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INVENTORY AND ETHNOBOTANICAL STUDIES OF MEDICINAL PLANTS IN THE ASANTEMANSO SACRED GROVE, ASHANTI REGION, GHANA

THIS IS THESIS SUBMITTED TO THE DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF MASTER OF SCIENCE DEGREE IN ENVIRONMENTAL SCIENCE

BY

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DECLARATION

"I hereby declare that I have wholly undertaken this study reported therein under the supervision of Dr. Ebenezer J. D. Belford and that except portions where references have been duly cited, this thesis is the outcome of my research".

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ABSTRACT

An ethnobotanical study was carried out in the Asantemanso sacred grove of the Ashanti Region of Ghana to take an inventory of the plant species used by communities around the grove for medicinal purposes and also to determine the status and medicinal importance of identified plant species. The study was carried out between December, 2009 and October, 2010. A total of 175 plant species were identified in the sacred grove comprising of 53 families. The most dominant families included Fabaceae, Rubiaceae and Euphorbiaceae. Some of the most common species were *Trichilia prieureana* (9.86), *Griffonia simplicifolia* (13.55), *Celtis mildbraedii* (4.98), *Blighia unijugata* (4.39), *Blighia sapida* (3.79), *Nesogordonia papaverifera* (5.76), *Baphia nitida* (5.25), *Pterogota macrocarpa* (2.25) and *Sterculia rhinopetala* (2.04). Trees were the most dominant life forms (58%). Plants species were categories into eight (8) star rating conservation status. Green star species recorded the highest number (71%), followed by Blue star rated species with 7%. Two Black Star-rated species, *Hippocratea vignei* and *Tapura ivorensis* recorded the least number (1.0%). A total of eight medicinal plant species, with *Khaya ivorensis* as the most cited species, were indicated by the respondents to be on the decline in the study area. However, several species including *Trichilia monadelpha, Strombosia pustulata, Ricinodendron heudelotii, Lannea welwitschii* and *Petersianthus macrocarpus* which were indicated to be on the decline were found to occur in the sacred grove. Ethnobotanical information was gathered using questionnaires from 53 inhabitants from four communities namely Essumegya, Sebedie, Kyekyewere and Boamang. Males constituted the majority (53%), and females represented 47%. The age of the respondents ranged between 27 and 90 years. About 57% of the respondents had no formal education but 41% and 2% had secondary and primary education, respectively. Majority of the respondents were Christians (90.57%) whereas only 9.43% were traditionalists. A total of 153 different medicinal plant species documented were used for various medicinal purposes such as treating fever, piles, cough, waist pains, anaemia, blood pressure, headache, rheumatism, broken bones, convulsions and stomach problems. Euphorbiaceae was the most dominant medicinal plant family. The most important medicinal plants encountered were *Alchornea cordifolia* (26.42%), *Bombax buonopozense* (24.53%), *Cleistopholis patens* (22.64%), *Ocimum gratissimum* (22.64%), *Khaya ivorensis* (22.64%), *Alstonia boonei* (20.75%) and *Paullinia pinnata* (20.75%). For most of the plants different parts cured different diseases but diseases treated involved predominantly the use of leaves – 46.9%; bark – 27.1%; roots – 17.9%; seed – 2.4% and flowers and fruits – 1.9% and 3.95% respectively. Medicinal remedies were administered in different forms predominantly as decoctions (38.1%), poultices (24.5%), concoctions (13.6%) and tinctures (12.2%). Out of the total 175 plants species enumerated in the sacred grove, 37 species, representing 21.14% of the plant species, were indicated to be of medicinal value through the ethnobotanical study. The presence of the two Black Star-rated species indicates that the Asantemanso sacred grove is not only a habitat for rare or endemic species but may also be a relic forest for plant species that may be under serious threats of extinction. The results shows that the sacred grove is an important source of plants for medicinal remedies and also indicative of the fact that indeed the sacred grove is a reservoir of medicinal plants.

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GLOSSORY OF TERMS

Pioneers: are species with the highest light demand, of which seedlings are only found in gaps and older plants are absent or very rare in the forest understorey.

Non-pioneer light demanders: are species with an intermediate light demanding of which seedlings are common in the understorey whereas adults are not (i.e. they require a gap to grow).

Shade bearers: are those species for which both young and older plants are frequently found in the shaded forest understorey.

Decoctions: are the long-term boiled extracts, usually of harder substances like roots or bark or the resulting liquid of extraction by boiling of dissolved chemicals from herbal or plant material.

Poultices: are soft moist mass of herbs or other adhesive substance, usually heated, spread on cloth, and applied to warm, moisten, or stimulate an aching or inflamed part of the body.

Powders: are dry, bulk solids composed of a large number of very fine particles that may flow freely when shaken or tilted.

Concoctions: are a combination of various ingredients, usually herbs, spices, condiments, powdery substances, or minerals, mixed up together, minced, dissolved, or macerated into liquids so as they can be ingested or drunk.

Infusions: are hot water extracts of herbs through steeping.

Tinctures: are alcoholic extracts of herbs, which are generally stronger than herbal teas. They are usually obtained by combining 100% pure ethanol (or a mixture of 100% ethanol with water) with the herb.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Plants are vital components of biodiversity and healthy ecosystems. They provide a range of ecosystem services and resources including food, fibre, fuel, shelter and medicines (Secretariat of the CBD, 2009). Medicinal plant species are relevant to people and from ancient times, have been a source of curing ailments across all cultures. The use of plants as medicines represents, by far, the biggest human use of the natural resources in the world with more than 50,000 species reported to be of medicinal value (Teklehaymanot and Giday, 2007). In Africa, about 4000 plants are known to have medicinal properties (Schmelzer and Gurib-Fakim, 2008).

Medicinal plants play a vital role in the maintenance of human health throughout the world and notably in the tropics. The traditional healers and remedies made from these plants play an important role in the health of millions of people in Africa with more than 80% of the population known to depend primarily on medicinal plants as a source of primary health care (Rukangira, 2004). A number of plant species in Ghana are also of medicinal value. Many of these plants have been investigated and found to contain active substances that are either therapeutically useful, and are used in allopathic medicine, or serve to authenticate or rationalize the traditional uses of these plants (Busia, 2007).

Although the importance of biodiversity such as plants to the health of people has increasingly been recognised, the continued availability of many of these plants is at risk (UNEP-WCMC, 2002). The extinction or scarcity of medicinal plants is not only a problem for conservation but it

also results in serious problems for people's health and livelihoods (Hamilton, 2008). In the face of this, several conservation strategies such as protected areas have been adopted for biodiversity.

Traditional protected areas such as sacred groves conserve biological resources using traditional approaches or norms such as taboos, totems and myths (Attuquayefio *et al*., 2009). The Asantemanso Sacred Grove at Essumegya in the Bekwai district of the Ashanti Region is considered to be the ancestral origin of the Asantes. There is a sacred site in the heart of the forest where the Ashanti kingdom is believed to have emerged. Because of the central role the grove plays in the history of the Ashanti's, the entire grove has been protected around this site since time immemorial.

1.2 Problem statement

Like most sacred groves, the traditional belief that have guided their conservation is now considered mere superstition and the traditional values that have protected the grove appears to be gradually disappearing with modernization, urbanisation and people's changing aspirations (Swamy *et al*., 2003). Although the Asantemanso Sacred Grove is comparatively well protected by strong traditional and cultural beliefs, encroachment has been gradual, subsequently reducing its size. Moreover, information on diversity of plants especially those of medicinal value in the sacred grove are unknown.

Accompanying the loss of medicinal plants is the loss of associated indigenous knowledge (Maundu *et al*., 2006). Every year, the sum total of human knowledge about the types,

distribution, ecology, management and methods of extracting the useful properties of medicinal plants is declining rapidly (Hamilton, 2008). With local knowledge gone, communities have little reason to conserve species (Maundu *et al*., 2006).

1.3 Justification

The Asantemanso Sacred Grove despite increasing pressures may shelter many plant species which have been lost elsewhere in the surrounding environment which may include wild, endemic and endangered species (Swamy *et al*., 2003). Well preserved sacred groves are storehouses of valuable medicinal and other plants having economic value, and serve as a refuge to threatened species (Anthwal *et al*., 2006). They are important to regulate the exploitation of medicinal plants.

Therefore, the destruction of these habitats causes not only the loss of plants species which are important as medicines for communities but also the loss of the source supply for modern pharmacopoeia to facilitate discovery of new sources of drugs and promote sustainable use of natural resources (Swamy *et al*., 2003; Lulekal *et al*., 2008; Flatie *et al*., 2009). Therefore, there is the need to identify, document, promote and monitor plant species of value in this sacred grove.

Loss of medicinal plants means not only an immediate loss of effective remedies but also rapid erosion on knowledge of their use (UNEP-WCMC, 2002). In the midst of this, there have been several calls over the years by several Ghanaian scientists and laymen for the documentation of information on our herbal medicines (Busia, 2007). Ethnobotany, the study of how people of a

particular culture make use of indigenous plants, has great potential to provide new and useful drugs (Morganstein, 1996). Documenting eroding plants and associated indigenous knowledge can also serve as a basis for developing management plans for conservation and sustainable use of medicinal plants in the area.

1.4 Aims and objectives

1.4.1 Main objective

- To obtain the ethnobotanical information on plants of medicinal value in the Asantemanso Sacred Grove in Ashanti Region of Ghana.

1.4.2 Specific objectives

- To identify and classify plant species in the Asantemanso Sacred Grove.
- To determine the diversity, frequency and life forms of plant species in the Asantemanso Sacred Grove.
- To collate information on the uses of medicinal plant species by the sacred grove fringe communities.
- To determine the conservation status of plants species in the Asantemanso Sacred Grove.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of Medicinal plants

Defining a 'medicinal species' is no simple matter because species of plants, animals, and microorganisms can enhance human health in so many ways (McNeely, 2006). Hamilton (2008) argued that no precise definition is possible for medicinal plants given its wide scope and because the use of plants as medicines grades into their use for other purposes such as for food, personal hygiene, beauty care, psychological support and spiritual practices. Notwithstanding, several authors have attempted to give various definitions for medicinal plants.

Haque (2004) defined medicinal plants as plants useful as therapeutic agents or as active ingredients for medicinal preparation. A medicinal species according to McNeely (2006) is one that is used whole or in part directly in the preparation of medicines. Medicinal plants are also defined by Hamilton (2008) as those used by people for various medicinal purposes such as to build or maintain health, stave off disease, or promote recovery from illness or misfortune. In fact, what puts medicinal plants together in a category from all other plants is their use in healing.

2.2 The importance of medicinal plants

Since the beginning of civilization, people have used plants as medicine. Perhaps as early as Neanderthal man, plants were believed to have healing powers. The earliest recorded uses are found in Babylon (circa 1770 B.C.) in the Code of Hammurabi and in ancient Egypt (circa 1550 B.C.). Ancient Egyptians believed medicinal plants to have utility even in the afterlife of their

pharaohs (Morganstein, 1996). Plants have also been used not only by humans but even animals for medicine for many hundreds of years (Trease and Evans, 1989).

There are between 35, 000 and 70, 000 plant species that have been used for medicinal purposes in the world (Bhattarai *et al*., 2010). Medicinal plants are rich sources of bioactive compounds and thus serve as important raw materials for drug production (Haque, 2004). They continue to be a vital part of Western medicine, and are still considered an important source of novel compounds in the field of drug discovery. In India, about 2,500 species are used for medicinal purposes, and about 90% of the medicinal plants provide raw materials for the herbal pharmaceuticals (Rao and Arora, 2004). According to Busia (2007), a number of medicinal plants which abound in Ghana's flora have also been investigated in recent times and found to contain active substances that are either therapeutically useful, and are used in allopathic medicine, or serve to authenticate or rationalize the traditional uses of these plants.

Medicinal plants play a vital role in the maintenance of human health throughout the world and notably in the tropics (Agbovie *et al*., 2002). In sub-Saharan Africa, traditional medicine has been in practice for centuries and still is the most affordable and accessible health care system (Schmelzer and Gurib-Fakim, 2008). Traditional healers use plants in the treatment of diseases like boils, bronchitis, cold, cough, asthma, dysentery, ear complications, headache, leucoderma, pneumonia, renal complications, piles, scorpion bite, snake bite and skin diseases (Diame, 2010). Caldwell (2010) also reports that fever, stomach pain, anaemia, cuts, rashes, colds, body pain and headache are the most frequently cited illnesses. In Ghana, successive governments have recognised the importance of traditional medicine, because an estimated 75% of the population

in both the urban and the rural areas depend on herbal medicine for their everyday health-care needs (Abbiw *et al*., 2002). The importance of medicinal plants as a cure for illnesses among the Murut society in Malaysia is also reported by Kulip (2003).

Although virtually everyone on earth benefits from medicinal plants, it is the financially poorest who are typically most closely dependent on medicinal plants. Medicinal plants contribute substantially to cultural integrity (Batugal, 2004) and income generation. For example, medicinal plants can provide a significant source of income for rural people in developing countries, especially through the sale of wild-harvested material. In the Himalayas, wild medicinal plants are collected in large quantities in some areas by large numbers of people, for whom this activity provides a substantial part of their income (Hamilton, 2008).

The livelihood benefits of medicinal plants trade have been studied in Nepal, where an estimated 323,000-470,000 households (2.6 million people) are engaged in the collection of wild medicinal plants for sale. In Uttarakhand, medicinal plants have become so economically important to this Indian state that it has been labeled 'Herbal State' (Hamilton, 2008). Medicinal plants contribute significantly to rural livelihoods of the people and social equilibrium in Africa (Schmelzer and Gurib-Fakim, 2008). According to Abbiw *et al*. (2002) Ghana also has a particularly strong tradition in using medicinal plants and they play an important cultural and economic role in poverty alleviation.

Medicinal plants also form part of the precious natural wealth of a country which can earn a good amount of foreign exchange by exporting this natural wealth to other countries (Haque,

2004). Herbal treatments are the most popular form of traditional medicine, and are highly lucrative in the international marketplace (Hamilton, 2008). Annual revenues in Western Europe reached US$ 5 billion in 2003-2004 and in China sales of products totalled US$ 14 billion in 2005. Herbal medicine revenue in Brazil was US$ 160 million in 2007 (Hamilton, 2008). Apart from the growing local and international demand of medicinal plants, bio-prospecting activities searching for sources of new drugs are also on the increase (Schmelzer and Gurib-Fakim, 2008).

2.3 Forest ecosystems

Forests are the world's most important and most valuable renewable natural resource and also repositories of terrestrial biological diversity (Katwal *et al*., 2003). A forest is a natural ecosystem in which trees are a significant component (Diame, 2010). The important role of forest as a carbon sink in mitigating climate change and as a reservoir of plant and animal biodiversity is well recognized. It is also important for the people who inhabit it, as it represents a living place and a source of income via wood and non-wood forest products. According to Katwal *et al*. (2003), Non-Timber Forest Products (NTFPs) play a very important role in India's economy as they form the basic raw material for phytopharmaceuticals and various other industries.

During the last few decades, deforestation in tropical rain forest areas has accelerated at an alarming rate. Furthermore, some 15-20% of species is likely to become extinct even before they are known to science. With the growing awareness of the problem, tropical rain forest biodiversity is of great concern and its conservation has become an issue of increasing priority (Tchouto, 2004). Forests in West Africa are seriously under threat. Deforestation is continuously

going on with a rate of 2 to 3%, and many forest areas have been transformed into agricultural fields. Remaining forests are degrading through hunting, illegal timber harvesting and agricultural plantings (Bongers *et al.*, 2005). According to the FAO (2005), over the last ten years, Ghana's deforestation rate has increased by 50%. The threats to forests loss is more pronounced mainly due to human activities such as urban development and construction, deforestation, expansion in agriculture, over exploitation and indiscriminate exploitation of natural resources (Diame, 2010).

Habitat destruction is currently ranked as the most important cause of species extinction worldwide (Pimm and Raven, 2000). Naturally, as habitat disappears, so do those species that depend on the habitat. For instance, opening of forests for agricultural development and timber harvesting makes medicinal resources scare (Kulip, 2003). Indeed, habitat loss in Ghana is considered one of the major threats to conservation of medicinal plants (Brown, 1992). Habitat destruction resulting from logging, expansion of farms, and unsustainable harvesting of NTFPs such as rattans and medicinal plants has been identified as a key threat to over 60% of Nigeria's endangered plant and animal species which are found within the forests of south western part of the country. Habitat destruction appears to be the most important of all the factors that threatens medicinal plants and any measure to conserve and sustainably use medicinal plants should address this (Maundu *et al*., 2006).

Disturbance regimes which open the forest canopy and eventually lead to forest fragmentation may be due to natural causes or can be human-induced (Bongers *et al*., 2005). Ghana's forests are considered by Conservation International (CI) to be one of the most fragmented ecosystems

in the world (CI, 2006). The highly fragmented forest patches that remain continue to be degraded or completely lost at an alarming rate (Mittermeier *et al*., 2004). Different disturbance regimes can open up the forest canopy for rapid colonisation by pioneer species (Owusu-Sekyere, 2008). Over time, habitat fragmentation can lead to the loss of genetic diversity which can affect a population's ability to respond to environmental changes, confounding the effects of climate change, contaminants and introduced species (Wilkinson, 2008).

Habitat conversion threatens not only plant resources but also traditional community life, cultural diversity, and the accompanying knowledge of the medicinal value of several endemic species (UNESCO, 1994). Anyinam (1995) reported that, the destruction of tropical forests means the increasing disappearance of native peoples who have been living in these areas and who have accumulated a compendium of folk knowledge about the usefulness of plants for curing various diseases. According to Caldwell (2007), what remains of Ghana's forests and environment is essential to maintain for conservation efforts due to the cultural importance, future use, and biodiversity values contained within.

2.3.1 Forest composition and species diversity

Information on floristic composition, simply expressed as a list of species, life forms and structure of vegetation, is a necessary basis of all ecological work (Diame, 2010). Species richness and diversity are particularly important attributes of tropical forests, and in some cases are more successful in distinguishing between primary and secondary forests than attributes such as mean diameter or number of trees (McElhinny, 2002).

A forest is a natural ecosystem in which trees are a significant component (Diame, 2010). Climbers contribute highly to the taxonomic diversity of tropical forests. Generally they make up around 25% of the diversity of all higher plants (Bongers *et al.*, 2005). Tchoute 2004 reported that, tree species richness seems to have a strong positive correlation with that of liana, indicating that tree species richness may be a relatively good indicator for the liana species richness. This correlation the authors partly explained by the fact that woody climbers are dependent on the presence of trees for their support.

2.4 Ethnobotany and medicinal plants

Traditional people around the world possess unique knowledge of the natural resources on which they depend including tremendous botanical expertise. Less than 1% of indigenous cultures have been surveyed for their knowledge of medical plants and other natural products (Johnson, 2009). Much of the knowledge on the medicinal uses of plants lies with oral traditions most of which are either unrecorded or poorly documented. There are already valid apprehensions that vast amount of folk medical knowledge may have been lost, just like undiscovered plant species (Tandon, 2006).

According to UNEP-WCMC (2002), for areas largely reliant on oral rather than written tradition, loss of medicinal plants means not only an immediate loss of effective remedies but also rapid erosion of knowledge of their use. For instance, according to Mahindapala (2006), as threatened as some of the medicinal plants of Sri Lanka were, the knowledge base on which traditional medicinal systems had been developed, because only a small portion of traditional knowledge and ethnobotanical information had been documented. However, the majority of traditional

knowledge remained recorded in ancient, obscure ola (palm leaf) manuscripts scattered throughout the country or locked in the memory of elderly practitioners who with their passing away meant a loss of this precious traditional knowledge.

Addo-Fordjour *et al*. (2008) also found that while most traditional herbalists were advancing in age, majority of them did not have trainees and even the few who attempted to learn the profession were compelled to abandon it because they did not possess qualities essential to succeeding in the field. This situation, according to the authors, made the loss of knowledge of traditional remedies inevitable. They also found that transmission of knowledge was mainly informal and generally records of the diseases treated and the plants used for the treatment were only kept by a few. These developments, they found, pose a threat to conservation of medicinal plants in the Bomma area of the Brong-Ahafo Region of Ghana because these traditional healers may pass on with their knowledge.

Another pressing threat to medicinal plants and their knowledge profiles appears to be cultural change, especially the seductive influence of modernization and the western worldview. According to Voeks and Leony (2004), folk healers and their oral traditions may well be at greater risk of extinction than their healing habitats because of the negative toll religious change on medicinal plants. They also mention the entry of western medicine and its practitioners into even the most remote regions of the tropics as having often spelt an end to belief in local healing traditions. Agbovie *et al*. (2002) similarly reported that *Hyptis suaveolens* which used to be grown in most villages for its medicinal value is now difficult to find. According to them, this plant which used to be commonly planted at the front of houses due to its spiritual significance to

the well being of the occupants has now been removed from these sites as a result of increasing Christianity in the villages and a shift away from traditional spiritual beliefs. In Asia, alongside the deterioration of resources, is the erosion of the cultural heritage surrounding medicinal plants (MAPPA, 2010). Kulip (2003) also found that, the popularity of plants with traditional uses among the Maruts of Malaysia was fading. He attributed this to migration, restriction from religion, loss of interest of the younger generations and heavy dependence on modern medicine.

According to CAI (2004), indigenous and local communities are concerned that the rate of knowledge erosion has never been as high as it is in the current generation, and that such knowledge erosion poses an even more serious threat to the conservation of biological diversity than resource erosion. There is therefore, an urgent need to formulate an array of incentive measures to ensure that members of the younger generations will value, learn, adapt and apply the traditional knowledge, innovation and practices of their elders (CAI, 2004).

Ethnobotany, which is the study of the interactions and relationships between plants and people over time and space (Ngugi, 2010) has proved its worth in recording traditional knowledge on plants. Ethnobotany includes all sorts of relationships between people and plants. The definition of ethnobotany can be summed up in four words i.e. people, plants, interactions, uses (Hamuyan, 2005). The term ethnobotany was for the first time used by John Harshberger in 1896. Martin (1995) also defines ethnobotany as the study of the classification, use and management of plants by people. Ethnobotanical studies also provide valuable information on the use, economic and cultural values of the biological diversity of a given place (Desissa, 2002). Ethnobotany is the knowledge on plants held by a group of people. Ethnobotany is a complex field that combines

concepts derived from many disciplines including botany, anthropology, ecology, agriculture, genetics, evolution, economics, conservation biology and biochemistry (Ngugi, 2010). Basic quantitative and experimental ethnobotany includes basic documentation, evaluation of use and management, and experimental assessment (Martin, 1995). Central issues in ethnobotany include the relationship between plant diversity and cultural diversity, as well as the perception, use, and management of plant resources (Ngugi, 2010).

The relationship between plants and human cultures is not limited to the use of plants for food, clothing, and shelter but also their use for religious ceremonies, ornamentation, and health care. Overall, data shows women to have a slightly higher level of plant knowledge than men in the categories of edible plants, animal fodder and fuelwood (Poling *et al*., 2003). However in the category of medicinal plants, men know a higher average number of plants. The authors concluded that these disparities could be expected given the division of labor.

According to Hamayun (2005), in the last 100 years, the science of ethnobotany has progressed and the trend is shifting from mere documentation process to a more practical one which emphasize on conservation and sustainable use of plant resources. Today, ethnobotanical surveys include applied projects that have the potential to ameliorate poverty levels of people, allowing them to make more educated decisions about their future directions. These new approaches enhance the quality of the science, provide compensation for the cultural groups, and take into account environmental concerns. This modern approach is based on an interdisciplinary team usually composed of an ethnobotanist, an anthropologist, an ecologist, and a physician (Flaster, 1996). Ethnobotanical studies are often significant in revealing locally important plant species

especially for the discovery of crude drugs (Teklehaymanot and Giday, 2007). Documenting traditional medical knowledge is important to facilitate discovery of new sources of drugs and promote sustainable use of natural resources (Flatie *et al*., 2009). Such an exercise is also important for the conservation of biological and cultural diversities (Lulekal *et al*. 2008; Sharma *et al*. 2011).

2.5 Protected areas and sacred groves

Several conservation strategies such as protected areas have been adopted for biodiversity. Protected areas are defined by the International Union for Conservation of Nature (IUCN) as a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (Dudley *et al*., 2005). Over 10% of the earth's surface is now officially classed as protected areas (Secretariat of the CBD, 2009). These areas play a key role in providing refuges for species and natural processes that have been eliminated or reduced elsewhere (Dudley *et al*., 2005).

Several types of conservation measures have been applied to medicinal plants, among them protected areas and other forms of legal control. Protected areas such as sacrd groves are useful for conserving medicinal plants as they are for biodiversity generally (Hamilton, 2008). They are strictly protected and managed by either the state or by local communities for intensive use (Shahabuddin and Rao, 2010). According to McNeely (2006), a national system of protected areas can serve as an essential antidote to habitat destruction, a major means of adapting to

changes in climate, a reservoir of medicinal species, and a means of maintaining ecosystems functions that are essential to human health.

2.5.1 Sacred groves

Sacred groves are one of the first instances of traditional conservation (Attuquayefio *et al*., 2009). They are defined as small patches or islands of remaining original habitat or traditionally-protected tracts of land of varying sizes that may be as old as mankind (Attuquayefio and Fobil, 2005). They are most often perfectly intact relics of original forests (Abbiw *et al*., 2002) or forest patches conserved by local people intertwined with their socio-cultural and religious practices (Anthwal *et al*., 2006). Most sacred groves represent the natural vegetation of their geographic location and in general have an important role to play in biodiversity (Swamy *et al*., 2003). They range in size from hundreds of hectares of forest to single trees or a few stones (Attuquayefio and Fobil, 2005).

Traditional protected areas such as sacred groves conserve biological resources using traditional approaches or norms such as taboos, totems and myths (Attuquayefio *et al*., 2009). Permission may be granted to only traditional priests, herbalists, healers, etc. and in specific times of the year (e.g. taboo days, festival days or special days). In many parts of West Africa, for example, forest areas and specific trees are protected and valued for particular cultural occasions and as historic symbols. Each community has its own traditions associated with sacred areas, and as a result the species found in them vary greatly (Brown, 1992).

Most sacred groves in Ghana are associated with particular taboos and forms of protection for particular species of plants and animals. Mention can be made of the "bongo" (*Tragelaphus euryceros*) which is protected by the 'Mintiminim god' in Nkwanta province and several plants including the "odum" tree (*Milicia excelsa*) and the liana "ahomakyem" (*Spiropetalum heterophyllum*) which are protected (Dudley *et al*., 2005). Taboos, customs and access and rights restrictions in relation to sacred groves may constitute sophisticated conservation strategies which have yet to be recognized (Brown, 1992). However, such traditional practices and beliefs offer protection to biological resources from human disturbances and prevent over-exploitation (Attuquayefio and Fobil, 2005).

We only have a vague idea about the number of sacred sites in the world, although some commentators believe that there are as many sacred sites as there are protected areas (Dudley *et al*., 2005). In Ghana, almost all 240 forest reserves have close links with sacred groves, and/or socio-cultural ties with the local people. Today, many sacred groves are at risk, from multiple factors including breakdown in culture values, pressure on land from local people for farming and other forms of development and pressure from the outside, including poaching, illegal logging, mining and pollution (Dudley *et al*., 2005).

Notwithstanding, threats of degradation emanating from logging, fire, subsistence farming, hunting and incessant extraction of forest products persist, sacred areas or fetish groves represent a special case of forest-use in Ghana, which in some cases at least precludes all other uses and is intrinsically protective. There are today many small patches of forest outside, and in most cases within, forest reserves which are considered sacred and cannot be farmed. Notwithstanding, such

indigenous attributes if not well understood, analysed and properly integrated into modern concepts of forest resource management and sustainable use could equally prove counter-productive (Amoako-Attah, 1998). However, restricting areas for spiritual reasons or because they are haunted by spirits will limit access to them. This can have the additional effect of conserving plant resources within that area (Poling *et al*., 2003).

2.5.2 Sacred groves and medicinal plants sustainability and conservation

Sacred groves are ecologically and genetically very important. They are the abodes of rare, endemic and endangered species of flora and fauna. Sacred groves are also good sources of a variety of non-wood products, fatty oils, species like pepper, cinnamon and nutmeg and medicinal plants (Anthwal *et al*., 2006).

These groves served different functions such as the protection of watersheds, prevention of severe erosion, or performance of other ecological functions. The groves are often the site for ritual healings and the location where medicinal plants can be found (Brown, 1992). According to Attuquayefio and Fobil (2005), sacred groves serve important socio-cultural functions by being sources of herbs for medicinal, social and religious purposes.

2.5.3 History of the Asantemanso Sacred Grove

The Asantes (Ashantis) are believed to have come from a hole in the ground in the present Asantemanso Sacred Grove according to belief. The forest from which they originated is called “Asanteman Kwae” (Asanteman forest). It is believed that the forest has a god called “Asanteman Kwabena”. It was born on Tuesday (Kwabena) and as such the day is observed as a

taboo day for the Asantes and nobody is permitted to enter the forest. This has been the traditional law enacted to protect and preserve the history of the origin or ancestry of the Asantes.

The sacred hole is regarded as a sacred ground in the heart of the forest and no one is allowed near it except a select few Asantes who pour libation at this central point during the festival called 'Nkyidwo". The 'Nkyidwo' festival of the grove is celebrated in the last Monday in November or first Monday in December biannually and it involves fetish priests, chiefs and all the royal family members in the Asante kingdom. This grove has been the source of their strength and inspiration that gave rise to the powerful Asante kingdom or empire in Ghanaian history. The name 'Asantemanso' means the origin of the Asantes.

The Ashanti's lived in the hole underground in the Forest for a long time because anyone who tried to come out never survived. However, one person called Adu Gyinae was able to leave the hole and survived in the Forest. Thereafter, three groups left the hole under the leaderships of Gyafunuma with symbol of a dog, Abrade Kwae left the hole with a symbol of a frog and Sa Mantaa left the hole with a symbol of a leopard and lived in the various parts of the Forest. The dog served as a guide for the people with the fire in its mouth. The frog made the river called "Asuo adwene" for drinking and for other activities. This river still flows through the grove. The leopard guarded the people and offered protection.

All the people lived together as one big family hunting for game and wild foods. During the hunting expeditions, they came across a maize field. Sa Mantaa and his group members settled in

the maize field “aburo kokofu” and it is now called Kokofu. But the Abrades migrated to Elmina (Edina coined from ‘Ediman’) close to the sea with plenty of fish. Adu Gyinae and Gyafunuma however, remained at Asantemanso for a long time. They also crossed the Subin River to settle beyond it (‘Subin na agya’) in the place now called Essumegya.

The Abrade people still protect the grove. Taboos of the forest are that women in their menstrual period are not allowed to enter. No one is also allowed to enter the forest on taboo days (Tuesdays). No one was allowed to enter with any foot wear (though this law is currently no more) and no one is allowed to neither defecate nor urinate in the forest. These have been the traditional methods of ensuring and maintaining clean and healthy ancestral home of the Asantes.

The Asantemanso forest is a virgin forest and worshipped as a god. Hence, nobody is allowed to cut anything from it unless prior permission is sought from the Paramount Chief and the entire Essumegya Traditional Council (Personal Comm., Queenmother of Essumegya, 2010). The Asantemanso Sacred Grove is surrounded by a number of communities including Essumegya, Chiraa-Nsa, Brosanko, Dominaase, Agyamaso, Betinko-Kyekyewere, Oseikrom, Tekurom, Sebedie, Wawaase, New Boamang and Sarfokurom.

2.6 Threats to medicinal plants

Despite the increasing recognition of the importance of biodiversity such as plants to the health of people has been recognised, the continued availability of many of these plants is at risk (UNEP-WCMC, 2002). Indeed, we do not yet know the exact number of plant species in the world (estimated currently at 370,000 known species). However, it is predicted that as many as

two-thirds of the world's plant species are in danger of extinction (Secretariat on CBD, 2009). Hamilton (2008) lamented that the inclination towards the revival and use of medicinal plants has resulted in undesirable outcomes with about 15, 000 species of medicinal plants now globally threatened. Threats to medicinal plant diversity as reported by several authors is due to a range of factors including a rapidly increasing human population, high rates of habitat loss and modification, deforestation, over-exploitation, the spread of invasive alien species, pollution and climate change (McNeely, 2006; Hamilton, 2008; Secretariat on CBD, 2009).

The majority of species of medicinal plants is harvested in the wild rather than cultivated, and this is expected to continue for a long time to come (Hamilton, 2008). However, the problem in recent decades, is the growing over-exploitation of medicinal plants from the wild this worsened by accelerating national and international demand for botanicals (Tandon, 2006). Though there is limited information and data on local, regional and international markets of many plants, the demand of the international market for botanicals is steadily growing, placing the more important medicinal plants at higher risk.

There is overwhelming evidence that plant genetic diversity, including medicinal plants, is drastically being eroded in many parts of the world especially in areas where high human population density, unplanned urbanization and massive deforestation are common (Batugal, 2004; Haque, 2004). Chapman and Chomchalow (2004) agreed that, as a result of population explosion in most Asian countries, medicinal plants which until recently were collected from the wild have almost ceased completely because they are becoming scarce or have been wiped out due to over extraction. A high population growth rate increases demand for herbal medicine that

also results in several issues such as urbanization. Urban centres tend to provide ready markets for medicinal plants (Maundu *et al*., 2006).

Local communities also tend to collect the most valued or popular plant species, leading to over-harvesting or species extinction (MAPPA, 2010). Though there is limited information and data on local, regional and international markets of many plants, the demand of the international market is steadily growing, placing the more important medicinal plants at higher risk. For instance, *Griffonia simplicifolia* in West Africa was reported by Maundu *et al*. (2006) to have been affected by commercial harvesting due to export for the production of drugs in Europe. They further reported that, increasing scarcity of popular species usually was followed by increased prices, which in turn, results in greater incentives to harvest remaining stocks.

Certain biological and ecological features also increase the vulnerability of plants (Hamilton, 2008). The part of the plant used as well as the growth and reproductive characteristics of the plant has important implications for harvest and its vulnerability to overexploitation (Brown, 1992). But many medicinal plants are trees or other types of woody plants with the roots or bark being collected: features that raise their vulnerability to over-harvesting (Hamilton, 2008). For instance, Agbovie *et al*. (2002) reported that *Cryptoplepis sanguinolenta* in Ghana is principally threatened by wild collection because it is the root that is harvested. Maundu *et al*. (2006) reported that over-harvesting, particularly of seeds, can reduce the regeneration potential of a species. Caldwell, (2010), stated that the method of harvesting is related to the preference of the plant parts for the formulation of medicines.

Climate change has become increasingly recognized as one of the greatest challenges to humankind and all other life on earth. Worldwide changes in seasonal patterns, weather events, temperature ranges, and other related phenomena have all been reported and attributed to global climate change (Cavaliere, 2009). Climate change poses an even more serious threat to the conservation and sustainable use of plant diversity and may compromise gains made this far, if not urgently addressed (Secretariat on CBD, 2009). Climate change is causing noticeable effects on the life cycles and distributions of the world's vegetation, including wild medicinal and aromatic plants (MAP's) (Cavaliere, 2009).

Some MAPs are endemic to geographic regions or ecosystems particularly vulnerable to climate change, which could put them at risk. Some experts postulate that climate change could affect the chemical composition and the survival of some MAPs in Arctic region (Cavaliere, 2009). Some studies have demonstrated that temperature stress can affect the secondary metabolites and other compounds produced by plants, which are usually the basis for their medicinal activity (Cavaliere, 2009). The possible effects of climate change on MAPs may be particularly significant due to their value within traditional systems of medicine and as economically useful plants (Cavaliere, 2009).

Again, research has shown that climate change affects vegetation patterns such as phenology and distribution (IPCC, 2007). Some wild plants, including MAPs, have begun to flower earlier and shift their ranges in response to changing temperatures and weather patterns. Shifting phenologies and distributions of plants have been recorded worldwide, and these factors could ultimately endanger wild MAP species by disrupting synchronized phenologies of

interdependent species, exposing some early-blooming MAP species to the dangers of late cold spells, allowing invasives to enter MAP species' habitats and compete for resources, and initiating migratory challenges, among other threats (Cavaliere, 2009). Shifting phenologies and ranges may seem of little importance at first glance, but they have the potential to cause great challenges to species' survival. They further serve as harbingers of future environmental conditions from climate change (IPCC, 2007).

Increased weather extremes are also predicted to accompany climate change (IPCC, 2007), and plant species' resilience in the face of these weather events may also factor into their abilities to adapt and survive. A rise in global temperature will increase the extinction rate of plant species (Secretariat on CBD, 2009). Extreme weather events already impact the availability and supply of MAPs on the global market, and projected future increases in extreme weather are likely to negatively affect MAP yields even further. Some medicinal plant species tend to also exhibit varied biochemical pathways as well as the production and storage of substances such as alkaloids, oils or other components or such substances are entirely absent when these species grow under different conditions or even at adjacent locations (Rao and Arora, 2004). Concerns regarding the survival and genetic integrity of some MAPs in the face of such challenges are increasingly being discussed (Cavaliere, 2009).

Fire is said to cause changes which depending on its compatibility with one's objective or use of the resource could be desirable or not. Fire is a very serious threat to the survival of forests and presents the biggest challenge for forest protection as it has negative influence on forest regeneration (NWCG, 1989). Although often perceived as a disaster to be prevented, fire is

usually a healthy thing in ecosystems where it has been common, renewing and maintaining the character of the ecosystem. For instance, fire plays an important role in determining the distribution of longleaf pine-wire grass association found in Southern part of the United States of America as these require periodic fire for their survival (NWCG, 1989).

Wildfire is perharps the single most important threat to the integrity of forests in Ghana and also the direct cause of irreversible environmental damage (NWMP, 2006). According to Epke (2002), about 30% of the forests in the Moist Semi-deciduous zone of Ghana were destroyed by fire, especially in the 1980s. Fire can wipe out species which hitherto have been common and cause such species to become rare. The incidence of fire can result in the loss of important species which may be medicinal because these species may not be able to withstand the effects of the fire (Siaw and Dabo, 2009).

2.7 Conservation and sustainable utilization of medicinal plants

Conservation of natural resources is a matter of vital interest to man from ancient time (Sharma *et al*., 2011). Conservation which is the protection, preservation, management, or restoration of wildlife and natural resources ensures the survival of many species and habitats which are threatened due to human and other activities. Other reasons for conservation include to secure valuable natural resources for future generations and to generally protect the well being of ecosystem functions (BBRC, 2010). While we will never know what we have lost before we knew about it, conserving the maximum biodiversity would seem a sound risk-averse strategy in maintaining future options (McNeely, 2006). Furthermore, plant species may have additional

uses which have not yet been uncovered and altogether, humans also have a moral responsibility to conserve biodiversity for future generations (ENSCONET, 2010).

Conservation can broadly be divided into two types as *in-situ* and *ex-situ*. *In-situ* conservation deals with the conservation of habitats, species and ecosystems where they naturally occur whereas *ex-situ* conservation deals with the conservation of elements of biodiversity out of the context of their natural habitats (BBRC, 2010). In situ conservation relies heavily on the active involvement of the communities living around the core forest area for promoting conservation and sustainable use of medicinal plants (Mahindapala, 2006).

The continued loss of global biodiversity and ecosystem services has fuelled much investigation into the effectiveness of conservation approaches (Shahabuddin and Rao, 2010). Historically, the greatest driver behind efforts to conserve medicinal plants has been the fear of losing species. Related to this is the concern about loss of genetic diversity, a serious matter with useful plants. A focus on medicinal plants goes to the heart of some major questions of conservation and the use of biological diversity. Conservation and livelihoods are closely linked with medicinal plants. If conserved, medicinal plants will continue to be available to provide continuing benefits for healthcare, income and support of cultural heritage (Hamilton, 2008).

Saving the world's plant resources call for more protection and management, more research, and an increasing level of public awareness about our vanishing heritage (CAI, 2004). Because the threats to medicinal plant species are often very similar to the threats faced by other species, conservation actions often will also be similar. This provides additional justification to these

actions, helping to build broader support for conserving species (McNeely, 2006). Conservation involve varied approaches, including cultivation of plants in home gardens to remove pressure on wild populations, limiting trade in medicinal plants to sustainable levels, halting the destruction of plant habitats, and documenting and promoting medicinal plant use (UNEP-WCMC, 2002).

2.7.1 Conservation status

The conservation status of a species is an indicator of whether the species is extant (members of it are still alive) and how likely the group is to become extinct in the near future (Ondine, 2009; Wikipedia, 2013). Many factors are taken into account when assessing conservation status and not simply the number of individuals remaining. These factors include the overall increase or decrease in the population over time, breeding success rates, and known threats.

The IUCN Red List of threatened species is the best-known worldwide conservation status listing and ranking system. Species are classified by the IUCN Red List into nine groups set through criteria such as rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation. Several countries have their own categorization though usually adapted from or integrated with the IUCN Red List system. Mention can be made of the NatureServe conservation status which focuses on Latin America, United States of America (USA), Canada and the Caribbean, the Red Data Book of the Russian Federation used within the Russian Federation and accepted in some parts of Africa, and the Endangered Species List of the USA (Wikipedia, 2013).

Hawthorne and Abu-Juam (1995) have equally developed a star rating system which defines the conservation status of species recorded in Ghana. This star rating system categorises plants species into eight (8) star categories, namely as Black, Gold, Blue, Scarlet, Red, Pink, Green and Unknown. According to Hawthorne (1996), the factors considered when categorising species into star categories are their distribution, ecology, local abundance, taxonomy, life history, interaction with ecosystem parameters and economic importance. Therefore, species that are endemic, rare, threatened, or likely to represent a scarce genetic resource, are more valuable than others. Hence, forests richer in such species receive a higher score than others.

Rare or threatened species are usually discussed in relation to their specific conservation risk codes. These codes effectively summarise the perceived level of threat for each species. The conservation value can be interpreted in terms of whether a site is serving as a good and undisturbed habitat for a plant species or otherwise (McElhinny, 2002).

Tchouto (2004) reported of the high conservation value and uniqueness of the Campo-Ma'an forest in south-western Cameroun because the site combined many vegetation types with species of high conservation priorities such as endemic, rare, new and threatened plant species. The site contained about 114 endemic species, 29 of which are only known from the area, 29 only occur in the southwestern part of Cameroon. Knowledge of species of high conservation priorities and where they are located allow managers to direct conservation resources to these locations. Therefore, an inventory is requisite for all conservation initiatives. An assessment of which species are threatened allows resources for species conservation to be prioritized (Secretariat of the CBD, 2009).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 The Study Area

The Asantemanso Sacred Grove is an approximately 100 ha rectangular forest patch that is located east of Bekwai at Essumegya, ~ 70 km south of Kumasi. It lies on longitude 6º 28' N and latitude 1 º 33' W (Larsen and Emmel, 1997).

3.1.1 Climate

The climate of the area is characterized by double maxima rainfall. The first major rainfall season starts from March and ends in July. The second rainfall starts from September and ends in November. The annual rainfall is between 1600 mm and 1800 mm. It has a fairly high and uniform temperature ranging between 20º C in August and 32º C in March. Relative humidity is fairly moderate but high during the rainy season ranging between 70% and 80%. Essumegya lies within the moist – semi- deciduous forest zone (Hall and Swaine, 1981).

3.1.2 Topography and drainage

Essumegya lies within the forest dissected plateau physiographic region with an average height between 150 m and 300 m above sea level. The topography is relatively flat with occasional undulating uplands which rise around 240 m to 300 m. The area is drained by the Oda River and its tributaries are Dankran and Anum portraying a dentritic pattern.

3.1.3 Land use

The major occupation in the area is predominantly agriculture which employs about half of the labour force and constitutes the main source of income for the people in Essumegya. Some of the major food crops produced includes cassava, maize, rice, yam, cocoyam and plantain, while the cash crops include cocoa, citrus, coffee and oil palm. The major rural industry in the area is agrobased and palm oil and palm kennel oil extraction are predominant.

3.2 Data collection

As custom demanded, the queen mother and elders of the Essumegya Tradition Council were consulted for permission to enter the sacred grove for the ethnobotanic studies. To perform the entry right, two bottles of schnapps, one goat and an amount of money were requested by the Traditional Council to perform sacrifices at the grove. These were provided and libation was poured in the grove before the field studies in the grove could begin.

3.2.1 Floristic assessment of plant species in the sacred grove

A team made up of a taxonomist, one field assistant, the research student and an indigene who is a member of the royal family who takes care of the sacred grove carried out the assessment. A reconnaissance survey was carried out to select an appropriate area for the floristic assessment. The selection of the site was based on how far the assessment team was allowed to go into the forest and the topography which was considered to capture representative vegetation for the entire grove. One hectare plot (100 m × 100 m) was demarcated with a compass, linear tape and ranging poles. The hectare plot was subdivided into 10 m × 10 m for a total of 100 sub-plots. All plant species within each of the 10 m × 10 m sub-plots were identified and enumerated.

Identification of plants species was done by the taxonomist assisted by the indigene. Local names were recorded in the field and where appropriate, scientific names were also recorded. The local and scientific names were authenticated by publications from PROTA, (2010), Hawthorne and Jongkind, (2006) Abbiw, (1990) Hawthorne, (1990) and Irvine, (1961). White paint was used to distinguish between counted stems from uncounted stems to avoid double counting of plant species. Voucher specimens of plants were collected, where there was doubt about identity for subsequent identification at the herbarium of Forestry Research Institute of Ghana, (FORIG) in Kumasi. Plant species identified were then classified into their various families, life forms, conservation status and ecological guild based on the reported shade tolerance of plants in Ghana (Hall and Swaine, 1981; Hawthorne, 1995).

Plate 1: A, B and C shows plant taxonomist, field assistant, the research student and an indigene of the Essumegya community conducting plant inventory in a one hectare plot of the Asantemanso Sacred Grove

3.2.2 Ethnobotanical studies of medicinal plants

The ethnobotanical information on plants used as medicines by the communities around the sacred grove were collected from responses obtained by questionnaire and interviews conducted between June, 2010 and October, 2010. Respondents were sampled randomly using the snowballing approach which allows for locating information-rich key informants (Patton, 1990). With the assistance of sub-chiefs potential respondents were contacted to assist in identifying other community members who have knowledge on and uses of plants of medicinal value and were also willing to cooperate with the researcher. The respondents selected comprised of people of varying ages, gender and place of residence.

Plate 2: A and B shows research student interviewing some of the inhabitants of the communities around the sacred grove for information on medicinal plants

Interviews were conducted in the local language (Twi). Four fringe communities namely Essumegya, Boamang, Kyekyewere and Sebedie were selected. These were communities very close to the sacred grove. The population of these communities according to the 2012 population census are: Essumegya - 2, 890: Boamang - 230, Kyekyewere - 1,333 and Sebedie – 518 (Bekwai Municipal Assembly, 2013).

Plate 3: A, B and C shows one respondent exhibiting some of the medicinal plant species and the parts she uses for medicinal remedies

3.3 Data analysis

3.3.1 Data analysis on inventory of plant species in the sacred grove

Data from floristic assessment of plants species in the sacred grove were analyzed using Microsoft Excel and the results presented in graphs, pie charts and tabular forms as appropriate.

3.3.1.1 Calculation of ecological indices of plant species

Density, relative density, frequency, percentage frequency, relative frequency and species diversity were calculated using the formulae given below by Curtis and McIntosh (1950):

i. **Density** = $\frac{\text{Total number of individuals of a plant species in all quadrats}}{\text{Total number of quadrats studied}}$

ii. **Relative density of a species A (%)** = $\frac{\text{Number of individuals of Species A}}{\text{Total number of individuals of all species}} \times 100$

iii. **Frequency of a species** = $\frac{\text{Number of quadrats in which a species occured}}{\text{Total number of quadrats studied}}$

iv. **Relative frequency of a species A** = $\frac{\text{Number of occurence of species A}}{\text{Total number of occurence of all species}} \times 100$

v. **Frequency (%) =** $\frac{\text{Number of quadrats in which a species occurred}}{\text{Total number of quadrats studied}} \times 100$

Species diversity

A diversity index is the measure of species diversity in a given community. Diversity was measured by recording the number of species (species richness) and their relative abundance in the different plots. Diversity is different from species richness in that unlike richness it also shows community composition and takes into account the relative abundance of species that are present in the community (OWWT, 2010).

i. Shannon-Weaver Diversity Index

Shannon-Weaver diversty ndex (**H′**) is a commonly used diversity index that takes into accounts both abundance and evenness of species present in the community. It is explained by the formula below (Shannon-Weaver, 1949):

$$H' = -\sum_{i=1}^{s} Pi * \ln Pi$$

Where H′ is the species diversity, s is the number of species, and pi is the proportion of individuals of each species belonging to the ith species.

A high value of H would be a representative of a diverse and equally distributed community and lower values represent less diverse community. An ecosystem with H value greater than 2 has been regarded as medium to high diversity in terms of species (Giliba *et al*., 2011).

ii. Simpson's index of diversity

Simpson's Index **(**D**)** measures the probability that two individuals randomly selected from a sample will belong to the same species (OWWT, 2010). The formular is given below:

$$D = \frac{\Sigma\, n\,(n-1)}{N\,(N-1)}$$

n is the total number of individuals of a particular species

N is the total number of individuals of all species

The value of **D** ranges between 0 and 1. With this index, 0 represents infinite diversity and 1, no diversity. The closer the Simpson's index value is to zero, the more diverse the area is (McElhinny, 2002). That is, the bigger the value of D, the lower the diversity. This is neither intuitive nor logical, so to get over this problem, D is often subtracted from 1 to give:

Simpson's index of diversity 1 - **D**

The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. This makes more sense. In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different species. Different levels of disturbance have different effects on plant diversity. If our goal is to preserve biodiversity in a given area, we need to be able to understand how diversity is impacted by different management strategies. Because diversity indices provide more information than simply the number of species (i.e. they account for some species being rare and others being common), they serve as valuable tools that enable biologists to quantify diversity in a community and describe its numerical structure (Beals *et al*., 2002).

3.3.1.2 The conservation status of plant species

A star rating system, based on Hawthorne and Abu-Juam (1995) in Ghana was used to define the conservation status of each of the species recorded (Table 1). Plants species were recorded under eight (8) star categories i.e. Black, Gold, Blue, Scarlet, Red, Pink, Green and Unknown. The Unknown category was made up of species whose conservation status had not been established.

Table 1: Star rating system for defining conservation status of plant species in Ghana

No.	Star rating	Definition
1	Black Star	Species rare internationally and at least uncommon in Ghana; urgent attention to conservation of populations needed
2	Gold Star	Fairly rare internationally and/or locally
3	Blue Star	Widespread internationally but rare in Ghana or vice-versa
4	Scarlet Star	Common, but under serious pressure from heavy exploitation
5	Red Star	Common, but under pressure from exploitation
6	Pink Star	Common & moderately exploited, non-abundant but high potential value
7	Green Star	No particular conservation concern, common in Ghana.
8	Unknown	No conservation status established or unable to identify the plant species

Source: Hawthorne and Abu-Juam (1995)

3.3.2 Data analysis of ethnobotanical studies of medicinal plants

The ethnobotanical data was analyzed using Microsoft Excel software and the results presented in graphs, tables and pie charts as appropriate.

CHAPTER FOUR

4.0 RESULTS

4.1 Inventory of plant species in the sacred grove

4.1.1 Diversity of plant species

The results of plants identified and classified in the Asantemanso Sacred Grove are presented in Table 2. The total number of individual plant stems counted was 12,580 comprising of 175 species. The total numbers of individuals and species were grouped into woody and non-woody components. Of the 12,580 individual plants 99% were woody and 1% was non-woody whilst for the 175 species 93% were woody and 7% were non-woody (Table 2) (Appendix A).

4.1.2 Composition of plant species by life forms

In the composition of life forms of plant species, tree species were the most dominant (58%) followed by climbers (31%), shrubs (6%) and herbs (3%). Ferns and grass species were the least, each with 1% (Table 2).

4.1.3 The conservation status of plant species

Plant species were grouped into eight (8) star categories namely Black, Gold, Blue, Scarlet, Red, Pink, Green and Unknown (Table 2). The most dominant star category was Green (71%), followed by Blue and Pink (7%) each. Scarlet and Red Star rated species, though common in Ghana but threatened by various degrees of exploitation were 1% and 4%, respectively (Table 2). Two Black Star-rated species representing 1% of the population (i.e. *Hippocratea vignei* and *Tapura ivorensis*) which require urgent conservation (because they are rare internationally and

very uncommon in Ghana) were also encountered in the grove. Plant species whose star ratings could not be established formed 5% of the population surveyed (Table 2).

4.1.4 Ecological guild of plant species

An important indicator of the ecological status of the flora of the grove is the species composition by ecological guild. Hawthorne (1996) defined the guild as a flexible concept used to circumscribe a group of plants species with a similar ecology and way of life. Shade bearers (SB) were the most dominant (33%) whereas non pioneer light demanders (NPLD) and Pioneers (P) occurred with proportions of 24% and 30% respectively (Table 2). Swamp (SP) species formed just about 1% of the species encountered. There were more Shade Bearers and Non Pioneer Light Demanders altogether (57%) than Pioneers (30%). Plant species whose ecological guild could not be established were labelled as unknown (Table 2).

4.1.5 Composition of plant species by family

The 175 different plant species were classified into 53 families and 133 genera. The most predominant families, comprising of five or more species, were Fabaceae (14%), Rubiaceae (9%), Apocynaceae (6%), Sapindaceae (6%), Sterculiaceae (5%), Annonaceae (5%), Meliaceae, Euphorbiaceae (3%) and Combretaceae (3%). Twenty-four families, including Araceae, Vitaceae and Rhamnaceae, with only one species were grouped as others (14%) (Fig. 1).

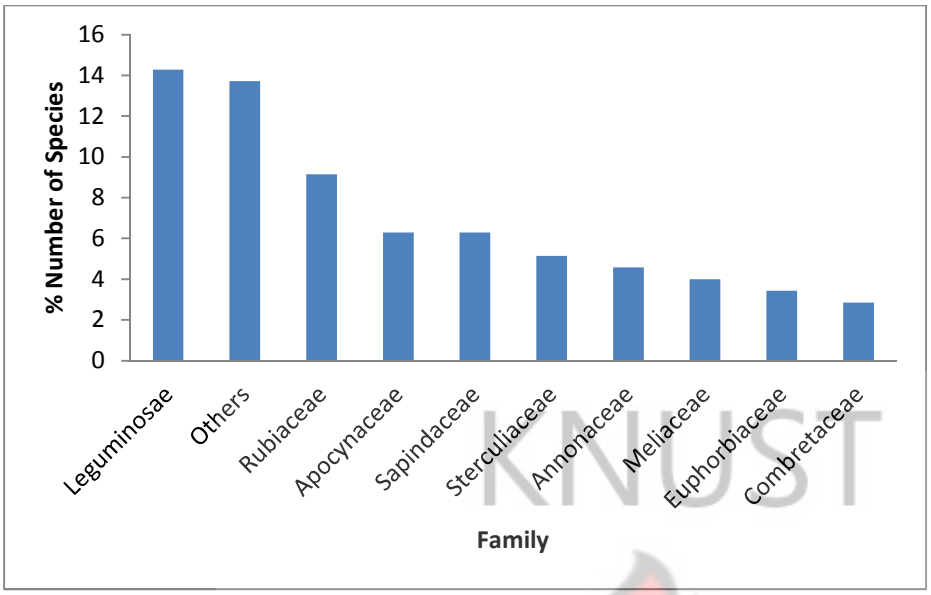

Figure 1: Percentage number of plant species in each family

Table 2: Taxonomy of plants encountered in the Asantemanso Sacred Grove

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
Acacia kamerunensis	Fabaceae	Climber	Woody	F	Green	NPLD
Adenia cissampeloides	Passifloraceae	Climber	Woody	F	Green	P
Adenopodia scelerata	Fabaceae	Climber	Woody	F	Green	P
*Aframomum stanfieldii**	Zingiberaceae	Herb	Non woody	F & D	Blue	P
Ageleae pentagyna	Connaraceae	Climber	Woody	F & D	Green	SB
Aidia genipiflora	Rubiaceae	Tree	Woody	F	Green	SB
Alafia barteri	Apocynaceae	Climber	Woody	F & D	Green	NPLD
Albizia adianthifolia	Fabaceae	Tree	Woody	F	Green	NPLD
*Albizia zygia**	Fabaceae	Tree	Woody	F	Green	NPLD
Allophyllus africanus	Sapindaceae	Tree	Woody	F & D	Green	P
Amphimas pterocarpoides	Fabaceae	Tree	Woody	F	Green	NPLD
Anopyxis klaineana	Rhizophoraceae	Tree	Woody	F	Red	NPLD
Anthonotha macrophylla	Fabaceae	Tree	Woody	F	Green	SB
*Antiaris toxicaria**	Moraceae	Tree	Woody	F	Red	NPLD

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
Antidesma laciniatum	Euphorbiaceae	Tree	Woody	F	Green	NPLD
Baissea baillonii	Apocynaceae	Climber	Woody	F and D	Green	Unknown
*Baphia nitida**	Fabaceae	Tree	Woody	F and D	Green	SB
*Baphia pubescens**	Fabaceae	Tree	Woody	F	Green	P
*Blighia sapida**	Sapindaceae	Tree	Woody	F and D	Green	NPLD
Blighia unijugata	Sapindaceae	Tree	Woody	F and D	Green	SB
Blighia welwitschii	Sapindaceae	Tree	Woody	F	Green	NPLD
Calpocalyx brevibracteatus	Fabaceae	Tree	Woody	F and D	Green	SB
Calycobolus africanus	Convolvulaceae	Climber	Woody	F	Green	SB
Carapa procera	Meliaceae	Tree	Woody	F	Green	SB
*Carpolobia lutea**	Polygalaceae	Shrub	Woody	F	Green	SB
Casearia barteri	Salicaceae	Tree	Woody	F	Gold	P
*Ceiba pentandra**	Bombacaceae	Tree	Woody	F	Pink	P
Celtis adolfi-fridericii	Ulmaceae	Tree	Woody	F	Green	P
Celtis mildbraedii	Ulmaceae	Tree	Woody	F	Green	SB

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
Celtis zenkeri	Ulmaceae	Tree	Woody	F	Green	NPLD
Chazaliella sciadephora	Rubiaceae	Shrub	Woody	F	Green	SB
Chlamydocarya macrocarpa	Icacinaceae	Climber	Woody	F	Gold	SB
*Chromolaena odorata**	Asteraceae	Herb	Non woody	F & D	Green	P
Chrysophyllum perpulchrum	Sapotaceae	Tree	Woody	F	Green	NPLD
Chytranthus carneus	Sapindaceae	Tree	Woody	F	Green	SB
Chytranthus macrobotrys	Sapindaceae	Tree	Woody	F	Green	SP
Cissus aralioides	Vitaceae	Climber	Non woody	F	Green	SB
Cissus producta	Vitaceae	Climber	Non woody	F	Green	Unknown
Clerodendrum capitatum	Verbenaceae	Climber	Woody	F	Green	P
Clerodendrum formicarum	Verbenaceae	Climber	Woody	F	Green	P
Cnestis ferruginea	Connaraceae	Climber	Woody	F & D	Green	P
Coffea stenophylla	Rubiaceae	Tree	Woody	Fa	Unknown	Unknown
Cola caricifolia	Sterculiaceae	Tree	Woody	F & D	Green	P
*Cola gigantea**	Sterculiaceae	Tree	Woody	F	Green	NPLD

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
*Cola nitida**	Sterculiaceae	Tree	Woody	F and Fa	Pink	SB
Combretum bipindense	Combretaceae	Climber	Woody	F	Blue	NPLD
Combretum mucronatum	Combretaceae	Climber	Woody	D	Green	P
Combretum oyemense	Combretaceae	Climber	Woody	F	Blue	P
Combretum zenkeri	Combretaceae	Climber	Woody	F	Blue	P
Copaifera salikounda	Fabaceae	Tree	Woody	F	Red	SB
Culcasia striolata	Araceae	Herb	Non woody	F	Green	SB
Cyclosorus afer	Thelypteridaceae	Fern	Non woody	F	Green	P
Dalbergia afzeliana	Fabaceae	Climber	Woody	F	Green	NPLD
Dalbergia saxatilis	Fabaceae	Climber	Woody	F and Fa	Green	Unknown
Daniella ogea	Fabaceae	Tree	Woody	F	Pink	P
Deinbollia grandifolia	Sapindaceae	Tree	Woody	F	Green	SB
Deinbollia pinnata	Sapindaceae	Tree	Woody	F	Green	NPLD
Dichapetalum toxicarium	Dichapetalaceae	Climber	Woody	F and D	Blue	NPLD
Dioscorea praehensilis	Dioscoreaceae	Climber	Non woody	F	Pink	P

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
Diospyros abyssinica	Ebenaceae	Tree	Woody	F	Green	P
Diospyros gabunensis	Ebenaceae	Tree	Woody	F	Blue	SB
Diospyros monbuttensis	Ebenaceae	Tree	Woody	F	Green	SB
Diospyros soubreana	Ebenaceae	Tree	Woody	F	Green	SB
Dracaena adamii	Dracaenaceae	Shrub	Woody	F	Gold	SB
Dracaena arborea	Dracaenaceae	Tree	Woody	F	Green	P
Dracaena cristula	Dracaenaceae	Tree	Woody	F	Unknown	SB
Dracaena surculosa	Dracaenaceae	Shrub	Woody	F	Green	SB
Drypetes aylmeri	Euphorbiaceae	Tree	Woody	F	Blue	SB
*Elaeis guineensis**	Arecaceae	Tree	Woody	Fa and F	Pink	P
Elaeophorbia grandifolia	Euphorbiaceae	Tree	Woody	F	Green	P
*Enantia polycarpa**	Annonaceae	Tree	Woody	F	Green	SB
Entandrophragma angolense	Meliaceae	Tree	Woody	F	Red	NPLD
Entandrophragma cylindricum	Meliaceae	Tree	Woody	F	Scarlet	NPLD
*Euadenia eminens**	Capparaceae	Shrub	Woody	F	Green	SB

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
Euclinia longiflora	Rubiaceae	Tree	Woody	F	Green	SB
Farquharia elliptica	Apocynaceae	Climber	Woody	F	Green	NPLD
Ficus exasperata	Moraceae	Tree	Woody	F	Green	P
Ficus vogeliana	Moraceae	Tree	Woody	F	Green	SP
Friesodielsia enghiana	Annonaceae	Climber	Woody	F	Green	Unknown
Funtumia africana	Apocynaceae	Tree	Woody	F	Green	NPLD
*Funtumia elastica**	Apocynaceae	Tree	Woody	F	Green	NPLD
Gardenia ternifolia	Rubiaceae	Tree	Woody	F	Unknown	Unknown
*Glyphaea brevis**	Tiliaceae	Tree	Woody	F and D	Green	SB
*Gongronema latifolium**	Asclepiadaceae	Climber	Woody	F	Green	NPLD
Grewia mollis	Tiliaceae	Tree	Woody	F	Green	P
*Griffonia simplicifolia**	Fabaceae	Climber	Woody	F	Green	NPLD
Guarea cedrata	Meliaceae	Tree	Woody	F	Pink	SB
Hannoa klaineana	Simaroubaceae	Tree	Woody	F	Green	P
Hippocratea vignei	Celastraceae	Climber	Woody	F and D	Black	NPLD

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
Holarrhena floribunda	Apocynaceae	Tree	Woody	F	Green	P
Holoptelea grandis	Ulmaceae	Tree	Woody	F	Green	P
Hymenostegia afzelii	Fabaceae	Tree	Woody	F	Green	SB
*Hypselodelphys poggeana**	Marantaceae	Climber	Woody	F & D	Green	P
Icacina mannii	Icacinaceae	Climber	Woody	F	Green	Unknown
Ixora nigerica	Rubiaceae	Shrub	Woody	F	Green	Unknown
Keetia hispida	Rubiaceae	Climber	Woody	F	Green	P
Landolphia micrantha	Apocynaceae	Climber	Woody	F	Blue	NPLD
Landolphia owariensis	Apocynaceae	Climber	Woody	F	Green	Unknown
*Lannea welwitschii**	Anacardiaceae	Tree	Woody	F	Green	P
Lecaniodiscus cupanioides	Sapindaceae	Tree	Woody	F	Green	SB
Lepisanthes senegalensis	Sapindaceae	Tree	Woody	F	Green	SB
Leptaspis zeylanica	Poaceae	Herb	Non woody	F	Green	SB
Leptoderris brachyptera	Fabaceae	Climber	Woody	F	Green	Unknown
Leptoderris micrantha	Fabaceae	Climber	Woody	F	Gold	Unknown

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
Leptoderris trifoliata	Fabaceae	Climber	Woody	F	Unknown	Unknown
Lijndenia barteri	Melastomataceae	Shrub	Woody	F	Unknown	Unknown
Lonchocarpus sericeus	Fabaceae	Tree	Woody	F	Green	NPLD
*Mallotus oppositifolius**	Euphorbiaceae	Tree	Woody	F & Fa	Green	SB
*Mareya micrantha**	Euphorbiaceae	Tree	Woody	F	Green	SB
Memecylon afzelii	Melastomataceae	Tree	Woody	F	Green	SB
Microdesmis keayana	Pandaceae	Tree	Woody	F	Unknown	Unknown
Millettia chrysophylla	Fabaceae	Climber	Woody	F	Green	NPLD
Millettia rhodantha	Fabaceae	Tree	Woody	F & D	Green	SB
*Millettia zechiana**	Fabaceae	Tree	Woody	F	Green	P
Monodora myristica	Annonaceae	Tree	Woody	F	Green	SB
Monodora tenuifolia	Annonaceae	Tree	Woody	F	Green	P
*Motandra guineensis**	Apocynaceae	Climber	Woody	F	Green	NPLD
Napoleonaea vogelii	Lecythidaceae	Tree	Woody	F	Green	SB
Nesogordonia papaverifera	Sterculiaceae	Tree	Woody	F	Pink	SB

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
*Newbouldia laevis**	Bignoniaceae	Tree	Woody	F	Green	P
Nichallea soyauxii	Rubiaceae	Climber	Woody	F	Green	Unknown
Olax gambecola	Olacaceae	Shrub	Woody	F	Green	SB
*Oplismenus burmannii**	Poaceae	Grass	Non woody	F & D	Unknown	Unknown
Oxyanthus speciosus	Rubiaceae	Tree	Woody	F & D	Green	SB
Parkia bicolor	Fabaceae	Tree	Woody	F	Green	NPLD
*Paullinia pinnata**	Sapindaceae	Climber	Woody	F & D	Green	P
Pavetta mollis	Rubiaceae	Tree	Woody	F & D	Blue	Unknown
*Petersianthus macrocarpus**	Lecythidaceae	Tree	Woody	F	Green	P
Phaulopsis ciliata	Acanthaceae	Herb	Non woody	F & D	Green	P
Piptadeniastrum africanum	Fabaceae	Tree	Woody	F	Pink	NPLD
Pisonia aculeata	Nyctaginaceae	Climber	Woody	F	Green	P
Pouteria altissima	Sapotaceae	Tree	Woody	F	Red	NPLD
Psychotria ivorensis	Rubiaceae	Shrub	Woody	F	Gold	SB
Psychotria peduncularis	Rubiaceae	Shrub	Woody	F	Green	Unknown

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
Psydrax subcordata	Rubiaceae	Tree	Woody	F	Green	P
Pterygota macrocarpa	Sterculiaceae	Tree	Woody	F	Red	NPLD
*Pycnanthus angolensis**	Myristicaceae	Tree	Woody	F	Pink	NPLD
*Rauvolfia vomitoria**	Apocynaceae	Tree	Woody	F	Green	P
Rhaphiostylis cordifolia	Icacinaceae	Climber	Woody	F	Blue	SB
Rhaphiostylis preussii	Icacinaceae	Climber	Woody	F	Green	SB
*Ricinodendron heudolotii**	Euphorbiaceae	Tree	Woody	F & D	Green	P
Rinorea oblongifolia	Violaceae	Tree	Woody	F	Green	SB
Rothmannia longiflora	Rubiaceae	Tree	Woody	F	Green	SB
Salacia columna	Celastraceae	Climber	Woody	F	Blue	SB
Salacia zenkeri	Celastraceae	Climber	Woody	F	Blue	Unknown
*Secamone afzelii**	Asclepiadaceae	Climber	Woody	D	Green	SB
Smilax anceps	Smilacaceae	Climber	Non woody	F	Green	P
*Sphenocentrum jollyanum**	Menispermaceae	Shrub	Woody	F	Green	SB
Sterculia oblonga	Sterculiaceae	Tree	Woody	F	Green	NPLD

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
Sterculia rhinopetala	Sterculiaceae	Tree	Woody	F	Pink	NPLD
Sterculia tragacantha	Sterculiaceae	Tree	Woody	F	Green	P
*Strombosia pustulata**	Olacaceae	Tree	Woody	F	Green	SB
*Strophanthus hispidus**	Apocynaceae	Climber	Woody	F & D	Pink	P
Strychnos aculeata	Loganiaceae	Climber	Woody	F	Green	P
Strychnos floribunda	Loganiaceae	Climber	Woody	F	Green	NPLD
Strychnos icaja	Loganiaceae	Climber	Woody	F	Green	Unknown
Tapura ivorensis	Dichapetelaceae	Tree	Woody	F	Black	SB
Terminalia superba	Combretaceae	Tree	Woody	F, D & Fa	Pink	P
Thaumatococcus daniellii	Maranthaceae	Herb	Non woody	F	Red	P
Tiliacora leonensis	Menispermaceae	Climber	Woody	F	Green	NPLD
Tricalysia discolor	Rubiaceae	Tree	Woody	F	Green	SB
Tricalysia pallens	Rubiaceae	Tree	Woody	F	Green	SB
*Trichilia monadelpha**	Meliaceae	Tree	Woody	F	Green	NPLD
Trichilia prieureana	Meliaceae	Tree	Woody	F	Green	NPLD

Table 2: Cont'd

Scientific name	Family	Life form	Stem type	Habitat	Star rating	Ecological guild
Triclisia dactiophylla	Menispermaceae	Climber	Woody	F & D	Green	P
*Triplochiton scleroxylon**	Sterculiaceae	Tree	Woody	F	Scarlet	P
Turraeanthus africanus	Meliaceae	Tree	Woody	F	Pink	SB
Uvaria angolensis	Annonaceae	Climber	Woody	F	Blue	Unknown
Uvaria mocoli	Annonaceae	Climber	Woody	F	Green	NPLD
Uvaria sassandrensis	Annonaceae	Climber	Woody	F	Green	P
Ventilago africana	Rhamnaceae	Climber	Woody	F	Green	P
Warneckea guineense	Melastomataceae	Tree	Woody	F	Green	SB
Xylopia villosa	Annonaceae	Tree	Woody	F	Green	SB
Zanthoxylum leprieurii	Rutaceae	Tree	Woody	F	Green	P

* **Medicinal plants in the sacred grove identified by respondents**

F = Forests; Fa = Farms; D = Disturbed areas; P = Pioneer; SB = Shade Bearing; NPLD =non pioneer light demanding

4.2 Density, abundance and species diversity of plants sampled in the sacred grove

4.2.1 Diversity of plant species

Two diversity indices, namely Shannon-Wiener Index (H) and Simpson's Index (D) recorded for this study were of 3.51 and 0.945 respectively.

The species with the highest densities were *Griffonia simplicifolia* (17.04), *Trichilia prieureana* (12.41) and *Hymenostegia afzelii* (12.10) whereas 34 species including *Tapura ivorensis*, *Euclina longiflora* and *Ficus exasperata* recorded the least density of 0.01per the hectare plot (Table 3).

The most common species were *Trichilia prieureana* (9.86), *Griffonia simplicifolia* (13.55), *Celtis mildbraedii* (4.98), *Blighia unijugata* (4.39), *Blighia sapida* (3.79), *Nesogordonia papaverifera* (5.76), *Baphia nitida* (5.25), *Pterogota macrocarpa* (2.25), *Sterculia rhinopetala* (2.04), *Nichallea soyauxii* (2.11), *Sterculia oblonga* (1.72), *Napoleonaea vogelii* (2.72), *Funtumia elastica* (1.40), *Motandra guineensis* (1.17) and *Cola gigantea* (1.60) (Table 3).

Table 3: Density, frequency and species diversity of plants sampled in the Sacred Grove

Scientific name	No. of ind.	D	RDe	F	% F	%Rfr	1-D	H′
Acacia kamerunensis	11	0.11	0.087	0.08	8	0.09	6.95E-07	-0.01
Adenia cissampeloides	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Adenopodia scelerata	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Aframomum stanfieldii	15	0.15	0.119	0.15	15	0.12	1.33E-06	-0.01
Agelaea pentagyna	145	1.45	1.153	0.50	50	1.15	1.32E-04	-0.05
Aidia genipiflora	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Alafia barteri	33	0.33	0.262	0.15	15	0.26	6.67E-06	-0.02
Albizia adianthifolia	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Albizia zygia	17	0.17	0.135	0.15	15	0.14	1.72E-06	-0.01
Allophyllus africanus	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Amphimas pterocarpoides	6	0.06	0.048	0.06	6	0.05	1.90E-07	0.00
Anopyxis klaineana	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Anthonotha macrophylla	7	0.07	0.056	0.07	7	0.06	2.65E-07	0.00

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Antiaris toxicaria	109	1.09	0.866	0.55	55	0.87	7.44E-05	-0.04
Antidesma laciniatum	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Baissea baillonii	3	0.03	0.024	0.03	3	0.02	3.79E-08	0.00
Baphia nitida	661	6.61	5.254	0.87	87	5.25	2.76E-03	-0.15
Baphia pubescens	24	0.24	0.191	0.11	11	0.19	3.49E-06	-0.01
Blighia sapida	477	4.77	3.792	0.95	95	3.79	1.43E-03	-0.12
Blighia unijugata	552	5.52	4.388	0.96	96	4.39	1.92E-03	-0.14
Blighia welwitschii	25	0.25	0.199	0.16	16	0.20	3.79E-06	-0.01
Calpocalyx brevibracteatus	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Calycobolus africanus	214	2.14	1.701	0.32	32	1.70	2.88E-04	-0.07
Carapa procera	63	0.63	0.501	0.39	39	0.50	2.47E-05	-0.03
Carpolobia lutea	2	0.02	0.016	0.01	1	0.02	1.26E-08	0.00
Casearia barteri	4	0.04	0.032	0.01	1	0.03	7.58E-08	0.00

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Ceiba pentandra	4	0.04	0.032	0.04	4	0.03	7.58E-08	0.00
Celtis adolfi-friderici	4	0.04	0.032	0.04	4	0.03	7.58E-08	0.00
Celtis mildbraedii	626	6.26	4.976	0.99	99	4.98	2.47E-03	-0.15
Celtis zenkeri	63	0.63	0.501	0.40	40	0.50	2.47E-05	-0.03
Chazaliella sciadephora	4	0.04	0.032	0.04	4	0.03	7.58E-08	0.00
Chlamydocarya macrocarpa	64	0.64	0.509	0.37	37	0.51	2.55E-05	-0.03
Chromolaena odorata	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Chrysophyllum perpulchrum	3	0.03	0.024	0.03	3	0.02	3.79E-08	0.00
Chytranthus carneus	5	0.05	0.040	0.04	4	0.04	1.26E-07	0.00
Chytranthus macrobotrys	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Cissus aralioides	6	0.06	0.048	0.06	6	0.05	1.90E-07	0.00
Cissus producta	5	0.05	0.040	0.05	5	0.04	1.26E-07	0.00
Clerodendrum capitatum	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Clerodendrum formicarum	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Cnestis ferruginea	18	0.18	0.143	0.13	13	0.14	1.93E-06	-0.01
Coffea stenophylla	42	0.42	0.334	0.28	28	0.33	1.09E-05	-0.02
Cola caricaefolia	10	0.1	0.079	0.09	9	0.08	5.69E-07	-0.01
Cola gigantea	218	2.18	1.733	0.66	66	1.73	2.99E-04	-0.07
Cola nitida	20	0.2	0.159	0.16	16	0.16	2.40E-06	-0.01
Combretum bipindense	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Combretum mucronatum	5	0.05	0.040	0.03	3	0.04	1.26E-07	0.00
Combretum oyemense	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Combretum zenkeri	45	0.45	0.358	0.33	33	0.36	1.25E-05	-0.02
Copaifera salikounda	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Culcasia striolata	57	0.57	0.453	0.57	57	0.45	2.02E-05	-0.02
Cyclosorus afer	3	0.03	0.024	0.03	3	0.02	3.79E-08	0.00

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Dalbergia afzeliana	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Dalbergia saxatilis	7	0.07	0.056	0.03	3	0.06	2.65E-07	0.00
Daniellia ogea	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Deinbollia grandifolia	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Deinbollia pinnata	86	0.86	0.684	0.50	50	0.68	4.62E-05	-0.03
Dialium dinklagei	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Dichapetalum toxicarium	11	0.11	0.087	0.10	10	0.09	6.95E-07	-0.01
Dioscorea praehensilis	4	0.04	0.032	0.04	4	0.03	7.58E-08	0.00
Diospyros abyssinica	4	0.04	0.032	0.02	2	0.03	7.58E-08	0.00
Diospyros gabunensis	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Diospyros monbuttensis	12	0.12	0.095	0.11	11	0.10	8.34E-07	-0.01
Diospyros soubreana	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Dracaena adamii	10	0.1	0.079	0.06	6	0.08	5.69E-07	-0.01

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Dracaena arborea	85	0.85	0.676	0.39	39	0.68	4.51E-05	-0.03
Dracaena cristula	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Dracaena surculosa	10	0.1	0.079	0.06	6	0.08	5.69E-07	-0.01
Drypetes aylmeri	12	0.12	0.095	0.11	11	0.10	8.34E-07	-0.01
Elaeis guineensis	80	0.8	0.636	0.49	49	0.64	3.99E-05	-0.03
Elaeophorbia grandifolia	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Enantia polycarpa	13	0.13	0.103	0.12	12	0.10	9.86E-07	-0.01
Entandrophragma angolense	5	0.05	0.040	0.05	5	0.04	1.26E-07	0.00
Entandrophragma cylindricum	5	0.05	0.040	0.05	5	0.04	1.26E-07	0.00
Euadenia eminens	2	0.02	0.016	0.01	1	0.02	1.26E-08	0.00
Euclinia longiflora	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Farquharia elliptica	5	0.05	0.040	0.05	5	0.04	1.26E-07	0.00
Ficus exasperata	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Ficus vogeliana	2	0.02	0.016	0.01	1	0.02	1.26E-08	0.00
Friesodielsia enghiana	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Funtumia africana	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Funtumia elastica	176	1.76	1.399	0.60	60	1.40	1.95E-04	-0.06
Gardenia ternifolia	6	0.06	0.048	0.04	4	0.05	1.90E-07	0.00
Glyphaea brevis	11	0.11	0.087	0.08	8	0.09	6.95E-07	-0.01
Gongronema latifolium	3	0.03	0.024	0.03	3	0.02	3.79E-08	0.00
Grewia mollis	116	1.16	0.922	0.50	50	0.92	8.43E-05	-0.04
Griffonia simplicifolia	1704	17.04	13.545	0.99	99	13.55	1.83E-02	-0.27
Guarea cedrata	10	0.1	0.079	0.07	7	0.08	5.69E-07	-0.01
Hannoa klaineana	5	0.05	0.040	0.04	4	0.04	1.26E-07	0.00
Hippocratea vignei	78	0.78	0.620	0.44	44	0.62	3.80E-05	-0.03
Holarrhena floribunda	6	0.06	0.048	0.06	6	0.05	1.90E-07	0.00

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Holoptelea grandis	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Hymenostegia afzelii	1210	12.1	9.618	0.46	46	9.62	9.24E-03	-0.23
Hypselodelphys poggeana	11	0.11	0.087	0.11	11	0.09	6.95E-07	-0.01
Icacina mannii	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Ixora nigerica	10	0.1	0.079	0.07	7	0.08	5.69E-07	-0.01
Keetia hispida	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Landolphia micrantha	27	0.27	0.215	0.19	19	0.21	4.44E-06	-0.01
Landolphia owariensis	98	0.98	0.779	0.48	48	0.78	6.01E-05	-0.04
Lannea welwitschii	7	0.07	0.056	0.07	7	0.06	2.65E-07	0.00
Lecaniodiscus cupanioides	151	1.51	1.200	0.58	58	1.20	1.43E-04	-0.05
Lepisanthes senegalensis	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Leptaspis zeylanica	47	0.47	0.374	0.47	47	0.37	1.37E-05	-0.02
Leptoderris brachyptera	4	0.04	0.032	0.03	3	0.03	7.58E-08	0.00

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Leptoderris micrantha	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Leptoderris trifoliata	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Lijndenia barteri	6	0.06	0.048	0.05	5	0.05	1.90E-07	0.00
Lonchocarpus sericeus	117	1.17	0.930	0.30	30	0.93	8.58E-05	-0.04
Mallotus oppositifolius	3	0.03	0.024	0.03	3	0.02	3.79E-08	0.00
Mareya micrantha	9	0.09	0.072	0.07	7	0.07	4.55E-07	-0.01
Memecylon afzelii	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Microdesmis keayana	4	0.04	0.032	0.02	2	0.03	7.58E-08	0.00
Millettia chrysophylla	95	0.95	0.755	0.38	38	0.76	5.64E-05	-0.04
Millettia rhodantha	11	0.11	0.087	0.05	5	0.09	6.95E-07	-0.01
Millettia zechiana	316	3.16	2.512	0.59	59	2.51	6.29E-04	-0.09
Monodora myristica	14	0.14	0.111	0.13	13	0.11	1.15E-06	-0.01
Monodora tenuifolia	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Motandra guineensis	147	1.47	1.169	0.62	62	1.17	1.36E-04	-0.05
Napoleonaea vogelii	342	3.42	2.719	0.72	72	2.72	7.37E-04	-0.10
Nesogordonia papaverifera	724	7.24	5.755	0.88	88	5.76	3.31E-03	-0.16
Newbouldia laevis	39	0.39	0.310	0.21	21	0.31	9.37E-06	-0.02
Nichallea soyauxii	266	2.66	2.114	0.78	78	2.11	4.45E-04	-0.08
Olax gambecola	38	0.38	0.302	0.24	24	0.30	8.89E-06	-0.02
Oplismenus burmannii	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Oxyanthus speciosus	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Parkia bicolor	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Paullinia pinnata	104	1.04	0.827	0.40	40	0.83	6.77E-05	-0.04
Pavetta mollis	15	0.15	0.119	0.12	12	0.12	1.33E-06	-0.01
Petersianthus macrocarpus	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Phaulopsis ciliata	32	0.32	0.254	0.32	32	0.25	6.27E-06	-0.02

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Piptadeniastrum africanum	6	0.06	0.048	0.06	6	0.05	1.90E-07	0.00
Pisonia aculeata	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Pouteria altissima	127	1.27	1.010	0.48	48	1.01	1.01E-04	-0.05
Psychotria ivorensis	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Psychotria peduncularis	5	0.05	0.040	0.05	5	0.04	1.26E-07	0.00
Psydrax subcordata	6	0.06	0.048	0.04	4	0.05	1.90E-07	0.00
Pterygota macrocarpa	283	2.83	2.250	0.85	85	2.25	5.04E-04	-0.09
Pycnanthus angolensis	86	0.86	0.684	0.42	42	0.68	4.62E-05	-0.03
Rauvolfia vomitoria	7	0.07	0.056	0.07	7	0.06	2.65E-07	0.00
Rhaphiostylis cordifolia	10	0.1	0.079	0.06	6	0.08	5.69E-07	-0.01
Rhaphiostylis preussii	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Ricinodendron heudelotii	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Rinorea oblongifolia	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Rothmannia longiflora	5	0.05	0.040	0.05	5	0.04	1.26E-07	0.00
Salacia columna	7	0.07	0.056	0.07	7	0.06	2.65E-07	0.00
Salacia zenkeri	41	0.41	0.326	0.18	18	0.33	1.04E-05	-0.02
Secamone afzelii	5	0.05	0.040	0.05	5	0.04	1.26E-07	0.00
Smilax kraussiana	4	0.04	0.032	0.04	4	0.03	7.58E-08	0.00
Sphenocentrom jollyanum	8	0.08	0.064	0.04	4	0.06	3.54E-07	0.00
Sterculia oblonga	217	2.17	1.725	0.78	78	1.72	2.96E-04	-0.07
Sterculia rhinopetala	257	2.57	2.043	0.80	80	2.04	4.16E-04	-0.08
Sterculia tragacantha	8	0.08	0.064	0.07	7	0.06	3.54E-07	0.00
Strombosia pustulata	106	1.06	0.843	0.57	57	0.84	7.03E-05	-0.04
Strophanthus hispidus	4	0.04	0.032	0.04	4	0.03	7.58E-08	0.00
Strychnos aculeata	9	0.09	0.072	0.04	4	0.07	4.55E-07	-0.01
Strychnos floribunda	34	0.34	0.270	0.12	12	0.27	7.09E-06	-0.02

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Strychnos icaja	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Tapura ivorensis	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Terminalia superba	4	0.04	0.032	0.04	4	0.03	7.58E-08	0.00
Thaumatococcus daniellii	11	0.11	0.087	0.02	2	0.09	6.95E-07	-0.01
Tiliacora leonensis	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Tricalysia discolor	10	0.1	0.079	0.08	8	0.08	5.69E-07	-0.01
Tricalysia pallens	19	0.19	0.151	0.14	14	0.15	2.16E-06	-0.01
Trichilia monadelpha	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00
Trichilia prieureana	1241	12.41	9.865	1.00	100	9.86	9.72E-03	-0.23
Triclisia dactiophylla	13	0.13	0.103	0.08	8	0.10	9.86E-07	-0.01
Triplochiton scleroxylon	68	0.68	0.541	0.37	37	0.54	2.88E-05	-0.03
Turraeanthus africanus	15	0.15	0.119	0.11	11	0.12	1.33E-06	-0.01
Uvaria angolensis	2	0.02	0.016	0.02	2	0.02	1.26E-08	0.00

Table 3: Cont'd

Scientific name	No. of ind.	D	RDe	F	%F	RFr	1-D	H′
Uvaria mocoli	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Uvaria sassandrensis	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Ventilago africana	5	0.05	0.040	0.05	5	0.04	1.26E-07	0.00
Warneckea guineense	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Xylopia villosa	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00
Zanthoxylum leprieurii	1	0.01	0.008	0.01	1	0.01	0.00E+00	0.00

No. of Ind. = Number of individuals; D = Density; RDe = Relative Density; F = Frequency; %F = Percentage Frequency

Rfr = Relative frequency; D - 1 = Simpson's Index of Diversity; H′ = Shannon Weaver Index

4.3 Ethnobotanical studies of medicinal plants species

4.3.1 Demographics of respondents

Fifty-three (53) respondents were interviewed in four communities around the grove namely Essumegya (33 respondents), Boamang (2 respondents), Kyekyewere (8 respondents) and Sebedie (10 respondents) (Appendix G). Males constituted the majority (53%) of the people intervieweed. However, the rest were females representing 47% (Fig. 2). The age of the respondents ranged from 27 to 90. About 57% of the respondents had no formal education. About 41% and 2% had secondary (Junior and Senior High) and primary education respectively (Fig. 3). Majority of the respondents were Christians (90.57%) whereas only 9.43% were Traditionalists (Fig. 4). None of the respondents were Moslems or belonged to other religion.

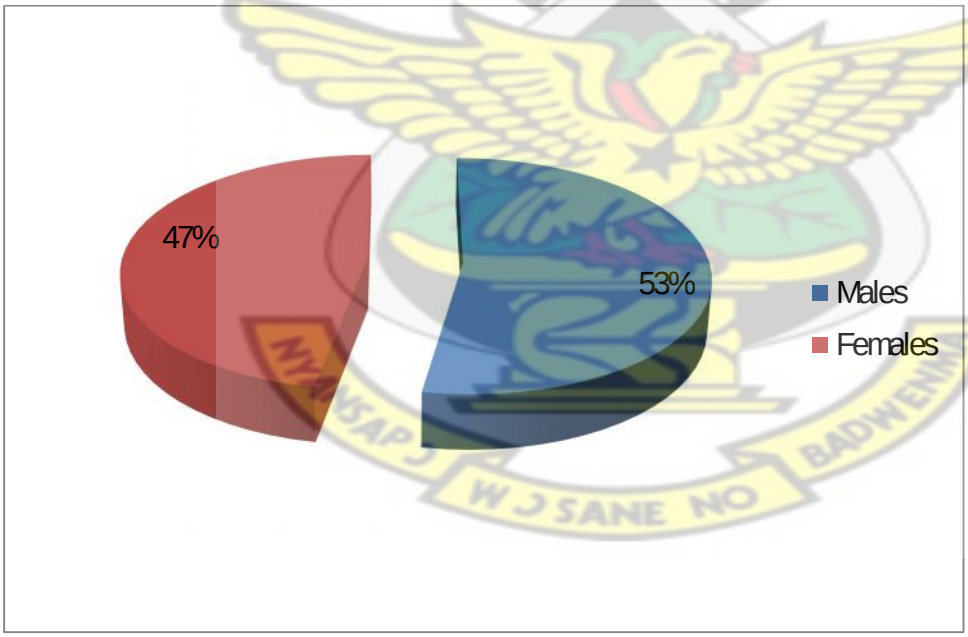

Figure 2: Percentage number of males and females of sampled respondents

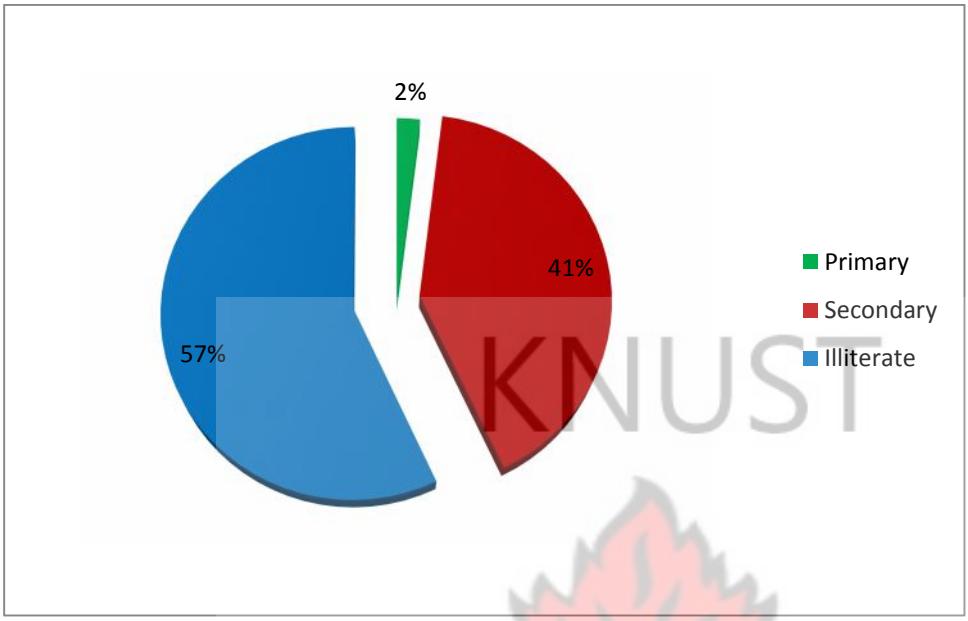

Figure 3: Percentage composition of educational status of respondents sampled

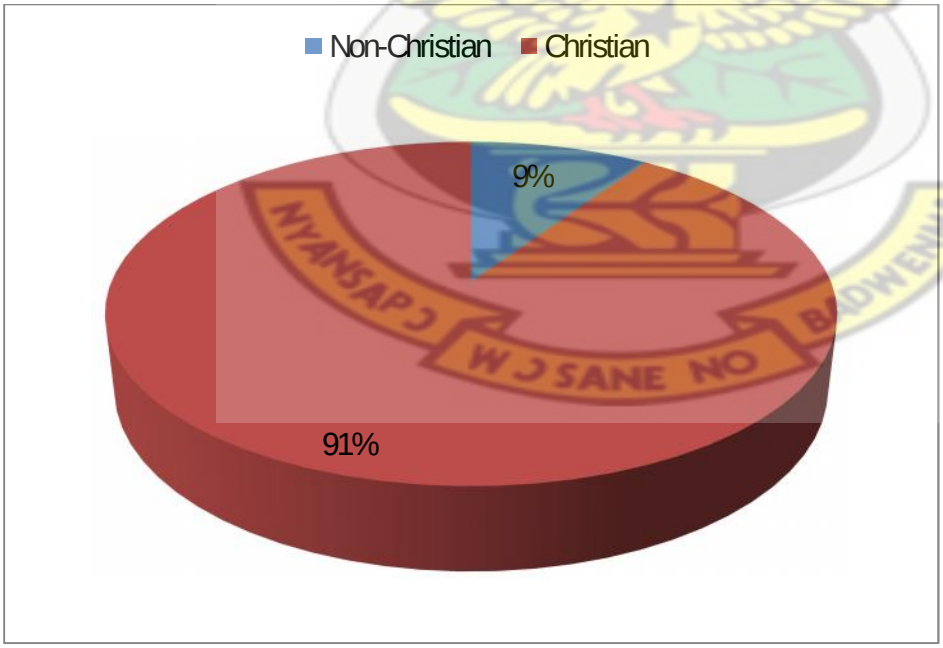

Figure 4: Percentage composition of religious denomination of respondents sampled

4.3.2 Taxonomic inventory of medicinal plants harvested and used by respondents

A total of 151 medicinal plants were recorded from the four communities (Table 5). Euphorbiaceae was the most predominant Family followed by the Families Apocynaceae and Caesalpiniaceae, Papilionaceae, Combretaceae and Acanthaceae. Families represented by only one species are Rubiaceae, Sapotaceae, Dracaenaceae and Maranthaceae (Table 5).

4.3.2.1 Medicinal plants identified in the sacred grove

Medicinal plants cited by respondents and identified during the inventory in the sacred grove are represented in Table 2 (Asterisked). Out of the total 175 plants species enumerated in the sacred grove, 37 species belonging to 23 families under 34 genera were indicated to be medicinal through the ethnobotanical studies. The 37 species represent about 21.14% of the plant species enumerated in the sacred grove. The species confirmed to be medicinal by the respondents were predominantly trees (64.9%). The proportions of the other life forms are as follows: climbers (18.9%), herbs (5.4%), shrubs (8.1) and unknown (2.7%) respectively.

Table 4: Medicinal plants harvested and used by respondents from the communities

Scientific name	Local name	Family	Habitat
Abelmoschus esculentus	Nkruma	Malvaceae	Farms & Disturbed areas
Abrus precatorius	Odwan nkyene	Papilionaceae	Farms & Forests
Aframomum melegueta	Fam wisa	Zingiberaceae	Farms, Forests & Disturbed areas
*Aframomum stanfieldii***	Sensam	Zingiberaceae	Farms, Forests & Disturbed areas
Ageratum conyzoides	Aguakuro	Asteraceae	Forests
*Albizia zygia***	Okoro	Mimosaceae	Forests
Alchornea cordifolia	Gyama	Euphorbiaceae	Farms
Allium cepa	Gyeine	Alliaceae	Forests
Alstonia boonei	Nyame dua	Apocynaceae	Farms & Disturbed areas
Amaranthus spinosus	Krokrofaa	Amaranthaceae	Farms & Disturbed areas
Ananas comosus	Abrobe	Bromeliaceae	Forests
Anchomanes difformis	Ope	Araceae	Forests
Anthocleista nobilis	WudifoↃ kɛtɛ	Loganiaceae	Forests
Anthrocaryon micraster	Apurokuma	Anacardiaceae	Forests
*Antiaris toxicaria***	Kyenkyen	Moraceae	Farms & Disturbed areas

Table 4: Cont'd

Scientific name	Local name	Family	Habitat
Arachis hypogaea	Nkatɛɛ	Papilionaceae	Farms
Aspilia africana	Nfofoo	Asteraceae	Forests & Disturbed areas
Axonopus compressus	Nsensan	Poaceae	Farms & Disturbed areas
Azadirachta indica	Dua gyeine	Meliaceae	Farms & Disturbed areas
Bombusa vulgaris	Nkanpuro	Poaceae	Forests & Disturbed areas
*Baphia nitida***	Odwono	Papilionaceae	Forests
*Baphia pubescens***	Sukubiri	Papilionaceae	Disturbed areas
Bidens pilosa	Agyninantwi	Asteraceae	Forests & Disturbed areas
Blighia sapida	Akyee	Sapindaceae	Disturbed areas
Boerhavia repens	Aposompo	Nyctaginaceae	Forests
Bombax buonopozense	Akata	Bombacaceae	Forests & Disturbed areas
Bryophyllum pinnatum	GorƆ	Crassulaceae	Farms & Disturbed areas
Caesalpinia benthamiana	Akobowere	Caesalpiniaceae	Farms & Disturbed areas
Capsicum frutescens	Mesewa	Solanaceae	Forests
Carica papaya	BrƆfrɛ	Caricaceae	Forests & Disturbed areas

Table 4: Cont'd

Scientific name	Local name	Family	Habitat
*Carpolobia lutea***	Ofoa	Polygalaceae	Forests
*Ceiba pentandra***	Onyina	Bombacaceae	Forests, Disturbed areas & Farms
Cercestis afzelii	Matatwene	Araceae	Forests & Disturbed areas
*Chromolaena odorata***	Akyeampong	Asteraceae	Farms & Disturbed areas
Chrysophyllum albidum	Akaasa	Sapotaceae	Farms & Disturbed areas
Citrus limon	Amomoe	Rutaceae	Farms, Forests & Disturbed areas
Citrus sinensis	Ankaa	Rutaceae	Farms & Disturbed areas
Cleistopholis patens	Ngo ne nkyene	Annonaceae	Forests
Cocos nucifera	Kube	Arecaceae	Farms
*Cola gigantea***	Wataapuo	Sterculiaceae	Disturbed areas
*Cola nitida***	Bese	Sterculiaceae	Disturbed areas & Farms
Comb*retum mucronatum*	Nkanfo dua	Sterculiaceae	Farms & Disturbed areas
Commelina benghalensis	Nyame nwu na mawu	Commelinaceae	Forests, Farms & Disturbed areas
Corchorus olitorius	Ayoyo	Tiliaceae	Forests, Farms & Disturbed areas
Costus dubius	Nsome	Costaceae	Disturbed areas

Table 4: Cont'd

Scientific name	Local name	Family	Habitat
Cussonia bancoensis	Kwaabofrɛ	Araliaceae	Forests & Swamps
Cyathula prostrata	Mpupuaa	Amaranthaceae	Forests & Farms
Cyclosorus striatus	Aya	Thelypteridaceae	Forests, Farms & Disturbed areas
Dalbergia welwitschii	Awenade	Papilionaceae	Forests
Distemonanthus benthamianus	Dua bonsam	Caesalpiniaceae	Forests
Dracaena mannii	Nkosene nkosene	Dracaenaceae	Forests
*Elaeis guineensis***	Abɛ	Arecaceae	Farms & Disturbed areas
*Enantia polycarpa***	Dua sika	Annonaceae	Forests
Eremomastax speciosa	Dwareansera	Acanthaceae	Forests
Erigeron floribundus	Ananse monto	Asteraceae	Forests
*Euadenia eminens***	Dunsinkoro	Capparaceae	Forests
Euphorbia hirta	Kakaweadwe	Euphorbiaceae	Forests
Ficus sur	Odoma	Moraceae	Farms & Disturbed areas
*Funtumia elastica***	Funtum	Apocynaceae	Forests
*Glyphaea brevis***	Foto	Tiliaceae	Forests & Disturbed areas

Table 4: Cont'd

Scientific name	Local name	Family	Habitat
*Gongronema latifolium***	Ansurogya	Asclepiadaceae	Disturbed areas
Gossypium hirsutum	Asaawa	Malvaceae	Forests
*Griffonia simplicifolia***	Kagya	Caesalpiniaceae	Forests
Harungana madagascariensis	Kosoa	Clusiaceae	Forests, Farms & Disturbed areas
Heliotropium indicum	Akomfemtikro	Boraginaceae	Farms & Disturbed areas
Hoslundia opposita	Nunum nini	Lamiaceae	Disturbed areas
*Hypselodelphys poggeana***	Babadua	Maranthaceae	Forests
Imperata cylindrica	Esere	Poaceae	Forests & Disturbed areas
Jatropha curcas	Nkranadua	Euphorbiaceae	Forests & Farms
Justicia flava	Afama	Acanthaceae	Disturbed areas
Khaya ivorensis	Dubini	Meliaceae	Farms & Forests
Kigelia africana	Nufotene	Bignoniaceae	Forests
Landolphia hirsuta	Agyaaman	Apocynaceae	Farms & Disturbed areas
*Lannea welwitschii***	Kumnini	Anacardiaceae	Farms & Disturbed areas
Lantana camara	Ananse dokono	Verbenaceae	Forests

Table 4: Cont'd

Scientific name	Local name	Family	Habitat
Leonatis nepetifolia	Pea	Lamiaceae	Forests
*Mallotus oppositifolius***	Nyanyanfrowa	Euphorbiaceae	Forests & Farms
Mammea africana	Bompagya	Clusiaceae	Forests
Mangifera indica	Amango	Anacardiaceae	Farms, Forests & Disturbed areas
Manihot esculenta	Bankye	Euphorbiaceae	Farms & Disturbed areas
Manniophyton fulvum	Hunhunu	Euphorbiaceae	Forests
Margaritaria discoidea	Pepea	Euphorbiaceae	Forests & Farms
Milicia excelsa	Odum	Moraceae	Forests
*Millettia zechiana***	Nsɛdua nsɛahoma	Papilionaceae	Farms & Disturbed areas
Momordica charantia	Nyanya	Cucurbitaceae	Farms & Disturbed areas
Morinda lucida	Konkroma	Rubiaceae	Farms & Forests
Moringa oleifera	Moringa	Moringaceae	Disturbed areas
Morus mesozygia	Wonton	Moraceae	Forests
*Motandra guineensis***	Manfohan	Apocynaceae	Forests & Swamps
Musa paradisiaca	BrƆdeɛ	Musaceae	Farms, Forests & Disturbed areas

Table 4: Cont'd

Scientific name	Local name	Family	Habitat
Musa sapientum	Kwadu	Musaceae	Farms, Forests & Disturbed areas
Musanga cecropioides	Odwuma	Cecropiaceae	Farms & Forests
Nephrolepsis biserrata	Abɛ ho aya	Nephrolepidaceae	Forests, Farms & Disturbed areas
*Newbouldia laevis***	Sosomasa	Bignoniaceae	Forests
Nymphaea lotus	Ntanaa	Nymphaeaceae	Forests
Ocimum gratissimum	Nunum	Lamiaceae	Farms & Disturbed areas
Okoubaka aubrevillei	Odii	Santalaceae	Forests
*Oplismenus burmannii***	Nanka kɛtɛ	Poaceae	Disturbed areas, Farms & Forests
Parquetina nigrescens	Abakamo	Asclepiadaceae	Forests
*Paullinia pinnata***	Tuientea	Sapindaceae	Disturbed areas
Persea americana	Paya	Lauraceae	Farms, Forests & Disturbed areas
*Petersianthus macrocarpus***	Esia	Lecythidaceae	Farms & Disturbed areas
Phaulopsis barteri	Aprapra yɛmuo	Acanthaceae	Forests
Phyllanthus melleri	AwɔbɛAwɔbɛ	Euphorbiaceae	Forests
Phyllanthus urinaria	BɔBɔma gu wakyire	Euphorbiaceae	Forests

Table 4: Cont'd

Scientific name	Local name	Family	Habitat
Piper guineense	Soro wisa	Piperaceae	Farms & Disturbed areas
Portulaca quadrifida	Asaase ne aboↃ	Portulacaceae	Forests
Pseudospondia microcarpa	Akatawani	Anacardiaceae	Forest, Farms & Disturbed areas
Psidium guajava	Guaba	Myrtaceae	Disturbed areas & Farms
*Pycnanthus angolensis***	Otie	Myristicaceae	Forests
*Rauvolfia vomitoria***	Kakapenpen	Apocynaceae	Disturbed areas
*Ricinodendron heudelotii***	Nwama	Euphorbiaceae	Forests & Disturbed areas
Saccharum officinarum	Ahwedeɛ	Poaceae	Forests
*Secamone afzelii***	Kwartemaa	Asclepiadaceae	Forests
Senna alata	Dua wusu	Caesalpiniaceae	Forests
Senna occidentalis	Nkwadaa nkwadaa bodeɛ	Caesalpiniaceae	Forests, Farms & Disturbed areas
Senna tora	Buronya	Caesalpiniaceae	Forests
Sida acuta	Tweta	Malvaceae	Disturbed areas & Forests
Solanum anguivi	Nsusua	Solanaceae	Disturbed areas & Farms
Solanum erianthum	Pepediawuo	Solanaceae	Disturbed areas

Table 4: Cont'd

Scientific name	Local name	Family	Habitat
Solanum torvum	Abeduro	Solanaceae	Forests & Disturbed areas
Spathodea campanulata	Akuakuo nisuo	Bignoniaceae	Farms & Disturbed areas
*Sphenocentrum jollyanum***	Kraman kote	Menispermaceae	Farms & Disturbed areas
Spondia mombin	Atoa	Anacardiaceae	Forests & Disturbed areas
*Strombosia pustulata***	Afena	Olacaceae	Forests
Strophanthus hispidus	Maatwa	Apocynaceae	Forests
Talinum triangulare	Efan	Portulacaceae	Farms & Disturbed areas
Tamarindus indica	Diko	Caesalpiniaceae	Farms & Disturbed areas
Tapinanthus bangwensis	Nkranpan	Loranthaceae	Farms, Forests & Disturbed areas
Tectona grandis	Teak	Verbenaceae	Forests & Disturbed areas
Terminalia catappa	Abrofo nkateɛ	Combretaceae	Forests & Disturbed areas
Terminalia glaucescens	KrokrodƆso	Combretaceae	Forests
Terminalia ivorensis	Emire	Combretaceae	Forests
Tetrapleura tetraptera	Prekesɛ	Mimosaceae	Forests & Farms
Theobroma cacao	Kookoo	Sterculiaceae	Farms

Table 4: Cont'd

Scientific name	Local name	Family	Habitat
Thevetia peruviana	Mengyeme ngyaame	Apocynaceae	Farms & Disturbed areas
Treculia africana	Birebiretem	Moraceae	Forests
Trema orientalis	Sesea	Ulmaceae	Farms & Disturbed areas
*Trichilia monadelpha***	Tanduro	Meliaceae	Farms, Forests & Disturbed areas
Trilepisium madagasariense	Okoro	Moraceae	Forests
*Triplochiton scleroxylon***	Wawa	Sterculiaceae	Forests
Uapaca guineensis	Kontan	Euphorbiaceae	Forests
Urera keayi	Ahyehyewonsa	Urticaceae	Forests
Vernonia amygdalina	AwƆnwono	Asteraceae	Farms & Forests
Voacanga africana	Bedaa	Apocynaceae	Forests
Xanthosoma sagittifolium	Mankani	Araceae	Farms & Disturbed areas
Zanthoxylum gilletii	Okuo	Rutaceae	Forests
Zea mays	Aburo	Poaceae	Farms & Disturbed areas
Zingiber officinale	Akekaduro	Zingiberaceae	Farms, Disturbed areas & Forests

** **Medicinal plants in the sacred grove identified by respondents**

Table 5: Medicinal plants part with single or multiple medicinal uses mentioned by the respondents

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Abelmoschus esculentus	Leaves	Expulsion of afterbirth	-
Abrus precatorius	Leaves	-	Pain in the throat, Heart problem & Anaemia
Aframomum melegueta	Fruits	-	Stomach problem & Fever
Aframomum stanfieldii	Leaves & Roots	-	Stye, Waist problem & Ear problem
Ageratum conyzoides	Bark & Leaves	-	Fever, Oligomenorrhoea, Wound healing, Aid navel tear in new borns & Cuts
Albizia zygia	Bark	Hernia	-
Alchornea cordifolia	Leaves & Roots	-	Wound healing, Tooth ache, For pregnancy, Stomach problem, Fever, Anaemia, Cuts, Dysentry & Convulsion
Allium cepa	Leaves	-	Epilepsy & Tooth ache
Alstonia boonei	Bark	-	Measles, Fever, Menopause, Waist problem & Breast problems
Amaranthus spinosus	Leaves	-	Stomach problem & Convulsion

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Ananas comosus	Bark (peels)	Fever	-
Anchomanes difformis	Bark & Leaves	-	Boils & Gonorrhoea
Anthocleista nobilis	Bark & Leaves	-	Fever, Stomach ache & Infertility
Anthrocaryon micraster	Bark	Generalised oedema	-
Antiaris toxicaria	Bark & Leaves	-	Oligomenorrhoea & Cough
Arachis hypogaea	Leaves	For pregnancy	-
Aspilia africana	Flowers & Leaves	-	Ear problems, Stomach ulcer, Stye & Anaemia
Axonopus compressus	Leaves & Roots	-	Fever, Waist problem, Aid children learning to walk & Anaemia
Azadirachta indica	Leaves	-	Fever & Eye problem
Bombusa vulgaris	Leaves	-	Heart problem & Stomach ache
Baphia nitida	Leaves	-	Stomach problem, Fever, Skin rash & Diarrhoea
Baphia pubescens	Leaves	-	For pregnancy & Swollen head

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Bidens pilosa	Leaves	-	For pregnancy, Fever, Stomach problem & Anaemia
Blighia sapida	Bark	-	Cough & Asthma
Boerhavia repens	Leaves	-	Boils, Tonsilliti & For pregnancy
Bombax buonopozense	Bark	-	Fever, Generalised oedema, Cough, Piles, Stomach ulcer & Miscarriage
Bryophyllum pinnatum	Leaves	-	Miscarriage & Swollen head
Caesalpinia benthamiana	Leaves & Roots	-	Cough & Mouth ulcer
Capsicum frutescens	Fruits & Leaves	-	Fever, Miscarriage & For pregnancy
Carica papaya	Leaves, Roots & Seeds	-	Broken bones, Stomach ulcer, Cuts, Fever, Wound healing, For pregnancy, Expulsion of afterbirth & Stomach ache
Carpolobia lutea	Roots	Swollen head	-
Ceiba pentandra	Bark	Waist problem	-
Cercestis afzelii	Leaves	Aid children learning to walk	-

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Chromolaena odorata	Leaves	Tooth ache	-
Chrysophyllum subnudum	Bark	Broken bones	-
Citrus limon	Bark, Leaves & Roots	-	Hypertension & Fever
Citrus sinensis	Seeds	Stomach ache	-
Cleistopholis patens	Bark, Leaves & Roots	-	Fever, Rheumatism, Hernia, Constipation & Piles
Cocos nucifera	Roots	-	Toothache, Heart problem, Asthma & Cough
Cola gigantea	Roots	-	Waist problem & For pregnancy
Cola nitida	Bark & Fruits	-	For pregnancy & Shingles
Comb*retum mucronatum*	Leaves	Body pains	-
Commelina benghalensis	Leaves, Roots & Bark	Wound healing	-
Corchorus olitorius	Leaves	Diarrhoea	-

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Costus dubius	Roots	Rheumatism	-
Cussonia bancoensis	Bark & Roots	-	Paronchia & Stomach ache
Cyathula prostrata	Leaves	-	Cut, Headache & Stomach ache
Cyclosorus striatus	Leaves	-	Rheumatism, Anaemia & Broken bones
Dalbergia welwitschii	Leaves	Vaginal sores	-
Distemonanthus benthamianus	Bark	Rheumatism	-
Dracaena mannii	Leaves	Anaemia	-
Elaeis guineensis	Leaves, Roots & Seeds	-	Fever, Infertility, Wound healing, Hiccups, For pregnancy, Miscarriage, Swollen head & Heart problems
Enantia polycarpa	Bark & Roots	-	Stomah ache & Heart problem
Eremomastax speciosa	Leaves	Stye	-
Erigeron floribundus	Leaves & Roots	-	Anaemia, Piles, Cuts & Waist problem
Euadenia eminens	Roots	-	Swollen head, Waist problem & Aid chidren learning to walk

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Euphorbia hirta	Leaves	-	Headache & Tooth ache
Ficus sur	Bark	-	Infertility, Broken bones & Piles
Funtumia elastica	Bark & Roots	-	Measles & Cough
Glyphaea brevis	Leaves	Stomach problem	-
Gongronema latifolium	Leaves	-	Swollen head & Cough
Gossypium hirsutum	Leaves	Infertility	-
Griffonia simplicifolia	Roots	-	Waist problem & Heart problem
Harungana madagascariensis	Bark	Wound healing	-
Heliotropium indicum	Leaves	-	Swollen head, Miscarriage, Heart problem & Disease of the new born
Hoslundia opposita	Leaves	-	Fever, Stomach problem & Disease of the new born
Hypselodelphys poggeana	Roots	Eye problem	-
Imperata cylindrica	Bark & Leaves	-	For pregnancy & Fever
Jatropha curcas	Leaves & Roots	-	Mouth ulcer & Waist problems

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Justicia flava	Leaves	-	Swollen head, Cough, Epilepsy, Viginal sores & Stomach ache
Khaya ivorensis	Bark	-	Piles, Fever, Waist problems & For pregnancy
Kigelia africana	Bark	-	Cough & Pregnancy
Landolphia hirsuta	Bark	-	Piles & Rheumatism
Lannea welwitschii	Bark	-	Body pains, Piles & Fever
Lantana camara	Leaves	Anaemia	-
Leonatis nepetifolia	Leaves	Headache	-
Mallotus oppositifolius	Leaves	-	Hypertension & Headache
Mammea africana	Bark	Rheumatism	-
Mangifera indica	Bark	-	Rheumatism, Fever & Bed wetting
Manihot esculenta	Leaves	-	Miscarriage, Fever, Dysentry & Diarrhoea
Manniophyton fulvum	Leaves	-	For pregnancy & Stomach problemm
Margaritaria discoidea	Bark	Piles	-

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Milicia excelsa	Bark	-	Miscarriage, Cancer & For pregnancy
Millettia zechiana	Leaves	Broken bones	-
Momordica charantia	Leaves	-	Epilepsy, Disease of the new born, Fever, Gonorrhoea & Headache
Morinda lucida	Bark, Leaves & Roots	-	Fever, Typhoid fever & Swollen head
Moringa oleifera	Leaves	-	Stye & For pregnancy
Morus mesozygia	Roots	Anaemia	-
Motandra guineensis	Bark & Leaves	-	Migraine & Fever
Musa indica	Leaves	Fever	-
Musa paradisiaca	Bark, Leaves & Roots	-	Stye, For pregnancy, Cuts, Fever, Convulsion, Snake bite, Headache & Production of abundant breast milk
Musa sapientum	Leaves & Roots	-	Swollen head & Wound healing
Musanga cecropioides	Bark	Asthma	-

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Nephrolepsis biserrata	Leaves	-	Rheumatism & Anaemia
Newbouldia laevis	Bark & Leaves	-	Fever
Nymphaea lotus	Bark & Leaves	-	Swollen head & Migraine
Ocimum gratissimum	Leaves & Roots	-	Stomach problem, Fever, Migraine, Piles, Headache, Ear problem, For pregnancy & Boils
Okoubaka aubrevillei	Seeds	-	Piles & Stomach problem
Oplismenus burmannii	Leaves	Anaemia	-
Parquetina nigrescens	Leaves	-	Viginal sores & Rheumatism
Paullinia pinnata	Leaves & Roots	-	Generalised oedema, Snake bite, Piles, Cough, Waist problem, Stomach ache, Swollen head & Broken bones
Persea americana	Bark, Leaves & Seeds	-	Fever, Anorexia, Anaemia & Hypertension

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Petersianthus macrocarpus	Bark	-	Waist problem, Rheumatism, Fever & Production of abundant breastmilk
Phaulopsis barteri	Leaves	Fever	-
Phyllanthus melleri	Bark, Flowers, Leaves & Roots		Stye, Fever, Eye problem, Hematuria, Dysentary, Anaemia, Epilepsy, Piles, Measles, For pregnancy, Aid navel tear in borns
Phyllanthus urinaria	Leaves	-	Diabetes & Fever
Piper guineense	Fruits	-	Cuts, Hernia & Waist problem
Portulaca quadrifida	Leaves	-	Fever, For pregnancy, Miscarriage & Tooth ache
Pseudospondia microcarpa	Bark	Anaemia	-
Psidium guajava	Leaves & Roots	-	Diarrhoea, Hernia & Migraine
Pycnanthus angolensis	Bark	-	Stomach ache & Piles

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Rauvolfia vomitoria	Roots	-	Gonorrhoea, Asthma, Waist problem & Convulsion
Ricinodendron heudelotii	Bark	-	Fever, For pregnancy & Anaemia
Saccharum officinarum	Fruits	Fever	-
Secamone afzelii	Leaves	-	Skin rash & Stomach problem
Senna alata	Bark & Leaves	-	Ringworm, Eczema, Fever, Piles, Anaemia, Diarrhoea & Hypertension
Senna occidentalis	Leaves	-	Fever, Epilepsy, Stomach ache & Snake bite
Senna tora	Leaves	Expulsion of afterbirth	-
Sida acuta	Leaves & Roots	-	Waist problems, For pregnancy & Tooth ache
Solanum anguivi	Roots	-	Fibrioid & Asthma
Solanum erianthum	Leaves	-	Piles & Wound healing
Solanum torvum	Leaves & Roots	-	Headache, Skin rash, Stomach problem, Anaemia & Urinary retention

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Spathodea campanulata	Bark & Leaves	-	Dysentry, Fever, Waist problem & For pregnancy
Sphenocentrum jollyanum	Roots	-	Waist problems & Migraine
Spondia mombin	Leaves	-	Snake bite, Stye & Expulsion of afterbirth
Strombosia pustulata	Bark	Wound healing after birth	-
Strophanthus hispidus	Roots	Swollen head	-
Talinum triangulare	Leaves	Hypertension	-
Tamarindus indica	Leaves	-	Tonsillitis & Anaemia
Tapinanthus bangwensis	Leaves	-	Broken bones, Epilepsy & for bathing children
Tectona grandis	Leaves	-	Fever & Piles
Terminalia catappa	Leaves	Fever	-
Terminalia glaucescens	Leaves	Stomach ulcer	-
Terminalia ivorensis	Bark	Stomach ulcer	-

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Tetrapleura tetraptera	Bark, Fruits & Leaves	-	Body pain, Hematuria, Piles, Anaemia, Stroke, Prostrate cancer & Tooth ache
Theobroma cacao	Leaves & Roots	-	Fever, Prostrate cancer, Anaemia, Cough & For pregnancy
Thevetia peruviana	Leaves & Roots	-	Generalised oedema, Urinary retention, Convulsion, For bathing children & Stomach ache
Treculia africana	Bark	Stomach ulcer	-
Trema orientalis	Bark & Leaves	-	Rheumatism, Fibriod & Stomach ulcer
Trichilia monadelpha	Bark	Hypertension	-
Trilepisium madagasariense	Bark	-	Stomach ache & Hernia
Triplochiton scleroxylon	Bark	Waist problem	-
Uapaca guineensis	Bark	Piles	-
Urera keayi	Leaves	Snake bite	-
Vernonia amygdalina	Leaves	-	Stomach problem & Fever

Table 5: Cont'd

Scientific name	Part(s) used	Single medicinal use	Multiple medicinal uses
Voacanga africana	Bark	-	Hernia, Miscarriage & Broken bones
Xanthosoma sagittifolium	Leaves	-	Anaemia, Generalised oedema & Snake bite
Zanthoxylum gilletii	Bark	-	Measles, Piles, Stomach problem & Hernia
Zea mays	Flower, Leaves & Flowers (silk)	-	Bed wetting, Stomach ulcer & Expulsion of afterbirth
Zingiber officinale	Roots (rhizome)	-	Waist problem, Cuts, Fever, Aid children learning to walk & Hernia

Out of the total 151 medicinal plant species identified by the respondents, 104 (68.87%) had multiple medicinal uses whereas 47 species (representing 31.13%) had only one medicinal therapeutic application (Table 5).

The most widely used medicinal plants included *Alchornea cordifolia* (26.42%), *Bombax buonopozense* (24.53%), *Cleistopholis patens* (22.64%), *Ocimum gratissimum* (22.64%), *Khaya ivorensis* (22.64%), *Alstonia boonei* (20.75%), *Paullinia pinnata* (20.75%), *Tetrapleura tetraptera* (18.87%), *Phyllanthus melleri* (18.87%) and *Baphia nitida* (15.09%) (Table 6).

Table 6: List of top 30 most commonly used medicinal plants identified by the respondents

No.	Scientific name	Number of respondents (N=53)	Percentage (%) Importance
1	*Alchornea cordifolia*	14	26.42
2	*Bombax buonopozense*	13	24.53
3	*Cleistopholis patens*	12	22.64
4	*Ocimum gratissimum*	12	22.64
5	*Khaya ivorensis*	12	22.64
6	*Alstonia boonei*	11	20.75
7	*Paullinia pinnata*	11	20.75
8	*Tetrapleura tetraptera*	10	18.87
9	*Phyllanthus melleri*	10	18.87
10	*Zanthoxylum gilletii*	9	16.98

Table 6: Cont'd

No.	Scientific name	Number of respondents (N=53)	Percentage (%) Importance
12	*Elaeis guineensis*	8	15.09
13	*Senna alata*	8	15.09
14	*Baphia nitida*	8	15.09
15	*Pycnanthus angolensis*	8	15.09
16	*Azadirachta indica*	8	15.09
17	*Newbouldia laevis*	7	13.21
18	*Senna occidentalis*	7	13.21
19	*Solanum torvum*	7	13.21
20	*Aspilia africana*	7	13.21
21	*Bryophyllum pinnatum*	7	13.21
22	*Caesalpinia benthamiana*	7	13.21
23	*Funtumia elastica*	7	13.21
24	*Justacia flava*	7	13.21
25	*Spathodea campanulata*	7	13.21
26	*Theobroma cacao*	7	13.21
27	*Portulaca quadrifida*	7	13.21
28	*Cola nitida*	6	11.32
29	*Ageratum conyzoides*	6	11.32
30	*Blighia sapida*	6	11.32

4.3.3 Most commonly used plant parts

Different plant parts were used to cure various diseases. Most of the therapeutic applications of the medicinal plants involved the use of leaves (46.9%), bark (27.1%) and roots (17.9%). Other plant parts were aso used in preparing medicinal remedies such as seeds (2.4%), flowers (1.9%) and fruits (3.9%) (Fig. 5). It was interesting to note that for some plants, for example *Alstonia boonei* one part could be used for the treatment of different ailments.

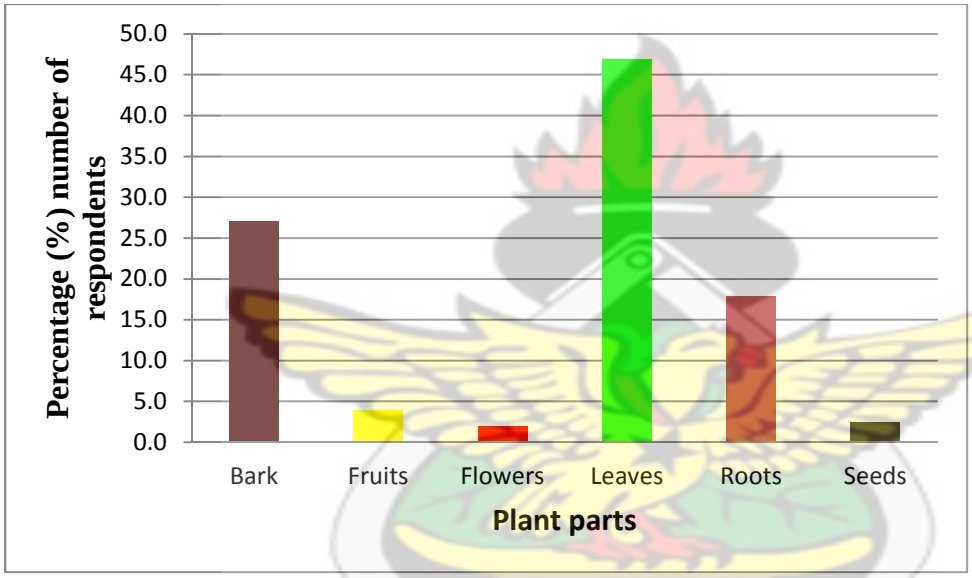

Figure 5: Plant parts used for the preparation of medicinal remedies in the study area

4.3.4 Therapeutic uses of identified medicinal plants

The total medicinal plants list indicated that medicinal plants were used for the treatment of 66 ailments (Appendix H). According to the respondents, most of the plants were used for the treatment of fever with 45 citations (11.3%) followed by anaemia (6.3%) and pregnancy (6.0%). Other medicinal therapeutic applications included piles (5.0%), cough (3.0%), waist problems with 20 (5.0%), tooth ache (2.0%), headache with (2.3%), rheumatism (2.5%), convulsion

(1.8%), asthma (1.3%) and stomach problem (5.0%) (Fig 6). The remaining 37 medicinal uses of the plants were lumped together and put into the category of their uses (Fig. 6; Appendix H). These were for the treatment of infertility, ringworm, fibroid, boils etc. (Appendix H).

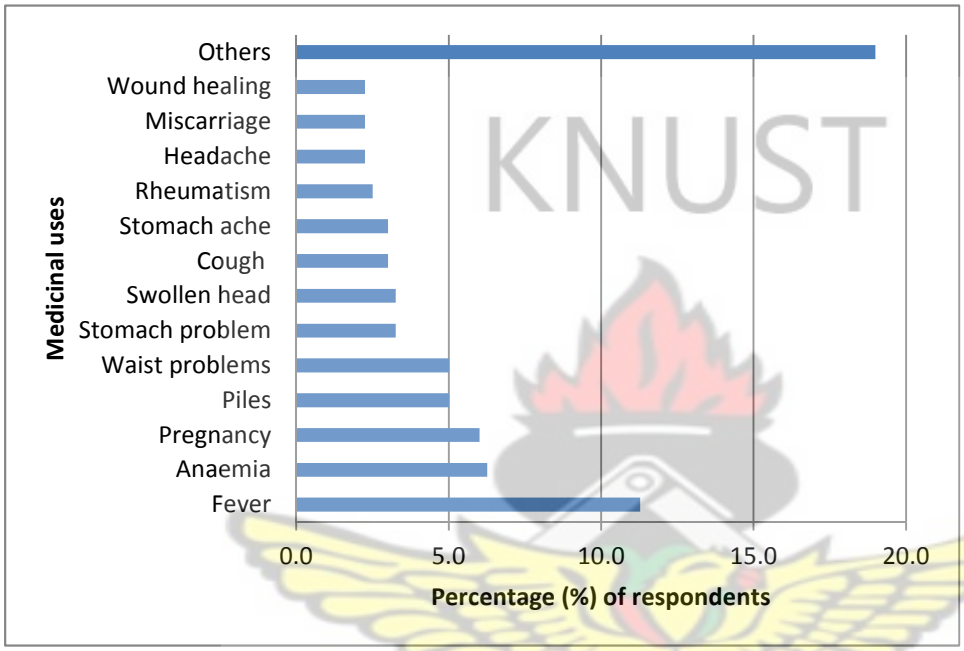

Figure 6: Percentage of therapeutic applications/medicinal uses

Medicinal remedies were administered in different forms but predominantly as decoctions (38.1%), poultices (24.5%), concoctions (13.6%) and tinctures (12.2%) (Fig.7). Medicines were also administered in powder form (10.0%) and as infusions (1.4%). Majority of the respondents (57.8%) used cutlass to harvest medicinal plants whereas 42.2% used hoes (Fig.8). Respondents employed other methods such as leaves plucking, bark slashing and roots cutting as some of the methods of harvesting medicinal plants (Fig. 9).

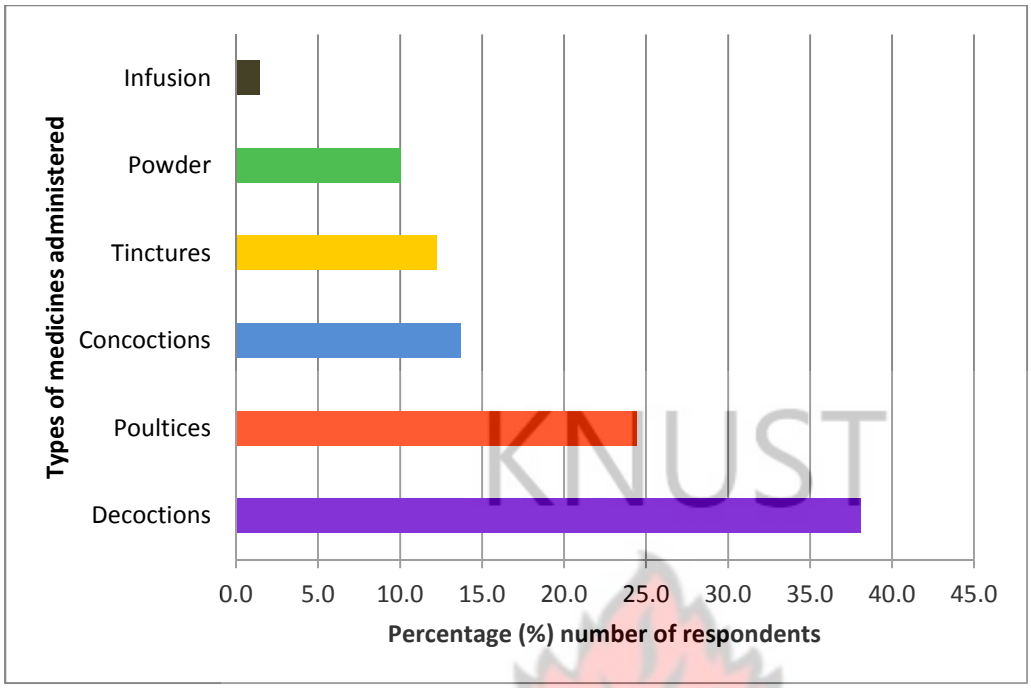

Figure 7: Percentage number of respondents indicating forms in which medicines were prepared and are applied

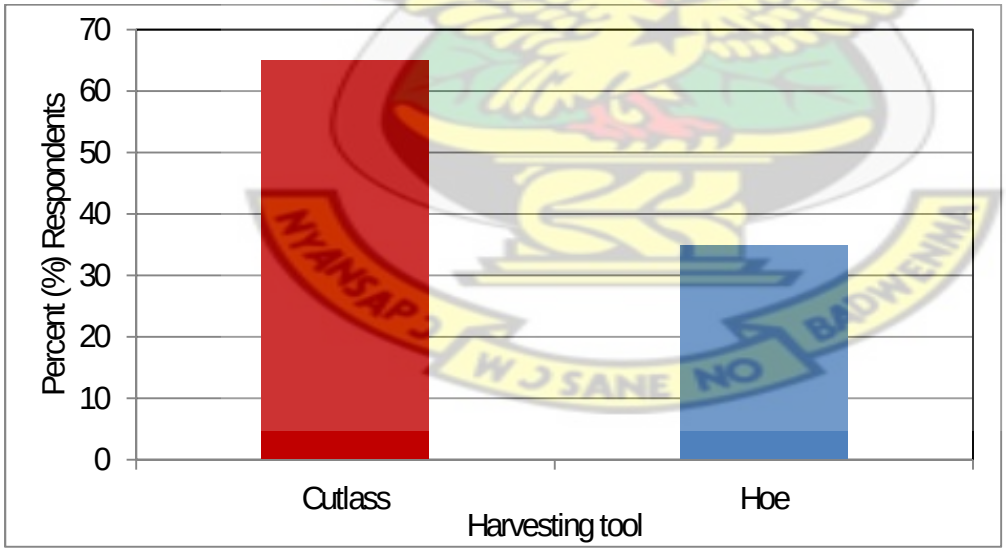

Figure 8: Implements used in harvesting medicinal plants by respondents

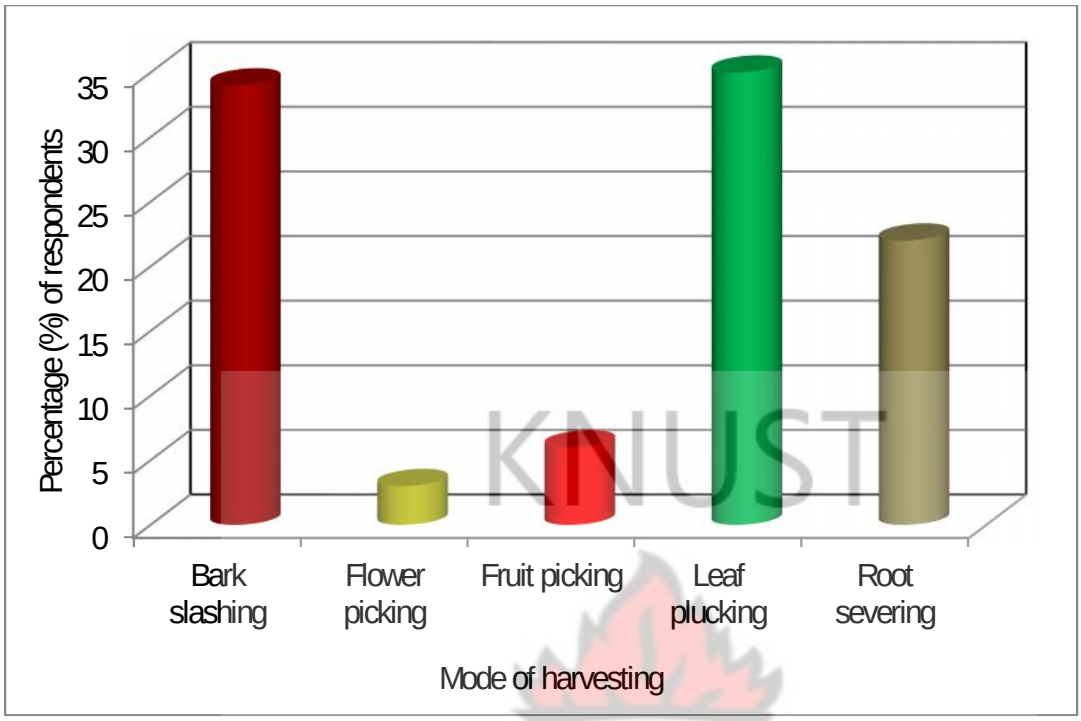

Figure 9: Percentage number of respondents indicating their mode of harvesting plant species

4.3.5 Sources of medicinal plant species used by respondents

Plants used for the preparation of medicinal remedies, indicated were obtained from their farms predominantly (96%), whereas some indicated that they collected plants from the forest (2%) and from a medicinal garden (2%) close to their houses (Fig. 10).

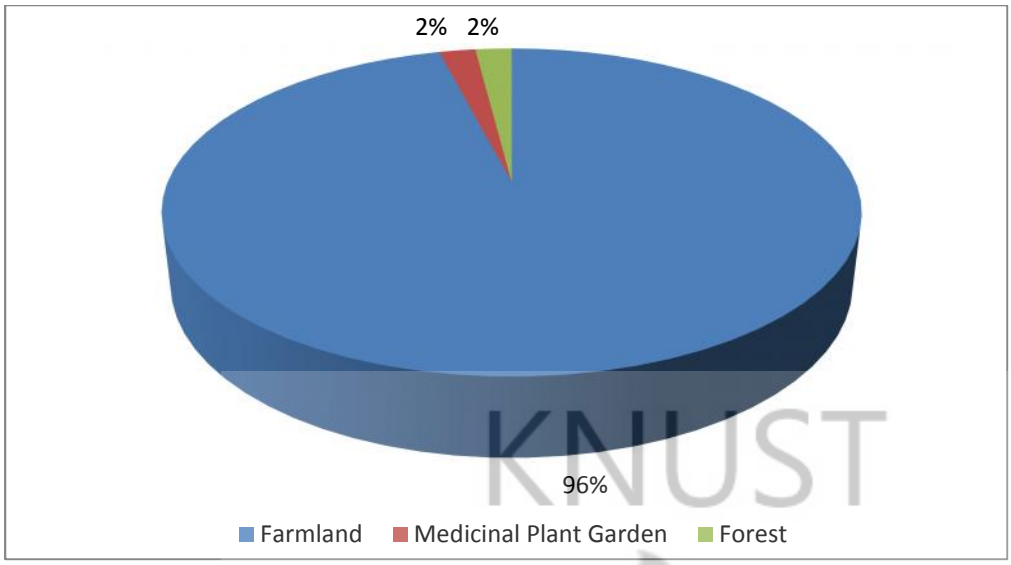

Figure 10: Percentage of respondents indicating location of medicinal plants harvested

4.3.6 Reduction in medicinal plants availability

Approximately 98% of the respondents were of the view that currently there was a reduction in the availability of medicinal plants. A total of eight species were indicated by the respondents to be on the decline in the study area. The medicinal plant most reported to be the decline was *Khaya ivorensis* (⅜). Other species reported to be on the decline were *Zanthoxylum gilletii* (¼), *Trichilia monadelpha, Strombosia glaucescens, Ricinodendron heudelotii, Lannea welwitschii, Petersianthus macrocarpus* and *Bombax buonopozense* (⅛). *K. ivorensis and Z. gilletii,* the two most reported plant species on the decline along with *Bombax buonopozense* incidentally were not encounted in the sacred grove. However, other species including *Trichilia monadelpha, Strombosia pustulata, Ricinodendron heudelotii, Lannea welwitschii* and *Petersianthus macrocarpus* were among some of the species found in the sacred grove though their populations were not high.

4.3.7 Reasons for reduction in medicinal plants

Approximately 98% of the respondents were of the view that currently there was a reduction in the availability of medicinal plants. About 33.6% of the respondents attributed the decline to bush fires basically as a result of hunting; 25.9% blamed weather changes such as drought, and intense insolation by sunshine: and 30.2% believed that land clearing for farm expansion and infrastructural development due to population increase was another reason for the decline in availability of medicinal plants. About 5.2% also reported that soil degradation due to spraying of agrochemicals on cash crops grown in the area e.g. cocoa and oil palm could have contributed to the decline and survival of medicinal plants. Urbanisation may also have a role in the near extinction of medicinal plants n the study area (Table 7).

Table 7: Reasons attributed to the decline in population of medicinal plant species in the study area

Reasons	Percentage (%)
Bush fires due to hunting	33.6
Weather changes due to too little rain, intense sunshine and drought	25.9
Soil degradation due to insecticide spraying on crops	5.2
Lack of knowledge on the importance of medicinal plants	1.7
Phenological changes	0.9
Land clearing due to farm expansion and infrastructural development	30.2
Doesn't think plants are declining	0.9
Urbanization	1.7

4.3.8 Mitigating measures for decline in population of medicinal plants species in the study area

On how to address the issue of reduction of medicinal plants, about 46.2% of the respondents suggested the need to replant trees or embark on reforestation programmes whereas 23.1% mentioned the need for fire prevention. Others suggested the need to protect/conserve forests or areas with medicinal plants (11.0%), cultivation of medicinal plant gardens/farms (7.7%), the need for education on the importance of medicinal plants and to conduct research (5.5%), the need to control insecticide spraying on cash crops in farmlands (4.1%) and the need to conserve trees on farms and also to document information on medicinal plants (1.1% each) as some of the ways to address the decline of medicinal plants (Table 8).

Table 8: Mitigation measures for sustaining population of medicinal plant species in the study area

	How to address reduction	Percentage (%)
1	Avoid bush fires	23.1
2	Reforestation or replant trees	46.2
3	Conserve trees on farms	1.1
4	Control insecticide spraying on crops	4.4
5	Replanting of medicinal plants in farms/gardens	7.7
6	Conserve/protect forests or areas with medicinal plants	11.0
7	The need for education and research	5.5
8	Document information on medicinal plants	1.1

CHAPTER FIVE

5.0 DISCUSSION

5.1 Floristic composition of the sacred grove

5.1.1 Classification of plant species

Out of the total 12,580 individual plant species recorded in the 1.0 ha plot of the sacred grove, woody species predominated (93%) followed by non-woody species (7%). This may be due to the fact that woody species such as trees, shrubs and some climbers (lianas) are available all year round in constrast with herbs which depend basically on availability of rainfall to thrive. Data from this thesis shows that, 37 plant species (constituting 73% of the woody plants) found in the grove had medicinal value. This implies that, the inhabitants would be assured of the continuous availability of medicinal species all year round as observed by Diame (2010).

A total of 175 different plant species were identified in the one hectare plot of the sacred grove belonging to 53 families and 133 genera. The total number of plant species identified in the one hectare plot was very high considering the fact that about 60 to 70 species per hectare were obtained in a West African tropical rain forest by Diame, (2010). The most dominant families were Annonaceae, Apocynaceae, Euphorbiaceae, Fabaceae, Meliaceae, Rubiaceae, Sapindaceae, and Sterculiaceae. Some studies have found that medicinal plants used by various people belong to some of these families especially Sterculiaceae and Euphorbiaceae (Addo-Fordjour *et al*., 2009 and Diame, 2010). The most frequently encountered species were *Trichilia prieureana*, *Griffonia simplicifolia*, *Celtis mildbraedii*, *Blighia unijugata*, *Blighia sapida*, *Nesogordonia papaverifera*, *Baphia nitida*, *Pterogota macrocarpa*, *Sterculia rhinopetala*, *Nichallea soyauxii*,

Sterculia oblonga, *Napoleonaea vogelii*, *Cola gigantea*, *Motandra guineensis* and *Funtumia elastica*. Most of these plants are typical semi- deciduous forest species.

5.1.2 Diversity of plant species

A diversity index is the measure of species diversity in a given community. Diversity is different from species richness in that unlike richness it also shows community composition and takes into account the relative abundance of species that are present in the community (Giliba *et al*., 2011). Because diversity indices provide more information than simply the number of species, they serve as valuable tools that enable biologists to quantify diversity in a community and describe its numerical structure (Beals *et al*., 2000). A high value of Shannon Index (H) would be a representative of a diverse and equally distributed community and lower values represent less diverse community. An ecosystem with H value greater than 2 has been regarded as medium to high diversity in terms of species (Giliba *et al*., 2011).

A Shannon index of 3.51 recorded implies that the sacred grove has high species diversity and probably has seen little or no disturbance considering the fact that most sacred groves are often perfectly intact relics of original forests (Abbiw *et al*., 2002) and that different levels of disturbance have different effects on plant diversity (Beals *et al*., 2000). Addo-Fordjour *et al*. (2009) equally recorded quantitatively higher plant diversity (H) in undisturbed forest type than in disturbed and disturbed-invaded forest. A Simpson's diversity index of 0.95 may mean that about 95% of the plant species are evenly distributed and belong to different genera. Knowledge about the diversity of the sacred grove is equally important if any conservation measure is ever to

be put in place since one would need to understand how diversity is impacted by different management strategies (Beals *et al*., 2000).

5.1.3 Composition of plant species by life forms

Tree component dominated (58%) followed by climbers (31%), shrubs (6%) in descending order and herbs were the least (3%). The high populations of tree and also the presence of shrub plants species identified in the grove may indicate that timber and medicinal plant species abound in the grove. Maundu *et al*. (2006) observed that many medicinal plants are trees species which also take a long time to mature. The high dominance of trees serving as medicinal plants also means in a situation where they are used for timber, continuous logging of natural stands can significantly reduce their populations (Diame, 2010). Where there also are no clear cut policies on exploitation of medicinal plants used for medicine and timber, there can be over-exploitation by both timber contractors and forest fringe communities. Tandon (2006) reported that the absence of policy or its failure represents the bigger threat to loss of medicinal plant diversity and its ultimate impact on livelihoods and health.

Climbers contribute to the taxonomic diversity of tropical forests. Generally they make up about 25% of the diversity of all higher plants (Bongers *et al.,* 2005). Climbers constituted up to 31.3% of the flora in the surveyed area. The presence of high population of climbers indicates that the grove has seen some form of disturbance whether human induced or natural. This observation agrees with that of Bongers *et al*. (2005) who observed that climbers abundance seems to be first of all determined by disturbance regimes and whether the forest is continuous or fragmented. However, the presence of a lower population of herbaceous plant species indicates that the grove

is intact and with very little disturbance (Owusu-Sekyere, 2008). The high population of trees and climbers observed is in line with the observation by Tchouto (2004) who found that tree species richness seems to have a strong positive correlation with that of liana, indicating that tree species richness may be a good indicator for liana species richness. This is because woody climbers depend on trees for their support.

5.1.4 Ecological guild of plant species

An important indicator of the ecological status of the flora of the grove is the species composition by ecological guild. The analysis showed shade bearers to be dominant (33%) whereas Non Pioneer Light Demanders and Pioneers occurred with proportions of 24% and 30% respectively. Collectively, there were more Shade Bearers and non pioneer light demanders altogether (57%) than Pioneers (30%). The Pioneer species may have regeneragted in the canopy gaps within the demarcated 1.0 ha study plot. The plant species that require light for germination and survival (ie Light Demanders, (LD) were absent (0%).

The sacred grove by the criterion of ecological guild, is fairly intact with little anthropogenic disturbance. This could also mean that though the sacred grove has had some disturbances, not too many gaps were created for rapid colonisation by Pioneers species or that they failed to survive in the gaps created (Owusu-Sekyere, 2008). It can be conjectured that the sacred grove has been well protected and managed by existing traditional beliefs enacted several years ago even in the face of current ecological and human threats.

5.2 Ethnobotanical studies

5.2.1 Demographics of respondents

Males constituted the majority (53%) of the respondents, although, females were also fairly represented (47%). The higher proportion of males interviewed is in agreement with the findings of Togola *et al*. (2005) who reported that men dominated in the practice of traditional medicine in Africa than women. However, other studies including Diame (2010) and Camejo-Rodrigues *et al*. (2003) found women to be more dominant than men in the practice of traditional medicine. The disparity could be because, in this study, most of the women approached were reluctant to be interviewed and even demanded money in some cases in order to provide the needed information.

The age of the respondents ranged between 27 and 90 with a majority of the respondents (58.49%) being above 50 years. This supports the findings of Mahindapala (2006) that, the majority of traditional knowledge and ethnobotanical information remains the preserve of elderly practitioners. This implies that, the passing away of these elderly practitioners connotes the loss of this precious traditional knowledge particularly in cases where such wealth of knowledge has not been passed on to other younger generations. Addo-Fordjour *et al*. (2000) observed that, this development can pose a threat to the conservation of medicinal plants since these elderly traditional healers may die without passing on their knowledge.

The religious disposition of a group of people from what they have previously been used to may influence the value they put on medicinal plants (Voeks and Leony, 2004). A majority of the respondents were Christians (90.57%) with only 9.43% being traditionalists. This observation

may have a great impact on the value the inhabitants put on biodiversity including medicinal plants. For instance, the Christian religion teaches that all creation is a loving act of God and that humanity may not destroy God's creation without the risk of destroying itself. This belief can greatly result in conservation of biological resources. For instance Dudley *et al*. (2005), noted that, so-called prayer trees, which are ancient trees once used by Christian communities in Estonia to attach papers or clothes containing prayers still remain as important sites of biodiversity although the custom has virtually been abandoned.

However, Voeks and Leony (2004) observed that indeed, folk healers and their oral traditions may well be at greater risk of extinction than their healing habitats because of the negative toll religious change has had on medicinal plants. Most often, the advent of western religion into an area has often spelt doom for belief in local healing traditions of medicinal plants. This implies that unless the people are continuously educated on the importance and great value of medicinal plants the loss of traditional knowledge and ethnobotanical information would be inevitable if the religious disposition of the inhabitant changes.

Agbovie *et al.* (2002) reported that increasing Christianity in the villages and away from traditional spiritual beliefs have resulted in the difficulty to find some plants which used to be grown in most villages for its medicinal value. Kulip (2003) also observed that, restriction from religion among several factors such as loss of interest of the younger generations and heavy dependence on modern medicine contributed to the loss of popularity and knowledge of plants with traditional uses.

5.2.2 Most important identified medicinal plant species

The use of plants as medicines plays an important role in the daily health care needs of people wherever they occur. Thirty-five medicinal plants were identified as most important due to the high numbers of refernces to use in herbal therapy they received. *Alchornea cordifolia* was cited as the most important medicinal plant species (26.42%). Diame (2010) reported *Alchornea cordiflora* to be one of the most frequently used species in her study and noted that the plant was frequently used to treating candidiasis and also for the treatment of abdominal pains during pregnancy as well as in other pregnancy and reproductive health related issues. Other species found to be equally important to the respondents included *Bombax buonopozense* (24.53%), *Cleistopholis patens* (22.64%), *Ocimum gratissimum* (22.64%), *Khaya ivorensis* (22.64%), *Alstonia boonei* (20.75%), *Paullinia pinnata* (20.75%), *Tetrapleura tetraptera* (18.87%), *Phyllanthus melleri* (18.87%) and *Baphia nitida* (15.09%).

Coincidentally these plants have been found to be commonly reported as having therapeutic medicinal properties by several authors (Irvine, 1961; Abbiw, 1990; Busia, 2007; Addo-Fordjour, 2009; Caldwell, 2010; Diame, 2010). For instance, Busia (2007) reported that a number of medicinal plants in Ghana's flora been found to be therapeutically useful through investigations and hence their rational uses in tradition or allopathic medicine. These medicinal plants are probably important to the people because of its usefulness in treating various common ailments.

This shows that some medicinal plants are more important to a particular group of people than others. MAPPA (2010) observed that, local communities tend to utilize most popular plant

species, leading to over-harvesting. Maundu *et al*. (2006) also reported that, increasing scarcity of popular species usually was followed by increased prices, which in turn, resulted in greater incentives to harvest the remaining stocks. Consequently, harvesting can lead to depletion of the quantities in the field.

Important medicinal plants need immediate conservation strategies in order to avoid their over-exploitation. This is because with the high importance attached to these plants, there is the possibility of overexploitation in a situation where demand becomes high. The situation could be worsened especially where no appropriate conservation measures are in place to ensure their continuous availability or where no other plant substitutes have been identified. Anbarashan and Anbarashan (2010) stated that, with potentially valuable species there should be cultivation and establishment of medicinal farms to prevent extinction.

5.2.3 Medicinal plant parts used, mode of harvesting and its implications for conservation

Different parts of plants ranging from roots and root bark, bark and stems, latex and sap, leaves, buds and flowers, and seeds are used in formulation of herbal remedies (Hamilton, 2008). Different plant parts were used to treat different diseases but most of the medicinal formulations involved predominantly the use of leaves (46.9%), bark (27.1%) and roots (17.9%) as observed in other studies (Acharya, 2012; Diame, 2010; Addo-Fordjour *et al*., 2009). In some instances, the same part of the plant was used to treat different kinds of diseases. For instance, the bark of *Alstonia boonei* was used for the treatment of measles, fever, menopause, waist and breast problems.

The part of the plant used as well as the growth and reproductive characteristics of the plant will have important implications in the timing for harvest and its vulnerability to overexploitation (Brown, 1992). Caldwell, (2010), stated that the method of harvesting is related to the preference of the plant parts for the formulation of medicines. Respondents reported leaves plucking, bark slashing and roots cutting respectively as the main harvesting methods employed on medicinal plants.

Harvesting methods can impact conservation because some types of harvesting are more sustainable than others. For instance, harvesting leaves may be more sustainable because of regeneration by new flushes of leaves in constrast with the bark which may not be fully regenerated over a long period. Harvesting bark and roots of tree species may pose a threat to sustainable harvesting (Hamilton, 2008). For example, Agbovie *et al*., 2002 reported that *Cryptoplepis sanguinolenta* in Ghana is principally threatened by wild collection because it is the root that is harvested, Maundu *et al*. (2006) also showed that over-harvesting, particularly of seeds, can reduce the regeneration potential of a species.

5.2.4 Different forms in which medicinal remedies are applied in herbal therapy

Medicinal plants play a vital role in the maintenance of human health throughout the world and especially in the tropics (Agbovie *et al*., 2002). The medicinal plants list in Table 4 (Appendix H) showed that these plants were used for 66 medicinal purposes. The medicinal were predominant for fever with 45 (11.3%) followed by treatment for anaemia (6.3%) and pregnancy (6.0%). In Table 4 (Appendix H) others included treatment for infertility (1.0%), ringworm (0.3%), fibroid (0.5%) and boils (0.8%). Majority of these uses agrees with the findings of

Caldwell (2010) who reported the treatment of fever, stomach pain, anaemia, cuts, rashes, colds, body pain and headache as the most frequently treated.

Medicinal remedies were administered in different forms predominantly as decoctions (38.1%), poultices (24.5%), concoctions (13.6%) and tinctures (12.2%) (Fig. 4). Medicines were also administered in the powder form (10.0%) and also as infusions (1.4%). Busia (2007) reported that, many medicinal plants are used in our traditional medicines as crude drugs in various forms as whole plants, crude extract, powdered, decoctions, dried extracts, infusions, poultices and tinctures.

5.2.5 Sources of medicinal plants collection

Majority of the respondents (96%) harvested plants used for medicinal remedies from their farms with only 2% each harvesting plants from the forest or their medicinal plants farm respectively. This contrasts the findings of Hamilton (2008) who stated that a great majority of species of medicinal plants are harvested in the wild rather than cultivated. However, most of the respondents mentioned the source of their medicinal remedies as their farms and it is possible that these farmlands were previously forest lands. Most of the medicinal plant species the respondents used occur in more than one habitat. An implication of this finding is that the inhabitants could easily have access to medicinal plants because they were found on their farms. The easy accessibility to medicinal plants can promote intense use and consequently unsustainable harvesting with the possibility of overexploitation. Batugal (2004) showed that harvesting of medicinal plants by cash-needy collectors to supply the growing urban and international markets has increasingly intensified exploitation and rendered these materials

cheaper and more accessible. This means that unless other ex-situ means of cultivation of medicinal plants practiced, with time, the availability of medicinal plants for the various communities will be greatly reduced.

5.2.6 Threats to sustainable harvesting of medicinal plants and proposed conservation methods

Although increasingly the importance of plants to the health delivery system of people has been recognised, the continued availability of many of these plants is at risk (UNEP-WCMC, 2002). Approximately 98% of the respondents were of the view that currently there was a decline in the availability of medicinal plants. This observation agrees with the findings of Hamilton (2008) who stated that, the revival and use of medicinal plants in health delivery has resulted in undesirable outcomes with about 15,000 species of medicinal plants now globally threatened.

Threats to medicinal plant diversity as reported by several authors is due to a range of factors including a rapidly increasing human population, high rates of habitat loss and modification, deforestation, over-exploitation, fire, the spread of invasive alien species, pollution and climate change (McNeely, 2006; Hamilton, 2008; Secretariat on CBD, 2009; Siaw and Dabo, 2009).

Fire is said to cause changes which depending on its compatibility with one's objective or use of the resource could be desirable or not (NWCG, 1989). About 33.6% of the respondents reported bush fires as a factor accounting for the decline in medicinal plants population in the area. Siaw and Dabo (2009) stated that, fire can wipe out species which hitherto have been common and cause such species to become rare. Furthermore, they reported the incidence of fire can result in

the loss of important species which may be of medicinal values since these species may not be able to withstand the effects of the fire.

Climate change has become increasingly recognized as one of the greatest challenges to humankind and all other life on earth. Worldwide changes in seasonal patterns, weather events, temperature ranges, and other related phenomena have all been reported and attributed to global climate change (Cavaliere, 2009). Also about 25.9% of the respondents stated that weather changes such as drought, too little rain and intense sunshine are factors contributing to the decline of medicinal plants. Cavaliere (2009) agrees that climate change is causing noticeable effects on the life cycles and distributions of the world's vegetation, including wild Medicinal and Aromatic Plants (MAP's). The result of this threat would be that, some MAPs which are endemic to geographic regions or ecosystems particularly vulnerable to climate change would be at risk of eventual extinction if this threat is not curtailed (Cavaliere, 2009).

Also a rise in global temperature will increase the extinction rate of plant species (Secretariat on CBD, 2009). Extreme weather events already impact the availability and supply of MAPs on the global market, and projected future increases in extreme weather are likely to further negatively affect MAP yields. Some studies have demonstrated that temperature stress can affect the secondary metabolites and other compounds that plants produce (Cavaliere, 2009) which are usually the basis for their medicinal activity. Climate change can affect medicinal plants patterns such as phenology and distribution (IPCC, 2007). Cavaliere (2009) observed that, shifting phenologies and distributions of plants could ultimately endanger wild MAP species by disrupting synchronized phenologies of interdependent species, exposing some early-blooming

MAP species to the dangers of late cold spells, allowing invasives to enter MAP species' habitats and compete for resources, and initiating migratory challenges, among other threats.

Habitat destruction is currently ranked as the most important cause of species extinction worldwide (Pimm and Raven, 2000). About 30.1% of the respondents reported land clearing for farm expansion and infrastructural development due to population increase as one of the reasons for the decline in medicinal plants availability. This observation agrees with the finding of Kulip (2003) who states that opening of forests for agricultural development and timber harvesting makes medicinal resources scare. Habitat destruction as a result of logging and expansion of farms, as well as unsustainable harvesting of non-timber forest products such as rattans and medicinal plants were identified as key threats to over 60% of Nigeria's endangered plant and animal species which are found within the forests of south west part of the country (Maundu *et al*., 2006). Habitat conversion threatens not only the loss of plant resources but also traditional community life, cultural diversity, and the accompanying knowledge of the medicinal value of several endemic species (CAI, 2004).

Naturally, as habitat disappears, so do those species that depend on the habitat. Indeed, habitat loss in Ghana is considered one of the major threats to survival of medicinal plants (Brown, 1992). Habitat destruction appears to be the most important of all the factors that threatens medicinal plants and any measure to conserve and sustainably use medicinal plants should address this (Maundu *et al*., 2006). Habitat destruction can equally affect substances produced by medicinal plants which give them their efficacy. Rao and Arora, (2004) reported that some medicinal plant species tend to exhibit varied biochemical pathways as well as the production

and storage of substances such as alkaloids, oils or other components or such substances are entirely absent when these species grow under different conditions or even at adjacent locations.

There is overwhelming documented evidence indicating that plant genetic diversity, including medicinal plants, is drastically being eroded in many parts of the world especially in areas where high human population density, unplanned urbanization and massive deforestation are common (Batugal, 2004; Haque, 2004). A high population growth rate increases demand for herbal medicine that also results in several issues such as urbanization. Urban centres tend to provide ready markets for medicinal plants (Maundu *et al*., 2006). The threat of increasing population means that there may be increased demands for medicinal plants in the area which with time will result in this precious resource becoming scare especially where other means to ensure its continuous availability is not instituted. This agrees with the findings of Chapman and Chomchalow (2004) who reported that as a result of population explosion in most Asian countries, medicinal plants which until recently was collected from the wild have almost ceased completely since they are becoming scarce or have been wiped out due to over extraction.

On how to ensure the conservation of medicinal plants, about 46.15% of the respondents mentioned the need to replant trees or embark on reforestation programmes. This agrees with the finding of Chapman and Chomchalow, 2004 who reported that cultivation may ensure conservation of endangered species in their natural habitat, continued supply of medicinal plants and income to farmers. Whereas 23.1% reported the need to put in place various measures to prevent or avoid bush fires. Siaw and Dabo (2009) observed that the incidence of fire can result

in the loss of important species which may be medicinal since these species may not be able to withstand the effects of the fire.

Seven point six-nine percent (7.9%) reported on the need to cultivate medicinal plant gardens/farms to offset the decline of medicinal plants. This agrees with the finding of Chapman and Chomchalow (2004) who found that cultivation, whether on a small or large scale, backyard garden or subsistence can reduce the pressure on collecting medicinal plants in the wild. However, Maundu *et al*. (2006) found that cultivation as an alternative to over-exploitation of scarce medicinal plants has not been successful in Africa due to the lack of support for production and dissemination of key species for cultivation by the state, lower prices paid for traditional medicinal plants by herbal medicine traders and urban herbalists, and the fact that many good medicinal plants are trees that take a long time to mature and thus is cheaper for harvesters to harvest from the wild. They, however, stated that if cultivation is to be successful as an alternative supply to improve the self-sufficiency of traditional medical practices and take harvesting pressure off wild stocks, then plants have to be produced cheaply and in large quantities in order to compete favourably with material obtained from the wild. Cultivation in urban areas, especially for herbaceous plants, needs to be encouraged.

Indigenous and local communities are concerned that the rate of knowledge erosion has never been as high as it is in the current generation, and that such knowledge erosion poses an even more serious threat to the conservation of biological diversity than resource erosion (CAI, 2004). About 1.1% of the respondents mentioned documenting information on medicinal plants as another way to address the decline of medicinal plants. The call for documentation by the

inhabitants of the areas echoes similar calls by Busia (2007) who found that the lack of documentation of our medicinal plants constitutes a serious drawback to our traditional medicine. CAI (2004) also reports of the urgent need to formulate an array of incentive measures to ensure that members of the younger generations learn, value, adapt and apply the traditional knowledge, innovation and practices of their elders in the effort to stem the loss of knowledge associated with medicinal plants. Ethnobotany, which is the study of the interactions and relationships between plants and people over time and space or the knowledge on plants held by a group of people (Ngugi, 2010) is invaluable to the documentation of traditional knowledge on various uses of plants including uses for medicinal purposes.

5.3 The importance of the Asantemanso sacred groves in medicinal plants conservation

Protected areas are useful for conserving medicinal plants as they are for biodiversity generally (Hamilton, 2008). Protected areas such as sacred groves are one of the first instances of traditional conservation. They possess a great heritage of diverse gene pool of many forest species having socio-religious attachment and possessing medicinal values. A total of 175 plant species belonging to 53 families were enumerated in the sacred grove. Out of the 175 plant species, 37 plants representing 21.14% were indicated to be medicinal. The results show that the sacred grove is an important source of plants for medicinal remedies. 21.14% of the plant species enumerated in the sacred grove were confirmed as medicinal by the respondents.

Though a greater percentage of about 78.86% were not indicated to be used for medicinal purposes by the respondents it does not necessarily mean they do not possess medicinal properties. This may only mean that their medicinal value has not yet been discovered by the

inhabitants of the area and also indicative of the fact that indeed the sacred grove is a reservoir of medicinal plants. The other medicinal plants mentioned could probably be sourced from other places such as their farms, other forest ares and also from their medicinal plants garden.

The small number of medicinal plants found to occur in the sacred grove cannot be attributed mainly to over-harvesting or over-exploitation of these plants. This is because there are strict rules governing the sacred grove such as no one being allowed to enter the grove on Tuesdays which is a taboo day. Again, the Asantemanso forest is a virgin forest and worshipped as a god: hence, nobody is allowed to cut anything from it unless prior permission is sought from the Paramount Chief and the entire Essumegya Traditional Council (Person. Comm., Queenmother of Essumegya, 2010). These are some of the traditional methods that have been used to ensure the preservation of the grove. This puts forward the importance of continuously monitoring the sacred grove or to ensure its conservation as well as preservation for posterity.

Sacred groves are ecologically and genetically very important. They are the abodes of rare, endemic and endangered species of both flora and fauna (Anthwal *et al*., 2006). Five plant species namely *Trichilia monadelpha, Strombosia pustulata, Ricinodendron heudelotii, Lannea welwitschii* and *Petersianthus macrocarpus* out of the eight plant species indicated to be on the decline by the respondents through the survey were found to occur in the sacred grove even though their populations were not so high.

Khaya ivorensis and Zanthoxylum gilletii, the two most reported plant species to be on the decline along with *Bombax buonopozense* incidentally were not enumerated in the sacred grove.

However, other species including *Trichilia monadelpha, Strombosia pustulata, Ricinodendron heudelotii, Lannea welwitschii* and *Petersianthus macrocarpus* were among some of the species found to occur in the sacred grove though their populations were not high.

The plant species inventoried through the floral survey shows that indeed the Asantemanso Sacred Grove is a site of importance for biodiversity conservation and as such should be protected. This observation agrees with the findings of Brown (1992) that in many parts of West Africa, forest areas and specific trees are protected and valued for particular cultural occasions and as historic symbols and that each community has its own traditions associated with sacred areas, and as a result the species found in them vary greatly. The groves are often the site for ritual healings and the location where medicinal plants can be found. Dudley *et al*. (2005) reported that most sacred groves in Ghana are associated with particular taboos and forms of protection for particular species of plants and animals.

5.4 Conservation status of species identified in the sacred grove

A challenge to overcome when it comes to maintaining Ghana's forest diversity is to ensure that natural forests are well preserved ones and at the same time threats to forest integrity and associated diversity are minimised. To do this, requires that every species value (commercial, genetic or ecological) is fully understood (Siaw and Dabo, 2009). Plants species were recorded under eight (8) status or star ratings as Black, Gold, blue, Scarlet, Red, Pink, Green and Unknown.

Green star rated species were the most dominant (71%) which implies that most of the species found in the sacred grove can equally be commonly found elsewhere. However, two Black Star rated species in the sacred grove *Hippocratea vignei* and *Tapura ivorensis* representing 1% are species requiring urgent conservation because they are rare internationally and very uncommon in Ghana. Scarlet, Red and Pink Star rated species, though common in Ghana but threatened by various degrees of exploitation were 1%, 4% and 7%, respectively.

The presence of Black star rated species as well as other Scarlet, Red and Pink star rated species which are threatened by various degrees of exploitation indicate that the Asantemanso Sacred Grove is not only a habitat for rare or endemic species but also may be a relic forest for plant species that may be under serious threats of extinction and therefore the grove should be well managed and protected. This is in line with the observation by Anthwal *et al*. (2006) that sacred groves are ecologically and genetically very important because they are the localities of rare, endemic and endangered species of flora.

Conservation value can also be interpreted in terms of whether a site is serving as a good and undisturbed habitat for a plant species or otherwise (McElhinny, 2002). Hawthorne and Abu-Juam (1995) reported that species that are endemic, rare, threatened, or likely to represent a scarce genetic resource, are more valuable than others. Hence, forests richer in such species receive a higher score than others. Because a higher percentage of the vegetation was composed of species that are currently of no conservation concern because they are common, the conservation value of the Asantemanso Sacred Grove should have been rated as low. However the presence of these Black star rated species (which are species of highest priority when it

comes to conservation) alongside Scarlet, Red and Pink Star rated species (which are species though common in Ghana but threatened by various degrees of exploitation) gives the sacred grove a good conservation value. This implies that the sacred grove is serving as a good and an undisturbed habitat for these high conservation priority species.

Tchouto (2004) also reported of the high conservation value and uniqueness of the Campo-Ma'an forest in south-western Cameroun because the site combined many vegetation types with species of high conservation priorities such as endemic, rare, new and threatened plant species. It is important to know which species are of high conservation priorities and where they are located, so that conservation resources can be targeted at these locations. An assessment of which species are threatened also allows resources for species conservation to be prioritized (Secretariat of the CBD, 2009).

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Plants are a vital component of biodiversity and components of a healthy ecosystem. They provide a range of ecosystem services and resources including food, fibre, fuel, shelter and medicines. The use of plants is faced with many constraints including rampant destruction of plant-rich habitats leading to their extinction or scarcity. The importance of traditional protected areas such as sacred groves in conserving biological resources such as plants using traditional approaches is recognized. Inventory and documentation ensures information is available to maximize the use of plants in a sustainable way.

A total of 175 plant species were identified in the sacred grove comprising of 53 families and 133 genera. The most dominant families included Fabaceae, Rubiaceae and Euphorbiaceae. Some of the most frequently occurring species were *Trichilia prieureana* (9.86), *Griffonia simplicifolia* (13.55), *Celtis mildbraedii* (4.98), *Blighia unijugata* (4.39), *Blighia sapida* (3.79) and *Nesogordonia papaverifera* (5.76). Tree species dominated (58%) as life form followed by climbers (31%), shrubs (6%) and herbs (3%).

Plants species categorised into eight (8) star ratings showed Green star species to be the highest (71%), followed by Blue star rated species with 7%. Two Black Star rated species *Hippocratea vignei* and *Tapura ivorensis*, were also recorded in the sacred grove. The presence of these Black star rated species as well as other Scarlet, Red and Pink star rated species which are threatened by various degrees of exploitation indicate that the Asantemanso Sacred Grove is not only a

habitat for rare or endemic species but also may be a relic forest for plant species that may be under serious threats of extinction.

Medicinal plants play a vital role in the maintenance of human health throughout the world and notably in the tropics. A total of 151 different medicinal plant species documented were used for various medicinal purposes such as fever, piles, cough, waist pains, anaemia, blood pressure, headache, rheumatism, broken bones, convulsion, stomach problem and to help maintain pregnancy. Euphorbiaceae was the most dominant family. For most of the plants different parts cured different diseases but medicinal remedies involved predominantly the use of leaves – 46.9%; bark – 27.1%; roots – 17.9%; seed – 2.4% and flowers and fruits – 1.9 and 3.9% respectively. Medicinal remedies were administered in different forms predominantly as decoctions (38.1%), poultices (24.5%), concoctions (13.6%) and tinctures (12.2%).

The most important (cited) medicinal plants reported included *Alchornea cordifolia* (26.42%), *Bombax buonopozense* (24.53%), *Cleistopholis patens* (22.64%), *Ocimum gratissimum* (22.64%), *Khaya ivorensis* (22.64%), *Alstonia boonei* (20.75%) and *Paullinia pinnata* (20.75%). These plants have been reported by several authors as being effective in their use for various medicinal purposes. Out of the total 175 plants species enumerated in the sacred grove, 37 (21.41%) of the plant species enumerated were indicated to be medicinal. This shows that the sacred grove is an important source of plants for medicinal remedies and also indicative of the fact that indeed the sacred grove is a reservoir of medicinal plants.

6.2 Recommendations

Further studies should be conducted to cover other areas of the grove because this is only one of the first ever botanical studies to be conducted within this grove.

There is the need to conduct educational campaigns so as to promote the understanding of the need to conserve medicinal plants and their habitats. There is also the need for more education on the importance of the sacred grove not only in terms of its species diversity but also because of the central role the grove plays in the history of the Ashanti kingdom.

There is also the need to protect or prioritise the conservation of plants species indicated to be important to the people especially those which were enumerated in the grove.

The various uses determined for the medicinal plants identified can be developed into a compendium of medicinal plants of the Asantemanso Sacred Grove and used as a tool to plan conservation programmes as well as boost the ecotourism potential of the area. There is also the need to conduct investigations into the efficacy of the medicinal plants identified.

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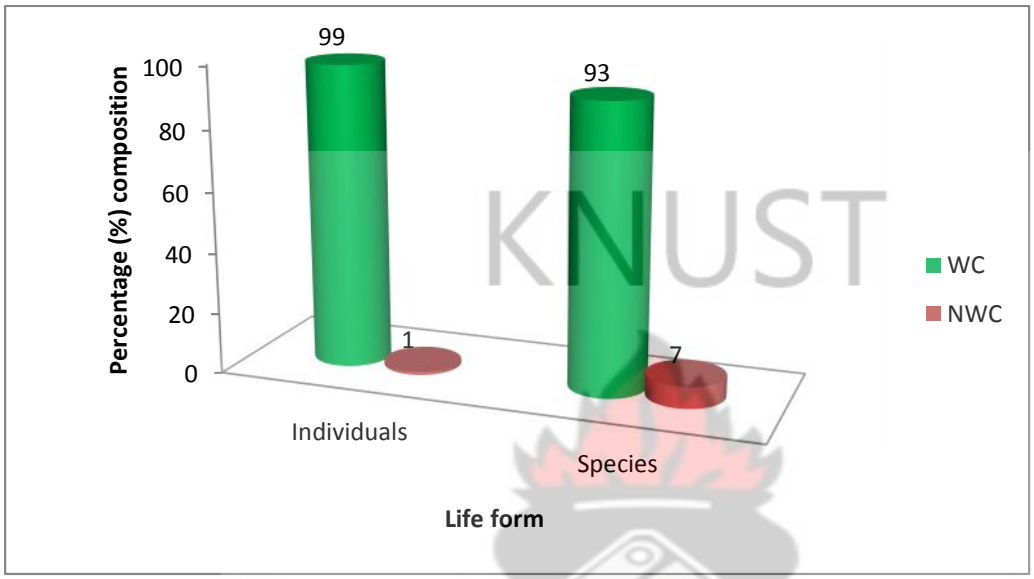
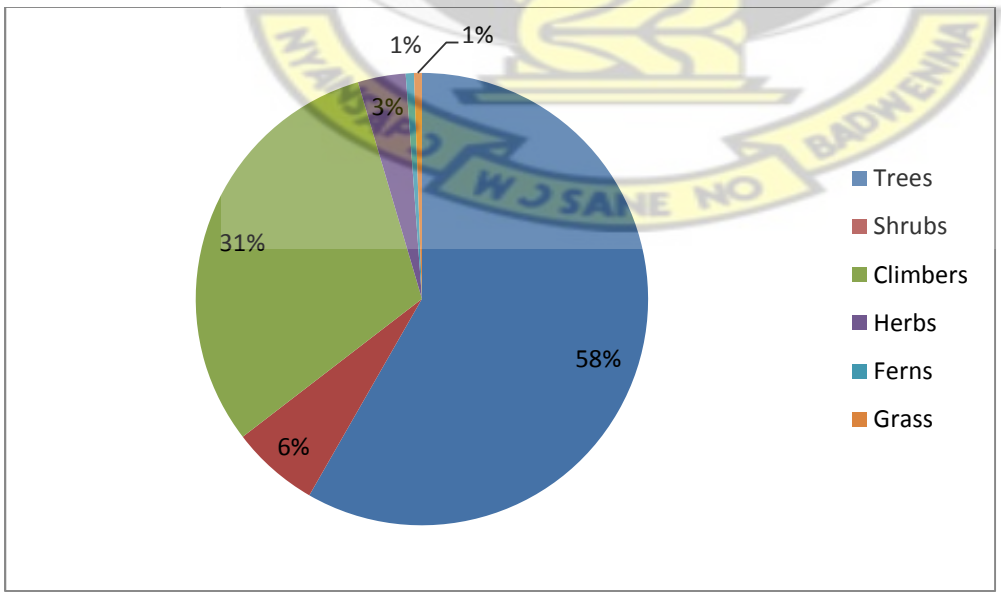
APPENDICES

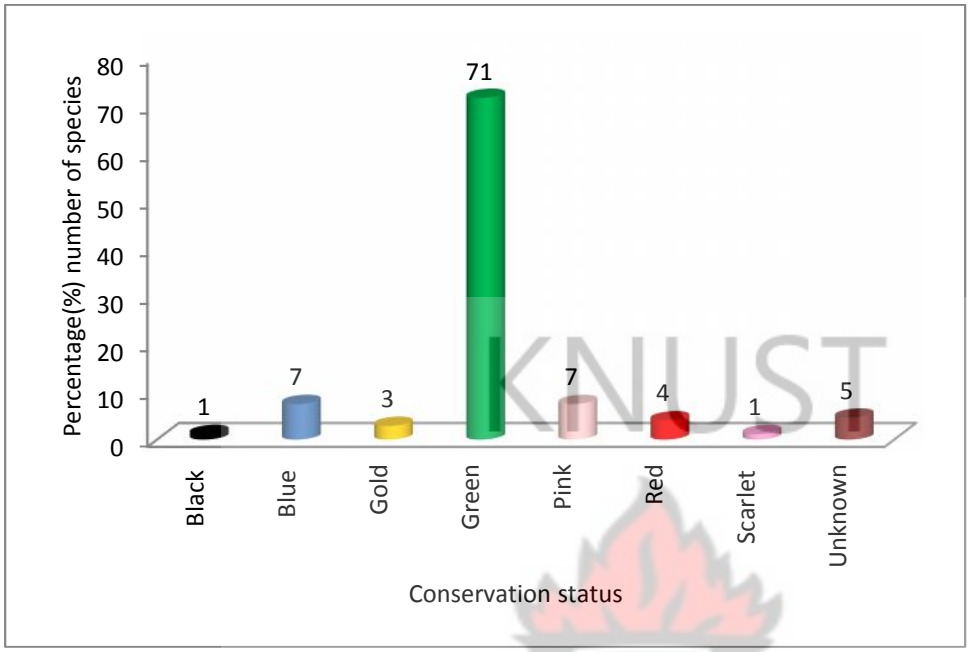
Inventory of plant species in the sacred grove



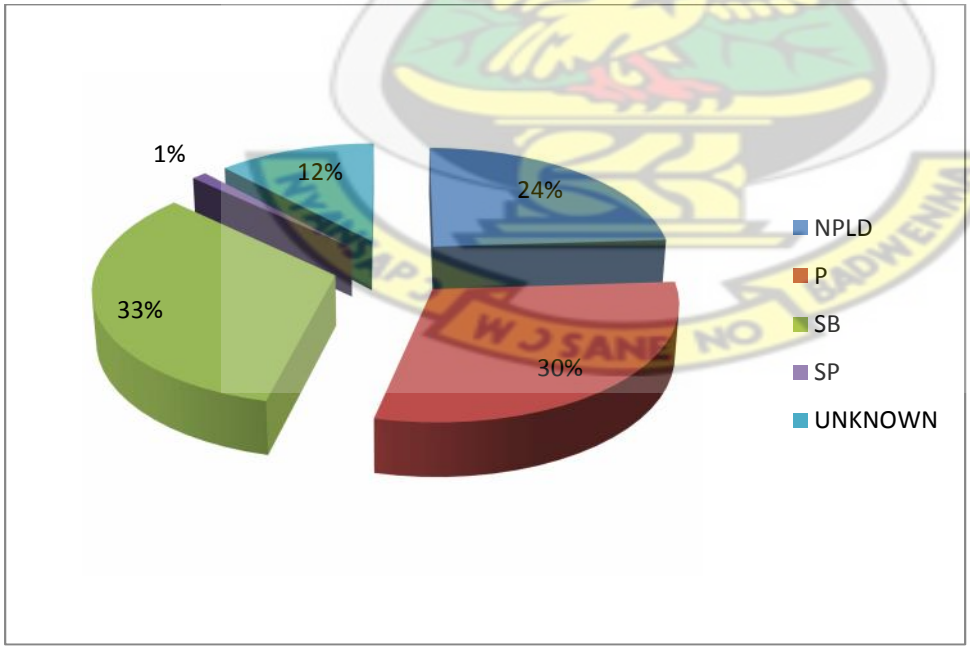
Appendix A: Percentage number of woody component (WC) and non-woody component (NWC) of individual plants and species



Appendix B: Percentage composition of life forms of sampled plant species



Appendix C: Percentage number of plant species in star rating conservation status



Appendix D: Percentage composition of sampled plant species by ecological guild

Appendix E: Questionnaire for the ethnobotanical studies

A. Personal Information

1. Name of Respondent:

2. Age:

3. Gender: Male: ☐ Female: ☐

4. Educational Status: Primary: ☐ Secondary: ☐ Tertiary: ☐

No formal education: ☐

5. Religion: Traditional: ☐ Christian: ☐ Islamic: ☐ Others: ☐

B. Ethnobotany of Medicinal Plants

6. What medicinal plants do you usually use

Local Name	Scientific Name

7. What diseases do they cure

Disease

8. In which forms do you administer the medicines: Powdered forms: ☐

Decoctions: ☐ Dried extracts: ☐ Infusions: ☐ Poultices: ☐

Tinctures: ☐

9. Where do you get your medicinal plants from: Sacred grove: ☐ Forest: ☐

Garden: ☐ Farm: ☐ Market: ☐ Others specify: ……..

9a. What tools do you use in harvesting your medicinal plants: Cutlass: ☐ Hoe: ☐

Hand sickle: ☐ Others specify: ……

10. How do you harvest the medicinal plants: Hand plucking: ☐ Bark slashing: ☐

Uprooting: ☐ Leaves plucking: ☐ Flowers plucking: ☐

Others specify: ……

11. What forms of plants are usually collected: Trees: ☐ Shrubs: ☐

Lianas: ☐

12. What plant parts are usually used: Leaves: ☐ Flowers: ☐

Fruits: ☐ Seed: ☐ Bark: ☐ Roots: ☐

13. What plant species are available recently:

List of Species	List of Species

14. Why are they available: Reasons…….

……

……

……..

15. What plants are on the decline:

Plant Species	Plant Species

16. What do you think accounts for their decline: Reasons…….....

…….....

……

…….....

17. What do you think should be done to address the decline of medicinal plants:…….....

……..…….....

…….....

…….....

.....

Appendix F: Percentage importance of reported medicinal plants

Scientific name	Frequency cited	Number of respondents	Percentage (%) importance
Abelmoschus esculentus	2	2	3.77
Abrus precatorius	5	5	9.43
Aframomum melegueta	4	2	3.77
Aframomum stanfieldii	3	2	3.77
Ageratum conyzoides	6	6	11.32
Albizia zygia	1	1	1.89
Alchornea cordifolia	15	14	26.42
Allium cepa	2	2	3.77
Alstonia boonei	11	11	20.75
Amaranthus spinosus	2	2	3.77
Ananas comosus	2	2	3.77
Anchomanes difformis	2	2	3.77
Anthocleista nobilis	5	5	9.43
Anthrocaryon micraster	1	1	1.89
Antiaris toxicaria	2	2	3.77
Arachis hypogaea	1	1	1.89
Aspilia africana	7	7	13.21
Axonopus compressus	4	4	7.55
Azadirachta indica	8	8	15.09

Appendix F Cont'd

Scientific name	Frequency cited	Number of respondents	Percentage (%) importance
Bambusa vulgaris	5	5	9.43
Baphia nitida	10	8	15.09
Baphia pubescens	4	4	7.55
Bidens pilosa	4	4	7.55
Blighia sapida	6	6	11.32
Boerhavia repens	6	5	9.43
Bombax buonopozens	14	13	24.53
Bryophyllum pinnatum	7	7	13.21
Caesalpinia benthamiana	7	7	13.21
Capsicum frutescens	4	3	5.66
Carica papaya	9	9	16.98
Carpolobia lutea	1	1	1.89
Ceiba pentandra	1	1	1.89
Cercestis afzelii	1	1	1.89
Chromolaena odorata	1	1	1.89
Chrysophyllum subnudum	1	1	1.89
Citrus limon	2	2	3.77
Citrus sinensis	2	2	3.77
Cleistopholis patens	13	12	22.64
Cocos nucifera	4	4	7.55

Appendix F Cont'd

Scientific name	Frequency cited	Number of respondents	Percentage (%) importance
Cola gigantea	2	2	3.77
Cola nitida	8	6	11.32
Combretum mucronatum	4	3	5.66
Commelina benghalensis	2	2	3.77
Corchorus olitorius	1	1	1.89
Costus dubius	1	1	1.89
Cussonia bancoensis	2	2	3.77
Cyathula prostrata	3	3	5.66
Cyclosorus striatus	2	2	3.77
Dalbergia welwitschii	1	1	1.89
Distemonanthus benthamianus	1	1	1.89
Dracaena mannii	1	1	1.89
Elaeis guineensis	11	8	15.09
Enantia polycarpa	4	4	7.55
Eremomastax speciosa	1	1	1.89
Erigeron floribundus	3	3	5.66
Euadenia eminens	3	3	5.66
Euphorbia hirta	3	3	5.66
Ficus sur	2	2	3.77
Funtumia elastica	7	7	13.21

Appendix F Cont'd

Scientific name	Frequency cited	Number of respondents	Percentage (%) importance
Glyphaea brevis	2	2	3.77
Gongronema latifolium	3	3	5.66
Gossypium hirsutum	1	1	1.89
Griffonia simplicifolia	2	2	3.77
Harungana madagascariensis	1	1	1.89
Heliotropium indicum	4	4	7.55
Hoslundia opposita	4	3	5.66
Hypselodelphys poggeana	1	1	1.89
Imperata cylindrica	5	5	9.43
Jatropha curcas	3	2	3.77
Justacia flava	7	7	13.21
Khaya ivorensis	12	12	22.64
Kigelia africana	3	3	5.66
Landolphia hirsuta	3	3	5.66
Lannea welwitschii	3	4	7.55
Lantana camara	1	1	1.89
Leonotis nepetifolia	1	1	1.89
Mallotus oppositifolius	3	3	5.66
Mammea africana	1	1	1.89
Mangifera indica	3	3	5.66

Appendix F Cont'd

Scientific name	Frequency cited	Number of respondents	Percentage (%) importance
Manihot esculenta	4	4	7.55
Manniophyton fulvum	3	3	5.66
Mareya micrantha	3	3	5.66
Margaritaria discoidea	1	1	1.89
Milicia excelsa	4	4	7.55
Millettia zechiana	1	1	1.89
Momordica charantia	6	6	11.32
Morinda lucida	4	3	5.66
Moringa oleifera	1	1	1.89
Morus mesozygia	1	1	1.89
Motandra guineesis	3	3	5.66
Musa indica	1	1	1.89
Musa paradisiaca	6	6	11.32
Musa sapientum	3	3	5.66
Musanga cecropioides	1	1	1.89
Nephrolepis biserrata	1	1	1.89
Newbouldia laevis	8	7	13.21
Nymphaea lotus	3	3	5.66
Ocimum gratissimum	13	12	22.64
Okoubaka aubrevillei	2	2	3.77

Appendix F Cont'd

Scientific name	Frequency cited	Number of respondents	Percentage (%) importance
Oplismenus burmannii	1	1	1.89
Parquetina nigrescens	4	4	7.55
Paullinia pinnata	11	11	20.75
Persea americana	5	5	9.43
Petersianthus macrocarpus	5	5	9.43
Phaulopsis barteri	3	1	1.89
Phyllanthus melleri	11	10	18.87
Phyllanthus urinaria	2	2	3.77
Piper guineense	2	1	1.89
Portulaca quadrifida	6	7	13.21
Pseudospondias microcarpa	1	1	1.89
Psidium guajava	5	5	9.43
Pycnanthus angolensis	9	8	15.09
Rauvolfia vomitoria	5	5	9.43
Ricinodendron heudelotii	6	6	11.32
Saccharum officinarum	1	1	1.89
Secamone afzelii	5	5	9.43
Senna alata	11	8	15.09
Senna occidentalis	8	7	13.21
Senna tora	1	1	1.89

Appendix F Cont'd

Scientific name	Frequency cited	Number of respondents	Percentage (%) importance
Sida acuta	4	4	7.55
Solanum anguivi	1	1	1.89
Solanum erianthum	3	3	5.66
Solanum torvum	8	7	13.21
Spathodea campanulata	7	7	13.21
Sphenocentrum jollyanum	4	4	7.55
Spondias mombin	3	3	5.66
Strombosia glaucescens	1	1	1.89
Strophanthus hispidus	1	1	1.89
Talinum triangulare	1	1	1.89
Tamarindus indica	2	2	3.77
Tapinanthus bangwensis	5	5	9.43
Tectona grandis	6	6	11.32
Terminalia catappa	3	4	7.55
Terminalia glaucescens	3	2	3.77
Terminalia ivorensis	1	1	1.89
Tetrapleura tetraptera	12	10	18.87
Theobroma cacao	7	7	13.21
Thevetia peruviana	3	3	5.66
Treculia africana	1	1	1.89

Appendix F Cont'd

Scientific name	Frequency cited	Number of respondents	Percentage (%) importance
Trema orientalis	3	3	5.66
Trichilia monadelpha	6	6	11.32
Trilepisium madagascariense	1	1	1.89
Triplochiton scleroxylon	1	1	1.89
Uapaca guineensis	2	1	1.89
Urera keayi	1	1	1.89
Vernonia amygdalina	4	4	7.55
Voacanga africana	4	4	7.55
Xanthosoma sagittifolium	5	5	9.43
Zanthoxylum gilletii	10	9	16.98
Zea mays	2	2	3.77
Zingiber officinale	5	4	7.55

Appendix G: Demographics of respondents

Respondent No.	Gender	Age	Educational status	Religion	Community
1	Male	63	No formal education	Christian	Essumegya
2	Female	56	No formal education	Christian	Essumegya
3	Male	90	No formal education	Christian	Essumegya
4	Male	72	No formal education	Christian	Essumegya
5	Male	38	Junior High	Christian	Essumegya
6	Female	90	No formal education	Christian	Essumegya
7	Male	70	Senior High	Traditional	Essumegya
8	Male	30	Junior High	Traditional	Essumegya
9	Male	74	Primary	Christian	Essumegya
10	Male	75	No formal education	Christian	Essumegya
11	Female	87	No formal education	Christian	Essumegya
12	Male	35	Junior High	Christian	Essumegya
13	Female	36	Senior High	Christian	Essumegya
14	Male	45	Senior High	Christian	Essumegya

Appendix G Cont'd

Respondent No.	Gender	Age	Educational status	Religion	Community
15	Male	47	No formal education	Traditional	Essumegya
16	Female	57	Senior High	Christian	Essumegya
17	Female	80	No formal education	Christian	Essumegya
18	Female	48	Senior High	Christian	Essumegya
19	Female	47	Senior High	Christian	Essumegya
20	Female	53	No formal education	Christian	Essumegya
21	Female	28	Senior High	Christian	Essumegya
22	Male	43	No formal education	Christian	Essumegya
23	Male	50	Senior High	Christian	Essumegya
24	Male	48	Senior High	Christian	Essumegya
25	Male	55	Senior High	Christian	Essumegya
26	Male	58	Senior High	Traditional	Essumegya
27	Male	27	Junior High	Christian	Essumegya
28	Male	44	Junior High	Christian	Essumegya
29	Female	36	No formal education	Christian	Essumegya

Appendix G Cont'd

Respondent No.	Gender	Age	Educational status	Religion	Community
30	Female	52	No formal education	Christian	Essumegya
31	Female	44	No formal education	Christian	Essumegya
32	Female	60	Senior High	Christian	Essumegya
33	Male	47	Senior High	Traditional	Essumegya
34	Female	72	No formal education	Christian	Kyekyewere
35	Female	60	No formal education	Christian	Kyekyewere
36	Female	65	No formal education	Christian	Kyekyewere
37	Male	60	Senior High	Christian	Kyekyewere
38	Male	72	No formal education	Christian	Kyekyewere
39	Male	43	Junior High	Christian	Kyekyewere
40	Female	64	No formal education	Christian	Kyekyewere
41	Male	46	Senior High	Christian	Kyekyewere
42	Male	60	No formal education	Christian	Sebedie
43	Female	48	No formal education	Christian	Sebedie
44	Female	74	No formal education	Christian	Sebedie

Appendix G Cont'd

Respondent No.	Gender	Age	Educational status	Religion	Community
45	Female	70	No formal education	Christian	Sebedie
46	Female	72	No formal education	Christian	Sebedie
47	Male	60	No formal education	Christian	Sebedie
48	Female	58	No formal education	Christian	Sebedie
49	Female	47	No formal education	Christian	Sebedie
50	Female	70	No formal education	Christian	Sebedie
51	Female	60	No formal education	Christian	Sebedie
52	Female	70	No formal education	Christian	Boamang
53	Male	30	Junior High	Christian	Boamang

Appendix H: Medicinal Uses of Identified Medicinal Plant Species

Medicinal use	Number of citations for single use	Number of citations for multiple uses	Total number of citations	Percentage (%) citations
Aid children to walk	1	3	4	1.0
Aid navel tearing in new borns	0	2	2	0.5
Anaemia	5	20	25	6.3
Anorexia	0	1	1	0.3
Asthma	1	4	5	1.3
Bed wetting	0	2	2	0.5
Body pains	1	2	3	0.8
Boils	0	3	3	0.8
Breast problem	0	1	1	0.3
Broken bones	2	6	8	2.0
Cancer	0	1	1	0.3
Constipation	0	1	1	0.3
Convulsion	0	7	7	1.8
Cough	0	12	12	3.0
Cuts	0	8	8	2.0
Diabetes	0	1	1	0.3
Diarrhoea	1	4	5	1.3
Disease of the new born	0	2	2	0.5
Dysentry	0	4	4	1.0

Appendix H Cont'd

Medicinal use	Number of citations for single uses	Number of citations for multiple uses	Total number of citations	Percentage (%) citations
Ear problem	0	4	4	1.0
Eczema	0	1	1	0.3
Epilepsy	0	6	6	1.5
Expulsion of afterbirth	2	3	5	1.3
Eye problem	1	2	3	0.8
Fever	5	40	45	11.3
Fibroid	0	2	2	0.5
For bathing children	0	2	2	0.5
For pregnancy	1	23	24	6.0
Generalised oedema	1	4	5	1.3
Gonorrhoea	0	3	3	0.8
Headache	1	8	9	2.3
Heart problem	0	6	6	1.5
Hematuria	0	2	2	0.5
Hernia	1	7	8	2.0
Hiccups	0	1	1	0.3
Hypertension	2	4	6	1.5
Infertility	1	3	4	1.0
Measles	0	4	4	1.0

Appendix H Cont'd

Medicinal use	Number of citations for single uses	Number of citations for multiple uses	Total number of citations	Percentage (%) citations
Menopause	0	1	1	0.3
Migraine	0	5	5	1.3
Miscarriage	0	9	9	2.3
Mouth ulcer	0	2	2	0.5
Oligomenorrhoea	0	2	2	0.5
Pain in the throat	0	1	1	0.3
Paranchia	0	1	1	0.3
Piles	2	18	20	5.0
Production of abundant breast milk	0	2	2	0.5
Prostrate cancer	0	2	2	0.5
Rheumatism	3	7	10	2.5
Ringworm	0	1	1	0.3
Shingles	0	1	1	0.3
Skin rash	0	3	3	0.8
Snake bite	1	5	6	1.5
Stomach ache	1	11	12	3.0
Stomach problem	1	12	13	3.3
Stomach ulcer	3	5	8	2.0
Stroke	0	1	1	0.3

Appendix H Cont'd

Medicinal use	Number of citations for single uses	Number of citations for multiple uses	Total number of citations	Percentage (%) citations
Stye	1	6	7	1.8
Swollen head	2	11	13	3.3
Tonsillitis	0	2	2	0.5
Tooth ache	1	7	8	2.0
Typhoid fever	0	1	1	0.3
Urinary retention	0	2	2	0.5
Viginal sores	1	2	3	0.8
Waist problems	2	18	20	5.0
Wound healing	3	6	9	2.3