endangering many important medicinal plant species and populations and creating an urgent need for improved methods of conservation and sustainable use of these vital plant resources (Leaman *et al*., 1999; Dharani and Yenesew, 2010).

Based on the changes that appear to be moving swiftly across Maasai land countrywide, this study will try to investigate the knowledge of ethno-medicine among the Maasai in three sites within Kajiado district and to identify threats to medicinal plant resources that are found locally within the study area in relation to the ecology of these plants.

1.2 Literature review

1.2.1 Medicinal Plants and Traditional Medicine

Despite the expansion and use of modern medicinal methods and practices, traditional medicine continues to be an integral part of primary health care in many developing countries. In the mid-1980s, the World Health Organization estimated that over 80% of the world's population relied mainly on traditional medicine for their primary health care needs (Farnsworth and Norman, 1985). Many people in developing countries seek and prefer traditional medicine even when modern medicine is accessible. Nations *et al.* (1988) stated that two low-income communities in Brazil, three quarters of mothers used traditional healers instead of going and consult western physicians when their children felt ill.

According to Njoroge *et al.* (2010), 90% of the population in Kenya has used medicinal plants at least once for various health conditions. In other regions such as Peru, it has been found that about 84% of the local people prefer traditional medicinal plants for their health care needs in comparison to modern pharmaceutical products. Some of the reasons given include the fact that they are of natural origin and no risks or harm is experienced when used (Bussman *et al.*, 2007).

The importance of medicinal plants for people in developing world as vital component of most traditional medicine systems is well documented. The WHO estimated that more than 3.5 billion people in the developing world rely on plants as components of their primary health care and Van Seters (1997) argues that more than 35,000 plant species are being used around the world for medicinal purposes. The use of herbal medicines however, is on the increase even in developed countries because of the belief that herbal remedies are safe due to their natural origin. Globally, there are about 120 plant-derived drugs in professional use; three quarters being obtained from traditional medicinal plants (Bussman *et al.*, 2007). Anyinam (1995) argues that inhabitants of Africa depend on medicinal plants for as much as 95% of their drug needs, while Taylor *et al*. (2001) assert that over 5000 plants are known to be used for medicinal purposes in Africa.

Over the last two decades, traditional medicine and medicinal plants use have taken significant attention in the international arena; in particular, it can be witnessed in the expansion of scientific research relating to traditional medicine and transitional markets for traditional medicinal products. Farnsworth and Norman (1985) assert that 74% of the 121 biologically active plant-derived compounds then in use worldwide were discovered as a result of scientific follow-up of well-known plants used in traditional medicine points towards the international pharmacological importance of traditional medicinal plants. More recent studies like Taylor *et al*. (2001) try to move beyond Farnsworth *et al*. (1985) indirect evidence by experimentally examining the extent to which specific medicinal plant and animal products benefit human health.

Unfortunately, according to a recent report, almost one third of medicinal plant species could become extinct, with losses reported in China, India, Kenya, Nepal, Tanzania and Uganda (Hamilton, 2009). Greater losses are expected to occur in arid and semi arid areas due to factors such as: climate change, erosion, expansion of agricultural land, wood consumption, and exploitation of natural vegetation, increased global trade in natural resources, domestication, selection and grazing among other factors (Weizel and Rath, 2002). In Cameroon, heavy exploitation of *Prunus africana*, a globally recognized treatment for prostate cancer, for international sale has devastated populations (Cunningham, 1997). Poverty generally makes the problem even worse; many commercial gatherers in developing countries are compelled to harvest unsustainably because they do not have alternative sources of income.

In Kenya arid and semi arid lands account for 88% of the land's surface area and are home to over 10 million people (Njoroge *et al.*, 2010). These areas are facing intense degradation due largely to pressure arising from over harvesting of wild plants to generate income. It has been noted that an estimated 70% of Kenya's rural population uses a combination of traditional and modern medicine while 20% use traditional forms only (Lekoyiet, 2006) and the traditional knowledge of medicinal plants is most often passed down within families and communities from generation to generation. Sindiga *et al.* (1995) found out that this high dependence on traditional medicine revolves around its ability to meet the four criteria of accessibility, availability, acceptability and dependability.

Modern health facilities in Kenya are spatially inequitable and favor urban areas where only about 15% of the country's 25 million people lives (Sindiga *et al.*, 1995). The inability of inhabitants to reach modern health facilities results in a heavy reliance on medicinal plants in Kenya, even in urban areas where western forms of medicine are available (Sindiga *et al.*, 1995; Dharani and Yenesew, 2010). For thousands of years worldwide, plants have been used in traditional medicine, resulting in the development of a large body of local knowledge. This knowledge base arises primarily from trial and error experiences and is rarely embedded in complete and systematic theories of medicine (Bo *et al*., 2003).

In many cases, local knowledge of medicinal plants remains poorly documented in the scientific literature. For example, in a study of herbs used for medicinal baths among the Red-headed Yao in China, only 5% of 110 species registered had been previously identified as having medicinal properties, and 79% were newly recorded for their use in medicinal baths (Li *et al*., 2006).

Local knowledge of how medicinal plants are used may be a rich basis for the phytochemical, pharmacological, and clinical studies necessary to secure sustainable and rational use of these plants as a resource. In addition to the limited documentation, much traditional medical plant knowledge is being lost before its incorporation into modern medical science. Environmental degradation and large changes in modern social and economic systems have affected medicinal plant use over the past few decades (Anyinam, 1995). A study of medicinal plants of the Zay in Ethiopia reported the use of 33 species, but the informants all agreed that more species had been used in the past (Giday *et al*., 2003). It was suggested that deforestation, degradation, and acculturation over many years caused the reduction. Likewise, in northwestern Yunnan in China, over-exploitation and deforestation are depleting the medicinal plants used by the Lisu (Ji *et al*., 2005).

In a study of local knowledge of medicinal and other useful plants, many researchers have made the assumption that all plants mentioned as useful are also actually being used. But a few studies for example Byg and Balslev (2001) have teased apart what people say and what they do, and it turns out that the local knowledge represented by what the informants tell the researcher, is not always equal to local use which refers to which plants and which uses are actually practiced. This gap between local knowledge and local use can be taken as the first sign of degradation of traditional ethnobotanical knowledge and can be used to measure loss of knowledge (Reyes-García *et al*., 2005).

The high anthropogenic pressures and associated fragmentation of the landscapes has resulted in loss of habitat and species. Under these conditions, medicinal plants are also being under constant threat due to over exploitation in natural habitats even in the absence of cultivation. During periods of food scarcity or famines in the dry areas of Kenya the poor rural communities harvest wild plants, including fruits and leaves for food (Jeruto *et al.*, 2010).The type of plants and parts removed vary from one locality to another and their use depends on the local indigenous knowledge and experience accumulated over centuries.

1.2.2. Threats to Medicinal plants

Demand for herbal products is on the increase, exerting a lot of pressure on the remaining indigenous medicinal plants. This calls for the need to devise strategies to increase the supply of these resources as well as protecting the source habitats. The major threats to the conservation of medicinal plant can be given as:

1.2.2.1 Deforestation

The availability of medicinal plants is reduced by forest conversion and land degradation. Deforestation caused by the need for human settlement and allied infrastructure development and cultural expansion, charcoal production, timber sales and overgrazing has further caused the shortage of herbal plants. Deforestation reduces the biodiversity of wild plant resources both directly and indirectly through the loss of habitat areas as well as other organisms important for ecosystem function.

Tropical deforestation is frequently listed as one of the more serious environmental threats facing humankind today (Hosier, 1988). It has been linked to climatic change, species and habitat extinction, and soil degradation. However, the causes and consequences of deforestation are far more complex. Rural farmers may be responsible for clearing land, but rural firewood users rarely cause deforestation. While urban charcoal users may contribute more to the process, they frequently purchase charcoal produced from surplus wood left after the clearance of land for agriculture and where trees are felled to provide fuel and trees; agricultural land, economic development seems to lead inevitably to environmental deterioration.

The primary causes of deforestation include the clearance of land for agriculture which comes as a result of increasing pressures to increase agricultural production and the harvesting of wood for fuel. Wood fuels (including wood and charcoal) constitute between 75% and 95% of the energy balance for all the countries in East Africa (Hosier, 1988). Thus, wood fuel consumption places a major pressure on forest resources.

1.2.2.2 Human density and biodiversity risk

The growth of the human population and its greater demand for resources are the driving forces behind land transformation and resulting biodiversity losses. The link between high human population densities and risk to biodiversity is mainly indirect (Cincotta *et al*., 2000).The correlation of human density with forest cover suggests that increasing human population density may make forests vulnerable as they are converted to agricultural or urban areas, or logged to provide timber. In addition, forests in heavily populated areas also remain vulnerable to overharvesting.

1.2.2.3 Land tenure policies

In recent years the government of Kenya has adopted a policy of promoting subdivision of group ranches in the Maasai region and the Maasai disregard individual landownership but support the informal arrangement of traditional herding practices (Seno and Shaw, 2002). Improper tenure rights over forests adjoining within nature reserves also make effective forest management difficult. In the study conducted by Sodhi *et al*. (2010) land and forest user rights in many places covered in case studies are not well defined or are difficult to enforce and sudden changes in tenure policy have historically been related to increases in the use of forest resources and even clear-felling. The introduction of the household responsibility system and forestland allocation policies in the early 1980s are two examples of forest tenure policy changes which in many sites led to excessive felling of timber, from which the forest has not still recovered.

1.2.2.4 Fuel wood and Charcoal provision

For the poor in developing countries, both urban as well as rural, fire wood is usually the principal source of energy for cooking food and for keeping warm. As populations have grown, this dependence has led inexorably to pressures on the wood resource which all too often have resulted both in the destruction of the forest and in a worsening of the situation of the hundreds of millions of people whose life is conditioned by the products of the forest. Fuelwood as a source of energy for heating and cooking is a common use of plant resources in many rural communities throughout Kenya. This is because of lack of alternative energy sources for domestic use. While reliance on wood for fuel has declined in the developed world over the past century, it is still the principal source of fuel for many developing nations like Kenya (Cunningham and Saigo, 1999).

Urban and rural dependence on firewood and charcoal is often presumed to be a major cause of deforestation in African savanna woodlands (Lekoyiet, 2006; Chidumayo, 1997). With such a high level of dependence on fuelwood, the increasing human populations in many developing countries are creating a deficit of this important resource. In eastern Africa, it is estimated that the demand for firewood is ten times the sustainable yield (Cunningham and Saigo, 1999).

Most rural communities in Kenya, including the Maasai, use wood fuel to provide for daily energy needs such as cooking, charcoal burning and home heating (Mugabe and Clark, 1998). Leach and Mearns (1988) found out that, due to the need to have access to sufficient quantities of woody resources to meet their daily demand, the Maasai move their homesteads to areas where energy needs can be guaranteed and a twist of events has been reported by Herlocker (1999) of cases of charcoal burning among the Maasai, in the recent past as an economic alternative to their declining pastoral lifestyle.

1.2.2.5 Impact of livestock grazing

Free grazing of livestock is another threat to the viability of medicinal plant production in the region. Uncontrolled grazing is leading to degradation of pastures containing numerous medicinal plants, herbs and shrubs. Expanding agriculture is also contributing to the elimination of many medicinal plants. A study by Xu and Wilkes (2004) indicated that, more than 80% of the total population in Northwest Yunna of Astore valley is highly dependent on agriculture and livestock for its livelihood, thus putting tremendous pressure on pastures and associated natural resources. Due to limited cultivable land there is rapid encroachment of forests and pastures.

1.2.3 Loss of Indigenous Knowledge

In addition to the outright threats of habitat disturbance and overexploitation on medicinal plants, threat of indigenous knowledge loss is also significance. Knowledge about a medicinal plant's uses and ecology can help facilitate safe and conservative use of the plant. For example, Rai *et al*. (2000) reported that if overharvesting is a significant problem, knowledge about sustainable harvesting techniques that do not decrease overall yield can help reduce pressure on wild populations. Some studies for example Voeks and Leony (2004), cultural change appears to be the most serious threat to local medicinal plant knowledge, particularly the influence of modernization and the western worldview.

Local or indigenous knowledge loss has possibly also been aggravated by the expansion of modern education, which has contributed to under- mining traditional values among the young (Giday *et al*., 2003). For example, in the Velliangiri hills in India, young people lack interest in Malasar traditional knowledge, and many of them leave their home villages in search of emerging opportunities in more industrialized settings (Ragupathy *et al*., 2008). In Lenc¸ óis, Bahia, Brazil, young people sometimes understand how plants were used in the past, but they never actually employ them and are not likely ever to do so (Voeks and Leony, 2004). Bussmann and Sharon (2006), in a study of medicinal plant knowledge in southern Ecuador, suggested that to avoid the loss of this intellectual heritage, which has evolved in traditional cultures over hundreds of years, and to keep it alive, it is necessary to document and describe traditional use of plants.

Most traditional healers who work with medicinal plants on a day-to-day basis understand the ecology of these plants and are able to articulate requirements for sustainable harvesting.

Traditional healers living adjacent to the Kruger National Park in South Africa, for example, argued that they were trained to utilize resources sustainably (Botha, 1998). Unfortunately, very little of this traditional knowledge has been documented or critically examined (Shanley and Luz, 2003) and much of it has been lost in recent years. Few young people are interested in learning about traditional medicine due to the dominance of westerns cultures. In addition, the virtues of modern medicine lead to the abandonment of local medicinal practices in many villages. In the Velliangiri hills in India, modern health care facilities are thought to be a barrier to effective dissemination of traditional aboriginal knowledge (Ragupathy *et al*., 2008). Folk healers and their orally transmitted traditions may be more vulnerable to extinction than medicinal plants themselves (Anyinam, 1995) because many healers are aged and are dying with their knowledge left unrecorded (Cox, 2000).

As a result, a growing number of traditional healers die without passing on their knowledge about medicinal plant products to future generations (Giday *et al*., 2003). Though this trend leads to a general loss of knowledge, Shanley and Luz (2003) indicate that commercial harvesting may actually facilitate a simultaneous gain in knowledge. They explain that as resources decline, seasoned collector experiment with various bark, root, and oil harvesting regimes. Harvesters can elucidate details regarding species phenology, use, collection techniques, and production trends.
Moreover, a large number of medicinal plants have become threatened due to their small population size, narrow distribution area, habitat specificity, destructive mode of harvesting, heavy livestock grazing, high value of utilization, climate change, habitat loss, present development activities and genetic drift (Kala, 2000; 2005).

1.2.4 Ecology of Medicinal plants

Much study hasn't been done regarding to the ecology of medicinal plant in the research sites. Medicinal species like *Acacia nilotica* are common in arid and semi-arid regions of Africa on wooded grassland, woodland and open bushland from coastal areas to altitudes of 2300m (Dharani and Yenesew, 2010) while species like *Balanites aegyptiaca* are common in dry bushland, bushed grassland, wooded grassland or woodland, but also grows along rivers, at altitudes of 250 – 2000m. Some species like *Boscia coriacea* are commonly found in *Acacia-Commiphora* bushland and semi-desert scrub, often in rocky areas, at altitudes of 150 – 1,500m.

A widely distributed acacia, *Acacia mellifera*, widespread in all arid and semiarid areas, may be dominant in dry *Acacia-Commiphora* bush land. It thrives in a variety of soils including rocky, loamy, volcanic and sandy conditions and growing between 300 m and 1,800 m altitude (Dharani *et al*., 2010).

1.3 Justification

Most indigenous medicinal plants usually grow in the wild where they receive little or no management actions. In areas where land is communally owned, indigenous medicinal plants and pasture resources for livestock are common property, which suffer degradation due to unsustainable exploitation. As human population pressure on natural vegetation increases, plant biodiversity including medicinal plants diminishes. The potential value of the drug-producing plants increases considerably and induces further scramble for remaining resource and complete land transformation into a biological desert. Therefore, African medicinal plant resources may be doomed to extinction through overexploitation resulting from excessive commercialization, habitat destruction and other man-made destructive influences unless concerted conservation efforts are made to reverse the current trends in biodiversity loss.

1.4 Statement of the problem

Kenya's arid and semi arid land (ASAL) ecosystems are globally significant repository of biodiversity (including indigenous medicinal plants), acclaimed for their species richness and habitat diversity. Central Kajiado is located in South Rift of Eastern block of the Great Rift Valley in Kenya. The population consists of Maasai pastoralists and the main economic activity has remained semi-nomadic pastoralism with the vast majority relying on livestock.

The vegetation of Central Kajiado is an important source of local building material, fuelwood and traditional medicines for the treatment of diseases in both human beings and their livestock. Indigenous Medicinal Plants (IMP) has been part and parcel of the African culture among the African traditional communities, including Maasai pastoralists, who rely on IMPs for primary healthcare in both human beings and their livestock. IMPs are not only used in primary healthcare but are also means of generating income for several traditional herbalists in this area.

Currently, by far the most pressing conservation concern in the study area today is the alarming rate at which old indigenous trees are cut down and forests are being destroyed for unsustainable logging and making charcoal. Due to land use tenure and lack of education in conservation of natural resources and biodiversity, deforestation resulting in land degradation has been a major problem of the area. Catastrophic habitat loss is threatening the survival of many important medicinal plants and poses an acute challenge to the survival of livestock and local livelihoods.

1.5 Main and Specific objectives

The general objective of this study was to determine ecological parameters that characterize medicinal plants and their contribution to primary health care of rural communities in central Kajiado County, Kenya. The specific objectives were:

1. To determine the composition, distribution and abundance of Indigenous Medicinal Plants in Central Kajiado County.
2. To determine the community structure (species richness and diversity) of local medicinal plants.
3. To determine the modes of exploitation and contribution of medicinal plants in primary health care and livelihoods of rural communities in the study area.

1.6 Research hypotheses

1. The composition, distribution and abundance of the indigenous medicinal plants in the research sites did not show any significant difference.

2. There was no difference in the community structure (species richness and diversity) of local medicinal plants in the research sites.

3. The plant species in the research sites were not subjected to different mode of exploitation.

4. The plant species' contribution to the primary health care of the local community was limited.

CHAPTER TWO

2.0 MATERIALS AND METHODS

2.1 Study area

The study was carried out at Central Kajiado District at three sites (Oltepesi, Elangata-Wuas (Mile 46) and Kenya Marble Quarry (KMQ)), located at the southern end of the Rift Valley Province. Kajiado county is bordered by the Republic of Tanzania to the southwest; and is situated between longitudes 36°5’ and 37°55’ East and latitudes 1°10’ and 3°10’ South. The district lies in the rain shadow of Mount Kilimanjaro and has semi-arid climate. Annual rainfall has a bimodal distribution pattern with precipitation usually occurring during the period between November and January (short rains) and March to May (long rains). The mean annual rainfall is low (350mm) and daily temperature ranges from 35^{o}C in February and March to 12^{o}C in July (Almann *et al*., 2002).

2.1.1 Study site and Sampling plot selection

The key characteristics of the three sites selected for this study are summarized in Table 1.

The average land elevation lies below 1600m and it is characterized by shallow soils and ground vegetation cover ranging from zero to 85%. The natural vegetation types are bushed grasslands, bush lands and open woodlands, especially in the seasonal river valleys.

Table 1. Geographical location of the study sites in Central Kajiado County, Kenya

Site name	GPS Location	Site elevation (m)	Habitat
Kenya Marble Quarry	S 01^{o} 55.241`, E 036$^{o}$ 38.176`	1534 - 1598	Open woodland
Mile 46	S 01^{o} 53.547`, E 036$^{o}$ 35.217`	1410 - 1424	Open woodland
Oltepesi	S 01^{o} 58.626`, E 036^{o} 36. 873	1409 - 1410	Open grassland & woodland

Ground reconnaissance was primarily carried out as to how sampling transects and plots were set up across the available vegetation types in the Kenya Marble Quarry, Mile 46 and Oltepesi areas. A quadrat measuring 10x10m were established within a distance of 100m between plots transect erected at each of the study sites. A total of 21 plots were set up at mile 46 and a total of 20 plots at Kenya Marble Quarry and Oltepesi.

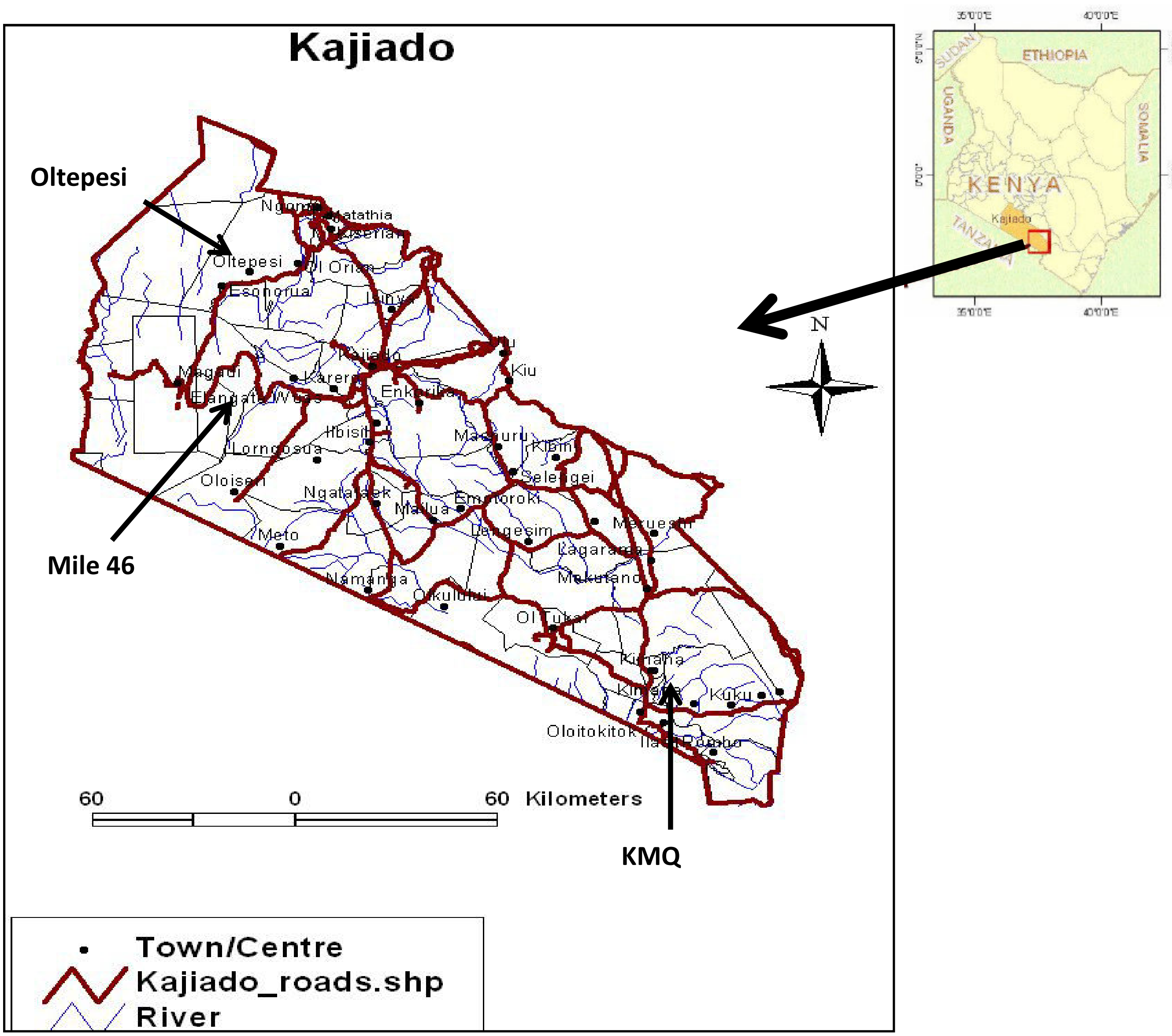

Figure 1. The study area showing the three sampling sites

(***Source:*** Department of Geography and Environmental Studies, University of Nairobi)

2.2 Vegetation sampling

On each of the sampling plots vegetation data were collected. These data included species of medicinal plants, number of individuals and diameter at breast height (DBH) for trees and tall shrubs, height and canopy diameter for trees.

2.2.1 Diameter at breast height (DBH)

The circumference of the plant species was measured at 1.5 m above the ground within each quadrant using a tape measure and the measurements were later converted to diameter values using the following formula.

$$D = \frac{C}{\pi} \text{ ……………………………………………….. (Equation 1)}$$

Where;

C= circumference (Cm)

D= diameter (Cm)

π= 3.14

2.2.2 Density of the plant species

Density refers to the number of individuals of a species per unit area (Cox, 1990)

$$D = \frac{N}{A} \text{……………………………………………… (Equation 2)}$$

Where;

D = Density

N= Total number of individuals of a species found

A = Area sampled (M^2)

2.3 Distribution Pattern of Medicinal Plants

According to Kandari *et al*. (2011) cited in the methods of Curtis and Cottom (1956), the ratio of abundance to frequency (A/F) is a relative measure to present the distribution of species in a community: as A/F <0.025 (regular), between 0.025 and 0.05 (random), and > 0.05 (contagious) distribution.

According to Curtis and McIntosh (1950), abundance and frequency are calculated as follows:

Frequency (F) = $\frac{Number\ of\ quadrats\ in\ which\ a\ species\ occurs}{Total\ number\ of\ quadrats\ examined}$ x 100 .... (Equation 3)

Abundance (A) = $\frac{Total\ number\ of\ individuals\ found}{Number\ of\ quadrats\ of\ occurence}$ .... (Equation 4)

Relative measure to present the distribution of species in a community = $\frac{Abundance}{Frequency}$ .... (Equation 5) (Curtis and Cottom, 1956)

Relative abundance = $\frac{Number\ of\ individuals\ of\ a\ species}{Total\ number\ of\ individuals\ of\ the\ species\ in\ the\ area}$ x 100 ...... (Equation 6)

2.4 Species diversity

Shannon diversity index (Shannon and Weaver, 1949) was used to quantify species richness and diversity within and outside the conservation area. The Shannon–Wiener index takes into account species richness and proportional abundance to calculate a single diversity measure. This is, in fact, a measure of evenness of species abundances in a sample with more even samples gaining a higher value. The Shannon diversity index (H’) is calculated with the formula:

H' = - $\sum pi \; ln \; pi$ …………………………………………… (Equation 7)

Where:

P_i = proportion of individuals belonging to species i

H' = Shannon-Wiener index

ln = natural log (i.e. base 2.718).

2.5 Importance Value Index

This index is calculated based on the following parameters:

Importance Value Index (IVI) = Relative density + Relative frequency + Relative dominance….. (Equation 8)

Relative density = Number of stems per ha of the i^{th} species / Total number of stems per Ha of all species x 100…………… (Equation 9)

Relative frequency = Frequency of i^{th} species / Total frequency of all species x 100…………………………….. (Equation 10)

Relative dominance = Sum basal area of i^{th} species / total basal area of all species x 100……………………………. (Equation 11)

2.6 Collection and assessment of ethno botanical data

Local elders as key informants were approached to help identify the important traditional medicinal plants. Key informants were used because they knew the medicinal plants and were willing to share their knowledge (Garcia, 2006). A research assistant with the knowledge of local language and vegetation was selected to help conduct structured interviews and administer questionnaires.

Structured questionnaires were prepared and administered to respondents in different households located in different villages in the three study sites and descriptive statistics was performed using SPSS 20. Semi structured interviews were used to get ethnobotanical data as it is described by Martin (2007). Moreover, medicinal plant inventories were conducted using local names and their occurrence in different plant life forms documented.

Respondents were also requested to mention potential threats to medicinal plant species within each sampling site and whether they had noticed a decline in their availability and abundance. A more in-depth discussion on these threats were undertaken to obtain insights and a clearer picture of the status and future of important medicinal plant resources to the community.

Use values of medicinal plants were assigned to the plant species use categories and used to estimate local people's use-preferences directly from the number of informants mentioning a species during free-listing interviews prepared in the questionnaire frame (Philips and Gentry, 1993; Martin, 2007).

Use value was calculated using the formula:

$UVis = \frac{\sum Uis}{nis}$ ………………………………………………….... (Equation 12)

Where,

UV_{is} = Use value of a species **s** for informant **i**

U_{is} = the number of uses mentioned in each event by informant **i**

n_{is}= the number of events for species **s** with informant **i**

The relative importance of individual plant species, for medicinal use by the community, was assessed by calculating their use values (UV_s) by a slight modification of the method described by Philips and Gentry (1993) and Martin (2007);

$$(UVs) = \frac{\sum UVis}{nis} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Equation 13)}$$

Where,

UV_{is} = the use value of one plant species to one informant

n_{is} = the number of informants interviewed for the species (i.e., the number of informants citing the use of species).

The assumption was that every informant had equal chances of mentioning any use of the species for different purposes in the area because of the way the questionnaire was structured.

Moreover, the species used by the society for different purposes including medicinal value were analyzed using beta diversity by presence-absence data in the plots. Beta diversity is used in similarity calculations based on the number of species present in each sample giving equal weight and count all species and to calculate this beta diversity R software was used. To determine the contribution, use and conservation status of medicinal plants in the research site, information collected through semi structured interview was coded and subjected to statistical software, SPSS 20 and R.

2.7 Total use of medicinal plants

To assess plant species use value it can be considered the frequency of use (U) and the local perception of quality of the species (Q). U can be defined as the proportion of positive mentions of plant species for a particular use, divided by the total number of interviews (Ladio and Lozada, 2004).

For instance, if to the question: the medicinal value of the plant species that you use to cure any disease, ten of the 25 men interviewed mentioned that the plant species are used as medicinal plant, Plant species' U value was calculated as: 10/25=0.4. The overall U of plant species was calculated as the total of all its U values ($U=\Sigma U1\ldots n$). As in the example above, if U values of medicinal were 0.4 and 0.5 (animal fodder), the overall plant's U value will be 0.9. Moreover, the frequency of use per species by taking into account the proportion of time a plant was mentioned out of the total number of interviews, that is, if a species was cited by 10 people of a total population of 20, the frequency of use of this species is 50%.

CHAPTER THREE

3.0 RESULTS AND DISCUSSION

3.1 Relative abundance of the species

Relative abundance indicates the percentage of individuals within each species present in a community and how that species relates numerically to the abundance of any other species present in that community. It also reveals ecological patterns that indicate which species is dominant or least dominant on that specific site.

Balanites aegyptiaca (36.92%) was the most dominant species in KMQ, while *Commiphora africana* (28.41%) and *Balanites aegyptiaca* (27.27%) in Mile 46; and *Balanites aegyptiaca* (39.4%) was the dominant species in Oltepesi (Table 2). This abundance and scarcity of species should inform what kind of conservation measures should be taken in the area. In conservation biology and management, information on relative abundances is of great importance to study the impact of habitat disturbances, such as fragmentation. It is well known that disturbed and fragmented habitats are usually dominated by a very few species compared to the undisturbed sites (Odat *et al.*, 2009).

The rank abundance curve provides a means for visually representing species richness and species evenness. Species richness can be viewed as the number of different species on the chart i.e., how many species were ranked. Species evenness is derived from the slope of the line that fits the graph. A steep gradient indicates low evenness as the high ranking species have much higher abundances than the low ranking species. A shallow gradient indicates high evenness as the abundances of different species are similar (Figure 2, 3 and 4).

Table 2. Relative abundance of the plant species in the study sites

Study sites	Plant Species	Relative abundance
KMQ	*Balanites aegyptiaca*	36.92%
	Commiphora africana	20%
	Acacia mellifera	14.62%
	Commiphora schimperi	14.62%
	Acacia tortilis	12.31%
	Acacia etabica	1.54%
Mile 46	*Commiphora africana*	28.41%
	Balanites aegyptiaca	27.27%
	Acacia drepanolobium	21.60%
	Commiphora schimperi	10.23%
	Acacia mellifera	5.68%
	Acacia tortilis	3.41%
	Acacia etabica	1.14%
	Acacia nilotica	1.14%
	Salvadora persica	1.14%
Oltepesi	*Balanites aegyptiaca*	39.40%
	Acacia tortilis	32.32%
	Acacia mellifera	17.17%
	Commiphora africana	5.05%
	Acacia etabica	2.02%
	Commiphora schimperi	2.02%
	Acacia nilotica	1.01%
	Acacia nubica	1.01%

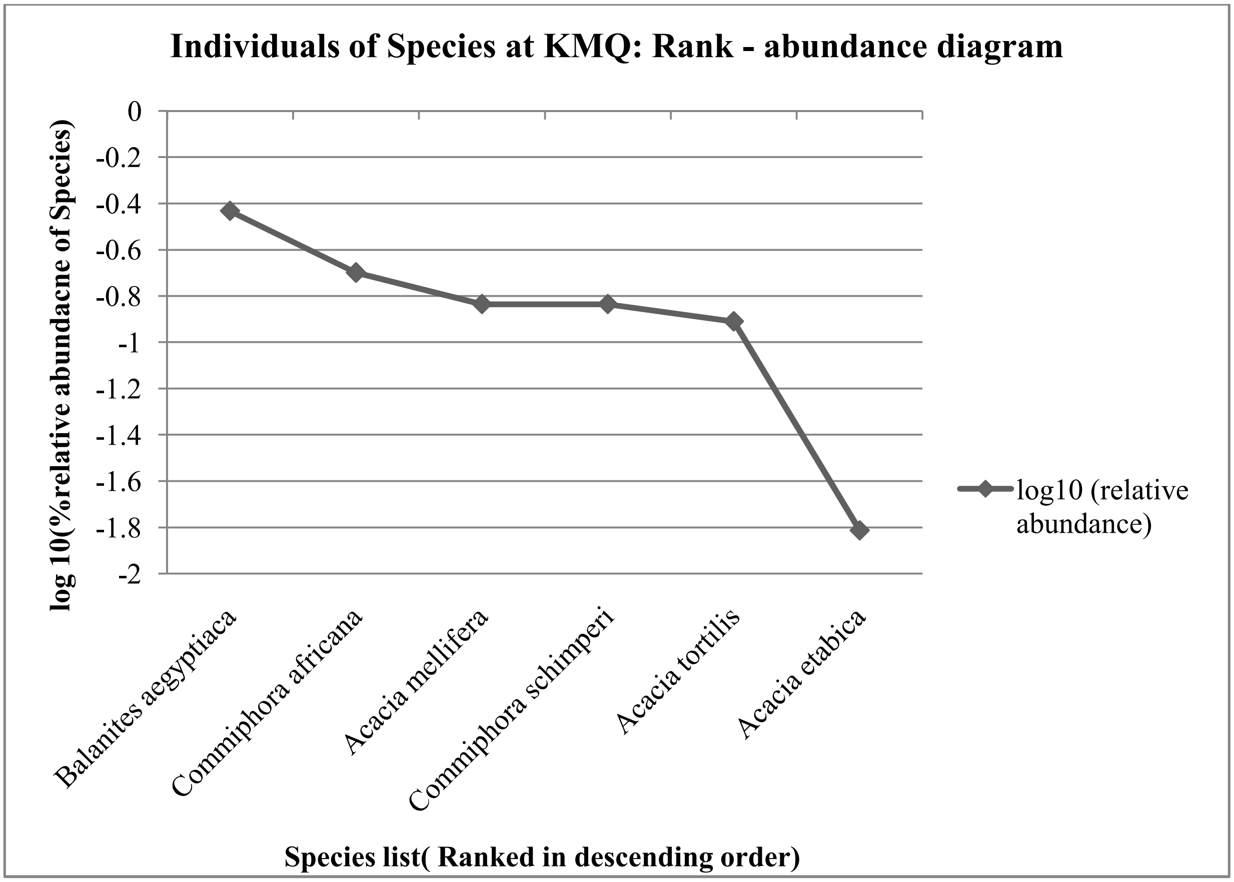

Figure 2. Relative abundance curve of the plant species at KMQ

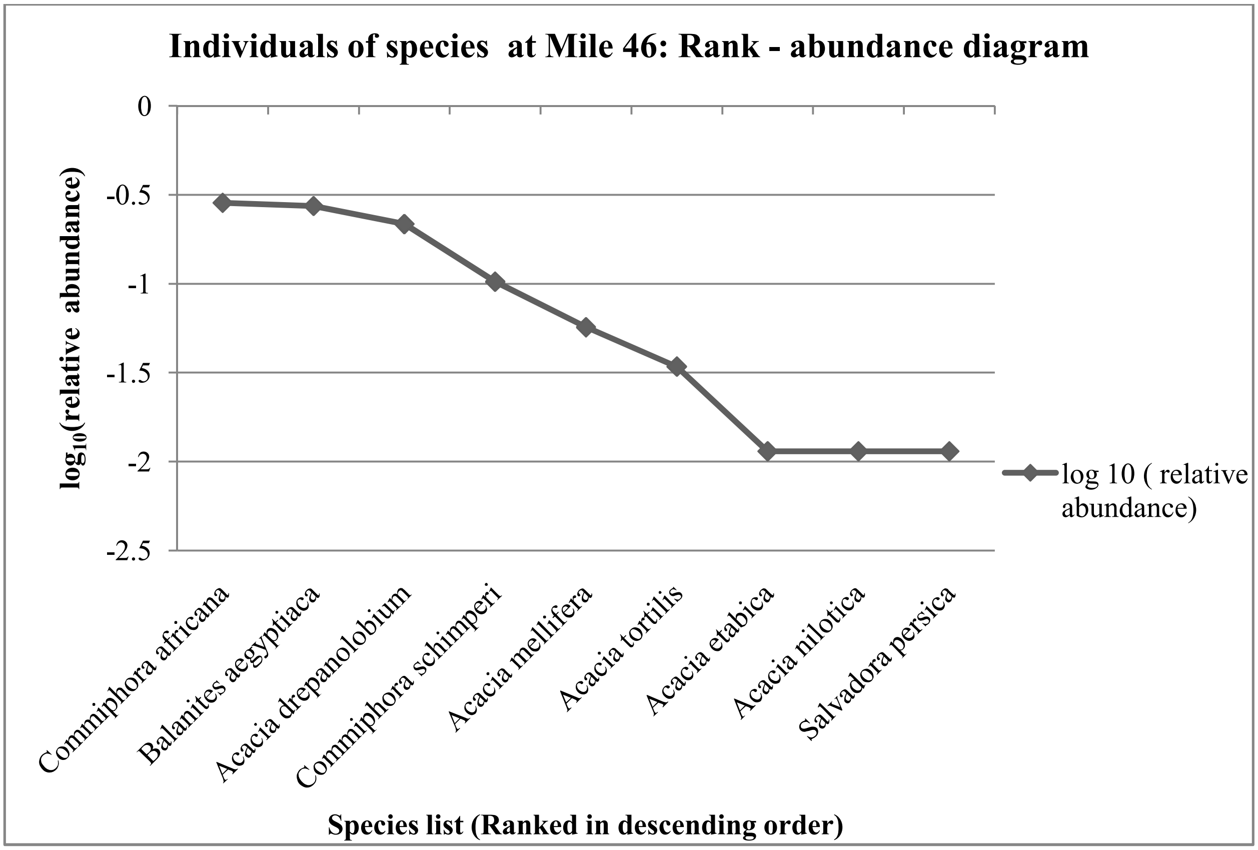

Figure 3. Relative abundance of the plant species at Mile 46

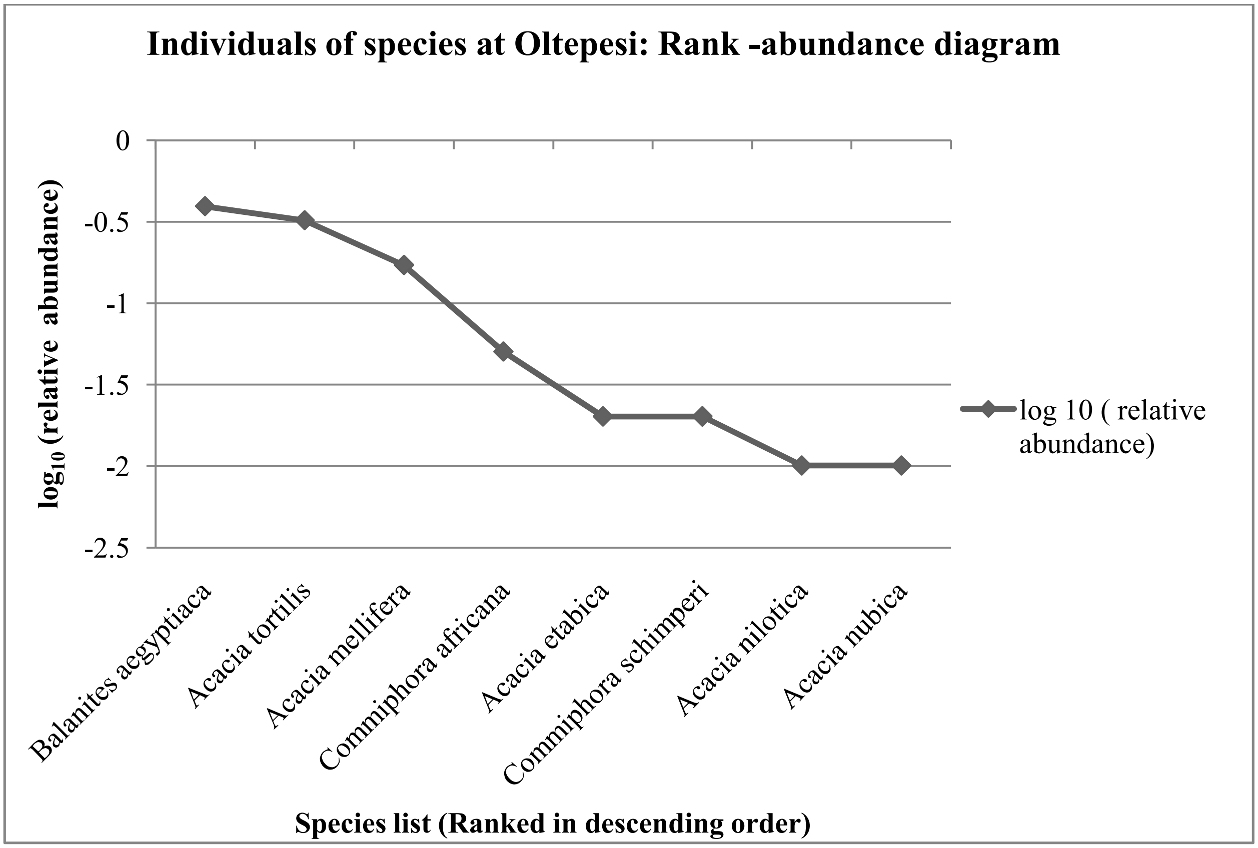

Figure 4. Relative abundance of the plant species at Oltepesi

3.2 Distribution pattern of the medicinal plants

The distribution pattern of medicinal plants in Mile 46 and KMQ, all the species had a contagious distribution while in Oltepesi, one species *Albizia anthelmintica* had a regular distribution. According to Odum (1971), contagious distribution is the most pervasive pattern in nature; random distribution is confined only in very uniform environments whereas regular distribution occurs in those areas where competition among several individuals exists. Contagious distribution depends on the local habitat, daily and seasonal weather change and reproductive process.

Table 3. Phytosociological attributes of the species in the study sites

Sites	Species	Phytosociological attributes		
		Frequency F (%)	Density (Plants ha^{-1})	Abundance Frequency ratio
Mile 46	*Acacia etabica*	4.76	4.76	21.00
	Acacia nilotica	4.76	4.76	21.00
	Salvadora persica	4.76	4.76	21.00
	Acacia mellifera	14.29	23.81	11.67
	Acacia tortilis	14.29	14.29	7.00
	Acacia drepanolobium	38.1	90.48	6.23
	Commiphora africana	47.62	119.05	5.25
	Commiphora schimperi	28.57	42.86	5.25
	Balanites aegyptiaca	47.62	114.29	5.04
KMQ	*Acacia etabica*	10.00	10.00	10.00
	Commiphora africana	50.00	130.00	5.20
	Balanites aegyptiaca	85.00	240	3.32
	Acacia mellifera	55.00	95.00	3.14
	Acacia tortilis	52.38	80.00	2.92
	Commiphora schimperi	65.00	95.00	2.25
Oltepesi	*Acacia nilotica*	5.00	5.00	20.00
	Acacia nubica	5.00	5.00	20.00
	Commiphora schimperi	10.00	10.00	10.00
	Acacia etabica	10.00	10.00	10.00
	Acacia mellifera	45.00	85.00	4.20
	Acacia tortilis	80.00	160.00	2.50
	Balanites aegyptiaca	80.00	160.00	2.50
	Albizia anthelmintica	5.00	0.05	0.2
	Commiphora africana	20.00	0.25	0.06

3.3 Species diversity

In Oltepesi, a lower species diversity and evenness was recorded as compared to the other two research sites, namely Mile 46 and Kenya Marble Quarry (KMQ). However, the ANOVA test did not reveal a significant differences (df = 2, P=0.259, α=0.05) among the research sites.

In Mile 46, higher species diversity was recorded as compared to KMQ and Oltepesi while KMQ had higher evenness than the other two sites.

Table 4. Shannon-Weiner Index (H') and Evenness (H'/Hmax) for Mile 46, KMQ and Oltepesi research sites in Kajiado County

No.	Site	H'	Evenness
1	Mile 46	1.707	0.777
2	KMQ	1.574	0.878
3	Oltepesi	1.436	0.691

Species diversity in these research sites did not reveal any significant difference which implied the research sites had homogenous type of species diversity. Song *et al*. (1997) stated that the distribution and diversity of plant species in a landscape depend on various factors (e.g., dispersal, ability, competition, environmental factors such as solar radiation, temperature and soil geological conditions). These factors may influence the landscape vegetation structure and would show significant effects on richness and diversity (Heydari and Madhavi 2009).

3.3.1 Beta diversity based on presence-absence data

Beta diversity is the difference in species composition between sites in geographical area as it measures the amount of species change (turn-over) between the sites (Koleff *et al*., 2003). The best known index of beta diversity is based on the ratio of total number of species in a collection of sites (S) and the average richness per one site (α). My result showed that Oltepesi had high beta diversity (2.52) while KMQ and Mile 46 had the same beta diversity index of 0.846.

3.4 Importance Value Index

Importance Value Index (IVI) was used to compare ecological significance of plant species in the research areas. Importance value index is the sum of relative density, relative frequency and relative basal area (ha^{-1}). The importance value index is useful for comparisons of ecologically significant species (Lekoyiet, 2006).

The species in the three research areas had different importance value indices. In Mile 46, *Commiphora africana* had the highest IVI value (77.69). In Kenya Marble Quarry (KMQ), *Balanites aegyptiaca* had the highest IVI value (81.99) and in Oltepesi, *Acacia tortilis* had the highest IVI value (129.24) (Table 5). The higher IVI value indicates that most of the available resources are being utilized by that species and the residual resources are being trapped by another species as the competitors and associates (Kukshal *et al*., 2009). The importance value index of all the species in the study sites is given in Table 5.

Table 5.The importance value index of the species in the study sites

Sites	Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value (IVI)
Mile 46	*Commiphora africana*	23.3	28.41	26.03	77.69
	Balanites aegyptiaca	23.3	27.27	14.13	64.66
	Acacia drepanolobium	18.6	21.6	17.84	58.04
	Commiphora schimperi	14	10.23	9.67	33.86
	Acacia tortilis	7	3.41	12.79	23.18
	Acacia mellifera	7	5.68	16.31	28.97
	Salvadora persica	2.3	1.14	1.58	5.04
	Acacia nilotica	2.3	1.14	1.04	4.5
	Acacia etabica	2.3	1.14	0.006	4.06
KMQ	*Balanites aegyptiaca*	26.78	36.92	18.29	81.99
	Acacia tortilis	16.50	12.31	29.12	57.93
	Commiphora schimperi	20.48	14.62	21.27	56.37
	Commiphora africana	15.75	0.2	19.46	55.22
	Acacia mellifera	17.33	14.61	10.68	42.62
	Acacia etabica	3.15	1.54	1.17	5.86
Oltepesi	*Acacia tortilis*	30.77	36.26	61.72	129.24
	Balanites aegyptiaca	30.77	36.76	16.97	84.51
	Acacia mellifera	17.31	19.53	15.04	51.88
	Commiphora africana	7.69	0.057	2.41	10.16
	Acacia etabica	3.85	2.297	1.84	7.98
	Commiphora schimperi	3.85	2.297	1.23	7.38
	Acacia nilotica	1.92	1.15	0.53	3.61
	Acacia nubica	1.92	1.15	0.26	3.33
	Albizia anthelmintica	1.92	0.012	0.79	2.72

3.5 Species density trend in the three research area

The mean density of the species in the three research areas varied in which highest density value was observed in Kenya Marble Quarry (KMQ) (108.33 trees per ha) followed by Oltepesi (48.37) and then Mile 46 (46.56).

There was no any significant difference (df=2, F= 2.065 and P=0.152) observed at $\alpha = 0.05$ regarding the density of the medicinal plant species in the research sites.

3.6 Vertical Structure

The comparison of species height in the research sites did not reveal a significance difference (df=2, F=1.757, P=0.174 and α=0.05). So, the species vertical structure was similar in the research sites.

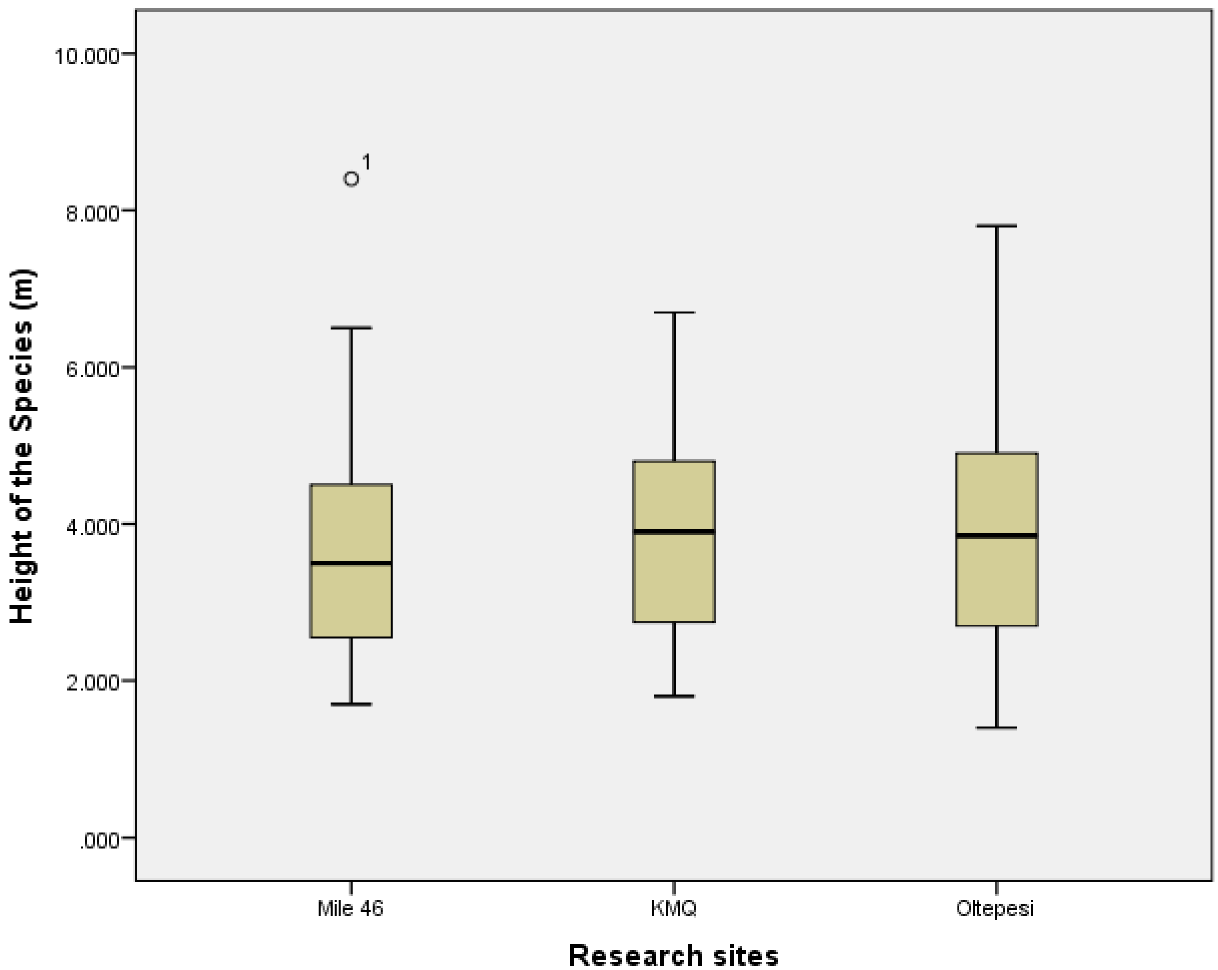

Figure 5. Height of the plant species in the study sites

3.7 Ethno botanical Data Analysis

3.7.1 Characteristics of Informants

In the study sites, 83.9% of the respondents were male and 16.1% were female. Both sexes have the indigenous knowledge of treating different diseases traditionally even though most were males in the area. The possible explanation for this might be in the Maasai culture females are more engaged in the house activities as compared to men and men are more involved in traditional medicinal plant practices. But, in the informal communication, it was said that women are highly curious in traditional medicines of childbirth, paediatrics and abortifacient herbs. The information provided by male and female did not reveal significant differences (df =1, F=0.597, P= 0.442 and α = 0.05) statistically in the research sites. The finding of this research is contrary to that of Kitula (2007) in Tanzania who reported that all traditional medicinal practitioners were females but it is in line with the finding of Giday *et al.* (2003) in Ethiopia who reported that men are usually involved in medicinal plant utilization in treating health abnormality traditionally.

3.7.2 Local community attitude towards conservation

Among the respondents at the three research sites, 97.2% of them believed that establishment of conservation area for medicinal plants in the region is very important to acquire their sustainable use in the local community and only 2.8% of them were against establishing a conservation area for medicinal plants. It was important to note that the local people considered sharing knowledge about the important species to take an important conservation strategy. This can be a basis for promoting conservation outside protected areas.

3.7.3 Total use of Medicinal plant

A total of around 40 useful plant species were identified through semi-structured questionnaires delivered to the local community in the three research sites. In Kenya Marble Quarry (KMQ), *Acacia tortilis, Acacia mellifera*, *Balanites glabra* and *Commiphora africana* had the highest total use value to the local community (Table 6). In Mile 46 sites, *Acacia tortilis, Acacia mellifera, Balanites aegyptiaca, Acacia nubica* and *Commiphora schimperi* (Table 7) in Oltepesi, *Acacia tortilis*, *Acacia mellifera*, *Balanites aegyptiaca* and *Acacia nubica* (Table 8) had the highest total use value to the local community**.**

In regard to medicinal value of the surveyed species, *Acacia mellifera*, *Acacia tortilis*, *Commiphora africana* and *Commiphora schimperi* (Table 6) were the top most species used by the local people for medicinal purpose in KMQ site while *Acacia tortilis*, *Acacia nubica*, *Commiphora schimperi*, *Acacia mellifera* and *Balanites aegyptiaca* (Table 7) were frequently used by the society in Mile 46 for the treatment of different diseases. *Acacia mellifera*, *Acacia tortilis* and *Salvadora persica* (Table 8) were frequently used as medicine for the treatment in Oltepesi site.

From this research findings, *Acacia tortilis*, *Acacia mellifera*, *Balanites aegyptiaca* and *Commiphora schimperi* in Kenya Marble Quarry (KMQ); *Acacia tortilis*, *Balanites aegyptiaca*, and *Acacia mellifera* in Mile 46; and *Acacia tortilis*, *Acacia mellifera*, and *Salvadora persica* in Oltepesi had the highest total use value to the local community. But, the total use value of the species did not reveal significant differences statistically across the research sites (df=2, F=1.456, P=0.238 and α=0.05). This implies that the species have various uses to the society and knowing and undertaking such kind of study helps to identify some useful plant species that should be considered as priorities for management and conservation, as suggested by Kvist

(2001). Moreover, one plant species has more than one use as Tabuti *et al*. (2003) found that some of the plant species used for herbal medicines had other uses such as firewood and in traditional cultural rites.

Low use value scores of plant species could be associated in part with their scarcity. As pointed out by Benz *et al*. (1994), the use of a plant resource is a function of its abundance, with more abundant species being more extensively used. In other words, the low use value of some plant species could be related to their scarcity or the decrease of their populations.

Table 6. Use value of Medicinal Plants used by the local community in KMQ (n=30)

No.	Maasai name	Botanical name	Food	Firewood	Construction	Medicine	Shade	Fencing	Animal Fodder	Charcoal	Total UV
1	Oltepesi	*Acacia tortilis*	0.83	0.8	0.87	0.83	0.87	0.83	0.83	0.83	6.69
2	Oiti	*Acacia mellifera*	0.77	0.77	0.8	0.9	0.77	0.8	0.8	0.77	6.38
3	Olng'oswa	*Balanites aegyptiaca*	0.67	0.67	0.67	0.7	0.63	0.67	0.67	0.63	5.31
4	Olailupai	*Commiphora africana*	0.47	0.67	0.8	0.83	0.77	0.8	0.67	0.07	5.08
5	Osilalei	*Commiphora schimperi*	0.57	0.67	0.63	0.8	0.63	0.73	0.73	0.03	4.79
6	Eseki	*Cordia monoica*	0.63	0.63	0.6	0.63	0.63	0.63	0.63	0.03	4.41
7	Esiteti	*Grewia bicolor*	0.57	0.57	0.6	0.73	0.6	0.53	0.57	0.17	4.34
8	Osiyiamalili	*Acacia etabaica*	0.33	0.47	0.5	0.6	0.47	0.47	0.47	0.47	3.78
9	Oremit	*Salvadora persica*	0.43	0.53	0.53	0.63	0.5	0.53	0.53	0	3.68
10	Olkiloriti	*Acacia nilotica*	0.17	0.47	0.47	0.47	0.43	0.43	0.47	0.47	3.38
11	Oluai	*Acacia drepanolobium*	0.33	0.33	0.33	0.37	0.33	0.33	0.33	0.33	2.68
12	Oldepe	*Acacia nubica*	0.33	0.37	0.33	0.37	0.37	0.37	0.37	0.03	2.54
13	Oldorko	*Cordia sinensis*	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	1.84
14	Olmunkushi	*Rhus vulgaris*	0.17	0.2	0.2	0.23	0.2	0.2	0.2	0.03	1.43
15	Olmukutan	*Albizia anthelmintica*	0	0.17	0.17	0.27	0.17	0.17	0.17	0.13	1.25
16	Osukuroi	*Aloe secundiflora*	0	0	0.03	0.5	0	0.33	0.37	0	1.23
17	Emankulai	*Grewia villosa*	0.17	0.17	0.17	0.2	0.17	0.17	0.17	0	1.22
18	Olmisigiyioi	*Rhus natalensis*	0.13	0.2	0.17	0.1	0.17	0.1	0.2	0.1	1.17
19	Oltimigomi	*Pappea capensis*	0.03	0.17	0.17	0.17	0.13	0.17	0.17	0.1	1.11
20	Olerai	*Acacia xanthophlea*	0.03	0.2	0.13	0.2	0.2	0.2	0.1	0.03	1.09
21	Olkokola	*Rhamnus staddo*	0	0.23	0.17	0.17	0.17	0.07	0.07	0	0.88
22	Olamuriaki	*Carissa edulis*	0.1	0.13	0	0.1	0.17	0.17	0.13	0	0.8
23	Eirri	*Grewia tembensis*	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0	0.8
24	Enkitarru	*Croton macrostachyus*	0	0.13	0.13	0.2	0.13	0.13	0.03	0	0.75
25	Olamai	*Ximenia americana*	0.07	0.17	0.07	0.17	0.07	0.07	0.07	0	0.69

26	Enchani-pus	*Cadaba farinosa*	0.03	0.2	0.1	0.13	0.07	0.07	0.07	0	0.67
27	Olperr-elongo	*Albizia amara*	0.03	0.1	0.1	0.1	0.1	0.1	0.1	0.03	0.66
28	Olenarran	*Euclea racemosa*	0.03	0.17	0.07	0.17	0.07	0.07	0.07	0	0.65
29	Oloireroi	*Bosica angustifolia*	0	0.1	0.1	0.1	0.1	0.1	0.1	0.03	0.63
30	Oloilei	*Euphorbia tirucalli*	0	0.07	0.07	0.13	0.07	0.07	0.07	0	0.48
31	Enchani-enkashe	*Turea abyssinica*	0	0.07	0.07	0.07	0.07	0.07	0.07	0	0.42
32	Oloirien	*Olea africana*	0	0.07	0.07	0.07	0.07	0.03	0.07	0	0.38
33	Eimmim	*Indigofera erecta*	0	0	0.1	0.17	0	0	0.1	0	0.37
34	Oldupai	*Sansevieria robusta*	0	0	0.1	0.03	0.03	0.1	0.1	0	0.36
35	Entulelei	*Solanum incanum*	0	0	0.03	0.13	0	0	0.13	0	0.29
36	Esonkoyo	*Justicia odora*	0.07	0	0	0.07	0	0	0.07	0	0.21
37	Olgumi	*Vangueria madagascariensis*	0.03	0	0.03	0.03	0.03	0.03	0.03	0	0.18
38	Olmakutukut	*clerodendrum myricoides*	0	0	0	0.03	0.03	0	0.03	0	0.09
39	Olorrondoi	*Quercus rotundifolia*	0	0	0	0.03	0.03	0	0.03	0	0.09
40	Osukurtuti	*Sericocomoposis hilderbrandoi*	0	0	0	0.03	0	0	0	0	0.03

Note: n=30 indicated the number of respondents interviewed in the research site.

Table 7. Use value of Medicinal plants used by the local community in Mile 46 (n=34)

No.	Maasai name	Botanical name	Food	Firewood	Construction	Medicine	Shade	Fencing	Animal Fodder	Other	Total UV
1	Oltepesi	*Acacia tortilis*	0	0.82	0.79	0.82	0.76	0.62	0.71	0.44	4.96
2	Olng'oswa	*Balanites aegyptiaca*	0.65	0.76	0.53	0.68	0.65	0.56	0.65	0.41	4.89
3	Oiti	*Acacia mellifera*	0.59	0.76	0.56	0.68	0.68	0.59	0.56	0.47	4.89
4	Oldepe	*Acacia nubica*	0.56	0.53	0.62	0.76	0.38	0.62	0.71	0.35	4.53
5	Osilalei	*Commiphora schimperi*	0.53	0.44	0.56	0.74	0.44	0.65	0.5	0.41	4.27
6	Olkiloriti	*Acacia nilotica*	0.29	0.38	0.44	0.59	0.59	0.47	0.38	0.41	3.55
7	Oremit	*Salvadora persica*	0.5	0.35	0.35	0.56	0.41	0.35	0.38	0.35	3.25
8	Oluai	*Acacia drepanolobium*	0.29	0.32	0.32	0.38	0.32	0.32	0.29	0.24	2.48
9	Esiteti	*Grewia bicolor*	0.38	0.21	0.29	0.41	0.29	0.18	0.41	0.29	2.46
10	Eseki	*Cordia monoica*	0.24	0.18	0.24	0.26	0.35	0.24	0.18	0.18	1.87
11	Osukuroi	*Aloe secundiflora*	0.15	0.06	0.03	0.5	0.03	0.38	0.38	0.21	1.74
12	Olmangulai	*Grewia villosa*	0.29	0.09	0.03	0.41	0.18	0.03	0.38	0.24	1.65
13	Eirri	*Grewia tembensis*	0.29	0	0.24	0.35	0.09	0.06	0.24	0.18	1.45
14	Osiyiamalili	*Acacia etbaica*	0.12	0.18	0.18	0.21	0.18	0.15	0.15	0.15	1.32
15	Enchani pus	*Cadaba farinosa*	0	0.09	0.24	0.18	0.24	0.15	0.15	0.15	1.2
16	Oloireroi	*Boscia angustifolia*		0.15	0.15	0.15	0.15	0.15	0.15	0.15	1.05
17	Enchani-enkashe	*Turaea abyssinica*	0	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.84
18	Eimmim	*Indigofera erector*	0	0	0.18	0.21	0	0.06	0.15	0.15	0.75
19	Olamoloki	*Maerua triphylla*	0.06	0.09	0.09	0.12	0.09	0.09	0.09	0.09	0.72
20	Olerai	*Acacia xanthophlea*	0	0.09	0.09	0.12	0.12	0.09	0.12	0.06	0.69
21	Oltimigomi	*Pappea capensis*	0	0.15	0.09	0.09	0.09	0.06	0.06	0.03	0.57
22	Oloirien	*Olea africana*	0.03	0	0.06	0.09	0.09	0.06	0.06	0.18	0.57
23	Enkokii	*Lycium europaeum*	0	0.06	0.06	0.09	0.06	0.06	0.06	0.06	0.45
24	Osarangi	*Balanties glabra*	0.06	0.06	0.03	0.06	0.06	0.06	0.06	0.03	0.42

25	Enkitarru	*Croton macrostachyus*	0	0.06	0.06	0.12	0.06	0.06	0	0.06	0.42
26	Olper-elongo	*Albizia amara*	0.03	0.06	0.06	0.06	0.03	0.06	0.06	0.03	0.39
27	Entulelei	*Solanum incunum*	0	0	0	0.12	0	0	0.12	0.06	0.3
28	Olamai	*Ximenia americana*	0.03	0.03	0.03	0.09	0.03	0.03	0.03	0	0.27
29	Enkangolol	*Opalia campestris*	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.24
30	Esonkoyo	*Justica odora*	0	0	0	0.09	0	0	0.06	0.06	0.21
31	Oloibor-lukunya	*Sericocomopsis hildebrandii*	0	0	0	0.15	0	0	0.03	0.03	0.21
32	Oldorko	*Cordia Sinensis*	0.03	0	0.03	0.03	0.03	0	0.03	0.03	0.18
33	Olorrondo	*Quercus rotundifolia*	0	0	0	0.12	0	0	0.03	0.03	0.18
34	Olmukutan	*Albizia anthelmintica*	0	0	0	0.18	0	0	0	0	0.18
35	Olpante	*Lannea schweinfurthii*	0.03	0.03	0	0	0.03	0.03	0.03	0	0.15
36	Olaimuriaki	*Carissa edulis*	0	0	0	0.12	0	0	0	0	0.12
37	Entipilikua		0	0	0	0.03	0	0	0.03	0.03	0.09
38	Osokoni	*Warburgia ugandensis*	0	0	0	0.03	0.03	0	0	0	0.06
39	Olenarran	*Euclea racemosa*	0	0	0	0.06	0	0	0	0	0.06
40	Olailupai	*Commiphora africana*	0	0	0	0.06	0	0	0	0	0.06
41	Olkirgirri	*Acacia berries*	0	0	0	0.03	0	0	0	0	0.03

Note: n= 34 indicated the number of respondents interviewed in the research site.

Table 8. Use value of Medicinal plants used by the local community in Oltepesi (n=32)

No.	Maasai name	Botanical name	Food	Firewood	Construction	Medicine	Shade	Fencing	Animal Fodder	Charcoal	Total UV
1	Oltepesi	*Acacia tortilis*	0.7	0.7	0.85	0.93	0.7	0.7	0.7	0.7	5.98
2	Oiti	*Acacia mellifera*	0.59	0.7	0.85	0.93	0.7	0.7	0.7	0.7	5.87
3	Oremit	*Salvadora persica*	0.81	0.81	0.7	0.81	0.81	0.78	0.78	0.3	5.8
4	Olng'oswa	*Balanites aegyptiaca*	0.74	0.74	0.56	0.67	0.74	0.74	0.74	0.74	5.67
5	Osilalei	*Commiphora schimperi*	0.22	0.89	0.78	0.74	0.89	0.89	0.89	0.19	5.49
6	Oldepe	*Acacia nubica*	0.67	0.67	0.81	0.93	0.67	0.67	0.67	0	5.09
7	Eseki	*Cordia monoica*	0.56	0.56	0.59	0.48	0.59	0.56	0.59	0.22	4.15
8	Esiteti	*Grewia bicolor*	0.52	0.52	0.67	0.56	0.52	0.52	0.52	0.15	3.98
9	Osiyiamalili	*Acacia etabaica*	0.3	0.44	0.44	0.52	0.44	0.44	0.44	0.44	3.46
10	Olailupai	*Commiphora africana*	0.26	0.37	0.48	0.44	0.37	0.37	0.37	0	2.66
11	Olkiloriti	*Acacia nilotica*	0.11	0.33	0.33	0.41	0.33	0.33	0.33	0.33	2.5
12	Eirri	*Grewia tembensis*	0.3	0.3	0.3	0.37	0.3	0.22	0.3	0	2.09
13	Olmukutan	*Albizia anthelmintica*	0	0.22	0.22	0.3	0.22	0.22	0.22	0.22	1.62
14	Oldorko	*Cordia sinensis*	0.19	0.19	0.19	0.22	0.19	0.19	0.19	0.19	1.55
15	Oluai	*Acacia drepanolobium*	0.15	0.19	0.19	0.22	0.19	0.19	0.19	0.19	1.51
16	Enchani-pus	*Cadaba farinosa*	0	0.19	0.22	0.26	0.15	0.22	0.22	0	1.26
17	Osukuroi	*Aloe secundiflora*	0.04	0	0.04	0.44	0	0.33	0.15	0	1.00
18	Olamoloki	*Maerua triphylla*	0.11	0.11	0.11	0.19	0.11	0.04	0.11	0	0.78
19	Elerai	*Acacia xanthophloea*	0	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.49
20	Enkitarru	*Croton macrostachyus*	0	0.07	0.07	0.07	0.07	0.07	0.04	0	0.39
21	Olperr-elongo	*Albizia amara*	0	0.04	0.04	0.07	0.04	0.04	0.04	0.04	0.31
22	Emankulai	*Grewia villosa*	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0	0.28
23	Entulelei	*Solanum incanum*	0	0	0.04	0.11	0	0	0.11	0	0.26
24	Eimmim	*Indigofera erector*	0	0	0.07	0.11	0	0	0.07	0	0.25
25	Olorrondoi	*Quercus rotundifolia*	0.04	0	0	0.11	0.04	0	0.04	0	0.23

26	Oloibor-benek	*Croton megalocarpus*	0	0.04	0.04	0.04	0.04	0.04	0	0	0.2
27	Olkokola	*Rhamnus staddo*	0	0	0	0.04	0.04	0	0	0	0.08
28	Olderkesi	*Acacia senegal*	0	0	0	0.04	0	0	0	0	0.04
29	Oltimigomi	*Pappea capensis*	0	0	0	0.04	0	0	0	0	0.04
30	Oloirien	*Olea africana*	0	0	0	0.04	0	0	0	0	0.04
31	Olenarran	*Euclea racemosa*	0	0	0	0.04	0	0	0	0	0.04

Note: n=32 indicated the number of respondents interviewed in the research site.

3.7.4 Correlation of use values of medicinal plants

Different use values of medicinal plants in the research sites were highly correlated which indicated that the relationship among them was high (Appendix 2). Since all use variables were highly correlated, they shouldn't all be used in the same model to avoid multi-collinearity where independent variables are strongly correlated and lead to high standard error and low t-statistics providing redundant information about the response. The consequence of multi-collinearity in general increased standard error of estimates of the β`s (decreases reliability) and often confusing and misleading results.

To avoid this multi-collinearity effect, the medicinal use value of the species was taken to see the medicinal use value of the species with their presence in each research sites.

Figures 6, 7 and 8 showed the medicinal use value of the plant species across the plot in the research sites.

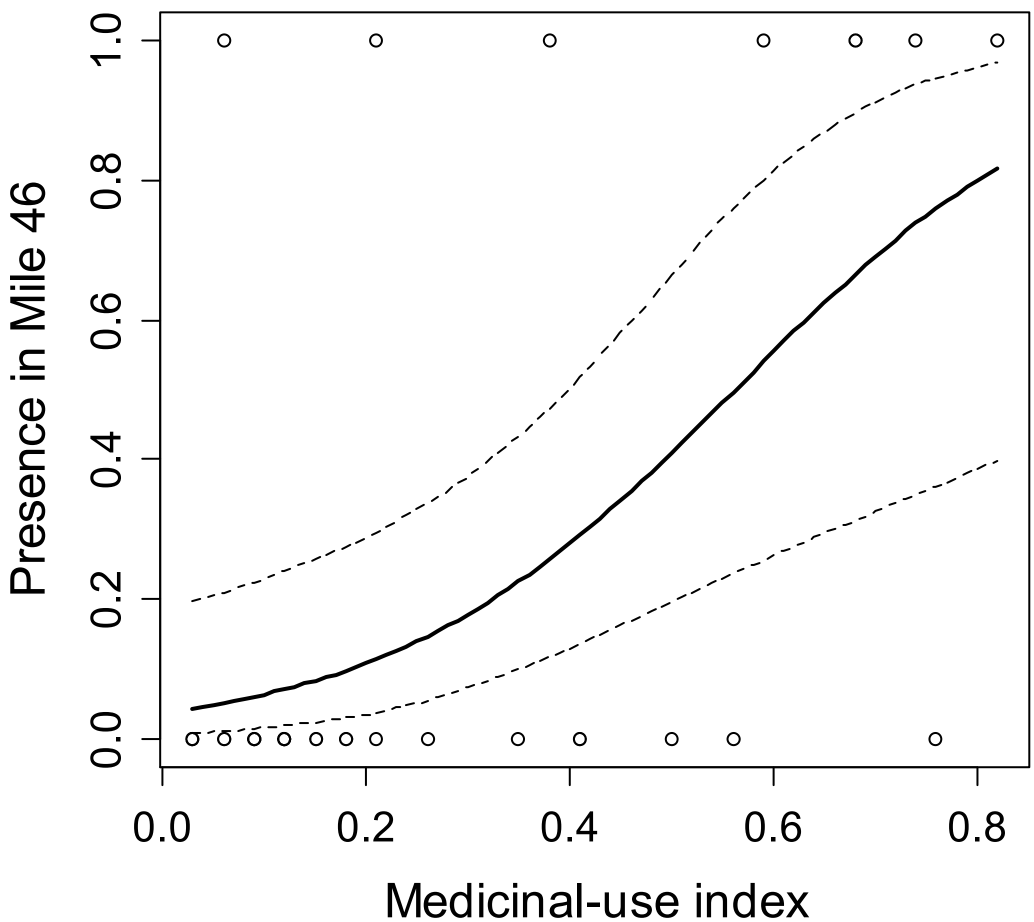

Figure 6. The medicinal use value of plant species across the plots in Mile46

The broken line in the figure represented the confidence interval and the solid line in the middle relates the medicinal-use index across the plots in Mile46. The medicinal use value of plant species in Mile 46 in the field across the plot increased significantly and revealed significant different statistically (One sample t-test: t = 5.049, df= 40, P=0.00)

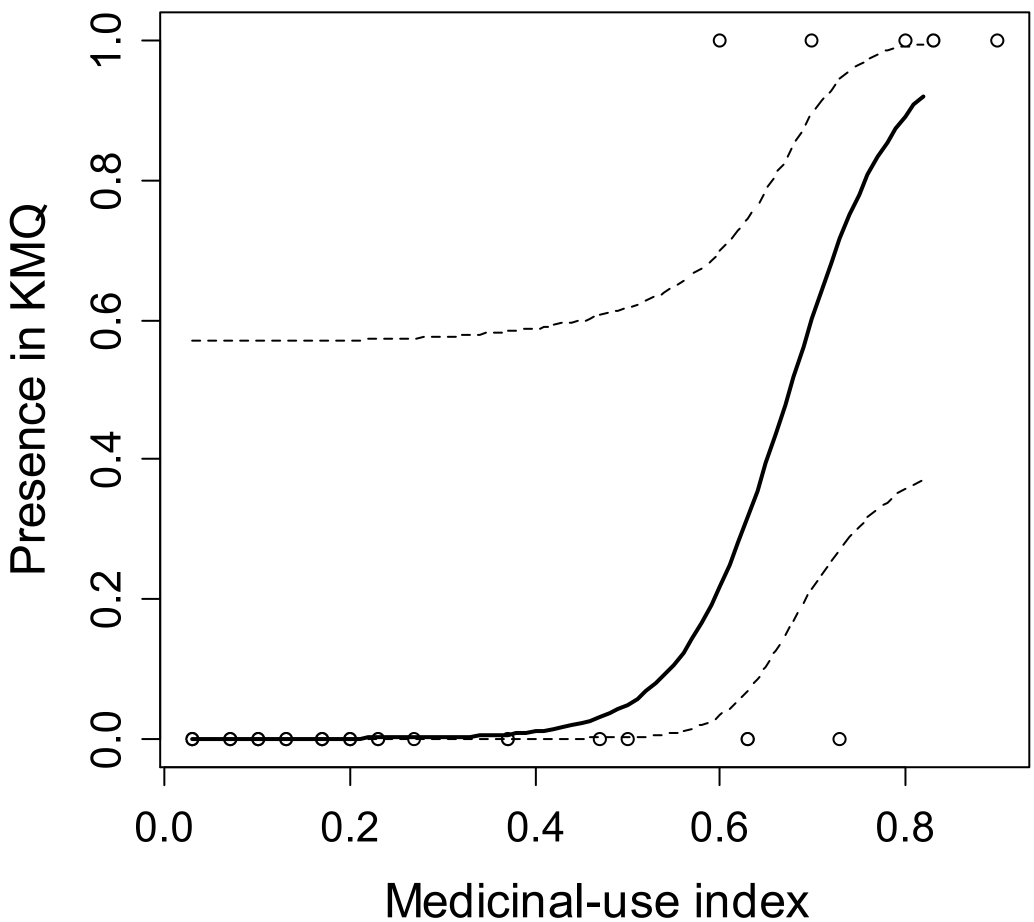

Figure 7. The medicinal use value of plant species across the plots in KMQ

The medicinal plant species in the field across the plot increases significantly (One sample t-test: t=5.713, df= 39, P=0.00) in KMQ and the confidence interval (the broken line) was wider as compared to the other two sites. This was partly because medicinal plant species weren't many as compared to the other two sites.

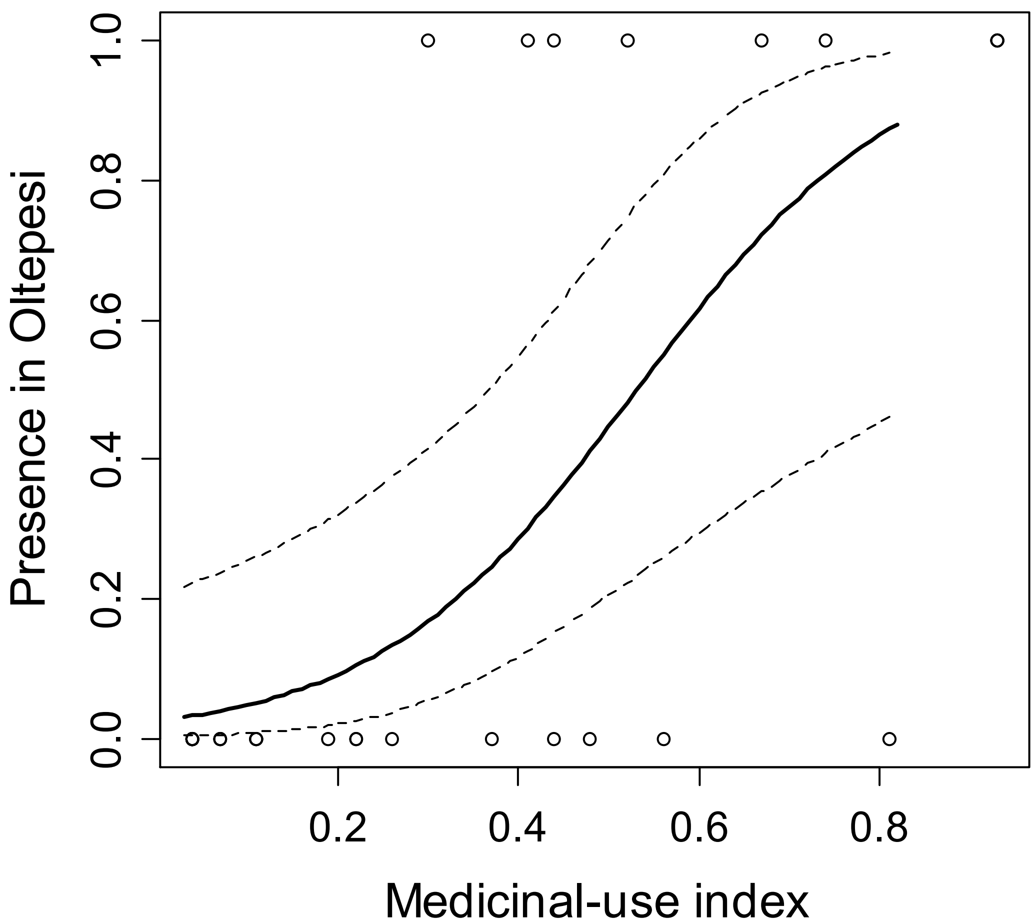

Figure 8. The medicinal use value of plant species across the plots in Oltepesi

The medicinal plant species in the field across the plot increases significantly (One sample t-test: t=5.055, df= 30, P=0.00) in Oltepesi. Figures 6, 7 and 8 revealed that medicinal plant species increase across the plots and found more on Mile46 and Oltepesi than KMQ as the confidence interval was wider in the KMQ due to less number of medicinal plants in the area.

3.8 People and threats of medicinal plants

From the respondents 53.9 % said the main threats of medicinal plants in the area is due to deforestation, drought, lack of awareness, urbanization and ignorance, while 31.5 % of them responded that deforestation, pollution, population increase and lack of awareness are the major threats in the area and the other 13.4 % included human settlements in the growing area as a major threats and 1.1% of the respondents revealed that deforestation is the only major threats in the area. But, the threats of medicinal plants across the research sited didn't reveal significant difference (df=2, F=0.564, P=0.571 and α=0.05) statistically. In this study the main threats of medicinal plants were deforestation, drought, lack of awareness, urbanization and ignorance and human settlements and this study report coincided with Muthe *et al.* (2011) said that pressure from agricultural expansion, wide spread cutting of fuel wood combined with seasonal drought is also reported in other studies.

In other studies like the one of Voeks and Leony (2004), it was shown that the most serious threat to local medicinal plant knowledge however, appears to be cultural change, particularly the influence of modernization and the western worldview. It was suggested that deforestation, degradation, and acculturation over many years caused the reduction (Giday *et al*., 2003). Likewise, in northwestern Yunnan in China, over-exploitation and deforestation are depleting the medicinal plants used by the Lisu (Ji *et al*., 2005).

CHAPTER FOUR

4.0 CONCLUSION AND RECOMMENDATION

4.1 Conclusion

The research sites were dominated by few medicinal plant species which would imply overutilization of the other species. The medicinal plant species diversity in the KMQ, Mile 46 and Oltepesi did not reveal a significant differences and showed homogenous diversity. The rural community heavily relied on medicinal plants for primary health care and these plants were also used for different purposes like firewood, grazing, charcoal, fencing, construction etc, and this showed that the plants were under pressure due to overall increasing demand on plant resources for various uses by the society. The major threats in the area were deforestation, drought, lack of awareness, urbanization, ignorance and human settlement to the growing area.

The similar threats prevailed in the research sites that similar kind of measures might be taken to alleviate the problem. The substantial knowledge of the local community on medicinal plant species and vegetation dynamics might be due to the frequent and lifelong interaction with the surrounding environment. The use value index, through use frequency, allowed identification of the relative importance of the plant species in the area and this helped to identify useful plant species that should be considered as priority in the management and conservation strategy. Low use value index was associated with the scarcity of the potential medicinal plant species.

4.2 Recommendations

1. The data and result obtained in this study to be used as a baseline for future integrated and multidisciplinary measures of conservation of natural resources especially medicinal plant species around the area. Further research is needed to see how conservation of medicinal plant species can be accelerated in order to prevent extinction of species.
2. The livelihood of the community in the area completely hinges on natural resources (plants, land, etc...) and there is a need of making and creating awareness to the society at lower level on conservation of natural resources especially to the young generation so as to use and keep it in efficient way.
3. An alternative way of maintaining the species could be planting of the species in the degraded or devastated area.
4. Documenting, evaluating and popularizing local strategies used by the local community to protect the most desired species is a viable and practical approach for conservation of the medicinal plant species.
5. Planners and decision-makers should be aware of the issues in the region of influence of overutilization of natural resources to engage and involve local communities in planning and implementing biodiversity conservation measures.

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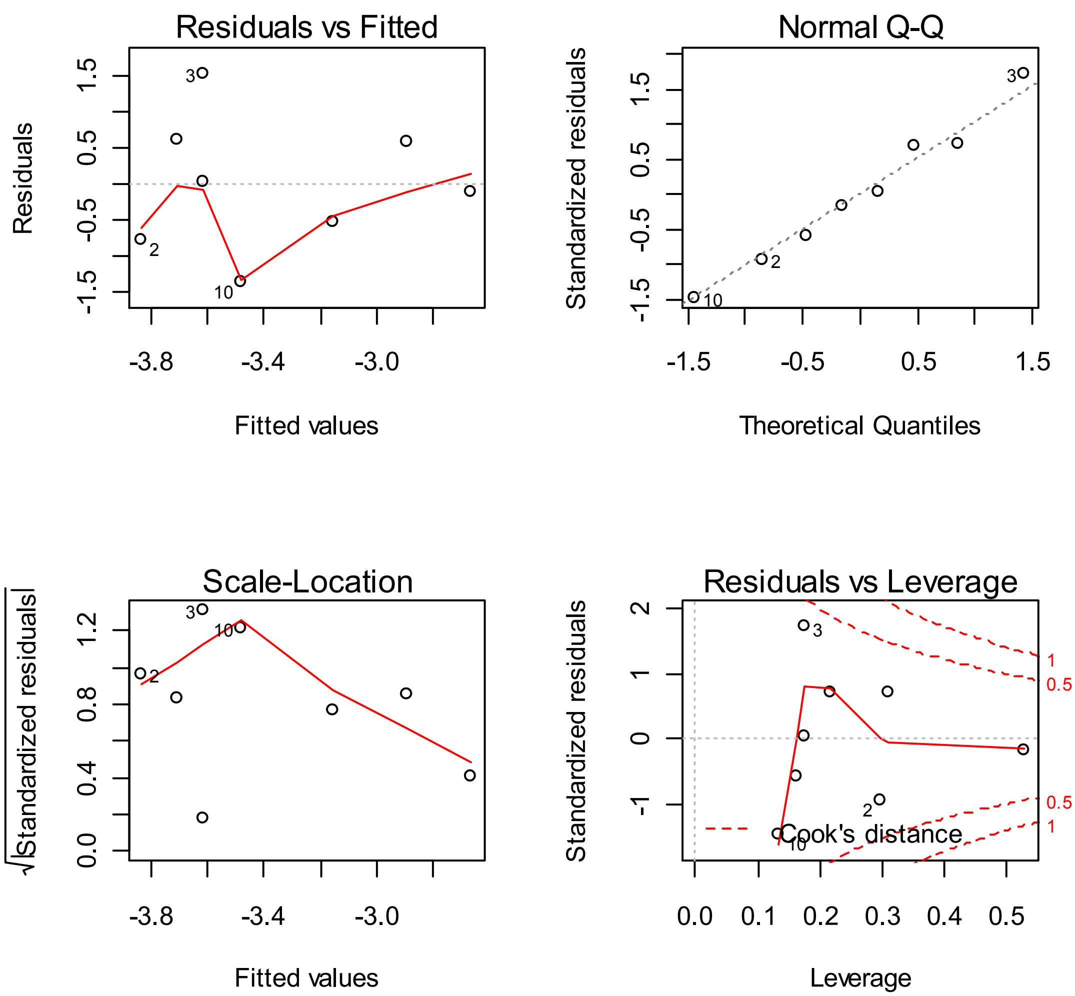
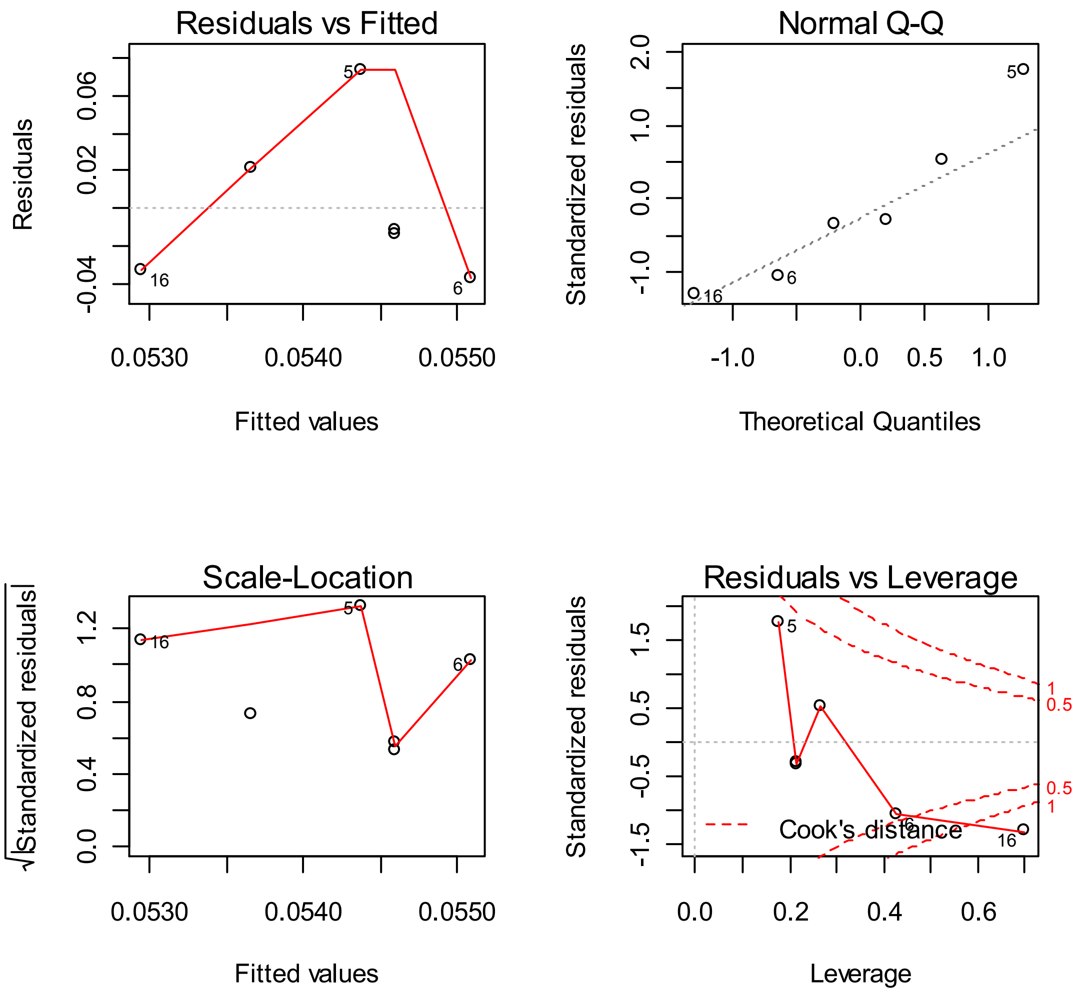
Appendices

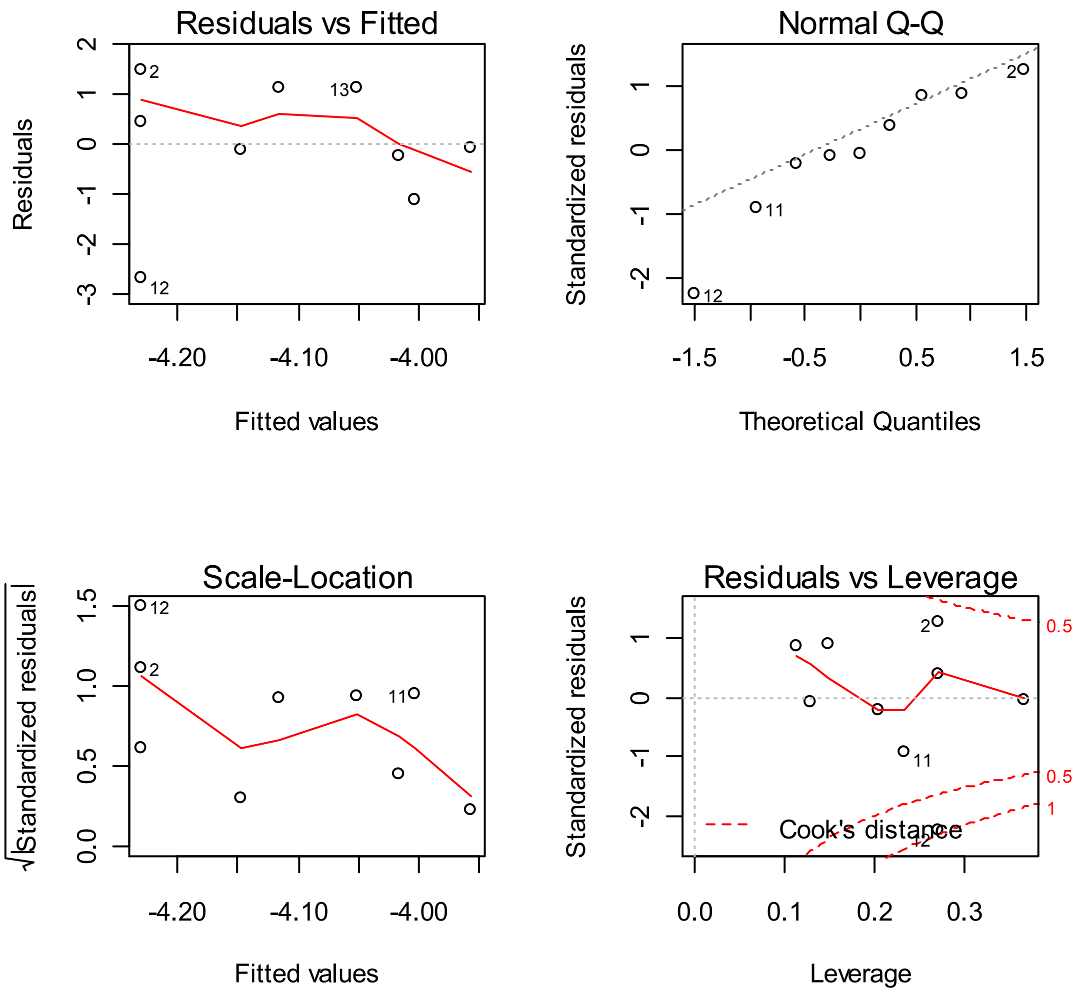
Appendix 1. Model-checks for normality of data in the research sites



Mile 46

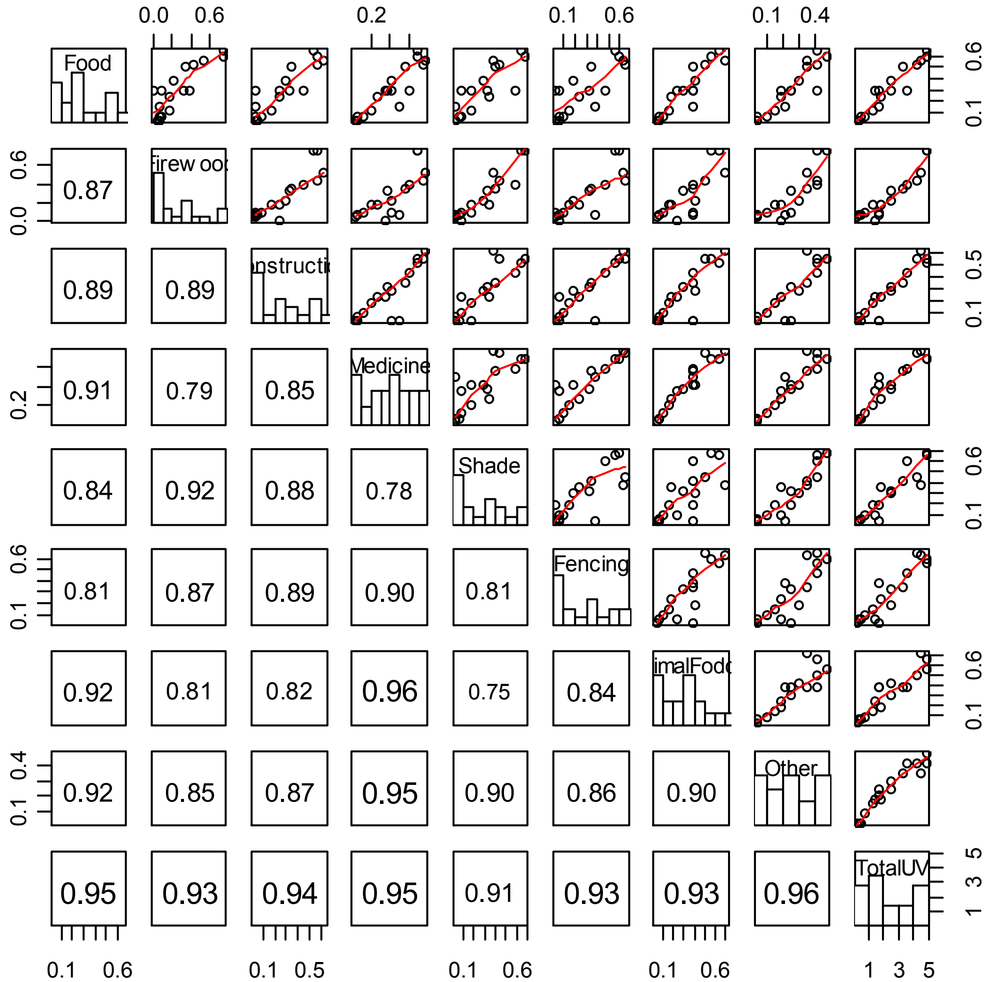


Kenya Marble Quarry (KMQ)

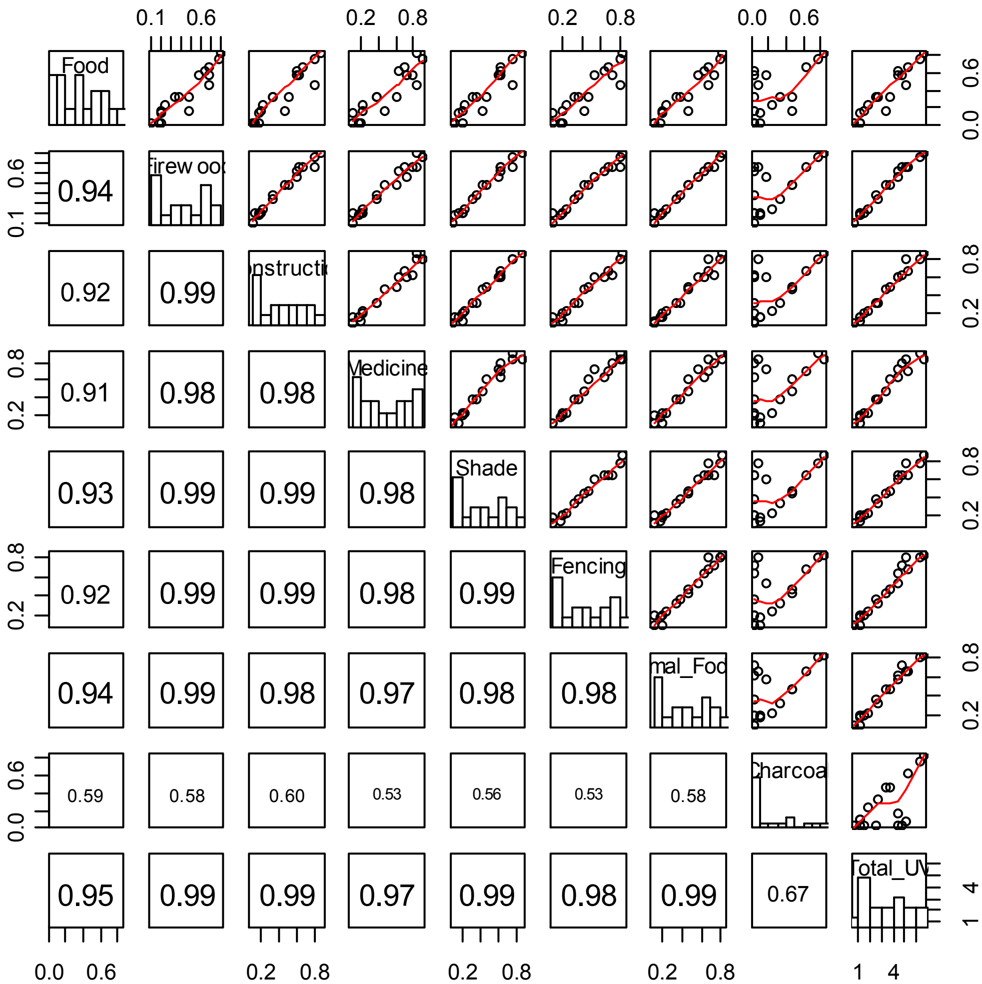

Residuals vs Fitted
Residuals
Fitted values
Normal Q-Q
Standardized residuals
Theoretical Quantiles
Scale-Location
√|Standardized residuals|
Fitted values
Residuals vs Leverage
Standardized residuals
Cook's distance
Leverage

Oltepesi

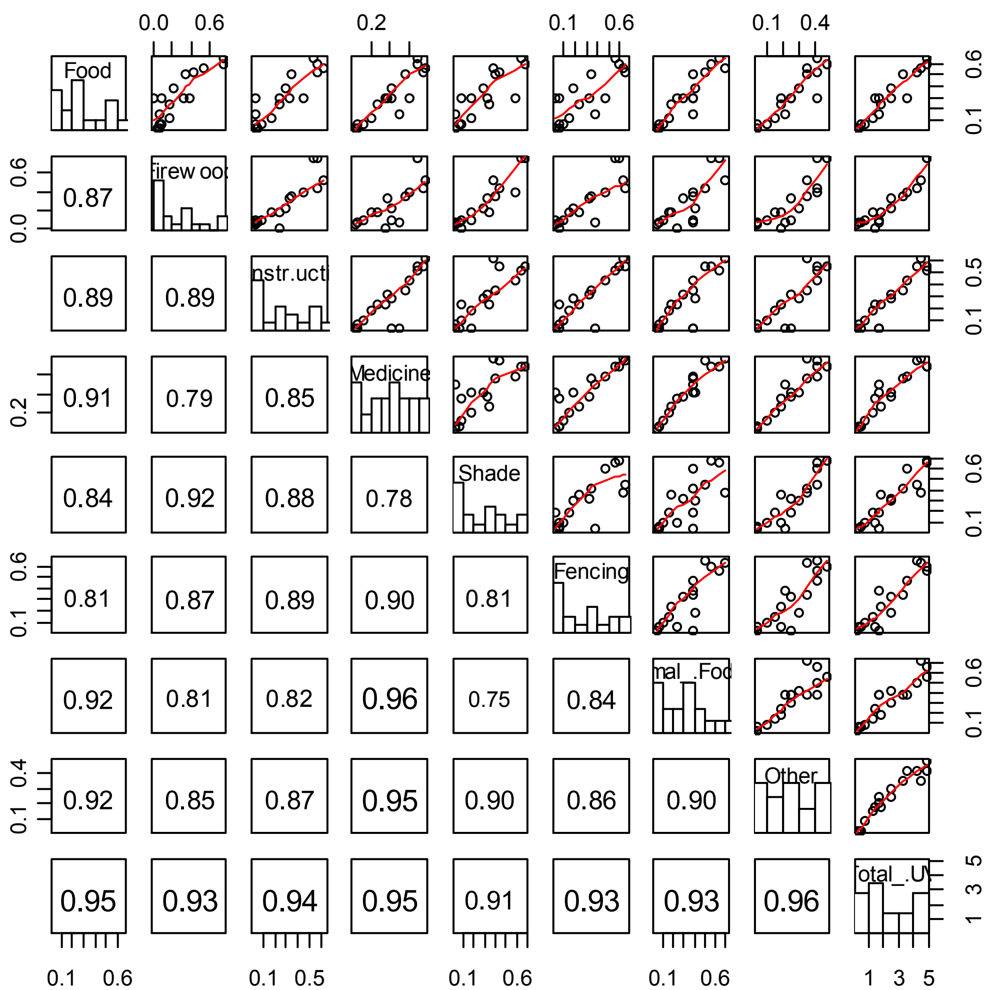
Appendix 2. The correlation values of use values of the plant species in study sites



Correlation value of the use values of medicinal plants in Mile46 (using R software)



Correlation value of the use values of medicinal plants in KMQ (using R software)



Correlation value of the use values of medicinal plants in Oltepesi (using R software)

Appendix 3.Medicinal plants that are used by local people in KMQ, Mile 46 and Oltepesi areas

Maasai Name	Botanical name	Treatment	Plant part
Oluai	*Acacia drepanolobium*	Appetite, stomachache, increase blood content, increase general health	Bark
Osiyiamalili	*Acacia etabica*	Diarrhea, stomachache, appetite	Bark
Oiti	*Acacia mellifera*	Stomachache, encourage health, typhoid, reduce vomiting	Bark
Olkiloriti	*Acacia nilotica*	Wounds, Gonorrhea, appetizer	Bark, root, pods
Oldepe	*Acacia nubica*	Gonorrhea, diarrhea, malaria, cough	Bark, root
Oltepesi	*Acacia tortilis*	Typhoid, womb cleaning, stomachache, reduce vomiting	Bark (inner part), pods
Olerai	*Acacia xanthophloea*	Diarrhea	Bark
Olperr-elongo	*Albizia amara*	Encourage health	Branch
Olperr-elongo	*Albizia amara*	Headache	Barks
Olmukutan	*Albizia anthelmintica*	Deworming	Bark
Osukuroi	*Aloe secundiflora*	Malaria, headache, diarrhea, eye-infection	Leaves, latex
Olong'osua	*Balanites aegyptiaca*	Vomiting, common-flu, tonsil, cough, typhoid, chest pain	Resin (gum), bark
Osaragi	*Balanites glabra*	Edible	fruits
Oloireroi	*Boscia angustifolia*	Induce vomiting	Bark
Enchani-pus	*Cadaba farinosa*	Swollen part of the body	Leaves
Olamuriaki	*Carissa edulis*	Diarrhea, Gonorrhea, sexual transmit disease infection	Root, fruits
Olmakutukut	*Clerodendrum myricoides*	Gonorrhea	roots
Osilalei	*Commiphora africana*	Diarrhea, food, stomachache	Bark
Olailupai	*Commiphora schimperi*	Diarrhea, stomachache	Roots, bark
Oseki	*Cordia monoica*	Eye-infection	Leaf
Oldorko	*Cordia sinensis*	Fruits are edible	Fruits
Enkitarru	*Croton macrostachyus*	Common cold, headache, malaria	Roots, bark
Oloibor-benek	*Croton magalocarpus*	Common cold	roots
Olenarran	*Euclea racemosa*	Increase blood in the body	Bark, branch
Oloilei	*Euphorbia tirucalli*	Allergy, toothache	New emerging shoots, branch
Ositeti	*Grewia bicolor*	Stomach pain in women during delivering, treating miscarriage woman	Bark, root
Oirri	*Grewia tembensis*	Fruit edible	fruits
Olmankulai	*Grewia villosa*	Fruit edible	fruits

Emimm	*Indigofera erector*	Stomachache, headache	Root
Enchani-enkashe	*Jurea abyssinica*	Backache	Stems
Esonkoyo	*Justicia odora*	Flavoring of food, perfume	Bark, roots
Oloirien	*Olea Africana*	Stomachache	Stem, leaves
Oltimigomi	*Pappea capensis*	Encourage health in adults, malaria	Bark
Olorrondoi	*Quercus rotundifolia*	Eye-infection	leaves
Olkokola	*Rhamnus staddo*	Malaria, headache, joint, make the body health	Bark, branch stem
Olmisigiyioi	*Rhus natalensis*	Chest pain, fruits edible, food	Bark/fruits
Olmunkushi	*Rhus vulgaris*	None, encourage health	Fruits
Oremit	*Salvadora persica*	Malaria, Gonorrhea, common cold, swollen part	Root, fruit
Entulelei	*Solanum incunum*	Headache, stomachache, malaria	Root
Enchani-enkashe	*Turea abyssinica*	Backache, Gonorrhea	Stem, roots
Olgumi	*Vangueria madagascariensis*	Fruits edible	Fruits
Olamai	*Ximenia Americana*	Encourage health, fruit edible	Bark, fruit

Appendix 4. Questionnaires

Questionnaires for the collection of Ethnobotanical knowledge and socio-economic data about medicinal plants in Kajiado district in four sites (Elangata-Wuas (Mile 46), Oltpesi and Kenya Marble Quarry (KMQ))**.**

1. Respondent's details:

Name:

Male/ Female:

Age..........Years

Occupation:

Location (Name of Village):

Data about medicinal plants and its use:

2. What are the primary activities (economic) you engage in within this location?

   i. Pastoralism

   ii. Agro-pastoralism (Self-cultivating or Leasing?)

   iii. Agriculture

   iv. Any other

3. Do you know the species and its name?

4. Do you know its uses? If he/she mentioned any, he/she will be asked: Which part of the plant is used? How is it prepared and consumed?

5. Do you gather it nowadays? Did you gather it in the past? If he/she gathered it in the past, but don't gather it anymore, he/she will be asked: Why don't you gather it anymore?

6. What trees and shrub plant species are commonly-utilized within the site?

7. State the various purposes to which they are put into. For which of the following categories the species is useful: food, firewood, construction, medicine, field trees, shade, and animal fodder (not, 0; moderately, 1; very, 2).

8. How abundant (accessible to the society) is it? (rare, 0; intermediate, 1; common, 2),

9. What is the general trend that you have noticed over the past 30 years in availability of woody plants within the site? What could be the causes of the observed trend?

10. What degree the species is declining (slightly, 0; moderately, 1; strongly, 2)).

11. How do you feel about the setting aside of a conservation area within the site? Is it important to conserve/maintain medicinal plants in the area (no, 0; yes, 1),

12. Has the setting aside of the conservation area affected any natural-resource accessibility? In what sense

13. What activities are you allowed to carry out within the conservation area?

14. Would you support the continued existence of a conservation site in future? Is it important to conserve/maintain medicinal plants in the area (no, 0; yes, 1),

15. Any additional comments/observations with respect to the existence of the conservation area within the location.

Questionnaire for Herbalists

1. Name of the market
2. Herbalist no 1
3. What plants did you see on his stall,
4. Name of plant
5. Which are the common plants used to cure diseases?
6. Which diseases are commonly cured by plants
7. Where do you get medicinal plants for sell
8. How much do you sell, how much money do you make?
9. How successful do you think medicinal plants are bringing income to the community?
10. What parts of plants are you selling?

	Fresh	Dry	Powder	Others
Seeds				
Roots				
Seedlings				
Bark				
Others				

11. Who do you sell to?

FEW MORE QUESTIONS ON CONSERVATION

1. Are any plant species growing in your area? If yes which species?

2. If not growing; are you planning to grow trees in your area to conserve important plants?

3. What is the abundance of plants in the area? (rare, moderate, many)

4. What is the distribution of plants in the area?
5. In which locality of the area can plants available in the maximum amount?

6. Do you know the area of occupancy by the plants?

7. Can you tell us the level of exploitation of plants in the area?

8. What conservation efforts are carried out to plants?

9. What kinds of threats (pollution, urbanization, lack of awareness, deforestation …) exist in the area?

10. Are free grazing and agriculture contributing to the threats of medicinal plants in the area?

11. What do you think about poverty (lack of incentive) of people in contributing or aggravating the conservation effort carried out in the area?