EVALUATION OF PRIORITIZED MEDICINAL PLANTS FOR THEIR BIOACTIVITY IN KAIMOSI AREA OF NANDI AND VIHIGA COUNTIES OF KENYA

BY

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DECLARATION

Declaration by the candidate

This thesis is my original work and has not been presented for any degree program in any other University. No part of this thesis may be reproduced without prior permission of the author and/or of University of Eldoret.

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DEDICATION

This thesis is dedicated to my entire family, for their endurance in seeing dad through the tiring toils in his incessant pursuit of further education.

ABSTRACT

The use of traditional plant medicine in treatment relies on presence of biologically active compounds that aid in combating diseases. In Kenya different plant species are used to treat several diseases especially among the population where modern medicine is either not accessible or affordable. Drawbacks facing traditional medicine include issues pertaining to safety, efficacy, quality, access and rational use of traditional herbal medicine, and training in herbal medicine. This study was undertaken to evaluate the prioritized medicinal plants in Kaimosi area of Nandi and Vihiga counties for bioactivity of plant extracts for validity of efficacy against disease causing microorganisms. Ethnomedicinal knowledge was documented using lead questions on a questionnaire from herbal practitioners and claims of efficacy of some of the plants as antimicrobial agents by herbal practitioners investigated. Various plants were select by ranking methods to be used for antimicrobial tests. The disc diffusion method was used to ascertain the efficacy of plant extracts and to detect those that were active so as to subsequently determine their minimum inhibitory concentrations using the microdilution method. One hundred and seven species belonging to 94 genera distributed in 44 families were documented with the highest number of species belonging to the Asteraceae (21.5%), followed by the Euphorbiaceae and Fabaceae (7.5%). Taxonomic keys were prepared for all the species collected. The leaves comprised the plant part most frequently used for medicinal purposes (78%) followed by the roots (34%) and the whole plant (21%). The methods commonly used to prepare the ethnomedicines included infusions (49.7%) and decoctions (21.7%), and the most common route of drug administration was oral (63.1%) followed by topical application (23%). Crude extracts of increasing polarity i.e. petroleum ether, chloroform, methanol and water from eleven selected plants; were tested against thirteen test microbes to evaluate their efficacy. The extracts from *Lantana trifolia* were the most active against bacteria (14 extracts out of 28) and those of *Fuerstia africana* (10 extracts out of 24) against fungal isolated with activity in the range of 1mm to 7 mm(6 mm subtracted from gross measure) for the former and from 1mm to 2 mm for the latter. The isolates most susceptible to the extracts were *Shigella sp.* (*Shigella flexneri,* 39 extracts and *Sh. sonnei,* 22 extracts), *Bacillus subtilis* (26 extracts) and *Staphylococcus aureus* (13 extracts) each out of 44 extracts. Chloroform and methanol extracts of *L. trifolia* had the largest inhibition zone of 7mm diameter against *Sh. flexneri* and 6.5mm against *S. aureus.* Isolates of *Pseudomonas aeruginosa, Salmonella typhi* and *Trichophyton mentagrophyte* were resistant to all plant extracts with no clearance zone on the agar plates. *Fuerstia africana* produced the most promising results on both fungal and bacterial isolates, giving a MIC value of 0.051 mg/ml against *Shigella flexneri* and 0.102 mg/ml against *Staphylococcus aureus*. The results of the documentation of medicinal plant in Kaimosi are significant in aiding in the production of the countries' pharmacopoeia and in overall, the study support the use of medicinal plants in the management of infectious diseases in the study area.

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LIST OF ABBREVIATIONS/ ACRONYMS

AST: Antimicrobial susceptibility tests

ATCC: American Type Culture Collection

BGCI: Botanical Gardens Conservation International

CA: Conserve Africa

CAI: Conserve Africa International

CAM : Complementary or Alternative Medicine

CFU: Colony Forming Units

CRDC: Centre for Respiratory Disease Control

DMSO: Dimethyl sulfoxide

IENICA: Interactive European Network for Industrial Crops and their applications

KEMRI: Kenya Medical Research Institute

KNBS: Kenya National Bureau of Statistics

KWG-MAPS: Kenya Working Group on Medicinal and Aromatic Plant Species

MIC: Minimum Inhibitory Concentration

NCCLS: National Committee for Clinical Laboratory Standards

TAM: Traditional or Alternative medicine

TMPs: Traditional Medical Practitioners

UNEP: United Nations Environmental Program

WHA: World Health Assembly

WHO: World Health Organization

WWF: World Wildlife Fund

DEFINITION OF TERMS

Exudates: Substance that oozes out from plant pores or openings

Complementary/alternative medicine (CAM): Often refers to a broad set of health care practices that are not part of a country's own tradition and are not integrated into the dominant health care system.

Climbers: Herbaceous plants twining or with tendrils to support them on other plants.

Decoction: The extraction of the water-soluble substances of a drug or medicinal plants by boiling.

Herbal remedies: Plant derived material or preparations with therapeutic or other human health benefits, which contain raw or processed ingredients from plants.

Herbs: Non-woody stemmed plants that die back after flowering and seeding. They are perennial plants growing repeatedly from the root.

Infusion: A liquid extract, as tea or plant juice prepared by steeping or soaking.

Lianas: Woody climbers

Poultices: a local moist and often heated application for the skin consisting of substances such as plant paste, kaolin, linseed, or mustard, used to improve the circulation, treat inflamed areas, etc

Phytomedicines: Plant-based pharmaceutical products with proven medical effica

Species: Smallest unit of classification of an organism

Traditional Medicine (TM): The sum total of knowledge, skills and practices based on the theories, beliefs and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in prevention, diagnosis, Improvement or treatment of physical and mental illnesses

Trees: Woody plants 7.5m or more in height usually with single trunk at least 1.2m to the first branch measured from the ground

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CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Traditional medicine refers to health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well-being (WHO, 2003). It is also referred to as folk medicine, a practice based on the use of plants or plant extracts for the treatment of ailments and which is recognized as a way of learning about potential future medicines (Fabricant and Farnsworth, 2001).

According to the World Health Organization (WHO), approximately 80% of the world's population relies on traditional medicine to fulfil their daily health needs (Hamann, 1991; Marshall, 1998). In industrialized countries, adaptations of traditional medicine are termed "Complementary'' or "Alternative" medicine (CAM) (WHO, 2003). The use of traditional medicines dates as far back as 3000 BC (World Wildlife Fund- WWF, 1993). Aristotle, Theophrastus and others described drug plants, while Dioscorides, as early as 77 BC in his book, *De Materia Medica,* gave invaluable and authoritative references about drug yielding plants that are still vital to date (Pandey and Chadha, 1993).

Traditional medicine is described by the World Health Organization (WHO) as one of the surest means of achieving total health care cover of the world's population (Rukangira, 2002). In 2002, the WHO launched the first ever traditional medicine strategy, which among other things set out to assist countries create a stronger evidence base on the safety, efficacy and quality of traditional medicine products and

practices and document traditional medicines (WHO, 2003). Only 25 of WHO's 191 member countries have a national policy on Traditional Medicine/Complementary or Alternative Medicine (TM/CAM) and only 64 countries regulate herbal medicines/Traditional Practice (TP) (WHO, 2005). National policies and regulations on TM/CAM could ensure the safety, quality and efficacy of these therapies and products, and function as important steps towards integrative healthcare systems (WHO, 2002).

The secrecy surrounding treatments offered by traditional healers and the fact that the knowledge held by these practitioners is often passed on orally from one person to another has made it difficult for information on different aspects of traditional medicine to be known (Lantum, 1980). The knowledge and the methods of processing crude drugs are only available in the rural communities and only perpetuated by word of mouth and within families and small communities (Kariuki and Njoroge, 2011). For example in Kenya, certain tribes are known to pass down knowledge and use of ethno-medicines orally from generation to generation (Sankan, 1995) presumably to trustworthy persons. This kind of communication is widespread among Kenyan communities (Ochieng'Obado and Odera, 1995; Sindiga *et al*., 1995).

In 1987, the World Health Assembly (WHA) urged member states to, "initiate comprehensive programs for the identification, evaluation, preparation, cultivation and conservation of medicinal plants used in traditional medicine" (Eloff, 1998a). Ethnobotanical data collection is thus an essential component in sustainable natural resource management, particularly with respect to the use of medicinal plants (Njoroge *et al.*, 2010). However, the extent to which important medicinal plants are harvested is often unclear, even in regions where large amounts of medicinal plants are being commercialized (Njoroge, 2006). In the tropics, many plants growing in the

wild are often useful in folk medicine (Pandey and Chadha, 1993). The medicinal aspect of such plants results from the presence of phytochemicals, often with antiviral, antibacterial and antifungal properties in a part of or in the whole plant (Engel, 2002). Such chemicals when consumed produce physiological action in the human body. They include alkaloids, tannins, glycosides, resins, gums, mucilages, tannins, essential oils and other compounds of carbon, hydrogen, oxygen and nitrogen (Okigbo *et al.*, 2009) and occur in the roots, stems, barks, leaves, seeds, fruits and flowers. In recent years, plant secondary metabolites, with unknown pharmacological activities, have been investigated extensively as a source of medicinal compounds (Voravuthikunchai *et al.*, 2004).

Over-collection and deforestation has put many medicinal plants at risk of extinction, threatening the discovery of future cures for diseases (Plantsave, 2011). Medicinal plants used in local traditional healthcare are gradually declining due to over utilization, population explosion and other anthropogenic reasons (Okello *et al.*, 2010). Some of the methods used in harvesting are usually destructive and therefore likely to result in the extinction of some species (Cunningham, 2002). The demand for medicinal plants in developing countries has resulted in indiscriminate harvesting of wild plants including those that are rare in forests (Rukangira, 2002). It is unfortunate that very few developing countries have policy guidelines to regulate the practice of traditional medicine (Falkenberg *et al.*, 2002). Environmentally damaging practices such as forest clearance for agriculture, uncontrolled burning, timber logging and livestock grazing, all destroy the habitats in which medicinal plants flourish (Kisangau and Kokwaro, 2010).

In Kenya, traditional medicine is widely practiced and is fast gaining popularity (Miaron *et al.*, 2004; Kareru *et al.*, 2007; Njoroge and Bussman, 2006). However,

much of the knowledge on traditional medicine remains undocumented and is gradually being lost because the younger educated generation rarely have any interest in traditional lifestyles (Kariuki and Njoroge, 2011). Other drawbacks facing traditional medicine in Kenya include the lack of a national policy and regulatory framework on TM/CAM, issues pertaining to safety, efficacy, quality, access and rational use of traditional herbal medicine, and the fact that medical doctors in Kenya do not receive any training in herbal medicine like in other countries of the world (Mwangi *et al.,* 2005).

The efficacy of many herbal medicines has not been tested to authenticate their traditionally claimed roles in disease management in Kenya (Kariuki and Njoroge, 2011). It is therefore possible that herbal medicines without known efficacy can unwittingly be used to replace medicines that have corroborated efficacy because many people tend to believe that all natural products are effective and safe (Vickers, 2007). There is need to document medicinal plants and their uses and in addition determine their efficacy in areas where this has not been done. Kaimosi area of the Lake Victoria Basin is a case in point and therefore the purposes of this study was to document medicinal plants and validate claims made by herbal practitioners in the area concerning the antimicrobial efficacy of some of the plants.

1.2 Statement of the problem

Documentation of medicinal plants in Kenya has not been done partially in some areas and even so few plants have been evaluated to validate their efficacy claims. Some of the areas that have been studied for documentation include; Makueni (Kisangau, 1999) Mount Elgon, Samburu (Omwenga, *et al*., 2009) (Okello *et al*., 2010), Kibwezi (Kariuki and Njoroge, 2011), Nandi (Jeruto, *et al*., 2008), among others. Some few individual plants have been studied from Kakamega rain forest;

hence there is need to document ethnomedicinal plant knowledge in Kaimosi area to ensure sustainable supply of medicinal plants from such information in future. Resistance to drugs by microorganisms has increased. This resistance have been attributed to ability of microorganisms to undergo genetic variability (mutation), hence there is need to come up with cheap, sensitive and effective drugs for disease management. Kaimosi area provides a myriad of the medicinal plants. There is need to carry out proper identification of the medicinal plants, their antimicrobial activity and know their phytochemical composition. This information will be necessary later for treatment purposes and potential cheap drug manufacturing in Kenya.

1.3 Justification of the study

Plants are natural reservoir of many antimicrobial, anticancer agents, analgesics, anti-diarrheal as well as various therapeutic compounds (Faysal, M. 2008). Kaimosi people have traditional medical practice as an integral part of their culture and a number of commercial herbalist encroached on plants from this area for sale as medicines. A lot of medicinal plants are available for the treatment of various diseases. However, scientific studies have not been conducted except to a limited extent with few medicinal plants.

In the past, an attempt has been made to control and standardize the traditional medicines (WHO, 2002). For example, the Kenya National Drug Policy (1994) recognized the role of herbalists and mandated the Pharmacy and Poisons Board to "determine the suitability of medicines and provide specifications for the practice and utilization of these medicines", but this was not attainable (Kisangau and Kokwaro, 2010).

The use of traditional medicine practices is polarized varying from contemptuous dismissal to romantic glorification of "our medicine". Arguments by herbal medicine

protagonists that it is safe because it is natural, border on the ridiculous. Others argue that herbal medicine is good because it has vitamins, flavonoids and trace elements among other beneficial components. The importance of herbal medicine does not lie in proving that it is superior to modern medicine but rather that it is yet another form of "alternative complementary medicine", neither superior nor inferior. It is important to look for ways of avoiding use of plants of questionable efficacy when it is possible to validate such medicines (Mwangi, *et al*., 2005). Herbalists can be allowed to continue advertising medicines for the cure of diabetes, cancer, sexually transmitted diseases, impotence and infertility when efficacy of such plants' efficacy is validated (Faysal, 2008). This study therefore is to provide a regional pharmacopoeia from which desired plants can be derive and especially plants with validated efficacy records. The rainforests like Kakamega forest are particularly rich in plant species which are still to be studied, discovered and documented therefore justifying this research.

1.4 Conceptual framework

The study dealt with documentation of medicinal plants and all related traditional knowledge for use of medicinal plants in the study area such as plant species used, parts of plants used, methods of preparing the medicines and their administration. Knowledge on the diseases treated was also collected and documented. From the collected plants, keys were prepared for identification of the plants followed by selection and testing of high ranking plants on common topical and oral pathogenic micro-organisms to validate efficacy claims made on the plants by the herbal practitioners. Validation of efficacy claims involved preliminary disc diffusion assay and minimum inhiditory concentration tests using standard and clinical pathogen strains.

1.5 Scope and limitations of the study

The study covered documentation of plants to the species level as much as possible. Strictly reknowned herbalists from the study area were involved in the exercise. Only highly ranking plants were used in the bioassays. Efficacy claims on crude plant extract were compared with standard drugs as controls. The extracts were obtained using solvents of increasing polarity in order to enhance extraction of active pharmacological principals from the plants. Synergism due to mixing of drugs was not carried and even mixing of extracts fron same plant extracted by difeerent solvents was not done.

Difficulties encountered included selection of herbalist based on their education level to filter out those who had learned fro documented literature, sieving of indigenous plants from exotic plants, unco-operation from some reknowned herbalists and inability to test all the plants for their efficacy. There was also inadequate equipment for proper isolation and purification of the plant extracts.

1.6 Objectives of the study

1.6.1 Main objective

This study was undertaken to evaluate the prioritized medicinal plants in Kaimosi area of Nandi and Vihiga counties for bioactivity of the plant extracts for validity of efficacy against common disease microorganisms.

1.6.2 Specific objectives

The specific objectives of the study were:

1. To document plant species used in traditional medicine in the Kaimosi area of the Lake Victoria Basin.

2. To prepare keys for the identification of plants used for medicinal purposes in the Kaimosi area of the Lake Victoria Basin.
3. To validate efficacy claims made on medicinal plants used for the treatment of topical and oral microbial infections.

1.6.3 Hypotheses

1. **Ho:** Many medicinal plant species are present within Kaimosi area

   H_A: Species of medicinal plants are scarce in Kaimosi area
2. **H_O:** Medicinal plant species in Kaimosi area can be identified using identification keys

   H_A: Construction of identification keys is not possible from medicinal plants of Kaimosi area.
3. **H_O:** Claims made by herbalists on efficacy of medicinal plants for the treatment of topical and oral microbial infections are valid

   H_A: Claims made by herbalist on efficacy of medicinal plants for the treatment of topical and oral microbial infections are not valid

CHAPTER TWO

LITERATURE REVIEW

2.1 Herbal medicine

Traditional medicine is a solid amalgamation of dynamic medical expertise and ancestral experience (Rukangira, 2002). The increasing acceptance of herbal medicine as an alternative form of healthcare has made the screening of medicinal plants for active compounds to become very important because such plants may serve as promising sources of novel antibiotic prototypes (Meurer-Grimes *et al.*, 1996; Rabe and Van Staden, 1997; Koduru *et al.*, 2006). Since 1977, when the World Health Assembly (WHA) first drew attention to the potential of traditional medicine (Sindiga *et al*., 1995), its benefits have reached popular international levels. According to the World Health Organization (WHO), more than 3.5 billion people in the developing world rely on medicinal plants as components of their healthcare (Balick and Cox, 1996). A large majority of people (70-80%) in Africa consult Traditional Medical Practitioners (TMPs) for their healthcare (Cunningham, 1993). Ethnomedicine is now being promoted and supported as a way of providing efficacious medicines for people in less developed areas (Kisangau and Kokwaro, 2010). The WHO first officially recognized the importance of traditional medicine as a source of primary health care in the Primary Health Care Declaration of 1978 in Alma Ata (WHO, 2002) and also described traditional medicine as one of the surest means to achieve total health care coverage of the world's population (Rukangira, 2002).

One of the strategies employed in selecting plants with medicinal properties is a careful observation of the use of the plants in folk medicine in different cultures, which also gives clues to the best methods of extraction (Rates, 2001). Many

indigenous plants have been scientifically tested and found to have medicinal properties that are useful in modern medicinal practices (Kisangau and Kokwaro, 2010). Plants used for medicinal purposes number more than 50,000 species of all the flowering plants in the World (Govaert, 2001). Of the estimated 250,000 flowering species that grace the face of the earth, less than 0.5% have been studied exhaustively for their chemical composition and medicinal values due to limited financial resources required to screen them for biological activity (Balick and Cox, 1994). Estimates show that by the nineteenth century 80% of all medicines originated from plants. The World Health Organization (WHO) has estimated that 80% of the global population in developing countries depends on traditional medicines mainly from plants (WHO, 2002).

In the past traditional medicine was stigmatized and disregarded, but it is now being actively promoted by Western and international institutions as the dominant primary health care in developing countries (WHO 2002). The high dependance on these remedies in most African populations is because of traditional beliefs and lack of reliable modern health care within the communities (Sindiga *et al.*, 1995). An overview of traditional medicine in Africa by Conserve Africa International (CAI) in 2001, revealed discrepancies in the relative ratios of traditional practitioners and university trained medical doctors in relation to the population in African countries. For example, in Kwahu District of Ghana, for every traditional healer there were 224 people whereas for one university trained doctor, there were 21,000 people with this replicated in all other African countries (Rukangira, 2001).

In Kenya, it is reported that, about 90% of the population consents to have used traditional medicines at least once for various health conditions (Chirchir *et al.*, 2006). The number of patients being treated in traditional health facilities is on the increase,

sometimes reaching well over 500 patients per month and attended to by just one herbalist (Njoroge, 2006). It is estimated that there is one traditional healer attending to every 987 people in Kenya urban areas (in Mathare) and 378 for rural areas (in Kilungu) compared to 7,142 people for every university-trained doctor (Mwangi, 2000). Very low budgetary allocation by the Kenyan government for the Ministry of Health has also contributed to high use of herbal medicine. For example, in 2002 the Ministry of Healths budget for medicine provision could cater for only 30% of the Kenyan population leaving 21 million people unable to access conventional medicine, hence relying on traditional medicine for their health care needs (Kareru *et al.*, 2007).

The countries in which the Lake Victoria Basin (LVB) spans have a rich reservoir of herbal-based healing practices, which are considered to be responsible for the renewed interest and efforts to document medicinal plants in the region and subsequently evaluate their extracts for biological activity (Moshi *et al.*, 2009; 2010). It is also significant to note that the high dependence on herbal remedies for healthcare has other consequences besides the benefits derived from their use. One of the dire consequences is that due to over utilization, population explosion and other anthropogenic reasons medicinal plants used in local health traditions are gradually becoming extinct (Okello *et al.*, 2010). In 2008 the Botanic Gardens Conservation International (BGCI) reported that 400 medicinal plants were at risk of extinction due to over-collection and deforestation and that, this is threatening the discovery of future cures for diseases (Plantsave, 2011).

2.2 Documentation of medicinal plants

Development of traditional medicine in Africa is constrained by quite a number of factors including insufficient documentation of medicinal plants and scientific experimentation for verification of herbalist's claims concerning the plants they use

(Cunningham, 1997). The need for the documentation of medicinal plants cannot therefore, be gainsaid. The WHO, for example, launched a comprehensive traditional medicine strategy in 2002 with one of the main objectives being to assist countries to document traditional medicines and remedies, and ensure their availability and affordability (WHO, 2003). Studies carried to document plants used in traditional medicine have shown that different areas in different parts of the world have a considerable amount of indigenous ethnomedicinal knowledge (Bekalo *et al*., 2009). For example in Africa, many tribes have sophisticated plant knowledge, although Western influences together with systematic loss of natural resources have led to an accelerated decline of this knowledge (Fratkin, 1996). Further decline in traditional knowledge is aggravated by the disinterest shown by many people towards herbal medicines due to changing lifestyles (Okello *et al.*, 2010), reluctance of traditional herbal practitioners to share their expertise (Kisangau and Kokwaro, 2010), natural attrition of herbalists (Balick and Cox, 1994) and rapid species decline due to loss of natural plant habitats (VanWyk *et al.*, 2002).

In a report by Conservation Africa International, it is reported that by 2001 Africa had about 216,634,000 ha of closed forest areas of which about 1% was being lost annually due to deforestation (Rukangira, 2001). This sort of destruction is known to decimate habitats in which medicinal plants flourish yet most of the useful medicinal species are known to be vulnerable because of their slow reproduction, slow growth or very limited distributions and their requirement for very specific habitats (Kisangau and Kokwaro, 2010), all of which points to the urgent need to document medicinal plants before they are completely decimated.

2.3 The effect of harvesting on the sustainability of herbal medicines

The current rise in the cost of living and the high price of contemporary medicine is causing a high demand for traditional medicine, both for use in treatment and as a source of livelihood for the traditional healers in developing countries (Rukangira, 2002). The high demand for medicinal plants calls for species preservation through application of sustainable harvesting methods and cultivation (Njoroge *et al.*, 2010). One method recommended for sustaining the use of these plants is their cultivation. In Asia, a big percentage of medicinal plants are being depleted due to over utilization to the extent that some have become endangered making their cultivation to be the only viable alternative for ensuring their continued availability (Sher *et al.*, 2010).

Plant parts commonly harvested for medicinal purposes include leaves, fruits, flowers, roots, bark, stem and even removal of the whole plant. Harvesting of leaves, flowers and fruits is considered to be of a lesser risk to the survival of a plant in most cases and is hence categorized as low-impact while that of the bark, root, stem and whole plant as high-impact (Cunningham, 2002). High-impact harvesting destroys or kills the plant, although the effect of each impact category depends on the biology of the harvested plant (Cunningham, 2002; Bridel, 2003). Harvesting of plant parts like the bark and the roots is non-sustainable as this can, for example, accelerate the death of a tree (Grace *et al.*, 2002). It is therefore apparent that the methods adopted for harvesting medicinal plants can also be a threat to their continued existence (Labadie, 1986).

2.4 Efficacy of medicinal plant extracts

Medicinal plants are reservoirs of curative elements used in the treatment of various diseases by a large population worldwide this notwithstanding the fact that their usage solely depends on ethnobotanical evidence that they are safe, acceptable,

affordable, culturally compatible and suitable for treatment of some chronic diseases (Okigbo *et al*, 2009). The World Health Organization has therefore come up with strategies to create a strong evidence base on the safety, efficacy and quality of Traditional or Complementary Alternative medicine (TAM/CAM) products and practices, and to document traditional medicines and remedies (WHO, 2003). Many consumers of herbal formulations believe that all natural products are effective and safe, which is not always the case (Mulay and Deshpande, 2006). Similar to prescribed drugs, a number of herbs can cause adverse effects when used for treatment (Talalay and Talalay, 2001) and therefore such formulations must prove to be as effective, safe and of good quality just like their synthetic counterparts to be accepted in modern science (Wagner, 1997).

The Word Health Organisation traditional medicine division recognizes the use of plant products as therapeutic resources, if proved effective (Gilbert *et al.*, 1997). However, hitherto, not much attention has been placed on proving the efficacy or safety of herbal formulations (Mulay and Deshpande, 2006). Despite this, many people, for example, in contemporary rural Africa and the urban poor, widely believe that these herbal products are effective and safe and therefore rely a lot on them for medication (Rukangira, 2002).

Phytochemical screening of medicinal plants has revealed that they contain bioactive chemical substances such as alkaloids, tannins, saponin, and others with therapeutic potentials (Farnsworth, 1996). The pharmacological activity of some plant extracts may be due to a combination of several active substances and therefore, in certain instances traditional healers mix plant extracts for enhanced activity (Rates, 2001). Sometimes medicinal plants may have other potentially useful active ingredients apart from those that one may be investigating (Williamson *et al*., 1996).

For example, *Catharanthus roseus* initially studied for anti-diabetic activity as described in folk medicine was found to also contain a powerful anti-tumour agent (Elujoba *et al*., 2005).

Many studies have been done to evaluate the efficacy of herbal preparations. Thus, antimicrobial assays (Moleyar *et al*., 1992; Kareru *et al*., 2008; Moses *et al*., 2006; Millogo-Kone *et al*., 2006), cytotoxicity (Alluri *et al*., 2005), antiprotozoal, (Camacho *et al*., 2003), and anthelmintic (Abebe *et al*., 2000; Dawo *et al*., 2001) tests have been used to validate the efficacy of plant extracts. However, validation should go hand in hand with regulation and evaluation of herbal treatments to avoid the administration of dangerous concoctions. The approach taken by many research groups has gradually shifted from pure phytochemical screening to include biological screening, which involves subjecting plant extracts or isolates to various bioassays to determine their biological activities (Jantan, 2004). The use of plant extracts and phytochemicals with known antimicrobial properties is of great significance in therapeutic treatments and is the reason why many studies (Ogbulie *et al*., 2007; Olaleye, 2007; Omonkhelin *et al*., 2007; Sofia *et al*., 2007; Selvamaleeswaran *et al*., 2010) conducted in different countries have aimed at proving the efficacy of such remedies.

The increasing acceptance of herbal medicine as an alternative form of healthcare has made the screening of medicinal plants for active compounds to become very important because such plants may serve as promising sources of novel antibiotic prototypes (Meurer-Grimes *et al*., 1996; Rabe and Van Staden, 1997; Koduru *et al*., 2006). The transformation of digitalis from a folk medicine, foxglove, to a modern drug, digoxin, illustrates principles of modern pharmacology that have helped make drugs safer and more effective (Goldman, 2001). Several other modern drugs,

originally developed like through traditional medicine, include morphine, aspirin, quinine, ergometrine, reserpine and atropine and are all currently being used by orthodox medicine in modern hospitals all over the world (Okigbo *et al*., 2009).

Screening plant materials *in vitro* has provided the needed preliminary observations necessary to select crude plant extracts with potentially useful properties for further chemical and pharmacological investigations (Mathekaga and Meyer, 1998). Many plant-synthesized chemicals are secondary metabolites (Athanasiadou *et al*., 2003) and often have antiviral, antibacterial and antifungal activity (Engel, 2002). Herbal practitioners normally use extracts from plants parts but do not isolate particular phytochemicals (Vickers and Zollman, 1999). However, proof of therapeutic claims of such plant extracts is important (Kiringe, 2006).

The phytochemicals occurring in medicinal plants often have antiviral, antibacterial and antifungal properties, and are considered to be the basis of self-medication by animals in the wild that feed on plants with medicinal properties (Engel, 2002). Lowland Gorillas, for example, take 90% of their diet from the fruits of *Aframomum melegueta*, a relative of the ginger plant, which is a potent antimicrobial and apparently keeps Shigellosis and similar infections at bay (Engel, 2002). It has been shown that among some 120 active compounds isolated from higher plants and widely used in modern medicine today, 80% show a positive correlation between their modern therapeutic use and the traditional use of the plants from which they were derived (Fabricant and Farnsworth, 2001). Further, at least 7,000 medical compounds in the modern pharmacopoeia are derivatives from plants (Holmes, 2005).

2.5 Preparation and extraction of plant materials

Fresh or dried plant materials are often used as a source for extracting secondary plant components. However, many scientists prefer to use plant material air dried to a

constant weight in extraction (Baris *et al*., 2006). Methods used for extraction usually involve the separation of medicinally active portions of a plant from the inactive/inert components by using selective solvents with an appropriate extraction technology. The extract used for testing should always be as approximate as possible to that used in the traditional process (Tesfaye, 2004). In many cases, simple extraction with hot water is used, but a variety of other solvents as well as various additives can be included in the treatment of materials before use. In most instances, however, it is likely that polar compounds are extracted, although the solubility of less polar substances can be increased considerably due to solubilizing compounds (Samuelsson, 1987). During extraction, solvents diffuse into the solid plant material and solubilise compounds with similar polarity (Green, 2004). The factors influencing the quality of an extract include the plant part used as starting material, the solvent used for extraction and the extraction technology (ICS-UNIDO, 2008). The effectiveness of a plant material as medicine depends on its nature, origin, degree of processing, moisture content and particle size (Handa, 2006).

The nature of solvent as well as solvent concentration and polarity will also affect quantity and active substance composition of an extract (Parekh *et al*., 2005). For a solvent to be used in plant extraction it must have low toxicity, ease of evaporation at low heat, promote rapid physiologic absorption of the extract, act as a preservative and should not cause the extract to complex or dissociate (where is the reference you had for this statement in your earlier version?? – you hasd attributed it to Hughs 2002). The most commonly used solvents for investigations of antimicrobial activity in plants are methanol, ethanol, petroleum ether and water (Parekh *et al*., 2005; Bisignino *et al*., 1999; Lourens *et al*., 2004; Salie *et al*., 1996; Rojas *et al*., 2006).

The extraction of active ingredients from plant material is normally improved by having a longer time of contact between solvent and plant material, grinding of the plant material into fine powder to increase the surface area for extraction and shaking of the plant material-solvent mixture (Eloff, 1998b). One common method of extraction is serial exhaustive extraction which involves successive extraction with solvents of increasing polarity which ensures that compounds with a wide range of polarity are extracted (Green, 2004). This is ideal when the aim is to screen plants for a variety of compounds (Nostro *et al*., 2000). Other methods employed include the soxhlet extraction of dried plant material using organic solvents (Kianbakht and Jahaniani, 2003). In this method samples are continually exposed to fresh solvent to improve the efficiency of extraction though the method cannot be used for thermolabile compounds because prolonged heating can lead to degradation of some of the compounds (de Paira *et al*., 2004).

2.6 Methods for antimicrobial susceptibility testing

Antimicrobial susceptibility tests (AST) are used to determine the efficacy of potential antimicrobials from biological extracts against a number of different microbial species. AST methods are used to screen plant extracts for antimicrobial activity but more commonly are used to determine the usefulness of an antimicrobial agent in combating infections by determining its minimum inhibitory concentration (MIC) (EUCAST, 2000). The discovery of novel natural antimicrobials has necessitated the development of new bioassay techniques sensitive enough to detect small amounts of biologically active chemicals (Lampinen, 2005).

Diffusion and dilution methods form the two broad categories of AST's for *in vitro* screening of plant extracts or compounds (EUCAST, 2003; Lampinen, 2005). Common diffusion tests include agar well diffusion, agar disc diffusion and

bioautography, while dilution methods include agar dilution and broth micro/macrodilution.

The broth and agar based methods are the conventional reference methods for AST (Tenover *et al.*, 1995). In this methods, paper discs of given sizes commonly 6 mm are saturated with filter sterilized plant extract at desired concentration, placed onto the surface of a suitable solid agar medium and then incubated overnight at 37 C for bacteria and 30° C for fungi to find out if any inhibition of microbial growth occurs around the disc (Salie *et al*., 1996). Muller Hinton is usually the medium of choice for culturing bacterial isolates internationally but it does not show any performance advantages over the other media (NCCLS, 2002). Tryptone soy agar (Lourens *et al*., 2004) or Nutrient agar (Doughari, 2006) have sometimes been used also. Often, the medium is pre-inoculated with the test organism. When using disc diffusion plates, inoculum sizes of 1 x 10^8 cfu/ml of bacteria are normally employed (Baris *et al*., 2006). However there has been debate on whether the discs should be impregnated with the extracts before or after placing them on the inoculated plate. Some people prefer to impregnate the discs before placing them on the agar (Lourens *et al*., 2004; Salie *et al*., 1996) while others place the discs on the plate first before impregnating them (Nostro *et al*., 2000; Baris *et al*., 2006). There is also variation in the way the paper discs are treated during or after impregnation. They can be soaked in the extract for some hours (Mbata *et al*., 2006) or left to dry under a laminar flow cabinet overnight after impregnation (Basri and Fan, 2005). The plates with the impregnated discs can also be refrigerated for an hour or two at 4°C to allow for the pre-diffusion of the extracts from the discs into the seeded agar layer before incubation (Lourens *et al*., 2004; Tepe *et al*., 2004; Schmourlo *et al*., 2004). The plates are then normally incubated at 37ºC for 24 hours when using bacteria and at 30ºC for 48 hours when

using fungi (Salie *et al*., 1996; Baris *et al*., 2006). The effectiveness of the extract impregnated on the discs is usually then established by determining the zone of inhibition which is recorded as the difference in diameter of the discs and that of the inhibition zones around the discs (Salie *et al.*, 1996).

The micro-titre plate or broth microdilution method has provided a potentially useful technique for determining MICs of test samples (Nostro *et al*., 2000; Lourens *et al*., 2004). One of its advantages over disc diffusion techniques is the increased sensitivity it has when it comes to quantitative determination of the MIC (Langfield *et al*., 2004). The MIC is the lowest concentration of the extract inhibiting the visible growth of each microorganism on an agar plate (Nostro *et al*., 2000; Hammer *et al*., 1999). The method is also applicable for a wide variety of microbes because it is not expensive and presents reproducible results (Salie *et al*., 1996). In the micro-titre plate method the plant extracts are normally dissolved in the solvent used for extraction (Grierson and Afolayan, 1999) or in DMSO to make a stock solution (Salie *et al*., 1996; Nostro *et al*., 2000; Baris *et al.*, 2006).

The stock solution is then serially diluted on the microtitre plate by transferring a half of volume of stock solution from the first well to the next well that contains the pure solvent only, then repeated between the second and third well, then to the succeeding wells in a similar manner. The inoculum size for the microtitre plate procedure is usually 1×10^6 cfu/ml (Lourens *et al*., 2004; Basri and Fan, 2005). After inoculation with the test organisms, the plates are examined for changes in turbidity as an indicator of growth and the first well in the plate that appears clear is usually taken to be the MIC of the extract while the minimum bactericidal concentration (MBC) is determined by sub-culturing the preparations that showed no growth in the MIC determination assay (EUCAST, 2003).

The agar dilution test is more versatile for the determination of MIC breakpoints where a stock solution of the extract is prepared in its extracting solvent, filter-sterilized, incorporated in molten agar and then cooled to 50^{o}C in a water bath, to obtain different concentrations of the extract in the agar (Silva *et al.*, 2005). The test organisms are normally streaked in radial patterns on the agar plates then incubated at 30^{o}C to 37^{o}C for 24h to 48 h for determination of MIC.

2.7 Challenges facing retention of traditional herbal medicine knowledge

Medicinal plants used in traditional healthcare are gradually being lost due to over utilization, population explosion and other anthropogenic reasons (Okello *et al*, 2010). According to a recent report, almost one third of medicinal plant species could become extinct and such losses have already been reported in China, India, Kenya, Nepal, Tanzania and Uganda (Plantsave, 2011). Practices such as forest clearance for agriculture, uncontrolled burning, timber logging and livestock grazing, all destroy medicinal plants together with the habitats where such plants flourish (Kisangau and Kokwaro, 2010) consequently leading to the disappearance of any knowledge attached to those plants. Given that most herbalists never keep written records but rather rely on oral transmission of their knowledge from one generation to another, knowledge retention among them is quite poor(Okello *et al*., 2010). Natural attrition among herbalists has also led to the loss of authentic knowledge of traditional treatment practices and this is further accentuated by the poor knowledge storage methods among traditional healers (Balick and Cox, 1994).

The change in lifestyles has also precipitated a lack of interest in traditional herbal knowledge thus impacting negatively on the retention of the same (Okello *et al*., 2010). All these factors contribute to the loss of traditional herbal medicinal knowledge. In view of the rapid loss of natural habitats, traditional community life,

cultural diversity and knowledge of medicinal plants, documentation of African traditional plants is a matter that needs urgent attention (VanWyk *et al*., 2002).

2.8 Traditional medicine in Kenya

Traditional medicine was incorporated into Kenya's national health policy framework in the late 1970s but little has been done to enforce this (WHO, 2005). Kenya's Development Plan 1989–1993 recognized traditional medicine and made a commitment to promote the welfare of traditional medicine practitioners (Republic of Kenya, 1989; Mwabu, 1995). Despite this being so, there was no coordinated plan for the sustainable use of medicinal plants for national development in the National Environment Action Plan of 1994 (Republic of Kenya, 1994), nor a specific legislation for traditional medicine. In 1977 the Medical Practitioners and Dentists Act was amended to reverse the exemption that had been given to practitioners of traditional medicine from compulsory registration (PPB, 2009). Currently, the practice of traditional medicine is overseen by the Ministry of Culture and Social Affairs and the Ministry of Health and it is a requirement that traditional medicine practitioners get registered with the Provincial Administration (Bridel, 2003). In 1999, Kenya's patent law was revised to include protection for traditional medicines (WHO, 2001) and in 2003, a legislative framework, the Traditional Health Practitioners Bill, was developed to regulate the sector, but is yet to be passed (Republic of Kenya, 2003).

Positive developments have in the meantime come up in the development of traditional medicine in Kenya. For example in 2001, a number of organizations working in research and interested in traditional medicine came together to develop the 'National Strategy and Action Plan for medicinal and Aromatic Plant Species 2003-2008'(KWG-MAPS, 2001). In addition, several research organisations have

developed interest in research on medicinal plants including the Kenya Medical Research Institute (KEMRI), which houses the Centre for Traditional Medicine and Drug Research; the Kenya Agricultural and Research Institute (KARI) and the Kenya Natural Resource Centre for Indigenous Knowledge (KENRIK) (Bridel, 2003). Importantly, KEMRI has established clear regulatory requirements for safety assessment of traditional use of herbal medicines within Kenya (WHO, 2005).

The WHO (2005) report covering the global survey of traditional medicine and regulation of herbal medicines pointed out some shortcomings facing traditional medicine in many countries including Kenya. These included lack of: (i) a national pharmacopoeia or monograph for use in the identification of medicinal plants, (ii) guidelines for use in the preparation of traditional medicines, (iii) references to documented scientific research on herbal medicines, (iv) a registration system and a control mechanism for the use of herbal medicines. In addition, unlike other countries where all health professionals receive training in herbal medicine where herbal medicines form a core part of their treatment options; In Kenya, medical doctors do not receive any training in herbal medicine (Mwangi *et al*., 2005). Despite these shortcomings, statistics show that 75% to 90% of local communities rely on ethno-medicine as the dominant health care system, and this is a pointer to the importance of these resources (Ochieng'Obado and Odera, 1995; Sindiga *et al*., 1995). In rural areas, many people depend on traditional medicines for their treatment due to the inadequate supply of modern medicines, shortage of qualified medical staff, increased population and high poverty levels (Republic of Kenya 2003).

Several studies to document medicinal plants and their uses have been carried out in different parts of Kenya amongst different communities. One such study is the work conducted among the Embu and Mbeere people in Eastern Province where 40

commonly used herbal plants were documented of which 25 were multi-purpose medicinal plants, and 15 treated one disease type (Kareru *et al*., 2007). Among the Samburu of Northern Kenya, about 120 species have been documented as useful for treatment of many common diseases (Fratkin, 1996) and in the same community, methanol extracts of three medicinal plants have been found to have significant antibacterial and antifungal activity (Mariita *et al*., 2011).

In Machakos and Kitui Districts, extracts of eleven medicinal plants have been recorded as being active against Gram-positive bacteria than on Gram-negative bacteria (Wagate *et al*., 2010). It has also been established that an elaborate and rich medicinal plant use exists among the Maasai (Sindiga *et al*., 1995; Kiringe, 2006), Gusii, Luo, Luhya and Kikuyu communities (Sindiga *et al*., 1995). Around the Lake Victoria basin there are a number of specific research studies that have been carried out to document medicinal plants. For example among the Nandi people in Nandi county, twenty five medicinal plants have been documented (Jeruto *et al*., 2010) while among the Luo in the Kit Mikayi area adjacent to Lake Victoria, thirty seven have been recorded (Arwa *et al*., 2010). In Kopsiro division of Mount Elgon District 107 medicinal plant species distributed in 56 families were identified while from the areas north-west of Kakamega forest occupied by the Luhya community, 168 species have been documented (Nyunja *et al*., 2009).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study area

This study was carried out in the area around Kaimosi covering parts of Vihiga and Nandi Counties along the areas traversed by the main road connecting Kapsabet town in Nandi County and Chavakali in Vihiga County (Figure 1). The area lies within latitudes, $0^{\circ}\ 7'$ N to $0^{\circ}\ 10'$ N and longitudes, $34^{\circ}\ 51'$ E to $34^{\circ}\ 56'$ E. It is located between North Nandi Forest reserve, the Kakamega Forest and South Nandi Forest reserve, which form a belt of nearly 50 km from north to south with a width of more than 20 km and an altitude ranging from about 1800 to over 2100 m above sea level (Zimmerman, 1972; Kigomo, 1991). The area is also part of the watershed for Yala River, flowing westwards through Kakamega Forest to Lake Victoria (Mann, 1980). It is cosmopolitan and a large proportion of the population has small-scale farmers many of who come from the Kalenjin and Luhya communities. According to the 2009 census, the population density in the area is approximately 261 persons per square kilometre (KNBS, 2012).

3.1.1 Climate

Rainfall in the area is bimodal with the long rains coming between March and June and the short rains from August to October. The mean annual rainfall is 1,800 mm with a temperature range of 14° C to 29° C (Zimmerman, 1972; Anonymous, 1997).

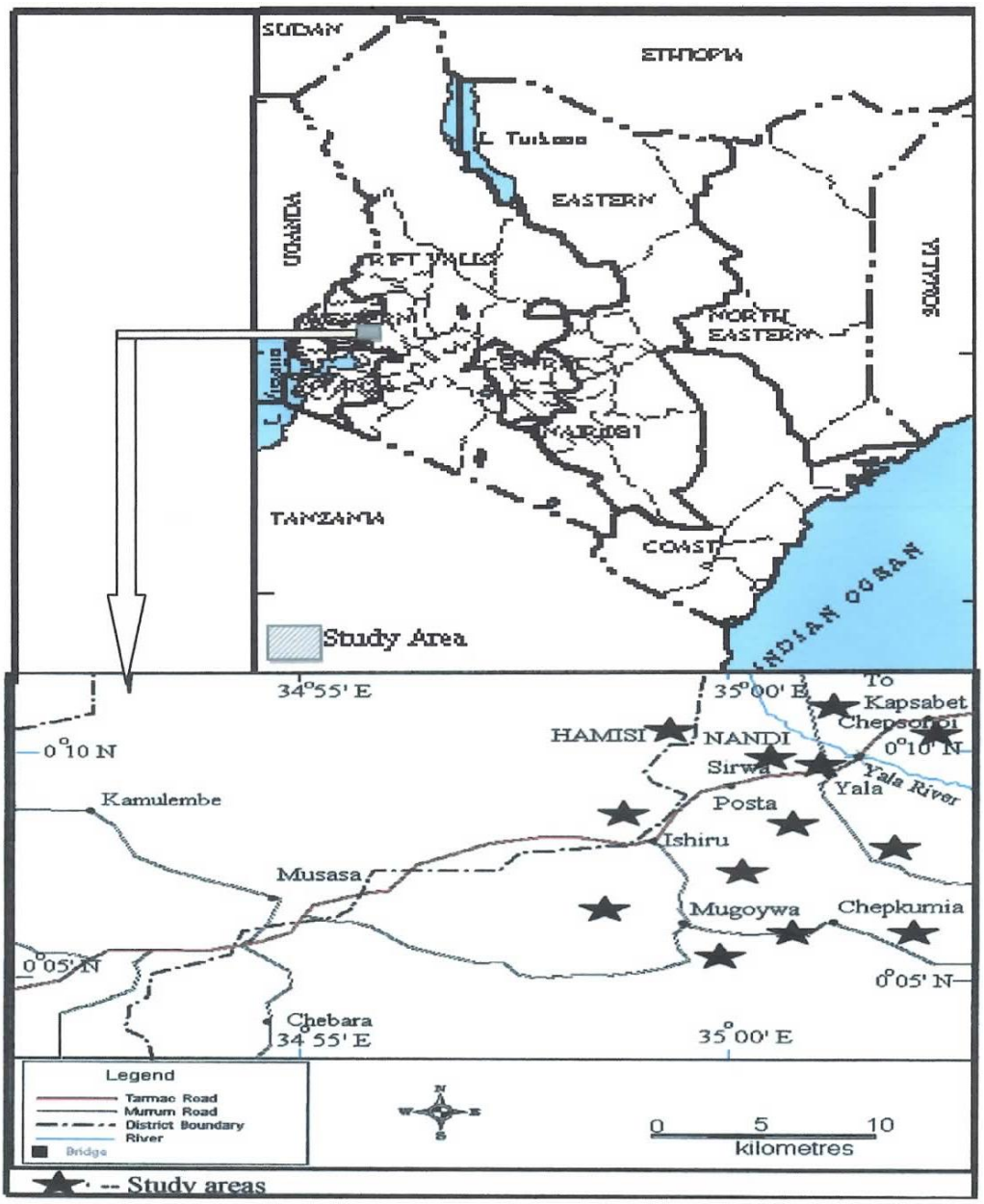

Figure 1: Map showing Location of the Kaimosi study site

Source: Roy Jorgensen Inc. August 2004.

Figure 3.1: Map showing Location of the Kaimosi Study site

3.1.2 Vegetation

Many of the settled areas around Kaimosi are surrounded by forests with numerous small streams flowing to form the Yala River. The area was apparently continuous with the Kakamega Forest in the past (Mann, 1980). The edges of the

many streams traversing the the area are covered with a dense vegetation of *Cyperus* and grasses while the surrounding forests are made up of a mixture of many different species (Ochanda, 1978). Stands of *Dracaena laxissima*, *Lantana sp*. and *Ensete ventricosum* occur in the more open settled areas which are also swamped by *Acanthus pubescens* and plants belonging to genera such as *Hibiscus*, *Vernonia*, *Crassocephalum*, *Solanum*, *Brilliantasia*, *Minulopsis* (Ochanda, 1978; Zimmerman, 1972; Diamond and Fayad, 1979) alongside cultivated plants. Some of these plants are often used for medicinal purposes by the surrounding community (Nyunja *et al.*, 2009).

3.2 Field data collection and analyses

An ethnobotanical survey was carried out in the study area between January and September 2009. Questionnaires were administered to 47 traditional medicine practitioners who gave their consent to participate in the study having been identified and selected from the surrounding villages with the help of the local administrators (Martin, 1995). For ethical reasons, prior informed consent was obtained from the informants before being interviewed. The respondents were asked to indicate the different plant species they considered to be of medicinal value, the part(s) of these plants that they used (e.g. roots, bark), the human ailments and conditions that they treated or managed using the plants, the methods they used to prepare and administer their medicines and methods they used to harvest the plants they used. Regular systematic walks in the bushes were used to identify and collect voucher specimens of the plants used by the traditional healers (Cunningham, 2001).

During the visits to the field with the herbalists, questions were asked on each medicinal plant encountered to fill in any missing knowledge from the interviews. Digital photographs of the plants were taken *in-situ*. Descriptive statistics

(percentages, frequency distributions and means) were employed to analyze and summarize the ethnobotanical data.

3.3 Plant identification and Preparation of Keys

Plants were collected and photographed, and voucher specimens prepared for each species encountered with the exception of some very commonly cultivated plants, which were identified in the field. The specimens were pressed and dried and herbarium vouchers prepared following standard botanical procedures. These were identified and confirmed by a taxonomist at the University Of Eldoret herbarium where the voucher specimens were subsequently deposited. Final determinations of the specimens collected were done based on reference keys given in Agnew and Agnew (1994) and Beentje (1994).

A taxon by character matrix based on morphological features of the medicinal plant species that were collected was generated and dichotomous keys of the medicinal plants occurring in the Kaimosi area prepared from data in this matrix (Zomlefer, 1994).

3.4 Selection of medicinal plants for antimicrobial bioassays

Three criteria were used for selecting plants to be used in antimicrobial bioassays. First, the tally of practitioners using a given plant species for the treatment of a particular condition was tabulated from the information collected among the traditional healers. From this exercise the species considered to be most important were taken to be those used by the greatest number of herbal practitioners for the treatment of particular microbial conditions (Njoroge, 2006). The first plant in this ranking was directly selected for bioassay.

In the second selection exercise, fifteen key informants selected randomly from among the 47 herbalists were asked to rank the plants from the first selection exercise according to their degree of scarcity. They were asked to categorize the plants into three categories; those that were common, scarce or rare. Only the plants that were categorized by the informants as being rare were given further consideration for use in the bioassays. The first plant in this ranking was also directly selected for bioassay as in the first ranking.

Finally, selection exercise involved the preference for the use of a particular plant as opposed to other plants. Plants from both the first and second rankings were used with exception of the first plant in each ranking that was directly selected for bioassay. Plants with at least 9 herbalists using it from the first ranking were used and plants with at least 4 informants from the second ranking were used. Randomly, one extra plant was selected from the remainder of plants with 7 or 8 herbalists from the first ranking and another from scarce plants not already selected from the second ranking. During this exercise, 10 informants selected randomly out of the 15 who participated in the second selection excercise were each asked to rank the plants from the second selection exercise that were categorized as rare, based on their personal preference or perceived degree of importance. The most important or preferred plants were assigned the highest score (7), while the least preferred species given the lowest (1) (Martin, 1995). The final score for each plant was obtained by summing up the scorings given by each selected respondent for that plant. The scores obtained by the plants used in the excercise were then ranked such that the highest sum was taken to have the best score and hence the most preferred.

The final selection list was done to include the two species that topped the first and second ranking exercises, the first six plants in the preference ranking list and

three other species categorized as scarce by at least 4 informants in the second ranking.

3.5 Preparation of plant extracts

Medicinal plants selected from the ranking exercise were extracted following a systematic procedure outlined (Willard *et al.*, 1986); Rois *et al.*, 1988); Salie *et al.*, 1996). The plant parts used for treatment purposes (e.g. leaves, stems and roots) were collected freshly from the field and air-dried at room temperature (Dilika *et al.*, 1996; Baris *et al*., 2006). Each dried plant sample was then ground into fine powder using a mortar and pestle to improve extraction.

The extraction of active antimicrobial substances from the ground plant parts involved successive use of solvents of increasing polarity, starting with a non-polar solvent (petroleum ether) to a more polar solvent (water) (Green, 2004). One hundred grams of the dry powder was soaked in 400 ml of petroleum ether for 24 hours with intermittent shaking to allow the active phytochemicals to dislodge into the solvent (Eloff, 1998b). The solvent soaked plant extracts were filtered using Whatman number one filter paper then evaporated using a rotary evaporator set at 40-50°C until a constant dry weight of the extract was obtained. The extraction process was repeated on the residue of the same powder but now using chloroform then methanol. Finally, the last extraction was done by soaking the powder in distilled water for 12 hrs. The powder-water mixture was then filtered, centrifuged and the supernatant freeze-dried. All the dried extracts were stored at 4°C for later use. The procedure was repeated for each plant powder.

3.6 Test microorganisms

Standard and clinical strains of common bacterial and fungal isolates were obtained from Kenya Medical Research Institute for testing against the plant extracts. The bacterial isolates included Gram- negative *Salmonella typhi*, *Escherichia coli* (Clinical strains) and *Pseudomonas aeruginosa* ATCC 278531. The Gram-positive bacterial isolates included *Staphylococcus aureus* ATCC 6051, *Bacillus subtilis* ATCC 6538, the Clinical strains were *Shigella sonnei* and *Shigella flexneri*. Fungal isolates included *Candida albicans ATCC 90028,* the Clinical strains *Aspergillus niger, Cryptococcus neoformans*, *Penicillium notatum, Trichophyton mentagrophyte* and *Microsporum gypseum.* All the isolates were sourced from the Kenya Medical Research Institute, Centre for Respiratory Disease Control (CRDC), Nairobi.

3.7 Determination of antimicrobial activity

3.7.1 Agar Disc diffusion Method

Preliminary screening of each plant extract for antimicrobial activity was carried out using the agar disc diffusion method on 24-hour test culture plates for bacterial isolates and 48 hour for fungal isolates (Bauer *et al*., 1966; Salie *et al*., 1996). Bacterial strains were cultured and tested on Mueller Hinton agar (Difco) while fungal isolates on Sabourand dextrose agar (Difco) (NCCLS, 2002). The plates with agar media were inoculated with the microbial isolates equivalent to MacFarland turbidity standard of 1 $x10^8$ Colony Forming Units- CFU/ml using swabs to ensure uniform distribution of colonies (Baris *et al*., 2006). Each extract was dissolved in 10 ml of 10% dimethylsulfoxide (DMSO) so that the concentration varied from one extract to another. Six-millimetre discs dipped into the plant extracts were introduced on seeded agar plates and incubated. The plates with bacterial isolates were incubated at 37 °C

for 24 hours and those with fungal isolates at 30^0C for 48 to 72 hours (Salie *et al*., 1996). Chloramphenicol (30 µg) was used as a positive control in antibacterial tests and Amphotericin B (25 µg) in the antifungal tests. In both cases, sterile 10% aqueous DMSO was used as the negative control. All tests were performed in triplicate and the antimicrobial activity was expressed as the mean of inhibition zones measured in millimetres from the edge of the disc.

3.7.2 Minimum Inhibitory Concentration (MIC)

The minimum inhibitory concentration of the extracts was determined using the Broth micro-dilution method with a 96-well micro-titre plate (Langfield *et al*., 2004). The extracts selected from the agar disc diffusion assay were diluted by two fold serial dilutions from the first well to obtain a concentration range of decreasing concentrations. To begin with, 20 microlitres of the selected extract was placed in the first well. The subsequent wells had 10 microlitres of DMSO each (Salie *et al*., 1996; Nostro *et al*., 2000; Baris *et al*., 2006). The resulting solution was serially diluted by transferring half of the solution in the first well to the second well and thoroughly mixing it. This procedure was repeated up to the last well.

Ten microlitres of the solution in each well was used to saturate a sterile disc which was then loaded onto an agar plate containing an inoculum of the test microorganism of approximately 10^8 CFU ml^{-1} (Baris *et al.*, 2006). The procedure was carried out in triplicate and the agar plates were incubated at 37ºC for 24 hours (Salie *et al.*, 1996; Evans *et al.*, 2002; Nester *et al.*, 2004; Talaro, 2005). The lowest concentration of the extract showing no growth represented the MIC.

The results were tabulated in triplicate. The fungal isolates were not tested as they did not have any significant inhibition diameters in the disc diffusion method.

CHAPTER FOUR

RESULTS

4.1 Parts of medicinal plants utilized as medicine

The plant parts used by the herbal practitioners for making traditional medicines included the bark, roots, leaves, shoot, seeds, fruits and the whole plant. The parts most frequently used were the leaves (47%), followed by the roots (20%), whole plant (12%), the bark (8%) and the shoot (7%). The least used plant parts were the seeds, fruits and tubers (Figure 4.1).

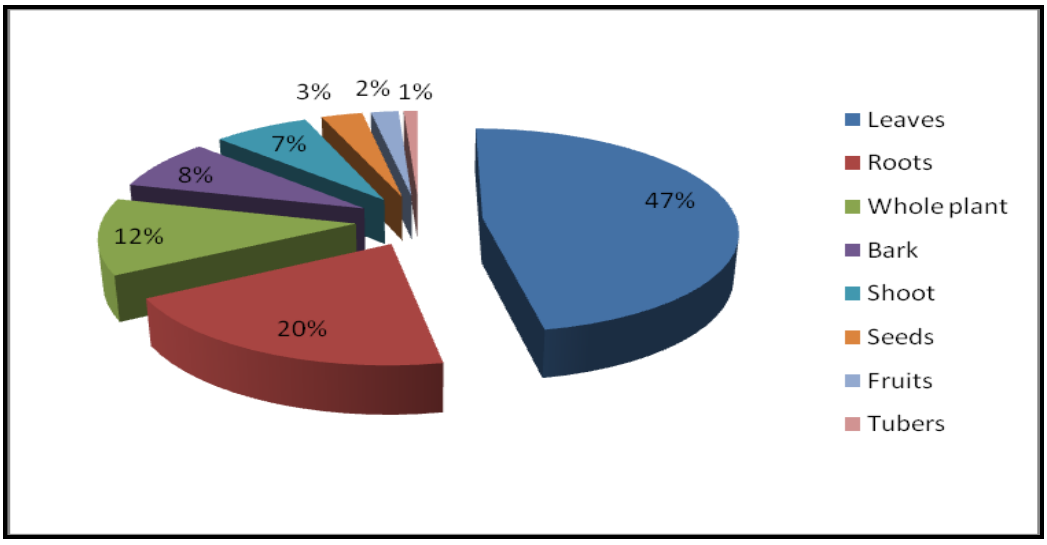

Figure 4.1: Plant parts used as medicines

4.2 Methods used in preparing the herbal medicines

The making of infusions was the most frequently used method for preparing herbal medicines followed by decoctions. Other methods used included crushing parts into paste (Poultices); burning into ash; powdering or grinding dried parts; chewing and extraction of oil (Figure 4.2). For some plants, multiple methods were employed to prepare the medicines e.g *Achyranthes aspera* L. (Poultices, decoction or ash),

Prunus africana (Hook f.) Kalkman (Infusion or decoction), *Phyllanthus fischeri* Pax. (Decoctions or poultices) among other plants (see appendix II).

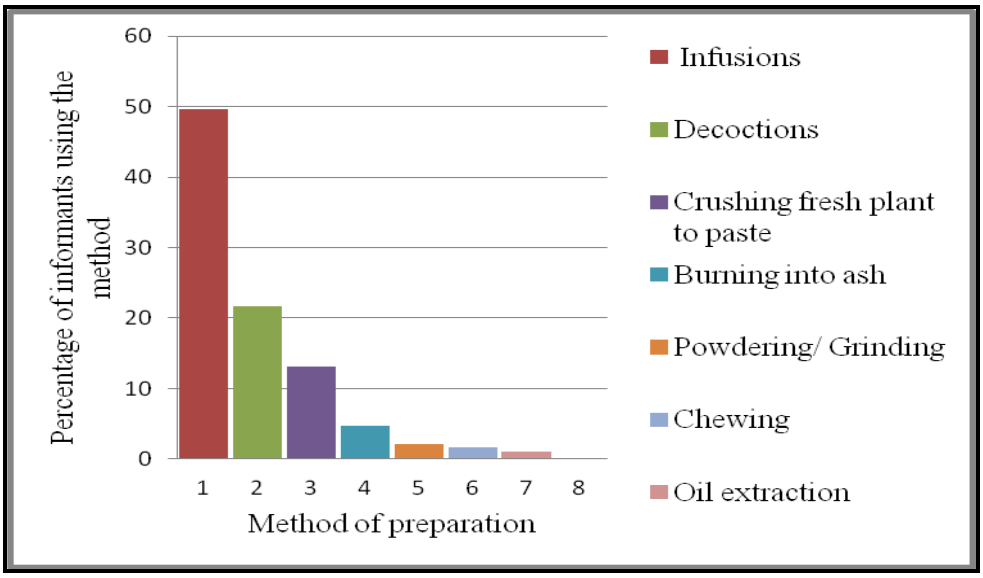

Figure 4.2: Methods used by the traditional healers to prepare herbal medicines

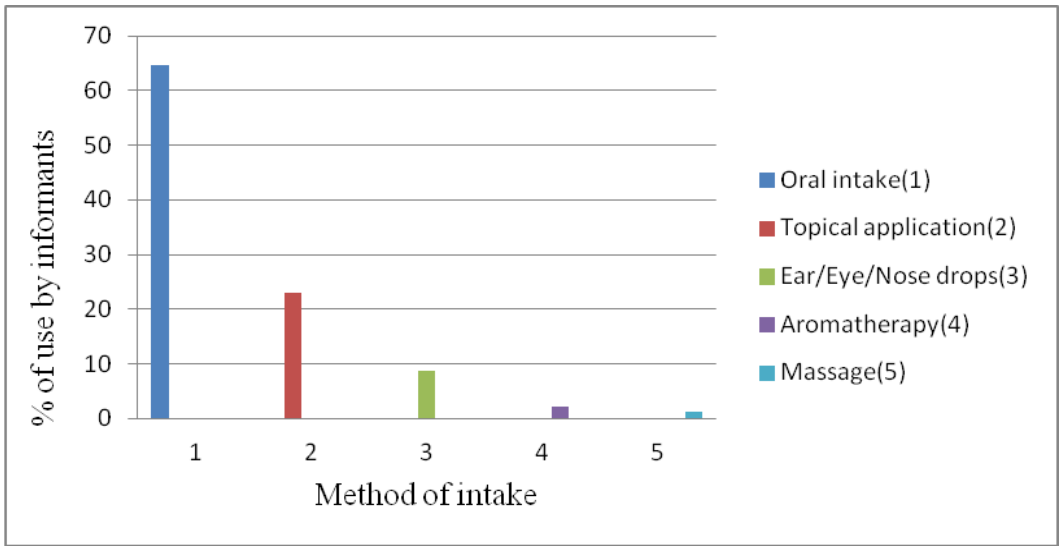

Figure 4.3: Methods used by traditional healers to administer drugs

4.3 Routes of administration of ethnomedicines

Methods used by the herbal practitioners to administer their medicines included oral intake which accounted for the largest proportion (64.7%), followed by topical

application (23%), ear/eye/nose drops (8.6%), aromatherapy (2.2%) and massage (1.1%) (Figure 4.3).

4.4 Medicinal plant diversity

In total the study documented 107 different plants species belonging to 94 genera and 44 families used as remedies for human ailments and conditions caused by microbial pathogens. The family Asteraceae with 23 species had the highest representation followed by Euphorbiaceae and Fabaceae each with 8 species, Lamiaceae with 7, Solananceae with 6 and Acanthaceae with 4. All the remaining families were represented by 3 species or less (Figure 4.4, Appendix II and monographs in Apendix III).

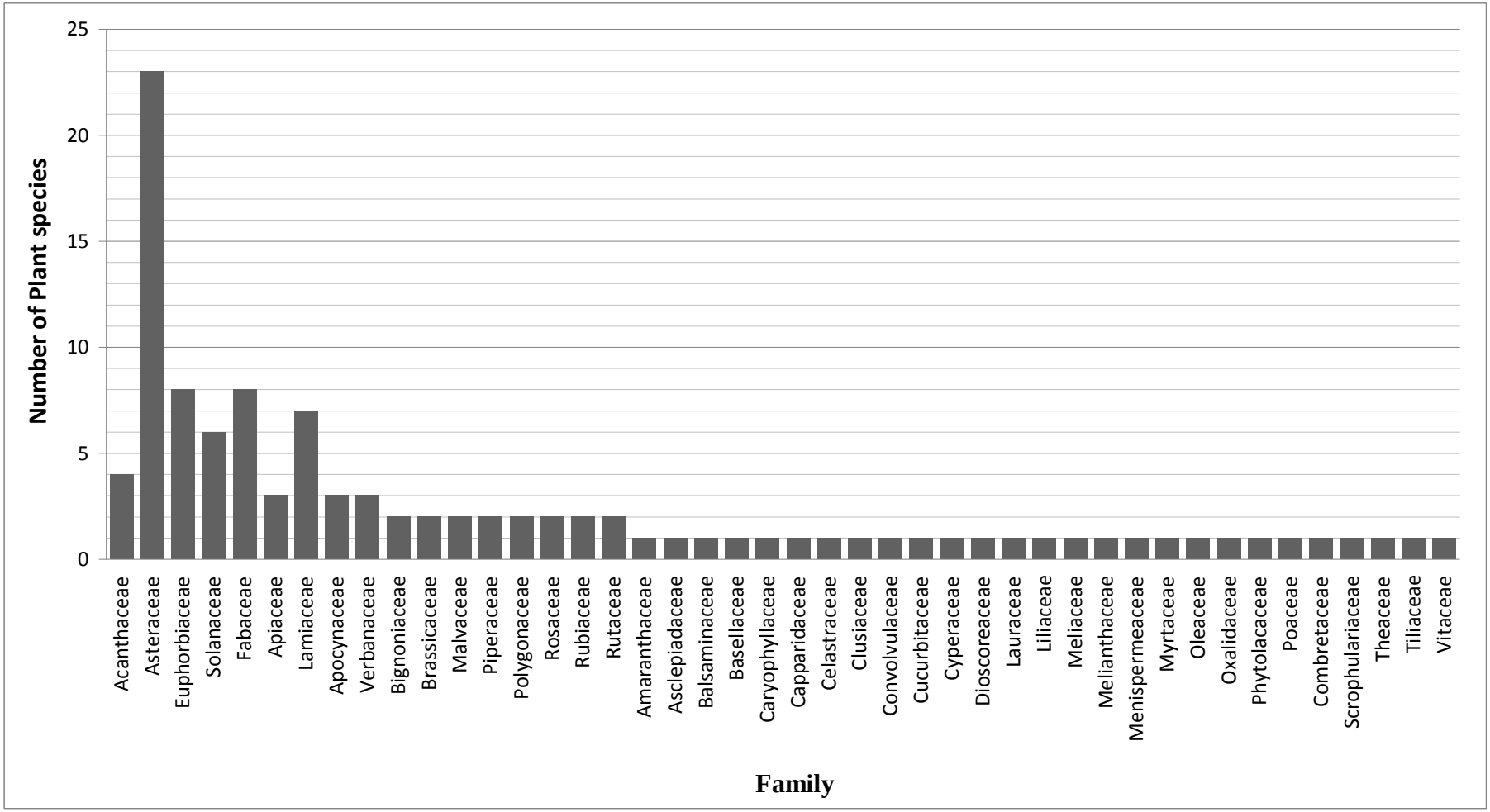

Figure 4.4: **Diversity of plant families and number of species documented in each family**

4.5 The keys to medicinal plants of Kaimosi area

The keys below represent the diversity in morphological characters that can be used to distinguish between the medicinal plants used by traditional healers in Kaimosi. The keys distinguish between dicots and monocots. Monocots are represented by Poaceae and Cyperaceae only. Amongst the dicots the following categories of plants are represented: trees, shrubs, erect herbs, lianas and climbers and creepers. Within each plant category keys were given to distinguish between families and even in families represented by more than one species to distinguish between the species.

MONOCOTS

1. Plant with nodes and internodes …….…. POACEAE (*Chloris pycnothrix*)

   Plant lacks nodes and internodes … CYPERACEAE (*Schoenoplectus corymbosus*)

DICOTS

Trees

1. Leaves simple..... 2

   Leaves compound..... 5

2. Leaves opposite ……..... 3

   Leaves alternate 9

3. Leaves with brown hairs, producing red latex …….. CLUSIACEAE (*Harugana madagascariensis*)

   Leaves glabrous producing no latex..... 4

4. Leaf veins not prominent; Fruit with four large, soft seeds ……..... RUBIACEAE (*Vangueria apiculata*)

   Leaf veins prominent; Fruit with many tiny hard seeds……..... MYRTACEAE (*Psidium guajava*)

5. Leaves with 3 leaflets per leaf……FABACEAE (*Erythrina abyssinica*)

   Leaves with 5 or more leaflets per leaf …….……..……..……..... 6

6. Leaf rachis distinctly winged ….....… MELIANTHACEAE (*Bersama abyssinica*)

   Leaf rachis not winged …….……..……..…… 7

7. Fruit a dehiscent capsule; seeds winged ……..……..…...….. BIGNONIACEAE

   Fruit a drupe or berry; seeds not winged ……..…..…….…..…… 8

8. Leaves tripinnate; leaflet margins serrate…...…MELIACEAE (*Azadirachta indica*)

   Leaves unipinnate; leaflet margins entire …..……..…RUTACEAE

9. Leaf margins dentate or serrate …….……..……...…. 10

   Leaf margins entire …….……..……... 11

10. Young buds red; fruit a berry ……..….. ROSACEAE (*Prunus africana*)

    Young buds green; fruit a capsule …… THEACEAE (*Camilla sinensis*)

11. Leaves/bark with milky exudate. ……...……..….. APOCYNACEAE

    Leaves/bark with clear or no exudate……...…….……....……...…12

12. Fruits winged ……..….COMBRETACEAE (*Combretum apiculatum*)

    Fruits without wings ……..……..……. 13

13. Bark producing white latex ……..……..……...…..... EUPHORBIACEAE

    Bark producing no latex…….....……..…….……...…… 14

14. Fruit a drupe ……..…….….. LAURACEAE (*Persea americana*)

    Fruit a berry ……..…….……..……. 15

15. Leaf axils with spines ……..……..…CELASTRACEAE (*Maytenus obscura*)

    Leaf axils lacking spines ……....……..… OLEACEAE (*Olea welwitschii*)

Families represented by more than one species

BIGNONIACEAE

1. Flowers red; fruit short and broad …….…..…… *Spathodea campanulata*

   Flowers yellow; fruit long and narrow …….……..…….……. *Markhamia lutea*

EUPHORBIACEAE

1. Stem with spines; fruit a berry ……..……..*Bridelia micrantha*

   Stem lacking spines; fruit a capsule ……..……..……..…… 2

2. Leaves narrow, whitish below; capsules large ……..… *Croton megalocarpus*

   Leaves broad, green; capsules small …..…..... *Croton macrostachyus*

RUTACEAE

1. Stem/leaf rachis prickly…….……..…….. *Zanthoxyllum gilletii*

   Stem/leaf rachis glabrous ……..……..… *Clausena anisata*

APOCYNACEAE

1. Leaves linear-lanceolate; fruit single ……..……..…. *Thevetia neriifolia*

   Leaves oblong-elliptic; fruit in pairs ……..……..... *Tabernaemontana stapfiana*

Shrubs

1. Flowers in heads……. ……...…. ASTERACEAE

   Flowers in cymes or racemes ……..……...……..……..... 2

2. Inflorescence of staminate and pistillate flowers……..…...…..... EUPHORBIACEAE
   Inflorescence of hermaphrodite flowers ……..……..….. 3

3. Stamens forming a staminal tube ……...……...……... MALVACEAE

   Stamens without a staminal tube ……..……..…..…. 4

4. Leaves compound……..……....……FABACEAE

   Leaves simple….. ……..……....……..……. 5

5. Style gynobasic ……..……...……..……... VERBERNACEAE

   Style attached at apex of ovary……..……..……..... 6

6. Leaves opposite ……...…...……..……...……... 7

   Leaves alternate ……...…...……..……...……. 9

7. Stems round/ terete when young ……..… APOCYNACEAE (*Catharanthus roseus*)

   Stems four sided/ribbed when young ……..…..…..…….……. 8

8. Leaf margins pinnatifid/ prickly ……..… ACANTHACEAE (*Acanthus pubecens*)

   Leaf margins serrate ……..……..….. LAMIACEAE

9. Leaves and stems with latex….. ASCLEPIADACEAE (*Gomphocarpus semilunatus*)

   Leaves and stems lacking latex ……..…….. 10

10. Stem with nodes; leaf base deeply cordate ……...……...… PIPERACEAE

    Stem lacking nodes; leaf base acute to round ……....……. 11

11. Fruit an achene; seeds four… ……..…. TILIACEAE (*Triumfetta rhomboidea*)

    Fruit a berry or capsule; seeds many ……..……..…….. SOLANACEAE

Families represented by more than one species

FABACEAE

1. Style straight …….…….…..…… *Indigofera homblei*

   Style curved to one side……...…..…… *Senna didymobotrya*

ASTERACEAE

1. Leaves opposite; flower heads with a chaffy receptacle ……..... *Tithonia diversifolia*

   Leaves alternate; flower heads with naked receptacle…….……..…….....2

2. Leaf scars conspicuous on branchlets …….……..…. *Solanecio mannii*

   Leaf scars not conspicuous on branchlets ……...……...……...…..… 3

3. Florets in capitula strictly homogamous ….……...……....……4

   Florets in capitula radiate or mixed with discoid/ disciform florets..... 5

4. Stems ribbed and striate; leaves sessile ……..…….. *Erlange*a *cordifolia*

   Stems terete and smooth; leaves petiolate …….……...…….. 6

5. Leaf margins cleft …….…….……...….. *Conyza bonariensis*

   Leaf margins parted …….…….……..…… *Conyza stricta*

6. Inflorescenses large; florets light to deep purple…….……..*Vernonia myriantha*

   Inflorescence small; florets creamy-white……....….*Vernonia amygdalina*

EUPHORBIACEAE

1. Leaves compound …….…….....…. *Phyllanthus fischeri*

   Leaves simple ……..……..…..…..……...……... 2

2. Leaves palmatifid; petioles hollow …….……..…..... *Ricinus communis*

   Leaves entire; petioles not hollow …….…….. *Clutia abyssinica*

MALVACEAE

1. Stem with dark brown hairs, leaf margins divided..….....… *Hibiscus fuscus*

   Stem glabrous, leaf margins serrate ……..……...……..…….. *Sida cordifolia*

VERBERNACEAE

1. Stem round when young; flowers yellowish ……...…….. *Clerodendrum scheffleri*

   Stems ribbed when young; flowers purple ……...……..…… 2

2. Stem with hooked spines ……..…….....….. *Lantana trifolia*

   Stem lacking spines …….……...……..... *Clerodendrum myricoides*

LAMIACEAE

1. Stem thick, succulent; leaves large, spongy.....……. *Plectranthus barbatus*

Stem woody; leaves small, non-spongy..……..…..….. *Ocimum kilimandischaricum*

SOLANACEAE

1. Fruit a capsule; seeds black ……..……..*Datura stramonium*

   Fruit a berry; seeds brown ….……...……..…..…...…….. 2

2. Fruit surface rough ……..……..…… *Solanum hastifolium*

   Fruit surface smooth ……..……..……..…….. 3

3. Leaf margins entire ……..……..……..…..….. *Solanum incanum*

   Leaf margins pinnatifid ……...……...……..….. *Solanum dubium*

Erect herbs

1. Leaves compound ……..……...……...…… 2

   Leaves simple ……..……...…….....…. 4

2. Petioles sheathing …….....…. APIACEAE (*Agrocharis incognita*)

   Petioles not sheathing ……...……...…….....…3

3. Leaves palmate; leaflets five……... CAPPARIDACEAE (*Cleome gynandra*)

   Leaves pinnate; leaflets more than 5 …….. FABACEAE (*Chamaecrista mimosoides*)

4. Inflorescence a capitulum ……..……...……..….. ASTERACEAE

   Inflorescence a raceme or cyme ……...……..…….…….5

5. Fruits with seed jaculators ……..…….. ACANTHACEAE

   Fruits lacking jaculators ……...……..…….……..……. 6

6. Leaves opposite ……..……..……. LAMIACEAE

   Leaves alternate ……...……..…….…..…… 7

7. Flowers actinomorphic ……..……..……..… 8

Flowers zygomorphic……..…...…….…… 10

8. Leaves serrate; fruit a berry ……..……..... SOLANACEAE

   Leaves lobed; fruit a siliqua or achene ……..……..……..… 9

9. Stem lacking swollen nodes; petiole bases non-sheathing ……..... BRASSICACEAE (*Crambe hispanica)*

   Stem with swollen nodes; petiole bases sheathing ……..…. POLYGONACEAE

10. Stem tuberous; flowers solitary and axillary …….....BALSAMINACEAE (*Impatiens tinctoria)*

    Stem woody; flowers forming a terminal raceme……..…..AMARANTHACEAE (*Achyranthes aspera*)

Families represented by more than one species

ASTERACEAE

1. Leaves opposite; heads with chaffy receptacle …….....2

   Leaves alternate; heads with naked receptacle ……..……...……..6

2. Florets purple ……..…...…...……...… *Ageratum conyzoides*

   Florets yellow to green ……..….....……3

3. Pappus of awns or barbs ……..…...…….……..……..……*Bidens pilosa*

   Pappus chaffy or reduced to scales or bristles ……..…..…….4

4. Leaves rough to touch; receptacular scales clasping florets ……... *Aspilia mossambiscensis*

   Leaves smooth to touch; receptacular scales not clasping florets.....…...5

5. Leaf margins serrate, apex acuminate……..… *Galinsoga parviflora*

   Leaf margins entire, apex acute……..…..... *Acanthospermum hispidum*

6. Plant laticiferous ……...……..…...……..……..……..…. *Sonchus asper*

Plants non-laticiferous.....…... 7

7. Leaves silvery to white ……..……..… *Helichrysum odoratissimum*

Leaves green or light green ……..……..……..…… 8

8. Capitula small, spherical ……..……..…… *Dichrocephala integrifolia*

Capitula large, cylindrical flat or inflated below..... 9

9. Rootstock with several stems……... ……...*Conyza gouanii*

Root stock with single stem …..…….……...…..……..…….……10

10. Stem succulent …….…….... *Crassocephalum crepidioides*

Stem woody ……..……..…… 11

11. Florets pink to red, cylindrical ……..……..……... *Emilia sonchifolia*

Florets yellow, disc shaped ……..……..……..…… *Emilia discifolia*

ACANTHACEAE

1. Flowers borne on long axillary peduncles …….…...…... *Justicia anselliana*

Flowers borne on terminal spikes …….……..... *Justicia betonica*

LAMIACEAE

1. Inflorescence of axillary flower ……...……...…….....… 2

Inflorescence of terminal flowers …….....…….…..……. 3

2. Calyx spine rigid……..……..……...…….....…*Leonotis mollissima*

Calyx spine soft …….…..... *Leucas martinicensis*

3. Florets purple to white ……..……... *Fuerstia africana*

Florets pink to red ……...…..*Achyrospemum schimperi*

SOLANACEAE

1. Calyx persistent ……..…..……..…….. *Physalis peruviana*

Calyx caducous ……..……... *Solanum nigrum*

POLYGONACEAE

1. Flowers axillary; fruit with 3 or 4 prickles ……..……..... *Oxygonum sinuatum*

   Flowers terminal; fruit glabrous ……...……...…..…… *Rumex bequaertii*

Lianas and climbers

1. Leaves compound …….……..……. 2

   Leaves simple …….……..…… 4

2. Stem with prickly spines ……..…….…..... ROSACEAE (*Rubus pinnatus*)

   Stem lacking spines …….……..……..…….…….……... 3

3. Tendrils present; fruit a berry ….. VITACEAE (*Cyphostemma kilimandischaricum*)

   Tendrils absent; fruit a pod/ loment ……..……..… FABACEAE

4. Leaf margins entire …….…….……. 5

   Leaf margins dentate/ serrate ……..……...……..…. 9

5. Leaves sessile; tendrils present ……..…….….. LILIACEAE (*Gloriosa superba*)

   Leaves petiolate; tendrils lacking ……..…….……..... 6

6. Plant tuberous …….…….…… DIOSCORACEAE (*Dioscorea bulbifera*)

   Plant non-tuberous …….…….…….....….. 7

7. Petiole attachment peltate …..... MENISPERMEACEAE (*Stephania abyssinica*)

   Petiole attachment basal ……..……..…….……..….. 8

8. Leaves lanceolate to elliptic, base acute ……… PHYTOLACACEAE (*Phytolacca dodecandra*)

   Leaves cordate, base sagittate ……. BASELLACEAE (*Basella alba*)

9. Inflorescence of solitary flowers ……..……..…..…..……..….. 10

   Inflorescence of clustered flowers …….…….……. 11

10. Tendrils present; flowers pure white ..….. CUCURBITACEAE (*Momordica foetida*)

    Tendrils absent; flowers cream to yellow ….……..…… ACANTHACEAE (*Thunbergia alata*)

11. Inflorescence a spike of cyathia ……..... EUPHORBIACEAE (*Acalypha fruticosa*)

    Inflorescence a corymb of heads …..…….…….....…… ASTERACEAE

Families represented by more than one species

FABACEAE

1. Stem with white hairs; leaves silvery ……..…… *Desmodium uncinatum*

   Stem with reddish brown hairs; leaves green……..…… *Desmodium intortum*

ASTERACEAE

1. Involucre campanulate..... *Senecio syringifolius*

Involucre cylindrical..... *Microglossa pyrifolia*

Creepers

1. Leaves compound ……..…….....…..……...…..….. 2

   Leaves simple ……..…….……..……..3

2. Herb bulbiferous; leaves trifoliate ……..… OXALIDACEAE (*Oxalis corniculata*)

   Herb lacking bulbs; leaves pinnate.……...…… FABACEAE (*Indigofera spicata*)

3. Leaf margins dentate or serrate……...……...…….……..4

   Leaf margins entire …….……..……. 8

4. Stems square when young…….....…. LAMIACEAE (*Orthosiphon roseus*)

   Stems terete when young ……..……...……...……..…….5

5. Leaves reniform ……..……...……..... APIACEAE

   Leaves elliptic to ovate/obovate ……..……..……..……... 6

6. Flowers solitary … ….……...… SCROPHULARIACEAE (*Cycnium adonense*)

   Flowers in clusters or heads ……..…….……..……7

7. Stems and leaves non-laticiferous ….…..…….……..….. ASTERACEAE

   Stems and leaves laticiferous.…….....… EUPHORBIACEAE (*Euphorbia hirta*)

8. Leaves alternate ……..…..…… CONVOLVULACEAE (*Dichondra repens*)

   Leaves opposite ……....…..…….……9

9. Leaves lanceolate, stipulate ……..…….. RUBIACEAE (*Spermacoce princeae*)

   Leaves broadly ovate, exstipulate…..…. CARYOPHYLACEAE (*Drymaria cordata*)

Families represented by more than one species

APIACEAE

1. Leaf margins serrate, lower surface glabrous …….……..……*Centella asiatica*

   Leaf margins divided, lower surface hairy ……..……...….... *Hydrocotyle mannii*

ASTERACEAE

1. Leaves opposite; involucre surface smooth……...……..…… *Acmella calirrhiza*

   Leaves alternate; involucre surface spiny …....…..…..… *Acanthospermum hispidum*

4.6 Selection of plants for antimicrobial testing

The first exercise to select plants for use in the antimicrobial tests yielded results presented in Table 4.1. *Ageratum conyzoides* was the most commonly used plant (15 herbalists) followed by *Fuerstia africana* (14), *Zanthoxyllum gilletii* (10), *Croton*

macrostachyus (10) and *Clerodendrum myricoides* (10) in that order. The least used plant was *Desmodium intortum* which was mentioned by two herbalists only.

Table 4.1: Medicinal plants mainly used to treat dermatological infections

No.	Name of plant	Local name	Herbalists using plant
1	*Ageratum conyzoides*	Ingui, Lunywere(L)	15
2	*Fuerstia africana*	Mkuviza nyingu (L)	14
3	*Croton macrostachyus*	Musudzu (L)/ Mtando (Ki)	10
4	*Zanthoxylum gilletii*	Shikuma (L)/ Sagawariet (Ka)	10
5	*Clerodendrum myricoides*	Kibabetyo (Ka)/Shitana, Kisugi, Shikuma (L)	10
6	*Momordica foetida*	Lilande (L)	10
7	*Lantana trifolia*	Shimenenwa-mburi (L)	9
8	*Rumex bequaertii*	Mnangoko (L)	9
9	*Microglossa pyrifolia*	Ingoi, Ingwe (L)	9
10	*Ricinus communis*	Livono (L)/ Mwariki, Mbariki (Ki)/ Maniat (Ka)	9
11	*Harungana madagascariensis*	Mnamsaai (L)/ Kipsomot (Ka)	8
12	*Thunbergia alata*	Endereresia (L)/ Chepchevayet (Ka)	8
13	*Aspilia mossambicensis*	Shilambila (L)	8
14	*Achyranthes aspera*	Kipsiromiot (Ka)/ Lusayi (L)	8
15	*Senna didymobotrya*	Luvinu (L)	8
16	*Justicia betonica*	Mwiro (L)	7
17	*Acalypha fruticosa*	Lusayi (L)/ Chepkalut (Ka)	7
18	*Acmella caliurrhiza*	Shirehiza marhe (L)/ Kutputik (Ka)	7
19	*Conyza bonariensis*	Kitandawili (L)/ Kipsaina (Ka)	7
20	*Markhamia lutea*	Lusiola (L)/ Movet (Ka)	7
21	*Cassia occidentalis*	Imbindi (L)/ Kipgargariat (Ka)	7
22	*Tithonia diversifolia*	Maua (L)	6
23	*Euphorbia hirta*	Imbehani (L)	5

No.	Name of plant	Local name	Herbalists using plant
24	*Acanthospermum hispidum*		5
25	*Spermacose princeae*	Irundi (L)	5
26	*Galinsoga parviflora*	Gavuludi (L)	5
27	*Vernonia amygdalina*	Muchatha (Ki)/ Msuluhiza (L)/ Sainat (Ka)	4
28	*Bidens pilosa*	Lukohe (L)/ Mishege (Ki)	4
29	*Vernonia myriantha*	Shusululiza (L)/ Mururwet (Ka)	4
30	*Desmodium intortum*	Luchaya (L)	2

Key: L- Luhya, Ka- Kalenjin, Ki- Kikuyu

In the second selection exercise where plants were ranked according to their degree of scarcity, *Clerodendrum myricoides* was mentioned by the highest number of respondents (12) as being the most rare followed by *Fuerstia africana* (11) and *Rumex bequaertii* (9) (Table 2). *Spermacoce princeae* was considered the most common given that it was mentioned as being rare by only two of the respondents. Only eighteen of the plants in Table 4.1 were ranked as scarce in Table 4.2 with the lowest in rank being *Acalypha fruticosa, Desmodium intortum* and *Ricinus cummunis*.

In the preference ranking exercise, *Fuerstia africana* had the highest total score followed by *Zanthoxyllum gilletii* and *Rumex bequaertii* (Table 4.3). The species that was lowest ranked was *Ricinus communis.*

Table 4.2: Ranking of plants according to their degree of scarcity

Plant species	No. of informants
Clerodendrum myricoides	12
Fuerstia africana	11
Rumex bequaertii	9
Harungana madagascariensis	8
Ageratum conyzoides	7
Lantana trifolia	5
Microglossa pyrifolia	4
Senna didymobotrya	4
Zanthoxyllum gilletii	4
Croton macrostachyus	4
Momordica foetida	3
Justicia betonica	3
Clerodendrum scheffleri	3
Cassia occidentalis	3
Spermacoce princeae	2
Acalypha fruticosa	1
Desmodium intortum	1
Ricinus communis	1

Table 4.3: Preference ranking values

Plant species	Key informants(coded A- J) /ranks given										Total	Rank
	A	B	C	D	E	F	G	H	I	J		
Fuerstia africana	6	4	7	7	6	6	3	7	5	7	**58**	1
Zanthoxyllum gilletii	7	3	7	7	5	4	7	5	5	3	**53**	2
Rumex bequaertii	7	7	5	5	7	3	2	4	3	5	**48**	3
Momordica foetida	5	6	2	2	3	6	6	6	6	4	**46**	4
Lantana trifolia	1	5	3	3	1	7	7	2	7	7	**43**	5
Microglossa pyrifolia	3	1	6	6	7	5	3	3	4	1	**37**	6
Acalypha fruticosa	2	7	4	4	2	2	4	7	2	1	**36**	7
Croton macrostachyus	2	4	6	6	1	1	5	2	1	2	**30**	8
Ricinus communis	4	2	1	1	4	1	6	1	1	6	**27**	9

Key: A-J; Informants randomlyselected to perfom the ranking exercise.

The plants that were finally selected for inclusion in the list for antimicrobial tests (Table 4.4) with plates among appendix III, comprised the two species that topped the first and second ranking exercises i.e. *Ageratum conyzoides* and *Clerodendrum myricoides,* the first six plants in the preference ranking list (Table 4.3) and three other species i.e. *Harungana madagascariensis, Senna didymobotrya* and *Croton macrostachyus* that were categorized as scarce by at least 4 informants (Table 4.2). The decision to include *Harungana madagascariensis* was strengthened when one herbalist who is highly respected in the study area made a special request for its testing.

Table 4.4: Plants selected for antimicrobial sensitivity tests

The plants selected for bioassay are tabulated below and illustrated in the plates within Appendix III.

Ageratum conyzoides	*Harungana madagascariensis*	*Rumex bequaertii*
Clerodendrum myricoides	*Lantana trifolia*	*Senna didymobotrya*
Croton macrostachyus	*Microglossa pyrifolia*	*Zanthoxyllum gilletii*
Fuerstia africana	*Momordica foetida*	

4.7 Antimicrobial susceptibility tests

4.7.1 Disc diffusion method

In the disc diffusion method used to screen plant extracts for anti-microbial activity, extracts of chloroform were the most active followed by those of methanol, water and petroleum ether (Table 4.5). Among all chloroform extracts, those that showed the highest antibacterial activity were extracts of *L. trif*olia with inhibition zones of 6 mm against *B. subtilis* and *Sh. sonnei*; and 7 mm against *Sh. flexneri*. Fungal isolates of the same extracts had very low activity with inhibition zones of 1 mm against *C. albicans*

and *M. gypseum* and 2mm against *C. neoformans* and *P. notatum*. The antibacterial activity of methanol extracts against the test isolates ranged from 1- 6.5 mm with the best activity observed in extracts of *L. trifolia* (5 mm against *B. subtilis* and 6.5 mm against *S. aureus*). None of the methanol extracts exhibited inhibition zones exceeding 1 mm against the fungal isolates. Water extracts had inhibition zones ranging between 1-5 mm against the test bacteria and 1-1.5 mm against fungal isolates. The highest inhibition zone against the test bacteria for the water extracts was noted in extracts of *H. madagascariensis* (5mm against *S. aureus*) while the highest against fungal isolates by extracts of *Z. gilletii* (1.5 mm against *C. albicans*). In general petroleum ether extracts showed the least antibacterial and antifungal activity when compared to all the other extracts (Table 4.5). However, for some species e.g. *L. trifolia*, the petroleum ether extracts exhibited high activity giving, for example, inhibition zones of 6 mm against *Sh. flexneri* and 5 mm against *B. subtilis*. All extracts of petroleum ether except from *F. africana* and *L. trifolia* showed no activity at all against any of the fungal isolates (Table 4.5). All fungal isolates except *Cryptococcus neoformans* and *Trichophytum mentagrophyte* showed susceptibility to petroleum ether extracts of *F. africana* and to only two of *L. trifolia* extracts (Table 4.5).

The Gram-positive bacteria were variously susceptible to the extracts of the different plants tested. The highest inhibition zones for the Gram-positive bacteria were recorded in chloroform and methanol extracts of *L. trifolia* against *B. subtilis* (6 mm) and *S. aureus* (6 mm), respectively (Table 5). Among the Gram-negative bacteria, the greatest susceptibility was observed with the two strains of *Shigella* in which inhibition zones ranged between 1-7 mm. The other Gram-negative bacteria, *E. coli*, *S. typhi* and *P. aeruginosa* were not susceptible to any of the extracts except *E. coli* that was susceptible to the chloroform extract of *A. conyzoides* (inhibition zone of 2 mm) and *S. typhii* that was also susceptible to the chloroform extract of *L. trifolia* (inhibition zone of 1 mm).

Based on the previous screening by disc diffusion assay of plant extracts of *Harungana madagascariensis, Fuerstia africana, Lantana trifolia* and *Senna didymobotrya* were identified to have potent antibacterial activity and their minimum inhibitory concentrations (MIC) were determined for *Bacillus subtilis, Shigella flexneri, Sh. sonnei* and *Staphylococcus aureus.*

Table 4.5: Inhibition zone Diameters (mm) of petroleum ether, chloroform, methanol and water extracts for selected medicinal plants.

Taxon	Ext	Bacteria							Fungi					
		Gram +ve		Gram -ve										
		Bs	Sa	Sh1	Sh2	Ec	St	Pa	Ca	Cn	An	Pn	Mg	Tm
Ageratum conyzoides	Et	-	-	<1	<1	-	-	-	-	-	-	-	-	-
	Ch	3	-	<1	1.5	2	-	-	-	-	-	-	-	-
	Me	-	-	<1	3	-	-	-	1	-	-	1	-	-
	Aq	-	-	<1	<1	-	-	-	1	-	-	-	-	-
Fuerstia africana	Et	2	**4.5**	2	**4.5**	-	-	-	2	-	1	1	1	-
	Ch	3	3	2.5	3	-	-	-	1	2	-	2	1	-
	Me	2	-	2.5	3	-	-	-	-	-	-	1	-	-
	Aq	-	-	1	1	-	-	-	1	-	-	-	-	-
Momordica foetida	Et	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ch	1	-	-	-	-	-	-	-	-	-	-	-	-
	Me	-	-	-	1	-	-	-	-	-	-	1	-	-
	Aq	-	-	-	-	-	-	-	I	-	-	-	-	-
Zanthozyllum gilletii	Et	-	-	<1	1	-	-	-	-	-	-	-	-	-
	Ch	1	-	-	1	-	-	-	-	-	-	1	-	-

Taxon	Ext	Bacteria							Fungi					
		Gram +ve		Gram -ve										
		Bs	Sa	Sh1	Sh2	Ec	St	Pa	Ca	Cn	An	Pn	Mg	Tm
Senna didymobotrya	Me	-	-	-	2	-	-	-	-	-	-	-	-	-
	Aq	-	-	-	<1	-	-	-	1.5	-	-	1	-	-
	Et	1	-	-	<1	-	-	-	-	-	-	-	-	-
	Ch	**4.5**	-	**4.5**	1	-	-	-	-	-	-	-	-	-
Microglossa pyrifolia	Me	1.5	-	-	1.5	-	-	-	-	-	-	-	-	-
	Aq	-	-	-	-	-	-	-	-	-	-	1	-	-
	Et	-	-	-	1	-	-	-	-	-	-	-	-	-
	Ch	2.5	-	3.5	2	-	-	-	-	-	-	-	-	-
Rumex bequaertii	Me	1	-	1	2.5	-	-	-	<1	-	-	1	-	-
	Aq	2	-	<1	1	-	-	-	-	1	-	-	-	-
	Et	3.5	1	-	1	-	-	-	-	-	-	-	-	-
	Ch	1	-	3.5	1	-	-	-	-	-	-	-	-	-
Harungana madagascariensis	Me	3	3	-	3	-	-	-	-	-	-	-	-	-
	Aq	2	1.5	1.5	2	-	-	-	-	-	-	-	-	-
	Et	-	2	1	2	-	-	-	-	-	-	-	-	-
	Ch	1	<1	2	1.5	-	-	-	-	-	-	-	-	-

Taxon	Ext	Bacteria							Fungi					
		Gram +ve		Gram -ve										
		Bs	Sa	Sh1	Sh2	Ec	St	Pa	Ca	Cn	An	Pn	Mg	Tm
Clerodendrum myricoides	Me	**5**	-	-	4	-	-	-	-	-	-	-	-	-
	Aq	2.5	**5**	3	4	-	-	-	-	-	-	-	-	-
	Et	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ch	-	-	2	1	-	-	-	-	-	-	-	-	-
Croton macrostachyus	Me	-	1	2	-	-	-	-	-	-	1	-	-	-
	Aq	1	-	2	-	-	-	<1	-	-	-	-	-	-
	Et	-	-	<1	-	-	-	-	-	-	-	-	-	-
	Ch	<1	-	1	-	-	-	-	-	-	-	-	-	-
Lantana trifolia	Me	<1	-	2	-	-	-	-	-	-	<1	1	-	-
	Aq	-	-	<1	-	-	-	<1	-	-	-	-	-	-
	Et	5	-	6	-	-	-	-	-	-	1	1	-	-
	Ch	**6**	6	**7**	-	1	-	<1	-	-	-	-	-	-
	Me	5	-	4.5	-	-	-	<1	-	-	-	-	-	-
	Aq	3	2	<1	-	-	-	<1	-	-	-	-	-	-
Control		7 C_1	10 C_1	10 C_1	7 C_1	7 C_1	7 C_1	5 C_2	7 C_2	3 C_2	3 C_2	5 C_2	5 C_2	5 C_2

Key:

An*:*	*Aspergillus niger*	Pn*:*	*Penicillium notatum*	Ch:	Chloroform
Bs*:*	*Bacillus subtilis* ATCC 6051	Sa-	*Staphylococcus aureus* ATCC 6538	Et:	Petroleum ether
Ca:	*Candida albicans* ATCC 90028	Sh1:	*Shigella sonnei*	Me:	Methanol
Cn*:*	*Cryptococcus neoformans*	Sh2*:*	*Shigella flexneri*	C2:	Amphotericin B
Ec*:*	*Escherichia coli*	St*:*	*Salmonella typhi*	C1:	C30-Chloramphenicol
Mg*:*	*Microsporium gypseum*	Tm*:*	*Trichophyton mentagrophyte*	Ext:	Extract
Pa:	*Pseudomonas aeruginosa*	Aq:	Water	- :	Resistant

Note:

(a) The controls C_1(C30- Chloramphenicol) Measured diameters of between 7 to 10 mm against Gram positive and Gram negative bacteria, while C_2(Amphotericin) had diameter range of 3 to 7 mm against fungal isolates.

(b) All measurements were an average of the triplicate inhibition zone diameter less the diameter of the paper disc(6 mm)

The extracts did not show any clear trend or pattern of activity with respect to their polarity. For example, extracts of *F. africana*, showed decreased activity with increasing extraction solvent polarity while those of *H. madagascariensis* showed increased activity with polar extracts. Other plant extracts such as those of *R. bequaertii, S. didymobotrya* and *M. pyrifolia,* elicited moderate inhibition but the remainder had mixed performance. In all cases, the positive controls recorded high inhibition zones (7-10 mm for bacteria and 3-7 mm for fungi) compared to the crude extracts.

4.7.2 Minimum inhibitory concentrations of selected medicinal plants

The minimum inhibitory concentrations of the extracts tested varied from 0.005 mg/ml to 9.52 mg/ml. Table 4.6 shows the MIC values of the extracts against the four bacterial strains. The most effective MIC values were obtained with petroleum ether extracts of *F. africana* against *Sh. flexneri* (0.005 mg/ml) and *S. aureus* (0.010 mg/ml). The MIC values of extracts from the remaining plants were relatively high, for example, 9.520 mg/ml for chloroform extract of *S. didymobotrya* against *B. subtilis* and *Sh. sonnei*.

Table 4.6: Minimum inhibitory concentrations of selected extracts

Plant species	Extract	Isolate	MIC (mg/ml)
Lantana trifolia	Ch	*Bacillus subtilis*	0.980
	Ch	*Shigella flexneri*	0.490
	Me	*Staphylococcus aureus*	3.750
Fuerstia africana	Et	*Staphylococcus aureus*	0.010
	Et	*Shigella flexneri*	0.005
Senna didymobotrya	Ch	*Bacillus subtilis*	9.520
	Ch	*Shigella sonnei*	9.520
Harungana	Me	*Bacillus subtilis*	3.040
madagascariensis	Aq	*Staphylococcus aureus*	4.350

CHAPTER FIVE

DISCUSSION

5.1 Floristics

Many families in this study were represented by a single species. This is an observation that has also been made in other studies conducted in tropical forests (Eilu *et al*., 2004). This could be due to the fact that many species in tropical forests tend to be rare and are invariably represented by very few individuals in an area whereas dominant species may have varying numbers of individuals in an area depending on the underlying ecological conditions and interspecific competition among the plants and these factors, therefore, tend to influence the distribution of species in families (Ssegawa and Nkuutu, 2006).

The relative distribution of the species in various families in this study when compared with the distribution seen in a study conducted in a forest on Ssese Island in Lake Victoria by Ssegawa and Nkuutu(2006), shows that there is coincidence in the way the species are distributed in the families to a certain degree. This is so despite the fact that the latter study was conducted on an island. The emergence of the Asteraceae and Euphorbiaceae, as the two most speciose families mirror results from similar studies done elsewhere in East Africa (Giday and Ameni, 2003; Balemie *et al.*, 2004; Yineger and Yewhalaw, 2007; Moshi *et al.*, 2010).

5.2 Medicinal plants use

The use of medicinal plants documented in this study in providing remedies for different human illnesses and conditions is a clear indication that the Kaimosi area of the Lake Victoria basin has a very rich diversity of medicinal plants (Appendix II and III). The fact that 86.4% of the plant families documented were represented by three

species or less points to this. The use of medicinal plants by the communities in Kaimosi suggests that over years there has been an accumulation of knowledge on medicinal plants among traditional healers in the area, and this confirms the suggestion that many communities in Kenya derive treatment of many health problems from traditional herbs growing naturally in the environment around the people (Sindiga, 1995). The treatment service is offered in most instances by renowned healers within the community (Fratkin, 1996; Sindiga, 1995). Many other studies similar to this have been done in other parts of Kenya showing that the use of medicinal plants is prevalent (Kareru *et al*., 2007; Kiringe, 2006; Nyunja *et al*., 2009; Okello *et al*., 2010; Jeruto *et al*., 2010; Arwa *et al*., 2010). According to the World Health Organization, traditional medicine is popular among rural communities since it is readily accessible, affordable and more importantly it is an integral part of these communities traditional cultural beliefs and practices (WHO, 2002).

The high frequency with which leaves were reported as being used for medicinal purposes compared to other parts of the plant in this study agrees with the results from other studies conducted elsewhere (Wassihun *et al.*, 2003; Giday *et al.*, 2003; Giday and Ameni, 2003; Asase *et al.*, 2005; Ayyanar and Ignacimuthu, 2005; Yineger and Yewhalaw, 2007; Moshi *et al.*, 2010). The reason for this could probably be the fact that leaves generally are the sites of photosynthesis and they produce active principles like innulins, tannins and other alkaloids (Okoegwale and Omefezi, 2001) which are microbially active. The use of leaves more than any other part of the plant is thought to lower the threat plants face from being exploited through harvesting hence making harvesting sustainable since plants often tolerate even the removal of a large amount of leaves (Giday *et al.*, 2003; Ayyanar and Ignacimuthu, 2005). The seeds, fruits and

tubers were the least used parts for medicinal purposes. This could be attributed to their seasonal appearance and availability.

The use of infusions was the most commonly used method reported for preparing herbal medicines in this study. In most cases, these were prepared using water for the simple reason that, for the majority of rural folk, water is often readily available, and hence the most likely to be used for making infusions. The infusions reported in this study were prepared from delicate parts like the leaves, flowers and stem buds. The advantage this method of preparation has over other methods used for preparing herbal remedies is that it extracts many active principles with virtually no alteration to their chemical structure thus preserving almost all their properties (George and Pamplona, 2000). Other methods such as making tinctures, herbal wine and elixirs, macerates, whole herb consumption, syrups and extract inhalation (Ehrlich, 2009; Herz, 2009 and ICS-UNIDO, 2008) along with application of topicals (Balemie, 2004; Scherrer *et al.*, 2005) are also normally used for preparing and applying traditional medicines though in this study none of these was mentioned by any of the respondents. However other methods like crushing, pounding to paste or making decoctions were also employed with the latter being used to prepare herbal teas from the barks of roots and stems.

Oral administration was the route the majority of the traditional healers in Kaimosi area preferred to use with their patients when administering drugs. It is known that phytochemicals taken orally sometimes undergo changes in the digestive tract which render them even more effective (Lees and Aliabadi, 2000). Thus, the prevalent use of the oral route for drug administration by the traditional healers in this study makes good scientific finding.

5.3 Antimicrobial tests

In this study, the antimicrobial screening using the disc diffusion method was carried out to validate claims made by the herbal practitioners concerning the efficacy of some of the plants they used for curing bacterial and fungal diseases. The disc diffusion assay showed that there were variations in the way the test cultures responded to the application of extracts from the different plants. For example, extracts from *L. trifolia, F. africana, R. bequaertii* and *H. madagascariensis* elicited wide zones of inhibition while those from *C. macrostachyus, Z. gilletii* and *M. foetida* showed small inhibition zones (Table 4.5). This difference in the zones of inhibition could be attributed to the nature and combinations of phytocompounds present in the extracts (Suree and Pana, 2005). The sensitivity of *B. subtilis, S. aureus, Sh. sonnei* and *S. flexneri* to aqueous fractions of *F. africana, R. bequaertii, H. madagascariensis,* and *L. trifolia* validates the use of these plants in the treatment of infections caused by these microorganisms.

However, it was interesting to note that the aqueous extracts of *M. foetida* and *S. didymobotrya* showed no activity against the test organisms. This could be attributed to the absence of active ingredients in the two plants or presence of active principles in insignificant amounts or if any active ingredient was present, it could have been insoluble in water and therefore not able to be extracted in an aqueous medium (Kariuki and Njoroge, 2011).

Among all the isolates, no zone of inhibition was observed when *P. aeruginosa* and *T. mentagrophyte* were used showing that these organisms were not susceptible to any of the extracts. The lack of activity of all the extracts used in this study against *P. aeruginosa* is in contrast to results in studies done by Omwenga *et al*., (2009) which showed that extracts of *Cordia monoica* had high inhibition zones of upto 36.33 mm

against the same isolate. *Pseudomonas aeruginosa* is known to have natural resistance to many antibiotics, which is often attributed to the permeability barrier offered by its outer membrane (Higgins *et al*., 2002). Possibly this could explain the lack of activity against this isolate by all extracts used in this study. The two other Gram-negative bacteria *E. coli* and *S. typhi* showed virtually no sensitivity to all the plant extracts except to the chloroform extracts of *A. conyzoides* and *L. trifolia,* respectively. This, however, is not totally unexpected given that Gram-negative bacteria are known not to be susceptible to plant extracts in low doses (Suffredini *et al.*, 2006). These bacteria have unique characteristics in the structure of their outer membrane, which comprises a complex lipopolysaccharide component that makes the cell wall impermeable to lipophilic solutes and porins that constitute a selective barrier to hydrophilic solutes with an exclusion limit of about 600 Da (Nikaido and Vaara, 1985). The membrane protects the bacteria from several antibiotics, drugs, dyes and detergents that would normally damage the inner membrane or cell wall (Grierson and Afolayan, 1999; Afolayan 2003) and could be the likely cause of the resistance observed in Gram-negative bacteria from the findings.

Of all the plant extracts tested against fungal isolates in this study, only *F. africana* extracts were active, giving inhibition zones not exceeding 2 mm wide. The plant belongs to the family Lamiaceae whose members have been found to contain terpenoids known to have antifungal properties (Waihenya *et al.*, 2002; Okigbo *et al*, 2009; Wagate *et al.*, 2010), a fact corroborated in this study.

Methanol extracts of *Croton macrostachyus* used here showed activity against *B. subtilis* and *Sh. flexneri*. However, this finding contrast that reported non-activity of *C. macrostachyus* methanol leaf extracts against bacteria (Matu and van Staden, 2003). Other plant extracts showed antibacterial and antifungal activities similar to

that reported elsewhere. These included extracts of *Microglossa pyrifolia* (Moshi *et al.*, 2010); *Clerodendrum myricoides,* (Kuria *et al*, 2001; Kareru *et al.*, 2007); *Ageratum conyzoides* (Noumi and Yomi, 2001; Arwa *et al*, 2010); and *Microglossa pyrifolia* (Watt and Breyer, 1962; Johns *et al*., 1990).

The results from disc diffusion assays showed that some of the extracts from plants such as *F. africana, R. bequaertii, H. madagascariensis, L. trifolia, M. pyrifolia, M. foetida* and *S. didymobotrya* had broad-spectrum antibacterial activity against both Gram-positive and Gram-negative bacteria. From previous studies, it is known that Gram-negative bacteria are more resistant to antimicrobial agents compared to Gram-positive bacteria (Grierson and Afolayan, 1999; Afolayan, 2003). Similar results were obtained when the plant extracts in this study were tested against Gram-negative and Gram-positive bacteria. However, very good performance was noted against the Gram-negative *Shigella* species. This was probably an indication of the presence of pharmacological ingredients in the extracts with good potency against these bacteria.

The findings from the MIC tests showed that the plants assayed have good potential as antimicrobials. *Fuerstia africana,* showed the best inhibitory concentrations against the isolates used in the study. It was observed that low doses of this plant were able to act on the selected bacterial isolates. A plant extract with such a low MIC could be effective in the control of bacterial infections. The genus *Fuerstia* is a member of the family *Lamiaceae* whose members are known to contain pharmacologically active compounds such as terpenoids, and glycosides (Matu and van Staden, 2003; Manguro *et al*., 2006) that are active against bacteria and other microbes. The extracts of *L. trifolia* also showed relatively low MICs against *B. subtilis* and *S. flexneri*. This is good indication that they may have potential for drug

development. The results generally validate the use of the two plants by herbal practitioners for the treatment of microbial infections caused by Gram-positive *B. subtilis* and *S. aureus,* and Gram-negative, *Sh. flexneri*.

Petroleum ether extract of *F. africana* and the chloroform extracts of *L. trifolia* produced some of the lowest MICs against bacterial isolates in this study. This is an indication that non-polar agents in the plants were responsible for the activity of the plant extracts against the bacterial isolates. Poor MIC results were, however, posted for the relatively polar extracts (methanol and water).

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study provides baseline information on the ethnomedicine of Kaimosi area. It reveals that there is a great diversity of medicinal plants in the Kaimosi area of the LVB and plenty of traditional knowledge on the use, preparation, and application of ethnomedicines among the communities in the area.

Identification keys were prepared for the purpose of distinguishing the plant species from each other during collection. Observable characters of the collected plant specimens were used and gave clear contrasting identification characters that individuals with interest can use in future for collection of same plants. The keys grouped the plants into easily identifiable families.

Generally, the findings from the testing of most plant extracts against various microorganisms in this study provided evidence for validation of claims made by the herbalists on the efficacy of plants used in treatment of some forms of dermatological microbial infections despite afew not showing activity. Of all the microorganisms that extracts were tested against, the greatest antibacterial activity was recorded against *Shigella* spp. Among the Gram-positive test cultures, *S. aureus* was the most susceptible. The activity observed in the extracts used in this study is possibly due to the presence of pharmacologically active phytochemicals common in medicinal plants and often known to have antibacterial properties. The antibacterial activity of the extracts of *A. conyzoides, F. africana, S. didymobotrya, M. pyrifolia, R. bequaertii, H. madagascariensis, L. trifolia* and *C. myricoides*, against both Gram positive and Gram-negative bacteria makes them good candidates for further research and it is possible that antibacterial agents could be isolated from these plants. *Fuerstia*

africana is probably a good candidate for the development of antifungal agents. The present results, therefore, offer a scientific basis for the traditional use of extracts of *A. conyzoides, C. myricoides, C. macrostachyus, F. africana, H. madagascariensis, L. trifolia, M. pyrifolia, M. foetida, R. bequaertii, S. didymobotrya* and *Z. gilletii* in the treatment of microbial infections.

6.2 Recommendations

- Similar studies should be carried out in other parts of Kenya for the purpose of generating information that can result in production of the countries pharmacopoeia. During such studies, it is important to vet indigenous plants from exotic medicinal plants.
- The herbalists using the plants need to be educated or trained on the use of identification keys for proper identification of the plants during collection to avoid using the wrong plant for treatment which can result in serious consequences such as poisoning.
- Phytochemical analyses and toxicological studies are needed to elucidate the active pharmacological principles and toxicity of the medicinal plants tested in this study. The rest of the plants documented need to be evaluated in the same manner.
- The synergistic effect of the medicinal plants used in the antimicrobial studies was to be tested and evaluated because in many occasions herbalists mix herbal medicinal plant for treatment.

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APPENDICES

Appendix I: Data acquisition questionnaire

Questionnaire for acquisition of data on utilization of medicinal plants in Kaimosi area, Western Kenya

PART A: RESPONDENTS DETAILS

Name: _____ Sex: _____ Age: _____

Location/ Residence: _____ Level of education: _____

PART B: DATA ON MEDICINAL PLANTS

Type of plant: _____

Collection number: _____

Condition of specimen: _____

Family: _____

Name of the plant:

a) Local: _____ b) Botanical: _____

Part(s) used as medicine_____

Preparation method(s): _____

Form of administration/ route: _____

Disease/ condition treated: _____

Approximate dosage: _____

Methods of harvesting: _____

Side effects: _____

Other uses: _____

PART C: DESCRIPTION OF THE PLANT

Appendix II: Ethnomedicinal plants of Kaimosi

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
ACANTHACEAE			
Acanthus pubescens (Oliv.) Engl.	Spleen disease	Dried leaves burnt into ash	Ash placed in the mouth (oral)
Justicia anselliana (Nees.) T.Anders.	Oral infection	Whole plant crushed in water	Infusion taken orally
Justicia betonica L.	Severe stomachache Oral infection	Leaves dried and crushed Whole plant dried and burnt	Infusion taken orally Ash licked
Thunbergia alata Bojer ex Sims.	Oral thrush/ plastic teeth Soft fontanelle/ back pain	Young leaves pounded in little water	Paste rubbed on gums Poultices applied on skin
AMARANTHACEAE			
Achyranthes aspera L.	Bleeding/ skin lesions Stitch/ venereal diseases Boils	Roots/leaves crushed in some water Roots crushed, boiled then stained Leaves dried, burnt	Poultices applied topically Decoction taken orally Ash applied topically
APIACEAE			
Agrocharis incognita (C.Norman) Heyw and Jury	Internal boils/abscesses	Leaves smashed with some water	Poultices applied topically
Centella asiatica (L.) Urb.	Skin ulcers/ wounds Fever/ oral or throat ulcers	Plant pounded into a paste	Paste applied on skin Infusion taken orally
Hydrocotyle mannii Hook. f.	Fresh wounds	Paste made from whole plant	Paste applied on wound

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
APOCYNACEAE	Abdominal pain	Leaves pasted, water added or may	Decoction taken orally
Catharanthus roseus (L.)G.Don	Leukemia / anaemia	be boiled	Infusion taken orally
Tabernaemontana stapfiana Britten	Whooping cough	Bark crushed and boiled	Decoction drank two spoonfuls daily
Thevetia neriifolia Juss.ex A.DC.	Rheumatism/ dropsy / tumors/ Abortion	Roots / fruits crushed into a paste	Infusion drank in small quantities
ASCLEPIADACEAE			
Gomphocarpus semilunatus A. Rich.	Gout	Leaves crushed into paste	Paste applied on skin
	Anti-vomit	Bark pounded in water	Infusion drank
	HIV and intestinal worms	Root washed & boiled	Decoction taken orally
ASTERACEAE			
Acanthospermum hispidum DC.	Oral infection	Whole plant-crushed when fresh or dry then mixed with little water	Infusion/ ash-small amount put in the mouth twice daily
Acmella caulirrhiza Del.	Oral ulcers/ infection	Whole shoot- pounded when fresh, some water added/ also chewed	Infusion or chewed herb held in the mouth for sometime
Ageratum conyzoides (L.) L.	Bleeding from cuts	Leaves made into a paste	Juice applied on cut
	Sore eyes	Leaves made into a paste	Drops into the eyes
	Coughing/ stomachache	Whole plant infusion in water	Infusion/ decoction drank
Aspilia mossambicensis (Oliv.)Wild	Oral thrush, Skin ulcers, worms	Whole shoot dried, burnt into ash or	Ash licked
	Conjunctivitis	crushed into a paste water added	Juice drank/ drops into eye
Bidens pilosa L.	Conjunctivitis	Leaf paste, water added	Infusion drops into the eye
Conyza bonariensis (L.) Cronq.	Stomachache	Root crushed or chewed	Infusion taken orally
	Oral sores/ thrush	Leaves pounded in water	Infusion taken orally

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
Conyza stricta Willd.	Indigestion	Leaves crushed when fresh and little	Infusion drank
	Headache	water added	Poultice inhaled
Conyza gouanii (L.) Willd.	Fainting	Leaves pounded into a paste	Poultices inhaled
Crassocephalum crepidioides (Benth.) S. Moore	Oral infection	Shoots dried then burnt	Ash applied on skin
Crassocephalum picridifolium (DC.) S.Moore	Blood purifier, Oral / throat ulcers/ Stomachache	Shoot pounded, water added then seived fresh or boiled	Infusion or decoction drank
	Skin lesions		Juice applied on skin
Dichrocephala integrifolia (L.f.) Kuntze	Bleeding from cuts, wounds, tetanus	Leaves made into a paste	Juice squeezed onto the cut or wound
Emilia discifolia (Oliv.) C. Jeffrey	Oral thrush/ throat infections	Whole plant dried then burnt	Ash licked
Emilia sonchifolia (L.) DC. Ex DC	Oral thrush/ throat infections	Whole plant dried, burnt into ash	Ash licked
Erlangea cordifolia (Benth. Ex Oliv.) S. Moore	Sores eyes	Leaves pasted with water	Eyewash with infusion
	Stomachache		Infusion drank
	Swollen joints		Massage with infusion
Helichrysum odoratissimum (L.) Sweet	Oral thrush / throat infections	Whole plant dried & burnt into ash	Ash licked
Galinsoga parviflora Cav.	Skin inflammation/ sores	Whole shoot paste in little water	Infusion on the affected part
	Obesity	Leaves pasted in water	Infusion drank
	Conjunctivitis, deafness	Leaf paste and some water added	Infusion drops into the eye/ear
Microglossa pyrifolia (Lam.) Kuntze	Skin wounds/ ulcers	Leaves made into dry powder	Powder put on skin
	Headache/ colds	Roots crushed in water	Infusion taken oral

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
Senecio syringifolius O.Hoffm.	Cough/ colds	Roots harvested, washed	Chewed and juice swallowed
Solanecio mannii (Hook. f.) C. Jeff.	Measles	Leaves crushed into paste	Paste applied on skin
	Indigestion/ dysentery	Roots boiled and strained	Decoction taken orally
Sonchus asper (L.) Hill	Plastic teeth/ toothache	Leaves crushed into a paste	Poultices rubbed on gums
	Boils/ oral thrush	Whole shoot ground in water	Infusion taken orally
Tithonia diversifolia (Hemsl.) A.Gray	Stomachache/ indigestion/ sore throat	Leaves crushed into a paste in water	Infusion taken orally
Vernonia amygdalina Delile	Stitch	Roots crushed in water	Infusion taken orally
	Body spots	Leaves made into a paste	Paste applied on skin
Vernonia myriantha Hook. f.	Skin scales	Leaves made into a paste	Paste applied on skin
	Oral ulcers/ rheumatism/ pneumonia	Bark pounded in water and may be boiled	Infusion or decoction drank
	Skin sores/ stitch/ cough	Bark boiled	Decoction taken orally
BALSAMINACEAE			
Impatiens tinctoria A. Rich.	Worms	Leaves / fruits crushed in water	Infusion taken orally
	Oral / throat ulcers	Stems pounded in water	Juice taken orally
BASELLACEAE			
Basella alba L.	Increased lactation	Leaves boiled in water	Decoction drank
BIGNONIACEAE			
Markhamia lutea (Benth.) K. Schum.	Conjunctivitis/ ophthalmia Sore throat	Young leaves chewed in the mouth	Vapour exhaled into eye
		Crush young leaves in water	Infusion taken orally
Spathodea campanulata P.Beauv.	Stitch/gonorrhea/ stomachache	Bark removed and boiled	Decoction taken orally

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
BRASSICACEAE	Induce vomiting	Leaves crushed, water added	Infusion taken orally
Brassica nigra (L.) K.Koch.			
Crambe hispanica L.	Oral infection	Whole shoot pounded	Infusion taken orally
CAPPARIDACEAE			
Cleome gynandra (L.) Briq.	Boils	Leaves made into a paste	Paste applied on skin
	Epilepsy/ ear-ache	Shoot pasted with some water	Infusion drops into nose/ear
	Stomachache	Shoot chopped, boiled	Decoction drank
CARYOPHYLLACEAE			
Drymaria cordata (L.) Willd. ex	Oral thrush/ ulcers	Leaves crushed in water	Infusion taken orally
Schult.	Chest pain	Leaves burnt in a container	Smoke inhaled
CELASTRACEAE			
Maytenus obscura (A. Rich.)	Whitlow	Leaves chewed into paste	Paste applied on skin
Cufod.	Diarrhoea	Leaves crushed with water	Infusion drank
	Leukemia/ Gonorrhea	Roots boiled	Decoction drank
CLUSIACEAE			
Harungana madagascariensis	Oral infection/ conjunctivitis	Leaves or bark crushed, in water	Infusion drank/ as eye drops
Lam. ex Poir.	Skin lesions	Whole plant chopped, boiled	Decoction applied on skin
CONVOLVULACEAE			
Dichondra repens J.R.Fost and G.Forst	Heartache or pain	Leaves pounded in water	Infusion taken orally
CUCURBITACEAE			
Momordica foetida Schumach.	Oral and throat infection-thrush/ ulcers/ coughs	Leaves pounded into a paste	Conc. Infusion drank

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
CYPERACEAE			
Schoenoplectus corymbosus (Roth ex Roem. and Schult.) J. Raynal	Measles	Roots crushed, water	Infusion taken orally
DIOSCOREACEAE			
Dioscorea bulbifera L.	Measles	Tubers crushed added	Infusion taken orally
EUPHORBIACEAE			
Acalypha fruticosa Forssk.	Oral infection	Fruits / leaves pasted	Infusion taken orally
Bridelia micrantha (Hochst.) Baill.	Joint pains Stomachache/ diarrhoea	Roots chopped boiled Bark removed, boiled	Decoction dunk Decoction drank
Clutia abyssinica Juab. & spach	Oral/ throat infections	Leaves pounded in little water	Infusion drank
Croton macrostachyus Hochst. Ex Delile	Malaria/ gonorrhea	Roots boiled	Decoction drank
	Skin wounds / warts	Young shoot pasted	Juice applied on skin
	Cough	Leaves dried, burnt to ash	Ash licked
Croton megalocarpus Hutch.	Skin tumors	Young leaves pasted	Juice applied on skin
	Whooping cough	Bark smashed in water	Infusion drank
Euphorbia hirta L.	Heartburn/Oral thrush/ boil	Leaf paste infusion in water	Infusion drank
	Eye infection	Whole plant crushed in water	Juice as eye drops
Phyllanthus fischeri Pax.	General body illness	Roots boiled	Decoction drank
	Backache/ abnormal growth of cervical vertebrae	Whole plant made into paste	Poultices applied on skin
Ricinus communis L.	Skin infection	Seeds pressed to release oil	Oil applied on skin
	Stomachache/ ulcers	Leaves made into a paste	Infusion drank
	Deworming/ diarrhoea	Seeds- oil extracted	Oil drops taken orally

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
FABACEAE			
Cassia occidentalis L.	Oral thrush/ fever/stomachache	Whole plant cut into pieces, boiled	Decoction drank
Chamaecrista mimosoides (L.) Greene	Oral infection in children	Whole plant pounded in some water	Infusion drank
Desmodium intortum (Mill.) Urb.	Allergy	Leaves made into a paste, water added	Infusion drank
Desmodium uncinatum (Jacq.) DC.	Wounds/ bacterial infection	Leaves crushed in water	Juice applied on skin
Erythrina abyssinica DC.	Eye inflammation	Young shoots crushed water	Drops into eye
	Syphilis/ gonorrhea	Root or bark boiled	Decoction drank
Indigofera homblei Baker f. & Martin.	Dislocation of bones	Leaves made into a paste	Paste applied on part
	Stomach disorders	Roots crushed, water added	Infusion drank
Indigofera spicata Forssk.	Abortion	Plant crushed, water added	Infusion drank
	Sore throat, stomach disorders	Roots crushed, water added	Infusion drank
Senna didymobotrya (Fres.) Irwin & Barneby	Skin disease/Measles	Leaves made into a paste	Poultices on skin
	Gonorrhea/ malaria	Leaves boiled	Juice applied on skin
	Stomachache	Leaves/roots boiled	Decoction drank
LAMIACEAE			
Achyrospermum schimperi (Hochst. ex Briq.) Perkins ex Mildbr.	Nose bleeding	Leaves pounded with water	Drops into the nose
	Boils		Infusion drank

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
Fuerstia africana T.C.E Fr.	Stomach ulcers/ oral thrush	Leaves crushed, water added	Infusion drank
	Conjunctivitis/ ophthalmia	Leaves made into a paste with some water	Drops into eye
Leonotis mollissima Guerke.	Conjunctivitis	Leaves crushed in water	Drops into eye
	Dysentery/ stomachache	Roots crushed, water added	Infusion drank
	Wounds/ sores	Roots made into a paste	Paste applied on sore
Leucas martinicensis (Jacq) R.Br.	Anti-vomit/ diarrhoea	Leaves crushed, water added	Infusion drank
Ocimum kilimandscharicum	Measles	Leaves cut and boiled	Bath with decoction
Guerke.	Colds and coughs	Leaves and flowers pasted	Poultices sniffed
Orthosiphon rubicundus (D.Don)	Oral thrush	Leaves made into a paste	Infusion taken orally
Benth.	Fontanelle healing		Paste applied on skin
Plectranthus barbatus Andrews	Stomachache	Leaves crushed, water added	Infusion drank
	Measles	Leaves boiled	Bath with decoction
LAURACEAE			
Persea Americana Mill.	Headache/ memory loss	Leaves crushed, water added	Infusion drank
	Diarrhoea/ blocked urine	Seed milled, water added	Infusion drank
	Toothache/ decay	Seed milled to powder	Powder inserted in tooth cavity
LILIACEAE			
Gloriosa superba L.	Indigestion	Roots pasted, water added	Juice drops taken orally
	Abortion		Infusion drank
MALVACEAE			
Hibiscus fuscus Garcke	Pneumonia	Leaves crushed, water added	Infusion drank
	Sore throat/ cough	Roots cleaned and chewed	Juice drank

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
Sida cordifolia L.	Lumbago/ Sunken Fontanelle	Roots/ leaves made into a paste	Paste applied on affected part
MELIACEAE			
Azadirachta indica A. Juss	Malaria/arthritis/ stomachache/ eczema	Bark, fruits, leaves, flowers and seeds crushed, water added	Infusion taken
MELIANTHACEAE			
Bersama abyssinica Fresen.	Toothache	Leaves made into a paste	Paste rubbed on gums
	Wounds/ Epilepsy	Roots boiled	Decoction drops on wound/drank
MENISPERMEACEAE			
Stephania abyssinica (Quart.-Dill. and Rich.) Walp.	Abdominal pains/ sexual desire	Roots washed pounded	Infusion drank
MYRTACEAE			
Psidium guajava L.	Diabetes	Young leaves crushed, water added	Infusion drank
OLEACEAE			
Olea welwitschii (Knobl.) Gilg & Schellenb.	Gonorrhea/ Stomach upsets	Bark removed, boiled	Decoction drank
OXALIDACEAE			
Oxalis corniculata L.	Boils/ oral thrush	Leaves crushed, water added	Infusion drank
PHYTOLACACEAE			
Phytolacca dodecandra L'Herit.	Worms	Leaves crushed in water	Dilute infusion drank
	Enlarged glands/ syphilis	Roots boiled in water	Dilute decoction drank
PIPERACEAE			
i)Piper capense L.f.	Sore throat and cough	Fruits crushed or chewed	Infusion drank
ii)Piper umbellatum L.	Cough/ throat ulcers; chest pain	Leaves/ flowers pounded in water	Infusion drank

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
POACEAE			
Chloris pycnothrix Trin.	Pneumonia	Shoot crushed and water added	Infusion drank, chewed
POLYGONACEAE			
i) Oxygonum sinuatum (Hochst. & Steud ex Meisn.) Dammer	Conjunctivitis Gonorrhea	Leaves made into a paste Roots boiled	Juice drops into eye Decoction drank
ii) Rumex bequaertii De Wild.	Throat infection / coughing	Roots crushed	Infusion drank, chewed
COMBRETACEAE			
Combretum apiculatum Sond.	Colds /fever/malaria	Leaves crushed in water/ boiled	Infusion/ Decoction drank
ROSACEAE			
Prunus africana (Hook f.) Kalkman	Stomachache Diabetes /prostate cancer	Bark cut or crushed in water or boiled	Infusion drank Decoction taken orally
Rubus pinnatus Willd.	Plastic teeth Cough/ colds	Leaves made into a paste Roots crushed in water	Paste rubbed on gums Infusion drank
RUBIACEAE			
Spermacoce princeae (K.Schum) Verdc.	Oral thrush/ Skin disease	Whole shoot made into a paste	Infusion/ paste drank or on skin
Vangueria apiculata K.Schum	Stomachache Deworming	Leaves crushed, water added Roots boiled	Juice taken orally Decoction drank
RUTACEAE			
Clausena anisata (Willd.) Hook.f. ex Benth.	Stitch/ stomachache/ gonorrhea	Leaves, bark boiled	Decoction drank
Zanthoxylum gilletii (De Wild.) P.G. Waterm.	Rheumatic fever	Bark crushed in water or boiled	Juice taken orally

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
SCROPHULARIACEAE			
Cycnium adonense E.Mey. ex Benth	Oral thrush/ Plastic teeth (children)	Whole plant dried, burnt	Ash rubbed on gums
	Blocked oviducts	Leaves crushed, water added	Infusion drank
SOLANACEAE			
Datura stramonium L.	Rheumatic fever	Leaves boiled	Bath with decoction
	Earache	Fruits burnt, juice squeezed out	Hot drops into ear
	Ringworms	Ash of leaves/seeds in fat	Paste rubbed on affected area
Physalis peruviana L.	Malaria/ stomachache	Leaves crushed, water added	Infusion drank
Solanum dubium Fresen.	Stomachache/ Threatened miscarriage	Roots crushed Roots boiled	Juice taken orally Decoction drank
Solanum hastifolium Dunal	Boils/ abscesses	Fruits burnt, cut when hot and applied on the boil	Fomentation applied topically
Solanum incanum L.	Severe stomachache	Roots crushed, water added	Infusion drank
	Earache	Leaves made into paste	Infusion as eardrops
Solanum nigrum L.	Gut ulcers/ boils/swollen glands	Leaves/ raw fruits crushed in water	Infusion drank orally
THEACEAE			
Camellia sinensis (L.) Kuntze	Stomachache/ gonorrhea/allergy	Root crushed, water added	Infusion drank
TILIACEAE			
Triumfetta rhomboidea Jacq**.**	Deworming/ Stitch	Root pounded, water added	Infusion drank
	Burns	Leaves made into paste	Paste applied on burn

FAMILY/ SPECIES	CONDITION TREATED	PREPARATION OF PARTS USED	METHOD OF USE OR APPLICATION
VERBENACEAE			
Clerodendrum myricoides R. Br.	Pneumonia/sore throat/ rheumatism	Roots crushed, water added	Infusion drank
	Gonorrhea	Leaves boiled then strained	Decoction drank
Clerodendrum scheffleri Gürke	Venereal diseases	Roots boiled and strained	Decoction drank
	Weak or thin body	Leaves pounded, water added	Juice applied on skin
	Labour pains/ stomachache	Bark chopped, boiled	Decoction drank
Lantana trifolia L.	Oral and throat infections	Leaves crushed, water added	Infusion drank
	Rheumatism	Leaves crushed and boiled	Decoction drank
VITACEAE			
Cyphostemma kilimandischaricum (Gilg) Desc. Ex Wild & R.B.Drumm	Throat infection	Leaves pounded, water added	Infusion taken orally

Appendix III: A monograph of Medicinal plants in Kaimosi

Plate 1a: ACANTHACEAE, *Acanthus pubescens* (Oliv.) Engl.
Local name: Lirhagalu (L)
Locality: All
Uses - Spleen disease
Form of administration- Leaf ash put in mouth

Plate 1b : ACANTHACEAE, *Justicia anselliana* (Nees) T. Anderson
Locality: All
Uses- Oral thrush, tongue infection & plastic teeth, fontanelle & back pain
Form of administration – Leaf infusion drank

Plate 1c:ACANTHACEAE, *Justicia betonica* L
Local name: Mwiro (L)
Locality: All
Uses-Oral infection
Form of administration - Leaf infusion drank or ash lick

Plate 1d: ACANTHACEAE, *Thunbergia alata* Bojer ex Sims.
Local name: Endereresia (L)/ Kanyanya (Ki)/ Chepchevayet (Ka)
Locality: Chepsonoi/ Shiru/ Chepkumia
Uses- Oral thrush, tongue infection & plastic teeth, fontanelle & back pain
Form of administration – Massage with paste

Plate 2: AMARANTHACEAE, *Achyranthes aspera* L.
Local name: Kipsiromiot (Ka)/ Lusayi (L)
Locality: Chepsonoi/ Shiru/ Chepkumia
Uses- Skin lesions/ boils, stitch & gonorrhea
Form of administration – Poultices, decoction, or ash applied topically

Plate 3a: APIACEAE, *Agrocharis incognita* (C.Norman) Heyw and Jury
Locality: Muguywa
Uses- Internal boils/abscesses
Form of administration –Leaf poultices applied topically

Plate 3b: APIACEAE, *Centella asiatica* (L.) Urb
Locality: Chepsonoi/ Shiru
Uses- Fever, oral/ throat infection, skin ulcers
Form of administration – Poultices/paste of plant applied topical

Plate 3c: APIACEAE, *Hydrocotyle mannii* Hook.f.
Locality: Kabwareng'/ Mugoywa
Uses- Whooping cough
Form of administration – Plant paste applied on wound

Plate 4a: APOCYNACEAE, *Catharanthus roseus* (L) G. Don
Local name: Maua (L)
Locality: Chepsonoi
Uses- Abdominal pain, Leukemia / anaemia
Form of administration – Leaf decoction taken orally

Plate 4b: APOCYNACEAE, *Tabernaemontana stapfiana* Britten
Local name: Mdondo (L)
Locality: Kabwareng'/ Mugoywa
Uses- Whooping cough
Form of administration – Two spoonfuls of bark decoction taken daily

Plate 4c: APOCYNACEAE, *Thevetia neriifolia* Juss.ex A.DC.
Locality: Sirwa-yala
Uses- Rheumatism, dropsy and tumors, abortion
Form of administration – Infusion of roots or fruits taken orally in small quantities

Plate 5: ASCLEPIADACEAE, *Gomphocarpus semilunatus* A. Rich
Local name: Livondwevondwe (L)
Locality: Chepsonoi
Uses- Gout, anti-vomit, HIV and intestinal worms
Form of administration – Bark or root infusion or decoction drank or applied on skin

Plate 6a: ASTERACEAE, *Conyza stricta* Willd.
Locality: Sirwa-yala
Uses- Indigestion, headache
Form of administration – Leaf infusion drank orally

Plate 6b: ASTERACEAE, *Acanthospermum hispidum* DC.
Locality: Chepsonoi/ Sirwa-yala
Uses- Oral infection
Form of administration – Small amount infusion or ash put in the mouth twice daily

Plate 6c: ASTERACEAE, *Acmella caulirrhiza* Del.
Local name: Shirehiza marhe (L)/ Kutputik (Ka)
Locality: Chepsonoi/ Mugoywa
Uses- Oral ulcers/infection
Form of administration - Infusion or plant chewed, fluid held in the mouth for sometime

Plate 6d: ASTERACEAE, *Ageratum conyzoides* (L.) L.
Local name: Engoi (L)
Locality: Chepsonoi/ Mugoywa
Uses- Bleeding from cuts, skin wounds, sore eyes, Coughing/ stomachache
Form of administration – Used as eyedrops or infusion/decoction taken orally

Plate 6e: ASTERACEAE, *Aspilia mossambicensis* (Oliv.) Wild
Local name: Shilambila (L)
Locality: Sirwa-yala/Chepsonoi
Uses- Oral thrush, skin ulcers, worms, conjunctivitis
Form of administration – Dried plant ash put in mouth, infusion/decoction drank or put on ulcers or into eyes

Plate 6f: ASTERACEAE, *Bidens pilosa* L.
Local name: Lukohe (L)/ Mishege (Ki)
Locality: Shiru/ Chepkumia/ Chepsonoi
Uses- Conjunctivitis
Form of administration – Infusion used as eye drops

Plate 6g: ASTERACEAE, *Conyza bonariensis* (L.) Cronq.
Local name: Kitandawili (L)/ Kipsaina (Ka)
Locality: Sirwa-yala/ Chepkumia
Uses- Stomachache, oral sores/ thrush
Form of administration – Root or leaf infusion taken orally

Plate 6h: ASTERACEAE, *Conyza gouanii* (L.) Willd
Locality: Chepsonoi
Uses- Fainting
Form of administration – Poultices or paste sniffed/ vapour inhaled

Plate 6i: ASTERACEAE, *Helichrysum odoratissimum* (L.) Sweet
Locality: Mugoywa/ Chepsonoi
Uses- Oral infection
Form of administration – Ash from dried burnt plant licked

Plate 6j: ASTERACEAE, *Solanecio manii* (Hook. f.) C. Jeffrey.
Locality: Chepsonoi/ Sirwa-yala
Uses- Measles, indigestion & dysentery
Form of administration - Leaf infusion applied on skin or root decoction drank

Plate 6k: ASTERACEAE, *Crassocephalum picridifolium* (D.C) S.Moore
Locality: Chepkumia/ Mugoywa
Uses- General infection, blood purifier, Oral / throat infection, stomachache, skin lesions
Form of administration - Infusion / decoction of shoot drank

Plate 6l: ASTERACEAE, *Crassocephalum crepidioides* (Benth.) S. Moore
Locality: Kabwereng'/ Chepsonoi
Uses- Oral/ throat infection
Form of administration - Shoots dried then burnt to ash put in mouth

Plate 6m: ASTERACEAE, *Dichrocephala integrifolia* (L.f.) Kuntze
Locality: Chepsonoi
Uses- Bleeding from cuts, skin wounds, sore eyes, Coughing, tetanus
Form of administration - Juice from leaf squeezed onto cut or wounds

Plate 6n: ASTERACEAE, *Emilia discifolia* (Oliv.) C. Jeffrey
Locality: Chepsonoi
Uses- Oral/ throat infection
Form of administration - Whole plant dried, burnt and ash licked

Plate 6o: ASTERACEAE, *Erlangea cordifolia* (Benth. Ex Oliv.) S. Moore
Locality: Chepsonoi (roadsides)
Form of administration – Leaf infusion used as eyewash, orally drank or for massage

Plate 6p: ASTERACEAE, *Galinsoga parviflora* Cav.
Local name: Gavuludi (L)
Locality: All
Uses- Skin inflammation/ sores, obesity, conjunctivitis/ deafness
Form of administration – Infusion of shoot applied topically, drank or used as eyedrops

Plate 6q: ASTERACEAE, *Microglossa pyrifolia* (Lam.) Kunth
Local name: Ingoi, Ingwe (L)/Rir osok (Ka)
Locality: All
Uses- Skin wounds/ ulcers, headache/ colds
Form of administration – Dried leaf powder applied on wounds or root infusion drank

Plate 6r: ASTERACEAE, *Senecio syringifolius* O.Hoffman
Locality: kabwareng'/ Chepsonoi
Uses- Cough / colds
Form of administration – Roots washed and chewed

Plate 6s: ASTERACEAE, *Sonchus asper* (L.) Hill
Local name: Rhitumusi (L)
Locality: Mugoywa/ Chepsonoi
Uses- Plastic teeth/toothache, boils / oral thrush
Form of administration – Poultices of shoot applied topically or infusion drank

Plate 6t: ASTERACEAE, *Tithonia diversifolia* (Hemsl.) A.Gray
Local name: Maua malulu (L)
Locality: Chepkumia/ Chepsonoi
Uses- Stomachache, indigestion, sore throat
Form of administration – Leaf infusion drank

Plate 6u: ASTERACEAE, *Vernonia amygdalina* Delile
Local name: Muchatha (Ki)/ Msuluhiza (L)/ Sainat (Ka)
Locality: All
Uses- Stitch, body spots
Form of administration – Root infusion drank or leaf paste applied on skin

Plate 6v: ASTERACEAE, *Vernonia myriantha* Hook. f.
Local name: Lisazi (L)
Locality: Mugoywa/ Kabwareng'
Uses- Skin scales, oral / throat infection, rheumatism/ pneumonia, skin sores, stitch, cough
Form of administration –Leaf paste applied on skin/ bark infusion on decoction drank

Plate 6w: ASTERACEAE, *Emilia sonchifolia* (L.) DC. ex DC.
Locality: Kabwereng'/ Chepsonoi
Uses- Oral/ throat infection
Form of administration - Dried plant, burnt into ash and licked

Plate 7: BALSAMINACEAE, *Impatiens tinctoria* A. Rich
Locality: Mugoywa/ Chepsonoi
Uses- Worms, oral / throat infections
Form of administration – Shoot infusion drank

Plate 8: BASELLACEAE, *Basella alba* L.
Local name: Nderema (L)
Locality: Chepsonoi/ Kabwareng'
Uses- Increased lactation
Form of administration – Leaf decoction drank

Plate 9a: BIGNONIACEAE, *Markhamia lutea* (Benth) K. Schum.
Local name: Lusiola (L)/ Movet (Ka)
Locality: Kabwareng'/ Chepsonoi
Uses- Conjunctivitis/ ophthalmia, sore throat
Form of administration - Vapour from chewed young leaves exhaled in eye or infusion drank

Plate 9b: BIGNONIACEAE, *Spathodea campanulata* P.Beauv.
Local name: Muzuriu (L)
Locality: Chepsonoi
Uses- Stitch, gonorrhea, stomachache
Form of administration – Bark decoction drank

Plate 10a: BRASSICACEAE, *Brassica nigra* (L.) Koch.
Local name: Kanzira (L)
Locality: Kabwareng'/ Chepsonoi
Uses- Induce vomiting
Form of administration –Shoot infusion drank

Plate 10b: BRASSICACEAE, *Crambe hispanica* L.
Locality: Mugoywa/ Chepsonoi
Uses- Oral infection
Form of administration - Shoot infusion drank

Plate 11a: FABACEAE, *Cassia occidentalis* L.
Local name: Imbindi (L)
Locality: All
Uses- Oral/throat infections, stomachache, fever
Form of administration – Shoot decoction drank

Plate 11b: FABACEAE, *Chamaecrista mimosoides* (L.) Greene.
Locality: Chepsonoi/ Mugoywa
Uses- Oral infection in children
Form of administration – Infusion of shoot drank

Plate 11c: FABACEAE, *Desmodium intortum* (Mill.) Urban
Local name: Luchaya (L)
Locality: All
Uses: Allergy, bacterial infection/ antiseptic
Form of administration –Leaf infusion drank

Plate 11d: FABACEAE, *Desmodium uncinatum* (Jacq.) DC.
Local name: Luchaya (L)
Locality: Kabwareng'
Uses- Wounds, bacterial infection
Form of administration – Leaf infusion applied on infection

Plate 11e: FABACEAE *Erythrina abyssinica* DC.
Local name: Mutembe (L)
Locality: Sirwa-yala/Kabwareng/ Chepsonoi
Uses- Eye inflammation, syphilis/ Gonorrhea
Form of administration – Juice from young shoot dropped in eye/ Decoction of bark drank

Plate 11f: FABACEAE, *Indigofera homblei* Bak.f.and Martin.
Locality: Chepsonoi/ Sirwa-yala
Uses- Dislocation of bones, stomach disorders
Form of administration – Leaf paste used to massage affected part

Plate 11g: FABACEAE, *Indigofera spicata* Forssk.
Locality: Chepsonoi
Uses- Abortion, sore throat& stomach disorders
Form of administration – Shoot / root infusion drank

Plate 11h: FABACEAE, *Senna didymobotrya* (Fes.) Irwin & Barneby
Local name: Luvinu (L)
Locality: All
Uses- Skin disease, measles, gonorrhea, stomachache, malaria
Form of administration –Leaf paste or decoction put on skin/ plant decoction drank

Plate 12: CAPPARIDACEAE, *Cleome gynandra* (L.) Briq.
Local name: Saka (L)
Locality: All
Uses- Boils/ earache, epilepsy, stomach-ache
Form of administration – Shoot infusion applied on skin, dropped in ear or nose, decoction drank

Plate 13: CARYOPHYLACEAE, *Drymaria cordata* (L.) Willd. ex Schult.
Locality: Mugoywa/ Sirwa-yala
Uses- Oral thrush/ ulcers, chest pain
Form of administration – Leaf infusion drank/ smoke from leaves inhalled,

Plate 14: CELASTRACEAE, *Maytenus obscura* (A. Rich.) Cufod.
Locality: Mugoywa/ Chepsonoi
Uses- Whitlow, diarrhea, Leukemia/ Gonorrhea
Form of administration – Leaf paste applied on finger/ Infusion of leaves drank or root decoction drank

Plate 15: CLUSIACEAE, *Harungana madagascariensis* Lam. ex Poiret
Local name: Mnamsai (L)
Locality: Kabwareng / Chepsonoi/ Mugoywa
Uses- Oral infection/ conjunctivitis, skin lesions
Form of administration – Infusion of leaves/ bark drank/ decoction applied on skin

Plate 16: CONVOLVULACEAE, *Dichondra repens* J.R. and G.Forst
Local name: Ritu llara (L)
Locality: Chepsonoi/ Shiru
Uses-Heartache or pain
Form of administration – Leaf infusion drank

Plate 17: CUCURBITACEAE, *Momordica foetida* Schumach
Local name: Lilande (L)
Locality: Mugoywa/ Kabwareng/ Chepsonoi
Uses- Oral/ throat infection- t
hrush, ulcers, coughing
Form of administration – Concentrated leaf infusion drank

Plate 18: CYPERACEAE, *Schoenoplectus corymbosus* (Roth ex Roem. and Schult.) J. Raynal
Locality: Kabwareng'
Uses- Measles
Form of administration – Root infusion drank

Plate19: DIOSCOREACEAE, *Dioscorea bulbifera* L.
Locality: Kabwareng'/ Chepsonoi
Uses- Measles
Form of administration- Tubers infusion drank

Plate 20a: EUPHORBIACEAE, *Acalypha fruticosa* Forssk.
Local name: Lusayi (L)/Chepkalut (Ka)
Locality: Mugoywa/ Chepsonoi
Uses- Oral infection
Form of administration- Infusion of leaves or fruits drank

Plate 20b: EUPHORBIACEAE, *Bridelia micrantha* (Hochst.) Baill.
Local name: Shikangania (L)
Locality: Sirwa-yala/ chepkumia
Uses- Stomachache/ diarrhea, joint pains
Form of administration- Decoction of roots or bark drank

Plate 20c: EUPHORBIACEAE, *Clutia abyssinica* Juab. & spach
Locality: Sirwa-yala
Uses- Oral/ throat infections
Form of administration- Leaf infusion drank

Plate 20d: EUPHORBIACEAE, *Croton macrostachyus* Hochst. Ex Delile
Local name: Musunzu (L)/Mtando (Ki)
Locality: All
Uses- Skin tumors, whooping cough
Form of administration- Young leaf infusion applied on skin/ Bark infusion drank

Plate 20e: EUPHORBIACEAE, *Croton megalocarpus* Hutch.
Local name: Musine (L)
Locality: Mugoywa/ Shiru
Uses- Malaria/ gonorrhea, skin wounds& warts, cough
Form of administration- Root decoction drank, Apical shoot infusion applied on wounds/ warts, dried burnt leaf ash licked

Plate 20f: EUPHORBIACEAE, *Euphorbia hirta* L.
Local name: Imbehani (L)
Locality: Shiru/Chepsonoi
Uses- Heartburn, eye infection, oral thrush, underarm boil
Form of administration- juice or infusion from plant drank or used as eye drops

Plate 20g: EUPHORBIACEAE, *Phyllanthus fischeri* Pax.
Locality: Chepsonoi
Uses- General body illness, backache/ abnormal growth of cervical vertebrae
Form of administration- Root decoction drank, plant paste used to massage affected area

Plate 20h: EUPHORBIACEAE, *Ricinus communis* L.
Local name:Livono(L)/Maniat (Ka)
Locality: All
Uses- Skin infection, stomachache/ ulcers, deworming/ diarrhoea
Form of administration- Seed oil applied on skin, Leaf infusion drank, few oil drops drank

Plate 21a: LAMIACEAE, *Achyrospermum schimperi* (Hochst. ex Briq.) Perkins ex Mildbr.
Local name: None
Locality: Kaimosi Tea Estate
Uses-Nose bleeding, boils
Form of administration- Leaf infusion drops into nose for nose bleeding; drunk for boils.

Plate 21b: LAMIACEAE, *Ocimum kilimandscharicum* Guerke
Local name: Shieyo (L)
Locality: Kabwareng'/ Shiru/ Chepsonoi
Uses- Measles, colds & coughs
Form of administration- Decoction used for bath, poultices sniffed, Infusion drank

Plate 21c: LAMIACEAE, *Fuerstia africana* T.C.E Fr.
Local name: Mkuviza nyingu (L)
Locality: All
Uses- Stomach ulcers/ oral thrush, conjunctivitis/ ophthalmia
Form of administration- Leaf infusion drank or can be used as eye-drops

Plate 21d: LAMIACEAE, *Leonotis mollissima* Guerke.
Local name:
Locality: All
Uses- Conjunctivitis, dysentery/ stomachache, wounds/ sores
Form of administration- Leaf infusion used as eyedrops, drank or applied on wounds

Plate 21e: LAMIACEAE, *Leucas martinicensis* (Jacq) R.Br.
Locality: Sirwa-yala/ Chepsonoi
Uses- Anti-vomit, diarrhoea
Form of administration- Leaf infusion drank

Plate 21f: LAMIACEAE, *Orthosiphon rubicundus* (D.Don) Benth.
Locality: Mugoywa
Uses: Oral thrush, fontanelle healing
Form of administration- Infusion drank. Paste applied on fontanelle

Plate 21g: LAMIACEAE, *Plectranthus barbatus* Andrews
Local name: Shiloka (L)
Locality: All
Uses- Stomachache, measles
Form of administration- Infusion drank, decoction used for bath

Plate 22: LAURACEAE, *Persea americana* Mill.
Local name: Mukado (L)
Locality: Kabwareng'/ Mugoywa/ Chepsonoi
Uses: Headache/ memory loss, diarrhoea/ blocked urine, toothache/ decay
Form of administration- Leaf infusion drank, seed powder in water drank, powder inserted in tooth.

Plate 23: LILIACEAE, *Gloriosa superba* L.
Local name: Idaywa (L)
Locality: Kabwareng'/ Chepkumia
Uses- Indigestion, abortion
Form of administration- Roots crushed and infusion drank

Plate 24a: MALVACEAE, *Hibiscus fuscus* Garcke
Locality: Shiru/ Kabwareng'
Uses: Pneumonia, sore throat & cough
Form of administration- Leaf infusion drank, roots chewed

Plate 24b: MALVACEAE, *Sida cordifolia* L.
Local name: Irundu (L)
Locality: All
Uses- Lumbago, sunken fontanelle
Form of administration- root or leaf paste used for massage of affected area

Plate 25: MELIACEAE, *Azadirachta indica* A. Juss
Local name: Muarubaini (L)
Locality: All
Uses- Malaria, stomachache, arthritis & eczema
Form of administration- Bark, fruits, leaves, flowers seeds and root infusion drank

Plate 26: MELIANTHACEAE, *Bersama abyssinica* Fresen
Locality: All
Uses: Toothache, wounds, epilepsy
Form of administration- Leaf paste applied topically, decoction used for bath or drank

Plate 27: MENISPERMACEAE, *Stephania abyssinica* (Quart.-Dill. and Rich.) Walp.
Locality: Chepsonoi/ Sirwa-yala
Uses- Abdominal pains, sexual desire
Form of administration- Roots chewed

Plate 28: MYRTACEAE, *Psidium guajava* L.
Local name: Shipera/ Lipera (L)
Locality: Chepsonoi/ Shiru
Uses- Diabetes
Form of administration- Infusion of young leaves drank

Plate 29: OLEACEAE, *Olea welwitschii* (Knobl.) Gilg & Schellenb.
Local name: Mduguyu (L)
Locality: Mugoywa
Uses- Gonorrhea, Stomach upsets
Form of administration- Decoction of the bark drank

Plate 30: OXALIDACEAE, *Oxalis corniculata* L.
Local name: inandwa (L)
Locality: All
Uses- Boils / oral thrush
Form of administration- Leaf infusion drank

Plate 31: PHYTOLACACEAE, *Phytolacca dodecandra* L'Herit.
Local name: Mavoko (L)
Locality: All
Uses- Worms, enlarged glands, syphilis
Form of administration- Dilute leaf infusion drank, root decoction drank.

Plate 32a: PIPERACEAE, *Piper capense* L.f.
Locality: Mugoywa/ Shiru/ Chepkumia
Uses- Sore throat/cough
Form of administration- Fruits chewed or infusion drank

Plate 32b: PIPERACEAE, *Piper umbellatum* L.
Locality: Sirwa-yala
Uses- Cough, throat ulcers & chest pain
Form of administration- Infusion of leaves and flowers drank

Plate 33: POACEAE, *Chloris pycnothrix* Trin.
Locality: All
Uses: Pneumonia
Form of administration- Whole grass chewed of infusion drank

Plate34a: POLYGONACEAE, *Oxygonum sinuatum* (Hochst. & Steud ex Meisn.) Dammer
Locality: Shiru/ Chepsonoi
Uses- Conjunctivitis, gonorrhea
Form of administration- Leaf infusion dropped into eye, root decoction drank

Plate 34b: POLYGONACEAE, *Rumex bequaertii* De Wild.
Local name: Mnangoko (L)
Locality: All
Uses: Throat infection & coughing
Form of administration- Roots chewed

Plate 35: COMBRETACEAE, *Combretum apiculatum* Sond.
Local name: Kiraha (L)
Locality: Chepsonoi/ Mugoywa
Uses- Colds/ headaches, malaria
Form of administration- Leaf infusion or root decoction drank

Plate 36a: ROSACEAE, *Prunus africana* (Hook f.) Kalkman
Local name: Mnamsai (L)
Locality: Mugoywa/ Chepkumia/ Sirwa-yala
Uses- Diabetes /prostate cancer, stomachache
Form of administration- Bark decoction drank, infusion drank

Plate36b: ROSACEAE, *Rubus pinnatus* Willd.
Local name: Vushererwa (L)
Locality: Chepsonoi/ Sirwa-yala
Use- Plastic teeth, cough/ colds
Form of administration- Leaf paste to massage gums, root infusion drank

Plate 37a- RUBIACEAE, *Spermacoce princeae* (K.Schum) Verdc.
Local name: Irundi (L)
Locality: All
Uses- Oral thrush/ ulcers, skin disease
Form of administration- Infusion of shoot drank, paste applied on skin

Plate 37b: RUBIACEAE, *Vangueria apiculata* K. Schum
Local name: Shikomori (L)
Locality: Chepsonoi/ Chepkumia
Uses- Stomachache, deworming
Form of administration- Leaf infusion drank, roots decoction drank

Plate 38a: RUTACEAE, *Clausena anisata* (Willd) Hook.f. ex Benth.
Local name: Kisimbati (L)
Locality: Mugoywa/ Chepsonoi
Uses- Stitch, stomachache, gonorrhea
Form of administration- Leaf/bark decoction drank

Plate 38b: RUTACEAE, *Zanthoxylum gilletii* (De Wild.) P.G.Waterm.
Local name: Shikhuma (L)/ Sagawariet (Ka)
Locality: All
Uses- Rheumatic fever
Form of administration- Bark decoction drank

Plate 39: SCROPHULARIACEAE, *Cycnium adonense* E. Mey. ex Benth
Local name: Lwalagarha (L)
Locality: Chepsonoi
Uses- Oral thrush, Plastic teeth (children), blocked tubes(females)
Form of administration- Ash used to massage gums, leaf infusion drank

Plate 40a: SOLANACEAE, *Datura stramonium* L.
Local name: Silulu (L)
Locality: Chepsonoi
Uses- Rheumatic fever/ earache/ ringworms
Form of administration- Leaf decoction applied topically/ hot fruit poultices used as eardrops/ leaf/ seed ash mixed with fat applied on skin.

Plate 40b: SOLANACEAE, *Physalis peruviana* L.
Local name: Imbuni (L)
Locality: Mugoywa
Uses- Malaria & stomachache
Form of administration- Leaf infusion drank

Plate 40c: SOLANACEAE, *Solanum dubium* Fresen.
Local name: Indalandalwa (L)
Locality: Mugoywa/ chepsonoi
Uses- Threatened miscarriage/ stomachache
Form of administration- Root decoction drank/ roof infusion drank

Plate 40d: SOLANACEAE, *Solanum hastifolium* Dunal
Locality: Shiru
Uses- Boils/ abscesses
Form of administration- Hot fruit fomentation applied on boil

Plate 40e: SOLANACEAE, *Solanum incanum* L.
Local name: Kitatura (L)
Locality: All
Uses- Severe stomachache/ earache
Form of administration- Root infusion drank/ Leaf infusion dropped in ear

Plate 40f: SOLANACEAE, *Solanum nigrum* L.
Local name: Lisitsa (L)/ Sutchet (Ka)
Locality: All
Uses- Stomach ulcers, boils & swollen glands
Form of administration- Leaf and green fruits infusion drank

Plate 41: THEACEAE, *Camillia sinensis* (L.) Kuntze
Local name: Lijani (L)
Locality: All
Uses- Stomachache, gonorrhea & allergy
Form of administration- Root infusion drank

Plate 42- TILIACEAE, *Triumfetta rhomboidea* Jacq.
Locality: Chepsonoi
Uses- Stitch, Deworming/ burns
Form of administration- Root infusion drank/ Leaf paste applied on burns

Plate 43a: VERBENACEA, *Lantana trifolia* L.
Local name: Shimenenwa-mburi (L)
Locality: Shiru/ Mugoywa/ Sirwa-yala
Uses- Oral or throat infections/ rheumatism
Form of administration- Leaf infusion drank/ decoction taken orally

Plate 43b: VERBENACEAE, *Clerodendrum myricoides* R. Br.
Local name: Shitana, Kisugi, Shikuma (L)/ Kibabetyo (Ka)
Locality: All
Uses-Pneumonia, sore throat & rheumatic fever, gonorrhea
Form of administration- Root infusion drank

Plate 43c: VERBENACEAE, *Clerodendrum scheffleri* Gurke.
Local name: Kekembekembia (L)
Locality: Shiru/ Chepsonoi/ Sirwa-yala/ Mugoywa
Uses- Venereal diseases, labour pains, stomachache/ weak or thin body,
Form of administration- Root decoction drank/ Leaf infusion for body massage
Key: L- Luhya, Ka- Kalenjin, Ki-Kikuyu

Plate 44: VITACEAE, *Cyphostemma kilimandscharicum* (Gilg) Desc. Ex Wild & R.B.Drumm Local name: Cheptorotwet(Ka)
Locality: Sirwa-yala/ Chepsonoi/Kabwareng'
Uses- Throat infection
Form of administration- Leaf infusion taken orally