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DIVERSITY AND STATUS OF INDIGENOUS PLANTS IN MOGLE MOUNTAIN, SEBETA AWAS WOREDA, WESTERN ETHIOPIA.



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Diversity and Status of Indigenous Plants in Mogle Mountain,
Sebeta Awas Woreda, Western Ethiopia.

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Abstract

The diversity and status of Indigenous plants in Mogle Mountain was studied from March 2020 to July 2021. Three line transects were laid on the site. A total of 6 Plots of size 20m X 20m were established at 50m intervals along line transects which were 100m apart. The starting point of all line transects were located randomly in each stand. The plots were laid in each stand and the first plot was located randomly. All sample plots were located at least at 50m intervals. Plant species in each plot were counted and recorded at individual level. Semi-structured interviews were also used to collect information about indigenous knowledge on the uses of indigenous plants, local names of plants and their conservation status. The abundance values, density, diameter at breast height, frequency, important value index and list of species were recorded in each plot. About 39 plant species belonging to 32 families and 37 genera were identified and documented. Out of these, 29 species (74.4%) were indigenous to Ethiopia. The growth habit of each species was also identified as trees 24(61.5%), shrubs 11(28.2%), herbs 3(7.7%) and climber 1(2.6%). Fabaceae had the highest number of species (10.25%) followed by Euphorbiaceae (7.7%), Acanthaceae and Rosaceae (5.6%) and the other families (87.5%) had one (2.56%) species each. Eight multipurpose species were selected out of all indigenous plants and 6 use categories were listed for 5 selected informants to assign use value to each species. *Juniperus procera* was found to be the highly used plant species by local community for multiple purposes, followed by *Cordia africana* and *Podocarpus falcatus*. According to preference ranking of 6 dominant plants, *Podocarpus falcatus* was found the most used species by local people for its value for construction. Among indigenous plants of Mogle Mountain, *Podocarpus falcatus*, *Cordia africana*, *Juniperus procera* and *Acacia abyssinica* need prior conservation measure.

Key word: Conservation, Diameter at breast height, Diversity, Ethiopia, Indigenous, Mogle Mountain.

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List of Acronyms

AAU	Addis Ababa University
ASL	Above Sea Level
BA	Basal Area
CSA	Central Statistical Agency
DBH	Diameter at Breast Height
EFAP	Ethiopian Forestry Action Plan
FAO	Food and Agricultural Organization
IBC	Institute of Biodiversity Conservation
IVI	Importance Value Index
MOA	Ministry of Agriculture
MSc	Master of Science
SAWFNRCA	Sebeta Awas Woreda Forest and Natural Resource Conservation Authority
SAWRADO	Sebeta Awas Woreda Rural and Agricultural Development Office

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

Ethiopia is one of the tropical countries with different climatic conditions that have contributed to the formation of diverse ecosystems inhabited with a great diversity of life forms of both animals and plants. The flora of Ethiopia consists of many types of vegetation, flowers and plants. In the Flora of Ethiopia and Eritrea about 6,027 vascular plant species (including subspecies), with about 10% endemism have been documented in eight volumes in ten books. Out of these, 1,882 species are common to both countries while 3,875 species recorded from Ethiopia and 270 species from Eritrea only. Thus, there are 5,757 species (including subspecies) in Ethiopia and about 2,152 species (including subspecies) in Eritrea (Ensermu Kelbessa, Sebsebe Demissew, 2014).

The different climate and geological zones of Ethiopia provide different types of plants for the country. Many types of plant species in Ethiopia are used for many purposes such as honey production, making oil and for food flavoring. Legesse Negash (personal communication) emphasized that indigenous forests are wombs for an array of above and below ground organisms, and thus there is urgent need to reverse the loss and degradation of indigenous trees, shrubs and herbs by restoring degraded landscapes with native forests. There are many indigenous species that have unique properties which have been used to develop specialized drugs. Once indigenous plants become extinct, they are lost forever. Despite the destruction, forests and forest products will continue to be central to the households' economy, as well as to food security and health through a number of traditional practices in the years to come. It is reported that currently, the entire rural population and the majority of the urban households rely on forest resources for their energy needs. The local people utilize both indigenous and introduced practices to manage soil degradation problems (IBC, 2012).

Indigenous plants are sometimes allowed to co-exist with lawn grass, ground covers, or garden vegetables, especially if they are not aggressive growers. Indeed, some homeowners favor them, growing native species in their landscapes either as a matter of principle or for practical reasons, as when, for example, they are drought-resistant plants. Some gardeners include indigenous plants

in a woodland garden. And, because some types of wildflowers grow under the forest canopy in their natural habitats, they can be fitting candidates for shade gardens in a landscaping. It is important to protect indigenous plant species because they have often evolved to cope with particular conditions, circumstances or situation (MOA, 2004).

1.2. Statement of the problem

The study area was selected because Mogle Mountain and its area are very critical for the local people and animals as a source of traditional medicine, source of water, source of food and for constructing their shelter. The introduction of exotic plant species and the lack of awareness on the uses of indigenous plants in Ethiopia lead to the destruction of indigenous plants. Understanding uses of Indigenous plants of the Mogle Mountain and conserving them should be based on ecological study of the area, which is very useful for the Mountain and the surroundings. There is no research done in this study area about indigenous plants. Therefore, the knowledge of local community on the uses of indigenous plants as traditional medicine and for other purposes is also not documented. The findings of this study will help people of the study area to be aware of problems associated with indigenous plants and give attention for sustainable use and conservation of indigenous plants of their surroundings.

1.3. Research Questions

The main focus of this study is to identify the diversity of indigenous plants and to record their status in the Mogle Mountain. The study attempts to answer the following questions.

Research questions:

1. Indigenous plants found on Mogle Mountain are high or low?
2. Which growth forms of plants of the Mogle mountain are dominant?
3. What is the diversity and composition of indigenous Plants on Mogle mountain?
4. How much is the local conservation status of indigenous plants found in Mogle mountain?
5. What are the uses of indigenous plants found in Mogle mountain?

1.4. Significance of the study

Indigenous Plants of Ethiopia have great values in the country. This study was carried out to give information on diversity and status of Indigenous plants in Mogle Mountain. The Study is targeted to give information on the indigenous plants of the Mogle Mountain and their corresponding uses. So, local community and other stake holders got awareness, and the plants get conserved. This study was also initiated to gather, record and document indigenous knowledge of local people of Mogle Mountain on the indigenous plants of their area so that they get awareness and conserve their natural resources and use them wisely in a sustainable way.

1.5. Objectives

1.5.1. General Objective

- To Study Diversity and Status of Indigenous Plants in Mogle Mountain, Sebeta Awas Woreda.

1.5.2. Specific Objectives

- To identify the diversity of indigenous plants in Mogle mountain.
- To record the status of indigenous plants in Mogle mountain.
- To identify the useful indigenous plant species found in Mogle mountain.
- To identify the threats to indigenous plants in Mogle mountain.
- To record the types of indigenous plant species in Mogle mountain.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Plant-People Interaction

Plants are very important to life, especially for human beings. Plants and peoples interaction are very high since basic needs of human beings depend on plants. For example: Plants are the sources of food, shelter and clothes. They also serve as sources of energy. Therefore, if there is no plant, there is no life. This interaction also has negative impacts on plants because it leads to different degrees deforestation. Therefore, using the natural resources wisely in a sustainable way is very important in plant-people interaction. Different studies from various countries show that People-plant interactions promote human well-being of different target groups, not only as curative but also as a preventive treatment for individuals. Working with plants is physically, mentally and socially beneficial for human well-being. Visiting a botanical garden lowers blood pressure and reduces heart rate (Owen, 1994).

Studies show that the presence of vegetation will speed recovery from stress (Ulrich *et al.* 1991; Kaplan, 1993). Leisure in green environments provides feelings of relaxation, autonomy and competition, and makes people open for reflection. Horticultural therapy in groups can enhance social interaction (Gezondheidsraad, 2004). Indigenous plants have medicinal value so people use them traditionally to cure different human and livestock ailments. People also use them traditionally as important sources of spices and oils.

2.2 Indigenous knowledge on indigenous plants

Indigenous knowledge is the accumulation of knowledge, rules, standards, skills, and mental ideas, which are possessed by local people in a particular area (Quanash, 1998). It is the result of many different generation experiences, careful observations and activities which is mostly based on trial and error experiments (Martin, 1995). Indigenous knowledge develops by indigenous people in the presence of their interaction with their environment (Debela Hunde, *et al.*, 2004). Indigenous Knowledge can provide problem solving strategies for local communities, especially the traditional societies. Local communities use indigenous plants as medicine for different diseases, spices, source of food and as timber for house constructions. Systematic application of

this indigenous knowledge is important for sustainable use of natural resources and sustainable development of an area. Biodiversity and traditional knowledge of its various properties and uses have long provided and continue to provide vital resources for medicine discovery and health care (SCBD, 2010).

Indigenous knowledge on traditional medicine simply refers to health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singly or in combination to treat, diagnose and prevent illness or maintain well-being (Dawit Abebe and Ahadu Ayehu, 1993). The intimate dependency of people of particular area on their natural resources leads to the accumulation of indigenous knowledge that make them to adapt to their environment and to survive in the area in which they live. Indigenous knowledge is unique to a given culture or society and it is the basis for activities such as agriculture, healthcare, food preparation, education and environmental conservation (Thomas, 1995).

2.3. Indigenous plants in Ethiopia

2.3.1 Overview of Indigenous Plants of Ethiopia.

Ethiopian indigenous plants are plants that grow only in Ethiopia and adapted to the different climatic conditions of the country. Among African countries, Ethiopia is often quoted as one of the six countries of the world where about 60% of the plants are said to be indigenous with their healing potential (Belachew Desta, 1984). These plants vary in their distribution over the country due to the varied geographic and climatic conditions (Amare Getahun, 1976). Natural forests of Ethiopia have been declining rapidly due to deforestation. These conditions are triggered mainly by population growth, and also due to ignorance about propagation and field establishment of indigenous trees. The high rate deforestation had serious consequences on the ecosystem of the country (EFAP, 1994; Legesse Negash, 1995; Feyera Senbeta *et al.*, 2002).

Indigenous species have the potential to maintain watersheds of an area for long. Despite this significance it is unfortunate to see that they are not commonly used in reforestation activities in the country. This is mainly due to the ignorance in the proper utilization of indigenous shrubs and tree species, which could comfortably maintain the watersheds in Ethiopia (Legesse Negash,

2002). In selecting species for reforestation, it is often best to choose the ones which are indigenous and that are already growing in the area, since such species are adapted to the environment and are thus able to regenerate naturally. If the choice lies between two species of comparable growth and quality, one of which is native and the other exotic, the native species is to be preferred (Evans, 1992).

2.3.2 Diversity and Distribution of Indigenous Plants in Ethiopia

Ethiopian indigenous plants are distributed in different parts of the Country in diverse forms. They exist as trees, shrubs, herbs, fruits and oil seeds. Ethiopia has diverse climate and soil types that enable the growth of several indigenous and exotic spices, herbs, medicinal as well as other essential oil bearing plants. Indigenous trees are adapted to the environment and are already integral part of the ecological niche. This state of condition may make them less susceptible to serious damage from diseases and pests since predators, viruses and climatic factors are already present there (Khan, 1987; Legesse Negash, 2002).

Endemism is reportedly high on the plateaus, mountains and in the western and south western highlands of Ethiopia (FAO, 2000). The centre of endemism on the highlands of Ethiopia can be identified as: the southwestern centre which is characterized by endemism of montane rainforest and evergreen bushland, the central plateau centre which contains endemic deciduous woodland and montane grassland, the high mountain centre which contains endemic ericaceous bushland and afroalpine grasslands (FAO, 2000).

2.3.3 The Uses of Indigenous Plants in Ethiopia

Ethiopian Indigenous plants have many uses than exotic plants and serve as homes for many biodiversities. Ethiopian plants have shown very effective medicinal value for some ailments of human and domestic animals. Thus traditional medicinal plants and knowing their uses contributes a great role to human and livestock health care needs of the country (Dawit Abebe and Ahadu Ayehu, 1993). Such plants include *Phytolacca dodecandra* (Aklilu Lemma, 1965). The grassy indigenous forest floors in different parts of the country commonly enable easy walking and even viewing of wild animals beside their attraction. For example, if one visits an indigenous *Hagenia abyssinica* dominant forest one can feel a grassy ground beside a wonderful fruity smell of fallen *Hagenia*

abyssinica leaves. This large indigenous tree of the rose family, has separate male and female species. The female contains anthelmintic biochemical, and are widely used in a decoction against the tapeworm. That was why the tree is called 'kosso' tree, 'kosso' standing for tape worm. This tree is also very useful for wooden crafts. Ethiopian traditional life is painted with the hallmark of widespread use of traditional medicinal plants with various levels of sophistication within the indigenous medicinal values (Dawit Abebe and Ahadu Ayehu, 1993).

There are several indigenous cultivated or semi cultivated root and tuber crops in Ethiopia. These crops have important places in the diet of the population. Ethiopia is one of the centers of origin and diversity for several oil crops. The major indigenous oil seeds displaying considerable diversity in the country are: Gomenzer (*Brassica carinata*), Noug (*Guizotia abyssinica*), Sesame (*Sesamum indicum*) and Linseed (*Linum sitatisimum*) (Vavilov, 1951).

2.4. The Status and Threats to Indigenous Plants

2.4.1 The Status of Indigenous Plants

The effort in growing indigenous plants in Ethiopia very low, since the attention of peoples is more on the exotic plant species than the native species. The *Hagenia abiyssinica* and *Juniperus procera* forests of the country are reduced quickly due to human activities such as using them as firewood and clearing land for agriculture (Legesse Negash, 1995).

Threatened endemic indigenous species require special attention because they are living in the only habitats in which they adapt to survive. If their habitats are destroyed, these plants are lost forever and with them go a wealth of indigenous flora and fauna which would be very difficult to replace. Similarly, Legesse Negash (2002) reported that forests determine the basic fabric of life on earth. Furthermore, Taye Bekele *et al.*, (1999) noted that, unless immediate rescue measures are taken, there is no guarantee that genetic resource of indigenous species can pass to the subsequent generations.

2.4.2. Threats to Indigenous plants

The common threats to indigenous plants of Ethiopia are deforestation and dominance of exotic plants (Legesse Negash, 2002). The lack of awareness on the difference between exotic plants and indigenous plants has contributed to the disturbance of indigenous plants and domination of invasive plant species. The demand for human settlement and expansion of agricultural activities lead to the decrease of indigenous plants in Ethiopia. The lack of effective institutions and the weak law enforcement pertinent to conserving indigenous plants made the forests and woodlands of the country to remain open to all forms of exploitation. People access forests of indigenous trees for timber, firewood, charcoal, construction material as well as forest grazing and browsing because there is no regulatory system or overseeing body over the harvesting of the products or other uses. This has resulted in the continuous and uncontrolled illegal logging that skims off selected valuable timber species, such as *Hagenia abyssinica*, *Podocarpus falcatus* and few others. This in turn brings decline in the productivity and regenerative capacity of indigenous plants as well as different endemic plant species harbored within them (Edwards, 2010).

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the Study Area

3.1.1. Geographical location

The study was conducted in Mogle Mountain which is found in Mogle kebele in Sebeta Awas woreda during 2020-2021 with a view to study diversity and Status of Indigenous plants. Sebeta is a town located in the Oromia Special Zone surrounding Finfinne of the Oromia Regional State. Sebeta Awas woreda is located between $8^{\circ}37' N$, $09^{\circ}3' N$ latitude and $38^{\circ}25' E$ and $38^{\circ}46' E$ longitude and an elevation of 2,356 meters (7,730 feet) above sea level (Fekadu Dereje, 2019). Sebeta town was established in 1986 (Fekadu Dereje, 2019), and also since under municipality eventually, its gradual development currently led the town as centre of investment activities, major business area, and tourism attraction center. Mogle Mountain is a forest covered area found around Mogle kebele in Sebeta Awas woreda.

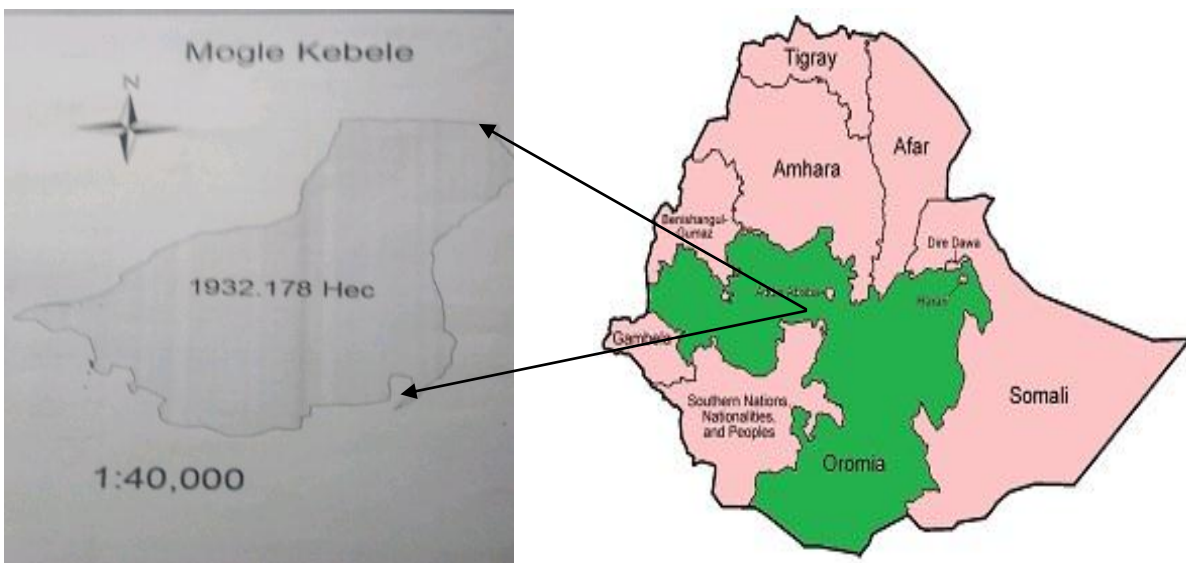


Figure 1: Map of Ethiopia showing Oromia regional State and the study area.

3.1.2. Topography, Soil and Climate

In the study area the altitude ranges between 2600m and 3385m a.s.l. Out of the total 41 kebeles in Sebeta Awas woreda, 36 kebeles are entirely rural kebeles. Mogle kebele has the highest elevation out of all rural kebeles. The major soil types that cover the study kebele is Red soil (Nitosol group). The Woreda is divided in to two agro-ecological zones locally called *Baddaa* (12%) and *Badda-daree* (88%) which means highland and midland respectively (SAWRADO, 2006). The main rain fall between June and September is locally called "rooba gannaa" and light rains between January and March locally called "rooba arfaasaa".

3.1.3. People, Land use and agriculture

According to the Central Statistical Agency (CSA, 2007) of Ethiopia, the Woreda population was 336,975 out of which 139,131 are males and 197,844 are females. Out of the total population residing in the study woreda, the majority are rural, while the remaining are urban dwellers. Agricultural activity is the dominant means of Livelihood for the majority of Sebeta Awas Woreda population.

Table 1: Major crop plants growing in the study area

No	Scientific name	Local name (Oro)	English name
1	<i>Hordeum vulgare</i> L.	Garbuu	Barley
2	<i>Vicia faba</i> L.	Baaqelaa	Bean
3	<i>Pisum sativum</i> L.	Atara	Peas
4	<i>Eragrotis tef</i> (Zucc.) Troteer	Xaafii	Teff
5	<i>Solanum tuberosum</i> L.	Dinnicha	Potato
6	<i>Brassica oleracea</i> L.	Raafuu	Cabbage

3.1.4. Vegetation

The area of Mogle Mountain was covered by vegetation. The vegetation of the study area consists of various trees. The natural vegetation of the study area is dominated by different indigenous trees like *Juniperus procera*, *Ficus sur*, *Podocarpus falcatus*, *Olea europaea* L. ssp. *cuspidata* and exotic trees like *Eucalyptus globulus* and *Gravellea robusta*. The vegetation in the area has been destroyed by human activities, particularly for construction material and other human settlements.

3.2. Materials

The major materials used during this study were the following: Plant press, Blanket, News paper, Card board, Note book, Pen, Plastic bag, Meter, Cables and Camera.

3.3. Methods

3.3.1. Selection of the study sites

A reconnaissance survey was made from March 02, 2020 to March 08, 2020 to obtain information on the sampling sites and general physiognomy of the vegetation in the study area. Basic information was collected from SAWFNRC office. This gave a general impression to identify the study sites. The field work was done between 11th of March 2020 and 20th of June 2021. The study sites were selected based on the availability and importance of indigenous plants. There were 41 Kebeles in the district. Out of these 5 were urban and 36 were rural kebeles, The Mogle Kebele housing the Mogle Mountain was purposefully selected since it was rich in housing different types of plant species.

3.3.2. Selection of Informants

After selection of the study sites, a total of 6 Informants (4 Males and 2 Females) with the ages between 35 and 63 were randomly selected from Mogle kebele focusing on those people residing around the forest regardless of sex, social status and educational background. The security member of the Mogle Mountain forest was also purposefully included (Since he knows the forest and the indigenous plant species very well) among the 6 informants serving as a field guide and an informant also during the interview and field observation tasks.

3.3.3. Methods of Ecological data collection

The ecological data were collected between 11th of March 2020 and 20th of June 2020 based on the methods used by Martin (1995) and Kent and Coker (1992). Vegetation assessment within the stands was conducted using a line transect survey. Three line transects were laid on the site. A total of 6 Plots of size 20m X 20m were established at 50m intervals along line transects which were 100m apart. The starting point of all line transects were located randomly in each stand (Kent and Coker, 1992). The plots were laid in each stand and the first plot was located

randomly. All sample plots were located at least at 50m intervals. Plant species in each plot were counted and recorded at individual level. Semi-structured interviews were also used to collect information about indigenous knowledge on the uses of indigenous plants, local names of plants and their conservation status. Interviews were based on a checklist of questions prepared before observation in English, and translated to Afan Oromo. Field observation and on spot data collection helped to come up with useful data pertinent to Indigenous plants of the Mogle Mountain.

3.3.3.1. Semi-structured interview

Semi-structured questions were employed (Appendix 5) for Interviewing the informants to record and collect information on existence, types, uses, distribution and status of indigenous plants in Mogle Mountain. All the interviews were held in Afan Oromo, the vernacular language of the local people. The methods and techniques followed were procedures recommended by Martin (1995).



Figure 2: Interview with informants. (photo: by Chaltu Bekele, 2021 in Mogle Mountain)

3.3.3.2. Field Observation

During field observation, the interview was conducted while walking through the study sites to collect the data on indigenous plants. Accordingly, field observations were performed with the help of the informants to collect plant specimens right from the Mogle Forest. All the necessary ecological and use information about indigenous plants of the Mogle Mountain were recorded on spot.



Figure 3: Guided field walk and specimen collection in Mogle Mountain (photo by Chaltu Bekele, 2021)

3.3.4. Plant specimen collection and identification

Voucher specimens were collected, numbered, pressed and taken to the National Herbarium of Ethiopia (ETH), Addis Ababa University, for identification and storage. The plant part collected from the study area were pressed by using plant press, dried, placed in deep freezer in Herbarium and species identified by referring to the Flora of Ethiopia and Eritrea (Volumes 1 to 8) and comparing with deposited specimen. The identified specimens were checked and confirmed by the research advisor Dr. Ermias Lulekal.



Figure 4: Plant pressing activity (photo by Chaltu Bekele, 2021)

3.3.5. Ethical consideration

Data were collected after permission was gained from the kebele administrators and from the volunteers who participated in the interview. Ethical considerations were carried out from the beginning to the end of data collection. Informants were informed that the objective of the research was for educational purpose and for scientific documentation of indigenous plants of the study area. Informants accepted the idea and gave information freely on indigenous plants and guided where those plants exist in the study area and informed about their uses.

3.3.6. Visual recognition of plant community types

Identification of existing dominant plant communities was exercised from visual observation of the Mogle Mountain range and available species. In this study vegetation classification in to plant community types was done visually to group and characterize the distribution of indigenous plants in the area.

3.3.7. Data analysis

3.3.7.1. Descriptive statistics

A descriptive statistical method was used to summarize and analyze the data. Ecological data were entered in to Microsoft Excel spreadsheet version 2007 software and summarized using descriptive statistics. Descriptive statistical methods such as Diameter at Breast Height (DBH), Frequency, Density and Important Value Index (IVI) of dominant Indigenous plants were calculated to analyze the data (Kent and Coker, 1992). The results were presented with graphs and tables. The following parameters were analyzed following the methods by (Kent and Coker, 1992).

- ❖ Density is the average number of individuals of species on a unit area basis. It is closely related to abundance but more useful in estimating the importance of a species. Relative density is the number of individuals of a species as a percentage of the total number of individuals of all species in that area. Density of dominant indigenous trees was computed by converting the count from the total quadrats in to a hectare basis.

$$\text{Density} = \frac{\text{the number of individual of that species}}{\text{total area sampled}}$$

$$\text{Relative density} = \frac{\text{density of a single species}}{\text{total density of all species}} \times 100$$

- ❖ DBH is a standard method of measuring the size of a tree. It refers to the tree diameter measured at >2.5m. DBH used to help calculate the basal area of a single tree. DBH was classified into 4 classes and the density distribution of dominant indigenous tree species were computed in each class.

$$\text{DBH} = \text{Circumference (C)} / \pi, \quad \pi=3.14$$

- ❖ Frequency is defined as the probability or chance of finding a species in a given sample area. The value obtained reflects the pattern of distribution and species diversity. Frequency of a species was computed as the proportion of samples within which a species is found.

$$\text{Frequency} = \frac{\text{the number of plots in which that species occur}}{\text{total no of plots} \times 100}$$

$$\text{Relative frequency} = \frac{\text{frequency of a single species}}{\text{total frequency of all species} \times 100}$$

- ❖ Basal area is the outline of a plant near ground surface and expressed in $\text{m}^2 \text{ha}^{-1}$

$$\text{Basal area (m}^2\text{)} = (\text{DBH}/200)^2 \pi, \pi=3.14$$

- ❖ Dominance is the degree of coverage of species as an expression of the space at ground level.

$$\text{Dominance} = \frac{\text{total of basal area}}{\text{area sampled}}$$

$$\text{Relative dominance} = \frac{\text{dominance of a single species}}{\text{total dominance of all species} \times 100}$$

- ❖ Important Value Index (IVI) is the degree of dominancy and abundance of a given species in relation to the other species in the area. Data from relative density, relative frequency and relative dominance were used to calculate the IVI of the vegetation. It indicates the relative ecological importance of a given woody species of particular site.

$$\text{Importance Value Index (IVI)} = \text{Relative Dominance of Species} + \text{Relative Frequency of Species} + \text{Relative Density of Species}.$$

3.3.7.2. Preference ranking

Preference ranking was employed with informants to rank some selected dominant indigenous plant species according to their value. The 5 informants were given 6 frequently preferred plant species having value for construction and asked to arrange them based on personal preferences. The numbers are summed for all respondents, given an overall ranking for the items by the selected group of respondents. This was done by ranking value of selected dominant plants given by respondents (Martin, 1995) (Table: 9).

3.3.7.3. Direct matrix ranking

Many indigenous plants were used for different purposes. On the uses of some dominant indigenous plant species an interview was made. Direct matrix ranking exercise was done following Martin (1995) in order to compare multipurpose use of a given species and to relate this to the extent of its importance. Based on information gathered from informants, 8 multipurpose tree species were selected out of the total indigenous plants and 6 use diversities of these plants were listed for 5 selected informants to assign use values to each species. Five key informants were asked to give value, 5 to the most used indigenous plant for that particular purpose and 1 to the least used one. The 6 major use values include: timber, fire wood, charcoal, medicine, construction and house hold tools (Table 10).

CHAPTER FOUR

4. RESULTS

4.1. Floristic Composition

A total of 39 Plant species which belong to 32 families and 37 genera were collected from the Mogle Mountain (Appendix 1). The study shows that the family Fabaceae was the most dominant family represented with 4 species, followed by Euphorbiaceae which was represented with 3 species and Acanthaceae and Rosaceae represented with 2 species each while the other families had single species representation each (Appendix 2). Out of the total 39 plant species identified, a total of 29 Species (74.4%) were found indigenous to Ethiopia (Appendix 3). *Croton macrostachyus* was found the most dominant Indigenous plant species in the area, followed by *Juniperus procera* and *Acacia abyssinica* species. *Podocarpus falcatus* was represented with very few scattered trees across the Mogle Mountain when compared to the other indigenous species in the area. The most dominant growth forms were trees with 24 species (61.5%) followed by shrubs with 11 species (28.2%) and herbs with 3 species (7.7%) and climber with one species (2.6%) (Table 3).

Table 2 : Distribution of Indigenous plant species into Families and Genera.

No	Family name	Number of Species	Species in percentage	Number of Genera	Genera in percentage
1	Acanthaceae	1	3.45	1	3.57
2	Aloaceae	1	3.45	1	3.57
3	Anacardaceae	1	3.45	1	3.57
4	Apocynaceae	1	3.45	1	3.57
5	Asteraceae	2	6.89	1	3.57
6	Balanitaceae	1	3.45	1	3.57
7	Boraginaceae	1	3.45	1	3.57
8	Crassulaceae	1	3.45	1	3.57
9	Cupressaceae	1	3.45	1	3.57
10	Euphorbiaceae	3	10.34	3	10.71

11	Fabaceae	3	10.34	3	10.71
12	Icacinaeae	1	3.45	1	3.57
13	Lamiaceae	1	3.45	1	3.57
14	Meliaceae	1	3.45	1	3.57
15	Moraceae	1	3.45	1	3.57
16	Myrsinaceae	1	3.45	1	3.57
17	Oleaceae	1	3.45	1	3.57
18	Phytolaccaceae	1	3.45	1	3.57
19	Podocarpaceae	1	3.45	1	3.57
20	Rosaceae	1	3.45	1	3.57
21	Rutaceae	1	3.45	1	3.57
22	Santalaceae	1	3.45	1	3.57
23	Solanaceae	1	3.45	1	3.57
24	Sterculiaceae	1	3.45	1	3.57
Total = 24		29	100	28	100

4.2. Diversity of Indigenous Plants in Mogle Mountain

There were diverse plant species distributed on Mogle Mountain. The Mogle kebele was surrounded by natural forests and community of the kebele also live in this forest. The surrounding people says that “*Moglee mucha sagalii tokko gu’u tokko elmatani* (Nine breasted Mogle if one can weaned one can milked)” this is because Mogle Mountain is rich in vegetation. Different species of Ethiopian Indigenous plants were also found scattered on the Mogle mountain. In addition, exotic species like *Eucalyptus globulus* trees are dominant in the mountain. Indigenous trees such as, *Juniperus procera*, *Podocarpus falcatus*, *Acacia abyssinica*, *Croton macrostachyus*, *Ficus sur*, *Cordia africana*, *Phytolacca dodecandra*, *Olea europaea* L. ssp. *Cuspidata*, *Justicia schimperiana*, *Aloe macrocarpa*, *Prunus africana*, *Euphorbia abyssinica* and other plant species were observed in the forest.

Indigenous plants found in this mountain were reported for their use as source of water to the downstream areas. For example, a water company named One water which is a natural spring

water company was established beneath the Mogle Mountain. The water comes from a 186 meter deep bore hole at Mogle mountain. Also under indigenous plants of this area the natural spring water emanating from the mountain is used as source for drinking water by the local people. The indigenous plants of the Mogle made the mountain the source of a river named Laga Charuu which means Charus' river. This river named by person whose name is "Charuu" and who lived in that area for a long time and after the area was dominated by forest expansion he moved to the area found above Mogle Mountain (Personal communication with informants).



Figure 5: Charus' river found in Mogle forest (Photo by Gadessie Bekele, 2021).

4.3. Conservation Status of Indigenous plants in Mogle Mountain

The conservation status of Indigenous plants in Mogle Mountain is relatively medium, because the area was found protected from overgrazing. The Mogle Mountain was not totally available for farming. The trees found in this mountain were not cleared for farming because, people who lived around these forests were concerned with conservation of the trees due to their religious views. The religious leaders and followers locally known as '*Warra Haadha Abbayii*', '*Warra Buubaa*', '*Warra Abbaa Cabsii*' and others were known for long in Mogle area. The view of the local people respecting Indigenous plants as religious symbols contributed a lot for conservation of the Mogle forest till present. Despite this some people were observed cutting plants in the area for different purposes since they didn't have awareness on the value of indigenous plants. For

example, *Hagenia abyssinica* species found in this area was observed very degraded due to human activity. Currently Sebeta Awas Woreda Forests and Natural Resources Conservation Authority (SAWFNRCA) started to deliver awareness creation activity for local the people and hence reafforestation of the area with indigenous plant and exotic plants was carried out in 2019 and 2020.

4.4. Plant Community types

4.4.1. Visual recognition of plant community types

Identification of existing dominant plant communities was exercised from the visual observation of the Mogle Mountain range and available species. Based on dominant plant species, the natural vegetation of the study area was categorized visually in to four plant community types. The visually recognized community types in the area were: *Juniperus procera* - *Olea europaea* ssp. *cuspidata*, *Acacia abyssinica*-*Croton macrostachyus*-*Aloe macrocarpa*, *Euphorbia abyssinica* - *Justicia schimperiana*, *Prunus africana* -*Ficus sur*- *Milletia ferruginea*.

A. *Juniperus procera* - *Olea europaea* L. ssp. *cuspidata* plant community

This plant community type was dominantly found in the study area. This community was composed of scattered individuals of *Juniperus procera*, *Olea europaea* L. ssp. *Cuspidata* and *Podocarpus falcatus*. Plant species such as *Eucalyptus globulus*, *Dovyalis abyssinica*, *Rhus vulgaris*, *Albizia schimperiana*, *Ekebergia capensis*, *Casuarina equisetifolia*, *Vernonia amygdalina*, *Solanum marginatum*, and many species of grasses were also common in this community type. Similarly *Dombiya torrida*, *Pavonia urens*, *Phytolaca dodecandra* were relatively rare species in this community type (Figure 6).



Figure 6: Plant community dominated by *Juniperus procera* (Photo: by Gadessie Bekele ,2021).

B. *Acacia abyssinica* - *Croton macrostachyus*- *Aloe macrocarpa* Plant community

This plant community was dominated by plant species such as *Acacia abyssinica*, *Croton macrostachyus* and *Aloe macrocarpa*. In addition this community also included *Cordia africana* , *Gravellia robusta*, *Acacia mearnsii*, *Eucalyptus globulus*, and different species of grasses. Other relatively rare plant species belonging to this plant community were *Dombiya torrida*, *vernonia amygdalina*, *Capparis simensis* and *Justicia schimperiana* (Figure 7).



A



B

Figure 7: A-B, Plant community dominated by *Acacia abyssinica* and *Aloe macrocarpa* (Photo: by Gadessie Bekele ,2021)

C. *Euphorbia abyssinica* – *Justicia schimperiana* Plant community type:

The dominant plant species of this community type were *Euphorbia abyssinica* and *Justicia schimperiana*. Other common characteristic species belonging to this community include: *Carissa spinarum*, *Kalanchoe petitiiana*, *Clematis simensis*, *Ricinus communis*, *Vernonia auriculifera*, *Croton macrostachyus*, *Capparis tomentosa* and other shrubs and different species of grasses (Figure 8).



Figure 8: Plant community dominated by *Euphorbia abyssinica* (Photo: by Gadessie Bekele ,2021)

D. *Prunus africana* – *Ficus sur* - *Milletia ferruginea* plant community type

Dominant plant species of this community were *Prunus africana*, *Ficus sur* and *Milletia ferruginea*. Relatively common species of this community type were *Maesa lanceolata*, *Rosa abyssinica*, *Vernonia auriculifera*, *Clausena anisata*, *Balanites aegyptiaca*, *Osyris quadripartita*, *Premna schimperi*, *Capparis tomentosa*, *Pittosporum viridiflorum*, *Apodytes dimidiata*, *Kalanchoe petitiiana* and grasses. Species such as *Ricinus communis*, *Olea europaea* ssp. *cuspidata*, *Rhus vulgaris* and *Eucalyptus globulus* were species found in this community type (Figure 9).

A



B



Figure 9: A-B, Plant community dominated by *Prunus africana* and *Ficus sur* (photo by Gadessie Bekele, 2021)

4.4.2. Growth habits distribution of plants in Mogle Mountain

The diversity of habits of plants in the study area showed that, trees were frequently reported with 24 (61.5%) species followed by shrubs with 11 (28.2%) species, herbs with 3 (7.7%) species and Climber with 1 species (2.6%).

Table 3: The distribution of plant species by their habits Mogle Mountain

No	Growth Habit	Number of Species	Percentage
1	Trees	24	61.5
2	Shrubs	11	28.2
3	Herbs	3	7.7
4	Climber	1	2.6
Total		39	100

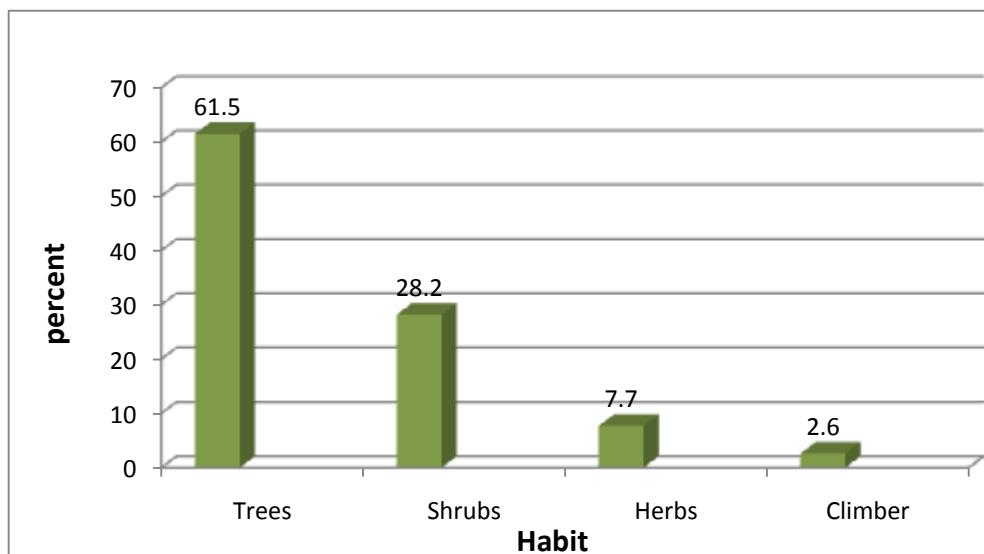


Figure 10: The distribution of plants species by their habits in the study area

4.4.3. Use values of some selected Indigenous plant species

The informants have pointed out major uses of woody and non woody products of the Mogle forest. Accordingly, the use of plants by local people was grouped into a number of categories. The use categories of the plants were: construction, firewood, timber, farm tools, charcoal, bee forage, medicinal, teeth brush, house hold tools, shade, landscape, detergent, aromatic, craft, ornamental and oil production. Out of the 29 indigenous plant species, 18 were identified for their medicinal species, 16 for construction, 9 for firewood and 8 for charcoal production and 6 were reported for their timber value (Appendix 4). In Mogle Mountain, a given species could serve for different purposes. For example: *Juniperus procera* serve for 11 different purposes, *Podocarpus falcatus*, *Olea europaea ssp cuspidata*, *Ekebergia capensis* and *Acacia abyssinica*

were reported for their 7 different uses followed by *Albizia schimperiana* and *Croton macrostachyus* reported for 6 different purposes. *Cordia africana*, *Euphorbia abyssinica* and *Balanites aegyptiaca* were reported for their 5 different purposes. Other indigenous plants in Mogle Mountain were reported for their different uses by the local people (Appendix 4).

4.5 Floristic Structure

4.5.1. Density and Frequency of Tree Species

The density of indigenous trees in Mogle Forest was 30.41 individuals ha⁻¹. The densities of the top most dominant species of the Mogle Forest are indicated in table 4.

Table 4: Density of dominant indigenous plant species in Mogle Mountain

No	Species	Density	Percentage
1	<i>Acacia abyssinica</i>	7.5	24.67
2	<i>Cordia africana</i>	2.5	8.22
3	<i>Croton macrostachyus</i>	5.83	19.17
4	<i>Juniperus procera</i>	8.33	27.39
5	<i>Podocarpus falcatus</i>	6.25	20.55
	Total	30.41	100

The Frequency and relative frequency of dominant indigenous plant species in Mogle mountain is indicated in table 5.

Table 5: Frequency of dominant indigenous plants in Mogle Mountain

No	Species name	Frequency	Relative frequency
1	<i>Acacia abyssinica</i>	66.67	44.45
2	<i>Cordia africana</i>	33.33	22.22
3	<i>Croton macrostachyus</i>	16.67	11.11
4	<i>Juniperus procera</i>	16.67	11.11
5	<i>Podocarpus falcatus</i>	16.67	11.11
	Total	150	100

4.5.2. Diameter at Breast Height (DBH)

Among the woody species recorded in the study area, the distribution of tree species in different diameter class is shown in table 6. Four DBH classes (2-10cm, 10-20cm, 20-30cm, >30cm) were identified for trees of the Mogle forest. Most species (about 60%) were found in the low diameter class distribution (2-10 cm).

Table 6: DBH of dominant indigenous plant trees in Mogle Mountain

No	Species	DBH (cm)	Percentage
1	<i>Acacia abyssinica</i>	8.92	14.15
2	<i>Cordia africana</i>	30.25	47.98
3	<i>Croton macrostachyus</i>	4.14	6.57
4	<i>Juniperus procera</i>	11.46	18.17
5	<i>Podocarpus falcatus</i>	8.28	13.13
Total		63.05	100

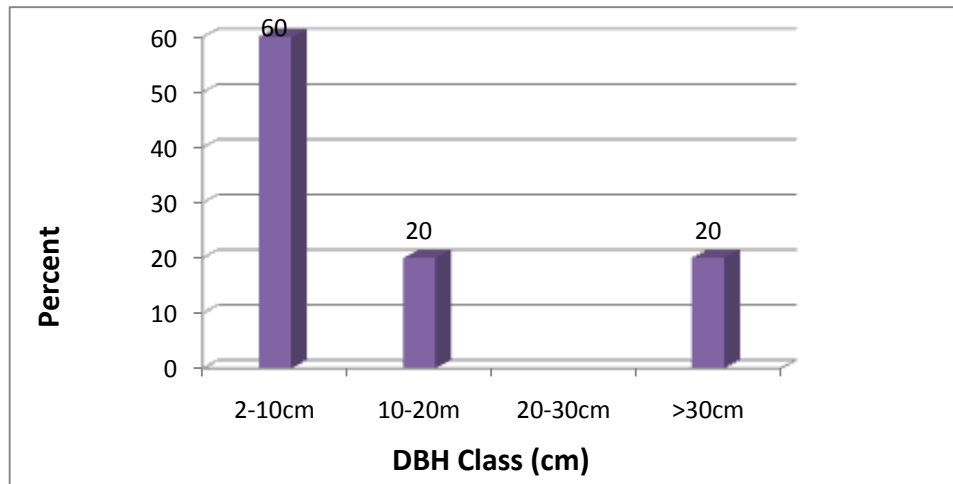


Figure 11: DBH class distribution of dominant plants in Mogle Mountain.

4.5.3. Basal Area

The total basal area in Mogle Mountain was 0.0895m²(Table 7). About 80.44% of the basal area was contributed by *Cordia africana* (Table 7).

Table 7: Basal area of dominant indigenous plant species in Mogle Mountain

No	Species	BA (m ² ha ⁻¹)	Percentage
1	<i>Acacia abyssinica</i>	0.0062	6.93
2	<i>Cordia africana</i>	0.072	80.44
3	<i>Croton macrostachyus</i>	0.0013	1.45
4	<i>Juniperus procera</i>	0.01	11.17
5	<i>Podocarpus falcatus</i>	0.0000092	0.01
Total		0.0895	100

4.5.4. Importance Value Index (IVI)

The result of the calculation of Importance Value Index helped to identify the dominant tree species in Mogle Mountain and it is indicated in table 8.

Table 8: Importance Value Index (IVI) of dominant indigenous tree species in Mogle Mountain.

Species	Relative dominance	Relative Density	Relative Frequency	IVX
<i>Acacia abyssinica</i>	6.93	24.67	44.45	76.05
<i>Cordia africana</i>	80.44	8.22	22.22	110.88
<i>Croton macrostachyus</i>	1.45	19.17	11.11	31.73
<i>Juniperus procera</i>	11.17	27.39	11.11	49.67
<i>Podocarpus falcatus</i>	0.01	20.55	11.11	31.67
Total	100	100	100	300

4.5.5. Preference ranking

The output of the preference ranking exercise is summarized in Table 9. Highest number (5) was given to the indigenous plant which informants thought to be the most effective in its use for construction material and the lowest number (1) is given to the least effective plant : (5=most valuable, 4= very good, 3= good, 2= less, 1= least valuable)).

Table 9: Preference ranking of frequently encountered indigenous plant species

No	Species name	Respondents					Total	Rank
		R1	R2	R3	R4	R5		
1	<i>Acacia abyssinica</i>	5	2	5	2	4	18	2 nd
2	<i>Cordia africana</i>	4	3	4	1	5	17	3 rd
3	<i>Croton macrostachyus</i>	2	1	2	4	5	15	5 th
4	<i>Ficus sur</i>	3	4	1	3	2	13	6 th
5	<i>Juniperus procera</i>	2	3	4	5	2	16	4 th
6	<i>Podocarpus falcatus</i>	5	4	3	5	3	20	1 st

4.5.6. Direct matrix ranking

Direct matrix ranking for the multipurpose of eight indigenous plants on six use criteria was done based on average score of five key informants (5 = most used, 4 = very good, 3 = good, 2 = less used, 1 = the least and 0 = not used) and result summarized below in table 10.

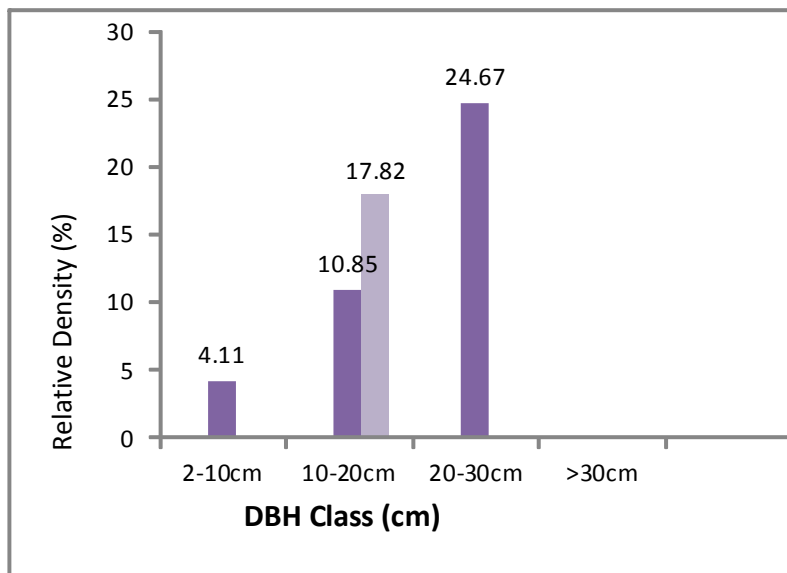
Table 10: Direct matrix ranking for the multipurpose of 8 indigenous plant species

No	Use categories	Species name								Total	Rank
		<i>Acacia abyssinica</i>	<i>Albizia schimperiana</i>	<i>Cordia africana</i>	<i>Croton macrostachyus</i>	<i>Ekebergia capensis</i>	<i>Ficus sur</i>	<i>Juniperus procera</i>	<i>Podocarpus falcatus</i>		
1	Timber	5	4	5	2	3	4	2	2	27	2 nd
2	Charcoal	2	1	2	3	3	2	4	3	20	3 rd
3	Firewood	3	3	5	2	3	3	5	3	27	2 nd
4	Medicine	0	0	2	3	0	1	3	3	12	4 th
5	Construction	4	3	3	5	4	4	4	4	31	1 st
6	Household tools	4	3	4	4	3	3	5	5	31	1 st
Total		18	14	21	19	16	17	23	20		
Rank		5 th	8 th	2 nd	4 th	7 th	6 th	1 st	3 rd		

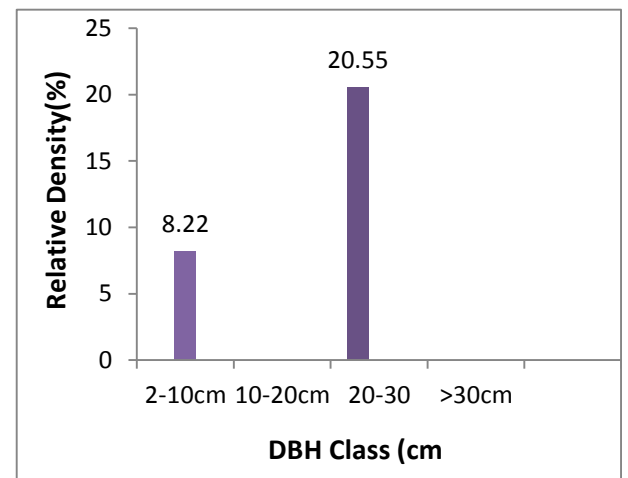
4.6. Population Structure

In this study, the population structure of four tree species (*Acacia abyssinica*, *Cordia africana*, *Juniperus procera* and *Podocarpus falcatus*) was determined using their density at the various DBH classes. The distribution of dominant tree species was categorized into four DBH classes: (2-10 cm; 10-20 cm; 20-30 cm and >30 cm) (Figure 12).

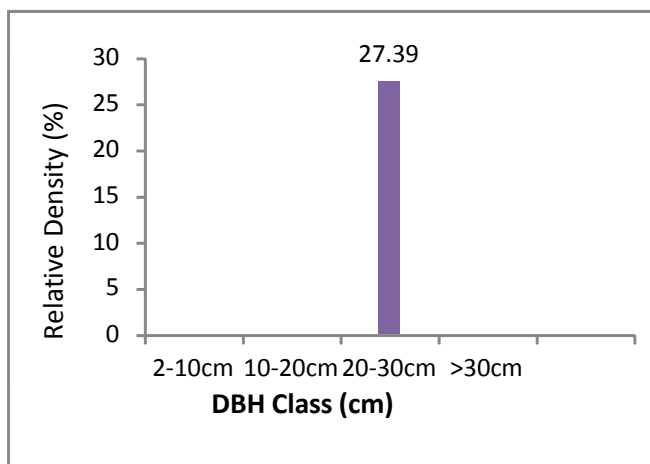
A= *Acacia abyssinica*



B= *Cordia africana*



C= *Juniperus procera*



D= *Podocarpus falcatus*

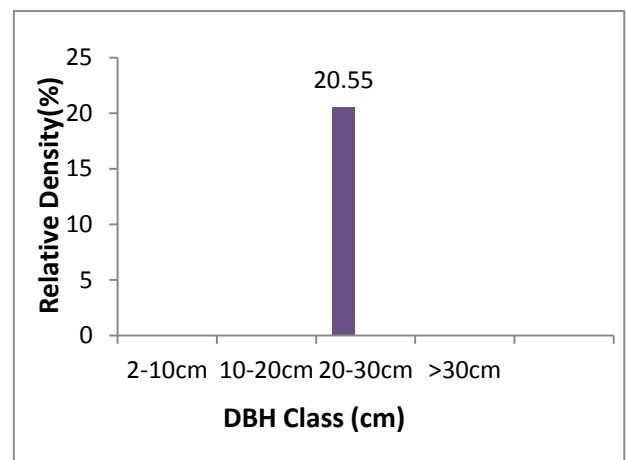


Figure 12: A-D, Population structure of representative indigenous plants in Mogle Mountain.

CHAPTER FIVE

5. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1. Discussion

5.1.1 Floristic Composition

The high diversity of indigenous plant species were recorded and documented in Mogle Mountain. A total of 39 plant species representing 37 genera and 32 families were recorded that indicate the area was rich in different plant species (Appendix 1). This is lower than other forest sites including Mana Angetu forest (75 families, 173 genera and 211 species) (Ermias Lulekal *et al.*, 2008), Jibat Natural forest (73 families, 159 genera and 183 species) (Tesfaye Burju *et al.*, 2013) and Majang forest (56 families, 115 genera and 158 species) (Semegnew Tadesse *et al.*, 2021). Among 39 plant species recorded in the study area 29 species (74.4%) were indigenous to Ethiopia (Appendix 3). These 29 indigenous plant species belonging to 28 genera and 24 families (Table 2). This shows that indigenous plant species are more diversified in Mogle forest. Fabaceae were found the dominant family represented by 4 species (10.25%) followed by Euphorbiaceae with 3 species (7.7%) and Rosaceae and Acanthaceae represented by two species (5.13%) each and other families contain single species (2.56%) each (Appendix 2). This finding was similar to the study by Tayachew Birhanu *et al.*, (2020) in which Fabaceae is dominant family represented by 9(12.5%) followed by Euphorbiaceae with 7(9.72%) and Acanthaceae and Rosaceae represented by 3(4.17%) species each.

5.1.2 Plant Community types

Plant community can be defined as the collection of plant species growing together in a particular location that shows definite associations of the communities better express their relationship to one another and environment than any other characteristics (Kent and Coker, 1992).

A total of four plant community types were identified by visual recognition. These are *Juniperus procera* - *Olea europaea* ssp. *cuspidata*, *Acacia abyssinica*-*Croton macrostachyus*-*Aloe macrocarpa*, *Euphorbia abyssinica* - *Justicia schimperiana*, *Prunus africana* -*Ficus sur*- *Milletia ferruginea*. Each plant community consists of different species of indigenous and exotic plants. Results of the study indicated that out of four plant community types the plant community type D exhibited the highest species richness. In general, the probable reasons for the variability of each value for the different community types arise from degree of disturbance involved in the area, human activities and different environmental factors which were not included in this study (Belete Kebede, 2012).

Growth habit

In terms of growth habit distribution of plant species in Mogle Mountain trees were dominant and constitute the largest category with 24 species (61.5%) followed by shrubs with 11 species (28.2 %), Herbs with 3 species (7.7%) and the least one is climber which constitute one species (2.6%)(Table 3). This indicates that the plant community of the study area is characterized by vegetations dominated by trees, also including shrubs and herbs which is similar with finding in Majang Forest that constitute 80 species (51%) trees, 26 species (16%) shrubs and 19 species (12%) herbs (Semegnew Tadesse *et al.*, 2021) and Church forest of Dangila which constitute 31 species (42.46%) trees, 27 species (36.99%) shrubs and 6 species (8.22%) climbers (Tayachew Birhanu *et al.*, 2020).

5.1.3 Floristic Structure

Density and Frequency

The total density of woody tree species of the study area was 30.41 individuals per hectare which is lower than Mana Angetu forest (408 individual ha⁻¹) (Ermias Lulekal *et al.*, 2008), Boditi forest (498 individual ha⁻¹) and Adelle forest (898 individual ha⁻¹) (Haile Yinegar *et al.*, 2008). As indicated in Table 4, *Juniperus procera* had density of 8.33 individual ha⁻¹ (27.39%) followed by *Acacia abyssinica* 7.5 individual ha⁻¹ (24.67%), *Podocarpus falcatus* 6.25 individual ha⁻¹ (20.55%), *Croton macrostachyus* 5.83 individual ha⁻¹ (19.17%) and *Cordia africana* 2.5 individual ha⁻¹ (8.22%).

Frequency indicates the homogeneity or heterogeneity of a given stand. High values in lower frequency classes and low values in higher frequency classes indicate a high degree of floristic heterogeneity (Lamprecht, 1989). An occurrence of a species in a given area indicates how species are distributed (Kent, 2011). As indicated in table 5, compared to dominant plant species existing in the study area, it was recorded that *Acacia abyssinica* is the most frequent dominant indigenous species followed by *Cordia africana*. This shows that both species have good distribution throughout the study area. Analysis of the frequency distribution indicated that *Croton macrostachyus*, *Juniperus procera* and *Podocarpus falcatus* were found to be with the lowest relative frequency indicating their poor distribution throughout the study area.

Diameter at Breast Height

The result of this study shows that the majority of the species had the highest number of individuals in the lower DBH class and low number of individual in the high DBH class. The distribution of trees was categorized in to 4 DBH class: (2-10cm, 10-20cm, 20-30cm >30cm). The first pattern indicated a high number of individuals in the 2-10cm DBH class followed by a progressive decline in the number of individuals with increasing DBH. The percentage distribution of trees in Mogle forest at different DBH class was computed and the result shows 60% found in the DBH class 2-10cm followed by 20% in class 10-20cm and >30cm each (Table 6). The large proportion of small sized tree species indicates that the vegetation of the area has good regeneration (Belete Kebede, 2012).

Basal Area

The total basal area of Mogle forest was $0.0895\text{m}^2\text{ha}^{-1}$ s. This shows the lowest basal area when compared with basal area in Adelle forest ($26\text{m}^2\text{ha}^{-1}$) and Boditi forest ($23\text{m}^2\text{ha}^{-1}$) (Haile Yinegar *et al.*, 2008), Menagesha forest ($36\text{m}^2\text{ha}^{-1}$) and Chilimo forest ($30\text{m}^2\text{ha}^{-1}$) (Tamrat Bekele, 1993) and Mana Angetu forest ($94\text{m}^2\text{ha}^{-1}$) (Ermias Lulekal *et al.*, 2008). As indicated in Table 7, about 80.44% of the basal area was contributed by *Cordia africana*. This implies that *Cordia africana* had the highest dominance in Mogle forest.

Important Value Index

The IVI analysis is used for comparison of ecological key species and ranking species for management and conservation priority. Those species with lower IVI need high conservation efforts while those with higher IVI values need sustainable management (Tayachew Birhanu *et al.*, 2020). In this study, the maximum IVI was contributed by *Cordia africana* (110.88) followed by *Acacia abyssinica* (76.05) and the lowest IVI was contributed by *Podocarpus falcatus* (31.67). This indicates *Cordia africana* and *Acacia abyssinica* was the most ecologically significant tree species in the study area. This result shows the highest IVI when compared with the maximum IVI in Adelle forest (99) and Boditi forest (86) (Haile Yinegar *et al.*, 2008), in Mana Angetu forest (79) (Ermias Lulekal *et al.*, 2008) and in Kafta- Sheraro National Park forest (30.8) (Fitsum Temesgen and Bikila Warkineh, 2020).

Preference Ranking

Ranking of indigenous plants showed that there are some indigenous plants that are preferred by local people than the others. The analysis of indigenous plants using preference ranking of 6 dominant plants from table 9 showed that *Podocarpus falcatus* and *Acacia abyssinica* are the most effective plants used by local people for their value as constructional material. Especially *Podocarpus falcatus* is the most preferred plant by local people for various uses and it would be the most threatened species for feature, which is shown by its rarely distribution around the study area. This scarcity is due to over harvesting not only for construction, but also for other uses. All of the species particularly the top ranked ones by preference and needs special urgent conservation action and sustainable uses. In this regard the results agree with the findings of Getnet Chekole (2011).

Direct Matrix Ranking

Direct matrix of randomly selected indigenous plants with different uses on given use criteria indicated that Indigenous plants broadly collected for different purposes such as construction, medicine, charcoal, firewood, timber and house hold tools. According to the result indicated in table 10, *Juniperus procera* was the most multipurpose plant scoring 23, followed by *Cordia africana* scoring 21 *Podocarpus falcatus* having score of 20 and the least one was *Albizia schimperiana* having score of 14. This implies that, as the value is getting high, the plants have multiple uses in the context of the local community (Etagegnew Yirsaw, 2018). Therefore, among indigenous plants of Mogle Mountain, *Podocarpus falcatus*, *Cordia africana*, *Juniperus procera* and *Acacia abyssinica* need prior conservation measure while they used by local communities for many purposes. This finding is similar with other research conducted by Etagegnew Yirsaw (2018).

5.1.4 Population Structure

Population structure defined as the distribution of individuals of each species in DBH classes to provide the overall regeneration profile of the study species (Peters, 1996; Simon Shibiru and Girma Balcha, 2004). Information on population structure helps to respect the healthy regeneration of the species under utilization (Kindeya G/ Hiywot, 2003). The general pattern DBH of Mogle forest showed an inverted J-shaped distribution where species had high frequencies in the lowest DBH classes and low frequencies in the high DBH classes as indicated in table 6. This shows the normal population structure that implies species existence in healthier condition. As indicated in figure 12, the population structure of four dominant indigenous plants of Mogle Mountain shows those plants need conservation and sustainable utilization. Therefore, the local community and administration of the woreda and other stake-holders should give attention to conserve plants including indigenous plants in the Mogle Mountain more and more for the future. Non-governmental Organization should also Plant the different types of plants including indigenous plants in Mogle Mountain. The attention of government on the conservation of indigenous plants are decreased. But, as much as possible the plants found on Mogle Mountain was conserved.

5.2. Conclusion and Recommendations

5.2.1. Conclusion

The result of this study indicated that the study area is relatively rich with its Indigenous plants distribution. The abundance of indigenous plants was 74.4% when compared with that of the exotic species in Mogle Mountain. From the study of diversity and status of indigenous plants in Mogle Mountain, 39 plant species belonging to 32 families and 37 genera were identified. Out of these, 24(61.5%) were trees, 11(28.2%) were shrubs, 3 (7.7%) were herbs and one (2.6%) were climber. Fabaceae had the highest number of species (10.25%) followed by Euphorbiaceae (7.5%), Acanthaceae and Rosaceae (5.12%) and the other families (87.5%) had one (2.56%) species each. Based on dominant plant species, the natural vegetation of the study area can be categorized visually into four plant community types. The community of plant types recognized visually during field observation are: *Juniperus procera* - *Olea europaea* ssp. *cuspidata*, *Acacia abyssinica*- *Croton macrostachyus*-*Aloe macrocarpa*, *Euphorbia abyssinica* - *Justicia schimperiana*, *Prunus africana* -*Ficus sur*- *Milletia ferruginea*. The result of this study shows that the majority of the species (about 60%) had the highest number of individuals in the lower DBH class (2-10cm). and low number of individual in the high DBH class. The large proportion of small sized tree species indicates that the vegetation of the area has good regeneration

potential. However, due to the poor conservation effort and lack of awareness about the indigenous plant wealth of the area the conservation status of the indigenous plants of Mogle Mountain was observed low and hence calls for prior conservation attention by stakeholders. 8 multipurpose species were selected out of total indigenous plants and 6 use categories were listed for 5 selected informants to assign use value to each species. *Juniperus procera* is found to be the highly used by local community for multiple purposes, followed by *Cordia africana* and *Podocarpus falcatus*. According to preference ranking of 6 dominant plants, *Podocarpus falcatus* is most used plant by local people for its value as constructional material.

5.2.2. Recommendations

The following recommendations are forwarded based on the findings of the present research:

- ✓ Governmental and Non-governmental organizations around the Mogle Mountain should give prior conservation attention for the identified Indigenous plants
- ✓ The district administration must give awareness for people of the Mogle Mountain area on the importance of Indigenous plants so that the local communities contribute their part to conserve their natural resources and use it wisely.
- ✓ All individuals who live around Mogle area have responsibility of planting and conserving Indigenous plants properly and using them in sustainable way.
- ✓ Researchers have responsibility of studying the current status and uses of Indigenous plants in Mogle Mountain and they must give recommendations on the conservation of Indigenous plants of the area.
- ✓ Special attention should be given by the district administration on an in depth research focusing on successful establishment of indigenous plant species in the area.
- ✓ Among indigenous plants of Mogle Mountain, *Podocarpus falcatus*, *Cordia africana*, *Juniperus procera* and *Acacia abyssinica* need prior conservation measure while they used by local communities for many purposes.

- ✓ Many indigenous plants of Mogle Mountain are used more for construction materials by local people. Therefore Government and other stakeholders must give attention to those plants and to prevent them from disturbance and ensure continuity of indigenous plants of the area.
- ✓ There are different indigenous plants in Mogle Mountain which have multipurpose values and used by local people. Therefore, all stakeholders must give awareness on their uses to local people and have responsibility of conserving them for sustainability.

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Appendix 1: List of plants found in the study area with scientific name, Family name, Local name, Habit (Tree, Shrub, Herb) and collection number.

No	Species name	Family name	Local name	Habit	Collection No
1	<i>Acacia abyssinica</i> Hochst. Ex Benth	Fabaceae	Laaftoo	Tree	GB 6
2	<i>Acacia mearnsii</i> De Wild.	Fabaceae	Kachaa	Tree	GB 4
3	<i>Albizia schimperiana</i> Oliv.,	Fabaceae	Ambaltaa	Tree	GB 27
4	<i>Aloe macrocarpa</i> Tod.,	Aloaceae	Argiisa	Herb	
5	<i>Apodytes dimidiata</i> E. Mey.ex Arn.,	Icacinaceae	Calalaqaa	Tree	GB 11
6	<i>Balanites aegyptiaca</i> (L.) Delile,	Balanitaceae	Daalachoo	Tree	GB 10
7	<i>Capparis tomentosa</i> (Lam.),	Capparidaceae	Arangamaa	Shrub	GB 8
8	<i>Carissa spinarum</i> (L.,)	Apocynaceae	Agamsa	Shrub	GB 24
9	<i>Casuarina equisetifolia</i> L.,	Casuarinaceae	Shuwaashuwee	Tree	GB 3
10	<i>Clausena anisata</i> (Willd.) Benth.	Rutaceae	Ulumaa	Tree	GB 12
11	<i>Clematis simensis</i> Fresen.	Ranunculaceae	Hidda	Climber	
12	<i>Cordia africana</i> L.,	Boraginaceae	Waddeesa	Tree	GB 5
13	<i>Croton macrostachyus</i> (Del.,)	Euphorbiaceae	Bakkanniisa	Tree	GB 23
14	<i>Dombeya torrida</i> (G.F.Gmel.) P. Bams	Sterculiaceae	Daannisa	Tree	GB 9
15	<i>Dovyalis abyssinica</i> (A.Rich.) Warb.,	Flacourtiaceae	Koshommii	Shrub	GB 2

16	<i>Ekebergia capensis</i> Sparrm.,	Meliaceae	Somboo	Tree	GB 20
17	<i>Eucalyptus globulus</i> Labill,	Myrtaceae	Baargamoo adii	Tree	GB 30
18	<i>Euphorbia abyssinica</i> Gmel,	Euphorbiaceae	Adaamii	Shrub	
19	<i>Ficus sur</i> Forssk.,	Moraceae	Harbuu	Tree	GB 15
20	<i>Grevillea robusta</i> R. Br.,	Proteaceae	Giraaviliyaa	Tree	GB 28
21	<i>Juniperus procera</i> Hochst. Ex Endl.,	Cupressaceae	Gaattiraa Habashaa	Tree	GB 14
22	<i>Justicia schimperiana</i> (Hochst.Ex Nees) T. Anders.	Acanthaceae	Dhummuugaa	Shrub	
23	<i>Kalanchoe petitiiana</i> A. Rich.	Crassulaceae	Bosoqqee	Herb	GB 33
24	<i>Maesa lanceolata</i> Forssk.,	Myrsinaceae	Abbayyii	Tree	GB 17
25	<i>Milletia ferruginea</i> (Hochst) Bak.,	Fabaceae	Birbirraa	Tree	GB 29
26	<i>Olea europaea</i> L. subsp. <i>cuspidata</i> (Wall. ex G Don) Cif.	Oleaceae	Ejersa	Tree	GB 16
27	<i>Osyris quadripartita</i> Decn.,	Santalaceae	Waato	Tree	GB 7
28	<i>Pavonia urens</i> Cav.	Malvaceae	Incinnii	Shrub	GB 1
29	<i>Pittosporum viridiflorum</i> Sims,	Pittosporaceae	Soolee	Tree	GB 26
30	<i>Phytolacca dodecandra</i> L ‘H’erit.,	Phytolaccaceae	Andoodee	Shrub	
31	<i>Podocarpus falcatus</i> (Thunb.) R.e Mirb.,	Podocarpaceae	Birbirsaa	Tree	GB 13
32	<i>Premna schimperii</i> Engl.,	Lamiaceae	Urgeechaa	Shrub	GB 18
33	<i>Prunus africana</i> (Hook. f.) Kalkm.	Rosaceae	Hoomii	Tree	
34	<i>Ricinus communis</i> L.,	Euphorbiaceae	Qobboo	Herb	GB 32
35	<i>Rhus vulgaris</i> Meikle,	Anacardiaceae	Xaaxechaa	Tree	GB 22
36	<i>Rosa abyssinica</i> Lindley	Rosaceae	Qaqawwee	Shrub	GB 21
37	<i>Solanum marginatum</i> L.f.	Solanaceae	Hiddii	Shrub	GB 19
38	<i>Vernonia amygdalina</i> Del.,	Asteraceae	Eebicha	Tree	GB 25
39	<i>Vernonia auriculifera</i> Hiern,	Asteraceae	Reejjii	Shrub	GB 31

Appendix 2: Plant families with their genera and species distribution percentage in the Mogle Mountain.

No	Family name	Number of Species	Species in percentage	Number of Genera	Genera in percentage
1	Acanthaceae	1	2.56	1	2.7
2	Aloaceae	1	2.56	1	2.7
3	Anacardaceae	1	2.56	1	2.7
4	Apocynaceae	1	2.56	1	2.7
5	Asteraceae	2	5.13	1	2.7
6	Balanitaceae	1	2.56	1	2.7
7	Boraginaceae	1	2.56	1	2.7
8	Capparidaceae	1	2.56	1	2.7
9	Casuarinaceae	1	2.56	1	2.7
10	Crassulaceae	1	2.56	1	2.7
11	Cupressaceae	1	2.56	1	2.7
12	Euphorbiaceae	3	7.7	3	8.1
13	Fabaceae	4	10.26	3	8.1
14	Flacourtiaceae	1	2.56	1	2.7
15	Icacinaceae	1	2.56	1	2.7

16	Lamiaceae	1	2.56	1	2.7
17	Malvaceae	1	2.56	1	2.7
18	Meliaceae	1	2.56	1	2.7
19	Moraceae	1	2.56	1	2.7
20	Myrsinaceae	1	2.56	1	2.7
21	Myrtaceae	1	2.56	1	2.7
22	Oleaceae	1	2.56	1	2.7
23	Phytolaccaceae	1	2.56	1	2.7
24	Pittosporaceae	1	2.56	1	2.7
25	Podocarpaceae	1	2.56	1	2.7
26	Proteaceae	1	2.56	1	2.7
27	Rosaceae	2	5.13	2	5.4
28	Rununculaceae	1	2.56	1	2.7
29	Rutaceae	1	2.56	1	2.7
30	Santalaceae	1	2.56	1	2.7
31	Solanaceae	1	2.56	1	2.7
32	Sterculiaceae	1	2.56	1	2.7
Total = 32		39	100	37	100

Appendix 3: List of Indigenous plants in the Mogle Mountain with their scientific name, Family name, Local name, Habit (Tree, Shrub, Herb) and Collection number.

No	Scientific Name	Family	Local Name	Habit	Collection No
1	<i>Acacia abyssinica</i> Hochst. Ex Benth	Fabaceae	Laaftoo	Tree	GB 6
2	<i>Albizia schimperiana</i> Oliv.,	Fabaceae	Ambaltaa	Tree	GB 27
3	<i>Aloe macrocarpa</i> Tod.,	Aloaceae	Argiisa	Herb	
4	<i>Apodytes dimidiata</i> E. Mey.ex Arn.,	Icacinaceae	Calalaqaa	Tree	GB 11
5	<i>Balanites aegyptiaca</i> (L.) Delile,	Balanitaceae	Daalachoo	Tree	GB 10
6	<i>Carissa spinarum</i> (L.,)	Apocynaceae	Agamsa	Shrub	GB 24
7	<i>Clausena anisata</i> (Willd.) Benth.	Rutaceae	Ulumaa	Tree	GB 12
8	<i>Cordia africana</i> L.,	Boraginaceae	Waddeesa	Tree	GB 5
9	<i>Croton macrostachyus</i> (Del.,)	Euphorbiaceae	Bakkanniisa	Tree	GB 23
10	<i>Dombeya torrida</i> (G.F. Gmel.) P.Bamps	Sterculiaceae	Daannisa	Tree	GB 9
11	<i>Ekebergia capensis</i> Sparrm.,	Meliaceae	Somboo	Tree	GB 20
12	<i>Euphorbia abyssinica</i> Gmel,	Euphorbiaceae	Adaamii	Shrub	
13	<i>Ficus sur</i> Forssk.,	Moraceae	Harbuu	Tree	GB 15
14	<i>Juniperus procera</i> Hochst. Ex Endl.,	Cupressaceae	Gaattiraa Habashaa	Tree	GB 14

15	<i>Justicia schimperiana</i> (Hochst. Ex Nees) T. Anders.	Acanthaceae	Dhummuugaa	Shrub	
16	<i>Kalanchoe petitiiana</i> A. Rich.	Crassulaceae	Bosoqqee	Herb	GB 33
17	<i>Maesa lanceolata</i> Forrsk.,	Myrsinaceae	Abbayyii	Tree	GB 17
18	<i>Milletia ferruginea</i> (Hochst) Bak.,	Fabaceae	Birbirraa	Tree	GB 29
19	<i>Olea europaea</i> L. subsp. <i>cuspidata</i> (Wall. ex G Don) Cif.	Oleaceae	Ejersa	Tree	GB 16
20	<i>Osyris quadripartita</i> Decn.,	Santalaceae	Waatoo	Tree	GB 7
21	<i>Phytolacca dodecandra</i> L ‘H’erit.,	Phytolaccaceae	Andoodee	Shrub	
22	<i>Podocarpus falcatus</i> (Thunb.) R. e Mirb.,	Podocarpaceae	Birbirsaa	Tree	GB 13
23	<i>Premna schimperi</i> Engl.,	Lamiaceae	Urgeechaa	Shrub	GB 18
24	<i>Prunus africana</i> (Hook. f.) Kalkm.	Rosaceae	Hoomii	Tree	
25	<i>Ricinus communis</i> L.,	Euphorbiaceae	Qobboo	Herb	GB 32
26	<i>Rhus vulgaris</i> Meikle,	Anacardiaceae	Xaaxechaa	Tree	GB 22
27	<i>Solanum marginatum</i> L.f.	Solanaceae	Hiddii	Shrub	GB 19
28	<i>Vernonia amygdalina</i> Del.,	Asteraceae	Eebicha	Tree	GB 25
29	<i>Vernonia auriculifera</i> Hiern,	Asteraceae	Reejjii	Shrub	GB 31

Appendix 4: List of uses of Indigenous plants in Mogle Mountain.

No	Scientific Name	Family	Local Name	Habit	Uses
1	<i>Acacia abyssinica</i> Hochst. Ex Benth	Fabaceae	Laaftoo	Tree	Feed, landscape, firewood, timber, medicine, manure, craft
2	<i>Albizia schimperiana</i> Oliv.,	Fabaceae	Ambaltaa	Tree	Shade, construction, tool handles, firewood, charcoal
3	<i>Aloe macrocarpa</i> Tod.,	Aloaceae	Argiisa	Herb	Medicine, Oil
4	<i>Apodytes dimidiata</i> E. Mey.ex Arn.,	Icacinaceae	Calalaqaa	Tree	Construction, House hold tools, Charcoal
5	<i>Balanites aegyptiaca</i> (L.) Delile,	Balanitaceae	Daalachoo	Tree	Farm tool, medicine, fodder, bee forage, shade
6	<i>Carissa spinarum</i> (L.,)	Apocynaceae	Agamsa	Shrub	Construction, medicine, food
7	<i>Clausena anisata</i> (Willd.) Benth.	Rutaceae	Ulumaa	Tree	Aromatic, construction, fire wood.
8	<i>Cordia africana</i> L.,	Boraginaceae	Waddeesa	Tree	Construction, Charcoal, feed, craft, forage for domestic animal
9	<i>Croton macrostachyus</i>	Euphorbiaceae	Bakkanniisa	Tree	Medicine, feed, construction,

	(Del.,)				craft, forage for domestic animals and bees.
10	<i>Dombeya torrida</i> (G.F. Gmel.) P.Bamps	Sterculiaceae	Daannisa	Tree	Fuel, Construction, medicine, bee forage
11	<i>Ekebergia capensis</i> Sparm.,	Meliaceae	Somboo	Tree	Construction, medicine, timber, charcoal, fire wood, animal food
12	<i>Euphorbia abyssinica</i> Gmel,	Euphorbiaceae	Adaamii	Shrub	Construction, Fire wood, timber, medicine, fencing
13	<i>Ficus sur</i> Forssk.,	Moraceae	Harbuu	Tree	Food, Household tool
14	<i>Juniperus procera</i> Hochst. Ex Endl.,	Cupressaceae	Gaattiraa Habashaa	Tree	Medicine, Construction, Charcoal, Fire wood, timber, craft, Household tools, landscape, shade, ornamental
15	<i>Justicia schimperiana</i> (Hochst. Ex Nees) T. Anders.	Acanthaceae	Dhummuugaa	Shrub	Construction, food for domestic animals, medicine
16	<i>Kalanchoe petitiiana</i> A. Rich.	Crassulaceae	Bosoqqee	Herb	Medicine
17	<i>Maesa lanceolata</i> Forrsk.,	Myrsinaceae	Abbayyii	Tree	Medicinal (Vermifuge), oil, craft
18	<i>Milletia ferruginea</i> (Hochst) Bak.,	Fabaceae	Birbirraa	Tree	Fire wood, Shade, house hold tools
19	<i>Olea europaea</i> L. subsp. <i>cuspidata</i> (Wall. ex G Don) Cif.	Oleaceae	Ejersa	Tree	Medicine, Food, oil, Craft, Fire wood, Cleaning, aromatic
20	<i>Osyris quadripartita</i> Decn.,	Santalaceae	Waattoo	Tree	Construction, Charcoal, Fire wood
21	<i>Phytolacca dodecandra</i> L 'H' erit.,	Phytolaccaceae	Andoodee	Shrub	Medicine, Detergent

22	<i>Podocarpus falcatus</i> (Thunb.) R. e Mirb.,	Podocarpaceae	Birbirsaa	Tree	Construction, Fire wood, Household tools, timber, landscape, shade, charcoal
23	<i>Premna schimperii</i> Engl.,	Lamiaceae	Urgeechaa	Shrub	Medicine, firewood, charcoal, fencing
24	<i>Prunus africana</i> (Hook. f.) Kalkman.	Rosaceae	Hoomii	Tree	Medicine, timber, construction, household tools
25	<i>Rhus vulgaris</i> Meikle,	Anacardiaceae	Xaaxechaa	Tree	Construction, Household tool
26	<i>Ricinus communis</i> L.,	Euphorbiaceae	Qobboo	Herb	Oil, Medicine,
27	<i>Solanum marginatum</i> L.f.	Solanaceae	Hiddii	Shrub	Medicine, oil
28	<i>Vernonia amygdalina</i> Del.,	Asteraceae	Eebicha	Tree	Medicine, Cleaning, food
29	<i>Vernonia auriculifera</i> Hiern,	Asteraceae	Reejjii	Shrub	Medicine, construction

Appendix 5: Questionnaires

Dear respondents these questionnaires are designed to collect information on the diversity and the status of indigenous plants in Mogle Mountain.

Personal Information

1. **Sex :** A. Male B. Female
2. **Age :** A. 15_ 25 years B. 26_35 years C. 36 and above
3. **Marital status :** A. Single B. Married C. Divorced D. Widowed
4. **Occupation:** A. Farmer B. Merchant C. Student
5. **Educational Level:** A. Uneducated B. Elementary C. High School
D. Certificate E. Diploma F. Degree

Questions

1. Indigenous plants present in Mogle Mountain?
A. Yes B. No
2. What types of individual plants are there?
A. Trees B. Shrubs C. Herbs D. All
3. There are diverse individual plants or the same species?
A. Diverse B. Same
4. What was the status of Indigenous Plants in Mogle Mountain?
A. Conserved B. Not conserved

5. Which plant is dominant in Mogle Mountain?
6. Local peoples use indigenous medicinal plants?
A. Yes B. No
7. What is the importance of Indigenous plants found in Mogle Mountain?

Appendix 6: Pictures showing part of the field activity.







