VASCULAR PLANTS DIVERSITY AND ETHNOBOTANY WITH EMPHASIS TO TRADITIONAL MEDICINAL AND WILD EDIBLE PLANTS IN DUGDA DAWA DISTRICT OF BORANA ZONE, OROMIA REGIONAL STATE, ETHIOPIA

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A Thesis Submitted to

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GRADUATE PROGRAMMES

This is to certify that the thesis prepared by Mersha Ashagre Eshete, entitled: "***Vascular Plants Diversity and Ethnobotany with Emphasis to Traditional Medicinal and Wild Edible Plants in Dugda Dawa District of Borana Zone, Oromia Regional State, Ethiopia***", and submitted in fulfillment of the requirements for the Degree of Doctor of Philosophy (Plant Biology and Biodiversity Management) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

Vascular Plants Diversity and Ethnobotany with Emphasis to Traditional Medicinal and Wild Edible Plants in Dugda Dawa District of Borana Zone, Oromia Regional State, Ethiopia
Mersha Ashagre, PhD Dissertation
Addis Ababa University, 2017

This research is aimed at documentation and analysis of plant diversity in Dugda Dawa District along with the ethnobotanical knowledge associated with traditional medicinal and wild edible plants used by the local people. Vegetation data were collected from 60 plots laid preferentially, 20 m x 20 m for trees and shrubs and 1m x 1m subplots for herbs. Woody species with a diameter at breast height (DBH) $\geq$ 3 cm were counted and cover abundance values estimated. Shannon-Wiener diversity index was used to assess species richness and evenness. Both Sorensen's similarity coefficient and Jaccard's index of similarity were used to measure similarities among communities in Dugda Dawa District vegetation, and only Sorensen's similarity coefficient to measure between this and other woodland vegetations types in Ethiopia. A hierarchical cluster analysis with PC-ORD was used to identify plant communities and synoptic values for detection of the dominant species for naming each plant community type. Frequency, density, DBH, basal area and importance value indices (IVI) of woody species were also computed. Ethnobotanical data were collected by interviewing 392 informants (290 males and 102 females). Guided field walk and discussion (group or individual discussion) were used in collecting the data.Quantitative approaches were used to determine informant consensus factor (ICF), fidelity level (FL), and use value (UV). Ethnomedicinal knowledge apprehended by different informant categories was compared using t-tests with R- software. The study area yielded 343 vascular plant species of which 12 were endemic and four were new records for the floristic region belonging to 227 genera and 81 families. The vegetation was classified into four community types, namely Prunus africana - Calpurnia aurea, Ehretia cymosa - Juniperus procera, Boscia mossambicensis - Lannea schimperi and Celtis africana - Podocarpus falcatus community types based on hierarchical cluster analysis. The overall Shannon-Wiener diversity and evenness values of Dugda Dawa District vegetation were 4.87 and 0.54 respectively. The percentage distribution of individual shrub and tree species across different DBH classes indicated relatively high proportion (53.9%) of individuals in DBH class 3 - 10 cm. Four representative woody plant population structures were identified. Results of the ethnobotanical study revealed 127 medicinal plant species in 123 genera and 82 fanilies; and 71 wild edible plant species belonging to 52 genera and 37 families in different vegetation formations of the study area. The family Fabaceae with 10 (7.9%) species of medicinal and 7 (9.9%) species of wild edibles was dominant followed by the Lamiaceae (7, 5.5%) species of medicinal plants and Anacardiaceae (7, 9.9%) species of wild edibles were the families represented by more species in the district. Plants in which leaves are used as medicine and fruits are used as wild food were more dominant (36.6% and 65.4% respectively) than other plant parts in the district. Significant difference ($P < 0.05$) was seen in the mean number of medicinal plants reported by informants in different age classes, education levels, and experiences. Similarly significant difference ($P < 0.05$) was observed in the mean number of wild edible plants reported by informants in different age classes and experiences. The highest ICF value (0.93) was recorded for human musculoskeletal and nervous system disease category. The highest fidelity level values were recorded for Ocimum urticifolium (97%) and Cyphostema serpens (97%). Dry evergreen afro-montane forest vegetation which encompasses community one, two and four in Dugda Dawa District is under great anthropogenic pressure including selective cutting of big trees in community four, medicinal plants (e.g. Prunus africana and Zanthoxylum chalybeum) as well as wild edible plants (e.g. Cordia africana and Syzygium guineense) which need strict conservation measures. Thus, priority conservation action should be given to the dry afromontane vegetation type which encompasses plant communities one, two, and four as they contain high plant species number (295) and high useful species (214) though the other vegetation types are also under threat and community - based conservation activities should be applied to create sustainable usage of resources. Warburgia ugandensis and Psophocarpus grandiflorus should be given cultivation and chemical analysis priority for their medicinal and food values respectively.

Key words: Dugda Dawa District, ethnobotany, medicinal plants, plant diversity, wild edible plants

DEDICATION

This thesis is dedicated to the people of Dugda Dawa District who showed their willingness to share their knowledge on the use of traditional medicinal plants and wild edible plants used by the community.

Acknowledgments

Above all, I thank the Almighty God for providing me this opportunity and granting me the capability to proceed successfully. This thesis appears in its current form due to the assistance and guidance of several people. I would therefore like to offer my sincere thanks to all of them.

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CHAPTER ONE

1. INTRODUCTION

1.1. Background

Plant diversity refers to the variety and variability of plant species. Due attention should be given to the concern of societies on natural assets around the world in order to alleviate their loss (WRI *et al.,* 1998). Losses of forest cover and biodiversity as a result of human-induced activities are growing concern in several parts of the world (Feyera Senbeta and Demel Teketay, 2003). Biodiversity resources together with their habitats are hastily disappearing in Ethiopia (Feyera Senbeta and Denich, 2006). The overall result of this environmental degradation in the country, whether at a local or ecosystem level, leads to desertification and its expressions are ultimately becoming the overriding causes for the loss of biodiversity. These disruptions are meant that much endemic biodiversity has been lost and more is threatened (Zerihun Woldu, 2008). The vegetation cover of a given area has a definite structure and composition, which is developed because of the long term interaction between biotic and abiotic factors. The topography and diverse climatic conditions of Ethiopia led to the emergence of habitats that are suitable for the growth of different plant species. These led to the evolution of some unique plant and animal species and their assemblages. Accordingly, Ethiopia is one of the countries in the world with high level of biodiversity (Vivero *et al*., 2005). Owing to the long history of farming and the variety of the environment, Ethiopia was identified as one of the 12 Vavilov centers of crop genetic diversity (Vavilov, 1926).

It is important to study and document the remaining vegetation to be able to promote knowledge based conservation and sustainable utilization of the plant resources. Plant communities are defined as recognizable units of vegetation in a uniform environment with a relatively uniform floristic composition and vegetation structure that is distinct from the surrounding vegetation (Kent and Coker, 1992). Recognition of plant communities helps in recommending appropriate management regimes for the community types as part which deserves separate management regimes. This further helps in planning and implementing conservation strategies and sustainable utilization of plant resources.

Ecological gradient analysis offers the fundamental causes for the pattern and distribution of plant communities on landscapes. Thus, evaluation of the spatial variation of environmental variables is essential to understand the causes governing the distribution and wealth of species (Getachew Tesfaye *et al*. 2008). Furthermore, examination of outlines of inhabitant's structures could provide valuable information about their regeneration and recruitment status that could be further employed for devising conservation and management strategies (Demel Teketay, 2005). Plant ecological studies in Ethiopia have been undertaken with emphasis to plant community investigation as could be seen in Abate Ayalew *et al*. (2006); Feyera Senbeta (2006); Simon Shibru and Zerihun Woldu (2006); Getachew Tesfaye *et al*. (2008); Haile Yineger *et al*. (2008). These studies demonstrated the variation in several attributes of plant communities with the variation in environmental variables.

Ethnobotany is defined by several authors as the study of human uses of plants. It is defined as "local people's interaction with the natural environment: how they classify, manage and use plants available around them" (Martin, 1995). It is the study of interactions of plants and people, including the influence of plants on human culture (Balick and Cox, 1996). Indigenous knowledge has developed as a result of human interaction with their environment. In this view, ethnobotanical studies are useful in documenting, analyzing, and communicating knowledge and interaction between plant diversity and human societies, how diversity in nature is used and influenced by human activities (Martin, 1995; Balick and Cox, 1996; Cotton, 1996). People have engaged in a relationship with medicinal, edible, and other useful local plants of the study area. The local plants of the study area have known uses as medicines, foods, feed, construction materials, fuel source (firewood and charcoal), materials and tools, as well as cultural and communal uses. In discussing the many potential uses and ways of interacting with local plants, we anticipated to express a sense of the value of the study area landscapes with the associated vegetation and respective indigenous knowledge.

Traditional knowledge is coming into the middle-of-the-road for sustainable development and biodiversity conservation discussion. Indigenous knowledge guides the choices and practices of pastoralists and farmers of many places and it is predictable that some 80% of the world's population fulfill their primary health needs through the use of traditional medicines (Nakashima and Rou´e, 2002). Even in developed countries, local knowledge built up across generations continues to play a fundamental role in supporting localized resource use practices whether they

are pastoralists, small-scale farmers, or the gatherers of wild produce. Indigenous people can contribute importantly to the understanding of the processes of change, whether these might be short, or long-term which can be bounded to local events or global transformation processes. Pastoral and peasant communities that have maintained traditional modes of production have today become the major guardians of the world's crop and domestic animal diversity. However, overstocking and farmland expansion have become the main causes of natural resources degradation. Despite these, studies on the floristic composition and ethnobotany of the woodland and dry afromontane vegetation in Dugda Dawa District are lacking. Furthermore, Magada Forest (the so called Regional Protected Forest, part of which is found in the study area) is highly disturbed due to selective logging by the local people and due to livestock herding in it. So, it is important to study the diversity of vascular plants and associated indigenous knowledge in the study area to determine the level of their depletion/ conservation with emphasis to traditional medicinal and wild edible plants.

1.2. Statement of the problem

There is a significant lack of information on the ecology and diversity of some of the vegetation types in the country. Generation of scientific knowledge through floristic analysis could be one of the intervention mechanisms to counteract the problem and contribute to the conservation of vegetation resources and the associated biodiversity in it. The vegetation in Dugda Dawa District has continued to be under pressure by the surrounding people due to overgrazing, illegal timber harvesting (logging) for market, firewood collection and charcoal production, wood cutting for construction and for satisfaction of other needs. Ethiopia has a rich heritage of indigenous knowledge associated with traditional medicinal and wild edible plants. But this knowledge is disappearing with the diminishing vegetation status, adaption and amalgamation of culture in the country. Of special concern this indigenous knowledge has not been documented and is not well known outside of Dugda Dawa. Since ecological and ethnobotanical knowledge is scanty in the district, meaningful environmental conservation action can't be drawn. Thus, the present study is initiated to generate basic scientific information on the diversity of plant species with emphasis to use and conservation of traditional medicinal plants of humans and livestock as well as wild edible plants.

1.3. Research questions, hypotheses and objectives

1.3.1. Research questions

The investigations in this research targeted towards addressing the following main questions:

- What type of plant communities exist in the vegetation of Dugda Dawa District?
- What is the measure of the species richness and diversity among different plant communities?
- What is the status and distribution of medicinal plants and wild edible plants across different plant communities?
- What are the traditional medicinal plants used by people in Dugda Dawa District to treat human, livestock and/or both humans and livestock ailments?
- Which health problems of humans and livestock are treated by traditional herbal medicine?
- Are there medicinal plants used to treat a particular disease with the agreement of local healers?
- What are the wild edible plants used by the local people of the study area?
- Are there medicinal plants that are also used as food by the community?
- Are there common wild edible plants which are highly used during food shortage in the study area?
- Is there a trend to sell medicinal and wild edible plants in the market by the indigenous people?
- How do the local people use traditional medicinal plants to treat ailments? Do these plants have uses other than their medicinal role?
- Are there factors affecting the transfer of traditional knowledge on medicinal plants and wild edible plants among different classes of the community members?
- What are the drivers of change in plant diversity and indigenous knowledge on plant uses?
- What are the threats and conservation status of vegetation and individual medicinal and wild edible plants in the study area?

1.3.2. Hypotheses

The following hypotheses were tested in this study:

1. The vegetation of the study area is with less species diversity and similar plant communities;
2. Different vegetation types and plant communities may not maintain useful plants (medicinal plants, wild edible plants and plants of other uses);
3. Depletion of plant diversity and loss of indigenous plant knowledge is at minimum and high consideration is given to conservation and sustainable utilization of plant resources in the study area;
4. Very few plant species are used for traditional medicine and as wild food;
5. The local people are ignorant (no knowledge and culture) in using wild plants for different purposes; and
6. The traditional herbalists in the community are not familiar with healing plants, their preparation, and applications.

1.3.3. Objectives of the study

General objective

- To improve societal welfare by identifying useful plants for wider use and determining the conservation needs of plant diversity and indigenous knowledge of medicinal and wild edible plants in Dugda Dawa District.

Specific objectives

1. Collect, make taxonomic determinations and prepare authentic list of plant species found in the district;
2. Drawing ecological knowledge through analyzing the diversity of vascular plants and ethnobotany with emphasis to medicinal and wild edible plants.
3. Identify plant community types of the vegetation of the study area;
4. Compare species richness and diversity among different plant communities;
5. Document information on medicinal plant parts used, modes of remedy preparation, routes of remedy administration and dosages;
6. Collect and record indigenous knowledge of the people on how the medicinal plants, wild edible plants and plants of other uses are utilized;
7. Identify major threats to and local conservation practices of plant species of the study area;

1.4. Arrangement of the thesis

This thesis is structured in five main chapters. The first chapter starts with a general introduction encompassing brief background about the subject of investigation followed by statement of the problem, research questions, hypotheses and objectives. Review of relevant literature makes up the second chapter. The third chapter is the materials and methods section which begins with description of the study area and continues with comprehensive presentation of research methods used in this research. Chapter four presents the results of the research and the fifth chapter deals with discussion of each result with its respective subsections, and the general conclusion and recommendation parts. Articles published during the course of this PhD work are listed below:

1. Mersha Ashagre Eshete, Zemede Asfaw and Ensermu Kelbessa (2016). Ethnobotanical study of wild edible plants in Burji District, Segan Area Zone of Southern Nations, Nationalities and Peoples Region (SNNPR), Ethiopia. *Journal of Ethnobiology and Ethnomedicine* 12:32/ DOI: 10.1186/s13002-016-0103-1.
2. Mersha Ashagre Eshete, Zemede Asfaw and Ensermu Kelbessa (2016). A review on taxonomic and use diversity of the family Amaranthaceae in Ethiopia. *Journal of Medicinal Plants Studies* 4(2): 185-194/ISSN 2320-3862.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Vegetation and ethnobotany

Vegetation can be defined as all the plants or plant life of a place, taken as a whole. Its patterns reflect complex interactions between physical factors such as topography, rainfall and geology with biological and socio-economic factors. It is equally important to recognize the great differences within and between forest and woodland systems in terms of patterns of disturbance and plant use (Kent and Coker, 1992). Plants have been an integral part of human society since the start of its origin. Ethnobotany is the study of interactions of plants and people (Balick and Cox, 1996). The main uses of plants include being sources of food, energy, ethno-medicine and ethno-veterinary medicine, pesticides and insecticides to protect the crops, wood for making implements, utensils, tools, musical instruments, as dye-colours, other household goods, commercial plants, etc.

2.1.1. Plant community types

When an ecologist or ethnobotanist stands on the top of a hill and surveys a scenery dominated by natural or semi-natural vegetation of a certain place, the main differences in pattern visible in the landscape will be those of plant communities (Kent and Coker, 1992). When an ethnobotanist does this what come out conspicuously will be the landform, the plant communities, and the land use pattern. But in different ways from that of an ecologist, ethnobotanists can use the emic (insider's) approach to classify plant communities with the participation of local informants. That means based on the research participants' words (insiders view or bottom - up approach) ethnobotanists can identify plant communities of a certain study area. This is today studied in ethnobotany and ethnoecology. Major distinction amid plant communities are made on the bases of the growth form of the vegetation. Plant communities are considered as kinds of vegetation recognized by their plant composition. The species compositions of communities better express their interaction to one another and environment than any other characteristic. The plant community can be defined as the group of plant species growing together in a particular location that show a definite association or affinity with each other (Kent and Coker, 1992) or it is a combination of plants that are dependent on

their environment, influence one another, and modify their own environment (Mueller - Dombois and Ellenberg, 1974). Mueller-Dombois and Elenberg (1974) further stated that the floristic composition of a given vegetation type includes all species occurring within a plant community. However, most plant communities consist of so many different species which are not unique to a given community. Hence, it is common to use the dominant species in naming plant communities (Kent and Coker, 1992).

2.1.2. Species diversity, richness, and similarity

The report of plant community involves the study of species diversity, evenness, and similarity. The variety and equitability of species in a given plant community is used to interpret the relative variations between and within the community and help to explain the underlying reasons for such a difference. The concept of species diversity involves two relatively distinct notions: species richness and evenness. Species richness refers to the total number of species in a community whereas evenness is the relative abundance of species within the sample or community (Kent and Coker, 1992). Diversity is, thus, measured by recording the number of species and their relative abundances. The two components may be examined separately or combined in some form of index like the Shannon diversity index. Prototypes of plant species diversity have often been noted for prioritizing conservation activities because they reflect the underlying ecological processes that are important for management (Lovett *et al*., 2000).

Species diversity can be viewed from different angles: alpha, beta and gamma diversity. Alpha diversity refers to the diversity of species within a certain habitat or community. Beta diversity is a measure of the rate and amount of change in species along a grade from one habitat to another and is between habitat diversity that indicates turnover rates. Beta diversity is occasionally called habitat diversity (Kent and Coker, 1992). Gamma diversity is the diversity of species in similar habitats along geographical transect and it depends on the alpha and beta diversity (Kent and Coker, 1992). Species diversity index provides information about community composition than simply species richness. Measures of species diversity are usually seen to be key indicators for the wellbeing of ecological systems. Among many of species diversity indices, diversity and evenness are often calculated using Shannon diversity index, which naturally varies between 1.5 and 3.5 and rarely exceeds 4.5 (Kent and Coker, 1992). It is the most widely used index that combines species richness with evenness.

2.1.3. Concept of ethnobotany

In 1895 John Harshberger coined the term ethnobotany for the first time (Jain, 1986). However, it has different interpretations and definitions depending on the interest of various workers but conceptually the same. Hence, ethnobotany has a long history and has proved difficult to underline single unified definition (Alcom, 1984) mainly because of wide conceptual scope. Cotton (1996) defined ethnobotany as the study of the use of plants by aboriginal people or the relationship between human societies with natural vegetation. On the other hand, Martin (1995) defined ethnobotany as the study of people's classification, management, and use of plants. There has been an ever increasing interest of botanists, anthropologists and explorers of the world to document the potential uses and economic potential of plants used by indigenous societies (Cotton, 1996). This has its landmarks in 1492 when Christopher Columbus discovered tobacco that was being used by local people, during his voyage to Cuba in the same year (Cotton, 1996). The British explorer, Richard Spuce around 1858, noted for the first time to the psychoactive properties of the South American Vine, *Banineriopsis ecapi* (Cotton, 1996). As the number of trips and educated communication went on widening, there has been an intensified and continuous search by researchers of different fields to disclose traditional use of plants in different parts of the world by indigenous society (Balick and Cox, 1996; Cotton, 1996). This search has been moving to the popularization of ethnobotany as a field of study in biological science.

In any case, ethnobotany is a broad term, which is considered the study of the direct interaction and interrelationships between humans and plants (Martin, 1995). It is both an interdisciplinary and multidisciplinary science (Jain, 1986; Martin, 1995) which focuses on compiling, analyzing, documenting and use of indigenous knowledge (IK) on plants as well as the proper utilization, conservation and management strategies (Martin, 1995). Moreover, Cotton (1996) and Balick and Cox (1996) described ethnobotany, as a useful science to explain the useful plants and associated indigenous knowledge of local community as well as their utilization and management. This multidisciplinary approach gives ethnobotanists more insight into the management of forest assets in a period of great environmental stress. Unfortunately, due to human factors that have influenced the ecological balance of these delicate ecosystems, we are presently faced with the possibility of losing forests. Ethnobotany as an emerging science has a

very important role in the improvement of plants and plant products. It certainly adds values to conservation and resource utilization. There is now growing recognition for the relevance of ethnobotanical knowledge and its potential role in the design of sustainable development and alternative economic options. Ethnobotanical knowledge refers to practical knowledge related to uses of biological resources within indigenous cultural groups based on their intimate experience accumulated over many generations (Heinrich, 2014). Application of ethnobotanical knowledge towards biodiversity management, community development and conservation is gaining thrust.

Applied ethnobotany emphasizes or focuses on:

- Systematic inventory of biodiversity;
- Assess the dynamic aspects on sustainable use of plant resources, particularly in the face of market economy;
- Document indigenous knowledge related to biological resources and their management;
- Transfer and replicate the indigenous practices and knowledge concerned into the places/situations/, systems, where conditions are similar for community conservation and development;
- Integrate for alternative economic options.

The two fundamental strengths of applied ethnobotany are:

1. Allowing the knowledge and practices of local people to play fuller roles in identifying and finding solutions to problems of conservation.

2. Involving the local people in all stages of research and practical follow-up, so there will be better chance of "buy-in" and more robust solutions (Ghillean, 1991*)*.

Informant selection, field observation, discussion, interviews, market survey and analytical tools such as preference ranking, direct matrix ranking, informant consensus factor, fidelity level (FL), use value, t- test or chi square are common methods in ethnobotanical study (Martin, 1995). Modern studies in ethnobotany are apparent from earlier studies of useful plants in that, modern ethnobotanical studies have a tendency to include more information about the cultural groups that use the plants medicinally or for other purposes. Modern ethnobotanical (ethnomedicinal) studies include information about: (1) cultural beliefs surrounding illness,

treatment, and medicinal, including the process by which a person looks for treatment for illness; (2) cultural beliefs about plant and human ecological interaction, and the part medicinal plants play in larger society; (3) ritual, traditional, and other uses of medicinal plants; and (4) the role of a traditional healer, shaman, or other ritual specialist who uses medicinal plants to take care of patients, whether the disease at issue is believed to have a natural or unrefined cause, or it is supposed to have been caused by spiritual forces, malevolence (evil) or another non- organic cause. In addition, modern ethnomedicinal studies often try to find evidence of their efficiency in treating illness and the plants' medicinal effects on the human body (Soejarto *et al*., 2003).

The progress of the relatively new social science, cultural anthropology, at the end of the nineteenth century also brought about a modern emphasis on the peoples and cultures that used medicinal plants. This evolution was facilitated, in one part, by a desire to better understand the medical science behind traditional medicinal plant use, and in other part, by convictions (being confidential) that traditional cultures, including medicinal plant information, were fast disappearing in the face of cultural changes (Soejarto *et al*., 2003). Hence, at present, ethnobotany has changed its focus from people's use of plants to the relationship between people and plants, which includes use, cognition, and ecology. Peoples of all cultures have always depended on plants for their primary needs (food, shelter, medicines, etc.), and have naturally learned various applications of plants. The investigation of plants and their uses is one of the most primary human anxieties and has been practiced by all cultures for many thousands of years, though it wasn't called 'Ethnobotany' then Ethnobotany is the scientific learning of plant tradition and agricultural background of a people. Concerning their wide range of knowledge of medicinal plants, indigenous people stay the ultimate reserve for retrieving this information for the purpose of use, particularly using these plants in modern medicine production (Ghillean, 1991) and other fields including agriculture, conservation, and nutrition.

2.1.4. Indigenous knowledge

Traditional knowledge (cultural knowledge or community knowledge) refers to the complete bodies of knowledge, know-how, practice, and representations that are maintained and developed by peoples with long histories of close interaction with the natural environment. According to Martin (1995), in describing traditional knowledge, these sets of understandings, interpretations, and connotations are part of a cultural composite which includes language, naming and

classification systems, ways of using resources, spirituality, rituals, and a worldview. It is transferred from generation to generation orally and is rarely documented.

Cultural knowledge has made, can still make, a significant contribution to resolving local problems (Nicolas, 2000*)*. It is playing a key role in different sectors: agriculture (intercropping techniques, animal production, insect control, crop variety, animal health care, seed selections, and fishing), human health care (through traditional medicines), utilization, and management of natural wealth (soil management, irrigation and other forms of water management). Traditional knowledge is causal to science in many fields relevant to natural resource management (Nakashima and Rou´e, 2002). In particular, it is helping scientists to understand issues of biodiversity and natural forest management. Traditional knowledge is also providing science with approaches into crop domestication, breeding, and management, and giving scientists a new pleasure of the ideology and practices in ecological processes that operate in agricultural production systems, agriculture incorporating the cultivation of trees, crop rotation, insect and soil management, and other areas of agricultural science. Scientists are often adapting indigenous knowledge and using it again in projects of development collaboration and other modern contexts. Therefore, it can be regarded as traditional knowledge and contemporary science can be seen as two schemes of knowledge that harmonize each other.

For indigenous peoples in the study area, traditional knowledge based on natural resources such as medicinal herbs forms the core of culture and identity. But this wealth of knowledge is under pressure. Indigenous communities are increasingly vulnerable to expulsion, environmental degradation and outside interests eager to monopolize control over their traditional resources. Intellectual property rights such as patents, however, sit uneasily with traditional knowledge. Due to fast changes in the system of life (such as countryside to city way of life); little knowledge on the importance of indigenous knowledge, lack of written documentation, disruption or poor communication channel (only through oral custom), cultural amalgamation, vanishing of indigenous practices, loss of biological species, traditions, beliefs, taboos and customs, secrecy in transmission of the knowledge (as the case of traditional medicine) indigenous information has been threatened. In some areas and communities (e.g. the current study area), it may have been lost before documentation. Lack of purpose and interest of the young generation in learning and applying indigenous knowledge is another point of concern.

Hence, if this knowledge has to keep on contributing to sustainable progress and poverty alleviation, documentation and transferring indigenous knowledge is a matter of importance. Hence, every stakeholder should be concerned and act accordingly. That is why this study was carried out in the remotest pastoralist's area to understand systematically, document and promote such valuable knowledge in ethnobotanical study.

2.1.5. Vegetation of Ethiopia

Vegetation is groupings of plant species and the ground cover they provide. It is the collective plant cover of an area (Jennings *et al.,* 2003). The complex geological history of Ethiopia that began long ago and is continuing highlights the irregularity of the surface; a highland complex of mountains and bisected plateau characterizes the landscape. The geographic diversity of the country has resulted in the pattern of a multitude of agro-ecological zones and subzones with varied climatic conditions. The new agroecologic classification divides the country into 32 major Agroecological zones (EIAR, 2011). Climatic elements such as precipitation, temperature, humidity, sunshine, and wind are affected by geographic setting and altitude. Ethiopia, being close to the equator and with an extensive altitude range, has a wide range of climatic features suitable for the presence of high biodiversity and different vegetation types. Climatic heterogeneity is a general characteristic of the country. Based on the results of the study conducted the various vegetation types of Ethiopia have been grouped into *Desert and Semi-desert Scrubland vegetation*, *Acacia - Commiphora woodland and bushland proper* (including *Acacia wooded grassland of the Rift Valley*), *Wooded grassland of the western Gambela region*, *Combretum - Terminalia* woodland, *Dry evergreen Afro - Montane Forest* and *Grassland complex*, *Moist Evergreen Afro-Montane Forest*, *Ericaceous Belt*, *Afro - alpine vegetation*, *Riverine vegetation*, *Freshwater lakes – lake shores, Marshes, swamps and floodplain vegetation* and *Salt –water lakes, lake shores , salt marshes and pan vegetation* (Friis *et al*., 2011). The Ethiopian forests and woodlands are repositories and gene pools for several domesticated and/or important wild plants and wild families of domesticated plants. For instance coffee (*Coffea arabica* L.) is found in the wild in the moist evergreen montane forests of the southeast, west, and southwest of the country. Priority species are those species which require conservation action because of their decline, rarity and/or importance (IUCN, 2008). The decline in the number and range of native species such as *Bothriocline schimperi, Erythrina brucei*, *Leucas abyssinica, Lippia adoensis, Millettia ferruginea* and *Thunbergia ruspolii* which are medicinal

plant species in the study area and the habitats where they occur are key factors in the loss of biodiversity and this requires conservation action. For a minority of species the only conservation action is monitoring and research to identify what further actions may be required. However the majority of species can be vulnerable to development and they need to be considered when determining planning applications. Priority species can be vulnerable to changes in land-use such as development. Impacts from development can be direct loss of the species or indirect loss through loss and degradation of suitable habitat caused by land take, changes in hydrology or water and air pollution. Some species are also sensitive to disturbance which can affect their survival. Forests are important not only for the products they provide and for the complex interactions they make with other organisms to build up and/or maintain the multipart stuff of biodiversity, but also for avoiding erosion and for affecting the climate in a positive way as forests are used in sequestering carbon dioxide (IBC, 2005). Three of the vegetation types of Ethiopia mentioned above that have relevance to the present study are described in some detail:

i). *Acacia - Commiphora* woodland and bushland vegetation

This vegetation type is described by drought resistant trees and shrubs occurring between 400 and 1800 m.a.s.l. It occurs in the northern, eastern, central, and southern parts of the country (Friis *et al*., 2011). The trees and shrubs form an almost absolute layer and include species of *Acacia*, *Balanites*, and *Commiphora*. There is appreciable variation in floristic composition, but species of *Acacia*, *Commiphora*, *Grewia* and various Capparidaceae species (*e.g. Boscia,* and *Cadaba)* are nearly always present. The prevailing *Acacia* species and some of the *Commiphora* species are spinous. Some *Commiphora* and *Terminalia* species have several massive branches that radiate from a common base. The majority of species are deciduous; losing their leaves simultaneously and usually for several weeks or months (White, 1983). This area, where Dugda Dawa District is included, is traditionally occupied by pastoralists and agro-pastoralists and is being affected by overgrazing, drought, and unsustainable fuel wood harvest in the form of both fire wood and charcoal.

ii). *Combretum -Terminalia* woodland vegetation

This vegetation type is described by small to middle-sized trees with fairly large deciduous leaves. These include members of the genus *Boswellia, Terminalia, Acacia, Grewia, Sterculia,*

Balanites, Combretum and species of *Lannea*. The vegetation in this ecosystem has developed under the influence of fire (Friis *et al*., 2011) and human influence is growing with local settlements and over grazing in the study area which is becoming potent threats to the vegetation and the later case is clearly seen in this study area.

iii). Dry evergreen afro-montane forest vegetation

This vegetation type ranges from (1500) 1800 to 3400 m a.s.l. in the central, eastern, southeastern and northern highlands. The major characteristic species are *Juniperus procera, Podocarpus falcatus, Prunus africana, Ekebergia capensis, Allophylus abyssinica, Olinia rochetiana, Dovyalis abyssinica, Myrsine africana* and *Calpurnia aurea* (Friis *et al*., 2011). This is the most extensively human inhabited vegetation zone in Ethiopia in general and in the study area in particular, where crop cultivation and grazing is widespread and forests have significantly diminished.

2.1.6. Ecological safeguard among pastoralists in Ethiopia

Ethiopia has the largest livestock population in Africa and over 60 per cent of its land area is semi-arid lowland, livestock herding claiming a major share of the economy (IFAD, 2004). Pastoralism is an economic and social system well-adapted to dryland environment and distinguished by a complex set of practices and knowledge that has permitted the maintenance of a sustainable equilibrium among pastures, livestock, and people. Pastoralists are people who live mostly in dry, remote areas and derive much of their incomes from livestock and livestock products. Their livelihoods depend on their intimate interaction with the surrounding ecosystem and on the welfare of their livestock. They inhabit zones where the potential for crop cultivation is limited due to low and highly variable rainfall conditions, steep topography, or extreme temperatures. Within this unpredictable, vulnerable, and dynamic environment, they have developed successful systems of adaptation to preserve an ecological balance between themselves and the natural environment. But now a day, as human and livestock populations increase from time to time, the influence on natural vegetation due to overgrazing, intensive, and illegal exploitation of natural resources becomes very high in different parts of the country including Dugda Dawa District.

2.1. 7. Traditional medicinal plants and ethnomedicine in Ethiopia

Studies on medicinal plants in Ethiopia have not been realized as fully as that of India or other traditional communities elsewhere (IWU, 1993). In Ethiopia there is limited development of therapeutic products and the indigenous knowledge on practice of medicinal plants as traditional remedies are being lost owing to migration from rural to urban areas, industrialization, fast loss of natural habitats and transformations in life style. There is also lack of adequate ethnobotanical surveys carried out in many parts of the country. In view of these, records of the traditional use of medicinal plants is an urgent matter and important to preserve the knowledge (Tesema Tanto *et al.*, 2003; Tilahun Teklehaymanot and Mirutse Giday, 2007).

More than 80% of the human population and 90% of the livestock depend on traditional medicine in Ethiopia (Mekonin Bishaw, 1990; Tesema Tanto *et al*., 2003). Socio- cultural appeal, the cultural acceptability of healers and local pharmacopoeias, accessibility, being fair in its price, and effectiveness against a number of health problems seem to foster its widespread use (Mwambazi, 1996; Kebede Deribe *et al*., 2006). The Ethiopian traditional medical system is characterized by variation and is shaped by the environmental diversities of the country, socio-cultural conditions of the different ethnic groups as well as historical developments that are related to migration, introduction of foreign culture and religion (Pankhurst, 1965; 1990; Sikkerveer, 1990; Dawit Abebe and Ahadu Ayehu, 1993). Traditional medical practitioners treat both people and domestic animals. Most of the health services rendered by these practitioners are focused on communicable diseases among people and domestic animals.

Modern veterinary services have been playing a relatively good role in the control and action taken to prevent livestock diseases in the past three decades in Ethiopia. However, they could not so far deliver complete coverage in preventive and healing health care practices because of inadequate work, logistic problems, unpredictable supply of drugs, and the high cost of drugs and equipment. As a result, the majority of those livestock breeders in rural areas are far from the site of veterinary clinics/posts, and those who have access to these clinics may not be able to afford to pay for them (Teshale Sori *et al*., 2004). Ethnoveterinary alternatives comprise traditional surgical and manipulative techniques, traditional immunization, magico-religious practices and beliefs, management practices and the use of herbal

remedies to prevent and treat a range of ailments encountered by livestock holders (Tafesse Mesfin and Mekonnen Lemma, 2001). Ethnoveterinary medicine provides traditional remedies, which are available nearby and usually cheaper than standard treatments. Livestock holders can prepare and use homemade remedies with minimum expense. So far, many livestock holders in rural areas where there are relatively few veterinarians and shortages of other facilities, traditional medicinal plants are the only choice to treat many ailments (Mc Corkle, 1995).

2.1. 8. Wild edible plants and their contribution to combat food shortage in Ethiopia

At present, there is improved global interest in documenting ethnobotanical information on neglected wild edible food resources (Bharucha and Pretty, 2010). While traditional knowledge on wild edible plants is being eroded through acculturation and the loss of plant biodiversity along with aboriginal people and their cultural background, promoting research on wild edible plants is crucial in order to maintain this information for future societies (Zemede Asfaw, 2009). The most important aim of ethnobotanical investigation into wild edible plants is the documentation of indigenous knowledge associated with these plants. Comparative studies on wild edible plants in different cultures or ethnic groups of the country may contribute to the identification of the most widely used species for further nutritional analysis (Termote *et al*., 2009; De Caluwé, 2010a, b). Food analysis results provide clues to aid the promotion of those species that have the best dietary values which helps to guarantee nutritional diversity and fulfill security objectives (Tardio *et al*., 2006). Undermining of the value of these wild edible plants can lead to the neglect of ecosystems that care for them and the indigenous knowledge schemes that are related to them (Pilgrim *et al*., 2008). The increasing collisions of climate change, including extreme weather actions, which are putting poor households at particular risk in food security during which the local people use wild edibles. Forest foods often form a small but critical part of otherwise bland and nutritionally poor diets. In most parts of Ethiopia, wild edibles form integral parts of the feeding habits of many communities (Kebu Balemie and Fassil Kibebew, 2006). However, consumption of wild edibles is more common in food insecure areas than in other areas in the country (Tilahun Teklehaymanot and Mirutse Giday, 2010). According to Zemede Asfaw (2001), people use many wild species of plants for food, clothing, shelter, fuel, fiber, income generation and for fulfilling cultural and spiritual

needs throughout the world in addition to medicinal value. Using these foods is common in pastoralists where there is no high production of crops. That is why the investigator initiated to carryout research concerning these plants in Dugda Dawa District.

2.1.9. Conservation and management of medicinal and wild edible plants in Ethiopia

Problems of continuity and sustainability is seen in Ethiopia's traditional medicine as elsewhere in Africa (Ensermu Kelbessa *et al*., 1992). The main causes of this trouble are loss of species of medicinal and wild edible plants, loss of habitats of medicinal and wild edible plants, and loss of indigenous knowledge on both. Some studies have revealed that most of the medicinal plants used by Ethiopian people are harvested from wild habitats (Mirutse Giday *et al*., 2003) and hence this aggravates the rate of loss of species with related indigenous knowledge. These threats to medicinal and wild edible plants can be categorized into anthropogenic and natural causes. Human-induced extinction of species and habitat degradation are the order of the day. Rapid increase in population, the need for fuel, urbanization, timber production, over harvesting, destructive harvesting, invasive species, commercialization, degradation, forest clearance for agricultural activities and habitat devastation are human caused threats to medicinal and wild edible plants. Likewise, natural causes include recurrent drought, bush fire, disease and pest outbreaks affect these plants (Ensermu Kelbessa *et al*., 1992). Intensive and unrestricted grazing, the presence of large number of livestock could lead to serious decline of medicinal and wild edible plants in particular and the entire vegetation as a whole.

As elsewhere in Ethiopia, Dugda Dawa District is not exceptional to these problems. Proper management of traditional medicinal and wild edible plant resources is essential, not only because of their value as a potential source of new drugs and food, but due to reliance on traditional medicinal plants for health and wild edible plants to combat problems of food shortage. Conservation of medicinal and wild edible plants can also be possible in home gardens, as the home garden is deliberate and perfect farming system for the conservation, production, and enhancement of medicinal and edible plants. Ethnobotanical studies can indicate management problems of medicinal and wild edible plants through interviews and market surveys and furthermore, it gives solutions by promoting local traditions and customs that had

conservation merits (Gadgil *et al*., 1993; Turner, 2000). Therefore, people living in Dugda Dawa District have traditional practices which they put into effect for generations to take care of themselves and their livestock health as well as using wild edibles. On the other hand, the area has been losing its indigenous flora over what went before due to human and other biotic and natural causes. This loss of forests obviously associates with the missing of important indigenous knowledge connected with the plants. Hence, there is a clear need to conduct ethnobotanical study on the diverse medicinal and wild edible plants in the area, to look into and compile relevant information and to document them before it become difficult to gain the knowledge of the indigenous people.

2.2. Ethnoecology: Merger between vegetation study and ethnobotany

Ethnoecology encompasses all studies which describe local people's interaction with the natural environment (Martin, 1995; Gerique, 2006). It is the science of how people understand the relationship between humans, animals, plants and physical elements of a local environment; the cross-cultural study of how people perceive and manipulate their environments. Ethnobotanical studies employ phytosociological sampling to relate information about vegetation usage and the actual quantity and frequency of the resource used. These relationships enable inferences to be made about plant richness and distributions, patterns of resource use, the degree of management of the studied fragment, and the priority species for conservation plans. The determination of species diversity is a subject of wide interest in ecological and ethnobotanical studies because it not only permits an understanding of the local biodiversity but also enables the detection of differences between and within biomes and the identification of the resources that are important for the social and economic development of a region (Araújo and Ferraz, 2010). In addition, ethnoecology has a complex provenance/attribution ranging from a consideration of cultural understanding of the relationships among organisms to an applied focus on the utility of such understandings to community development and community-based resource management. When the vegetation of an area is studied together with ethnobotany of the same area, as it was done in this study, ethnoecology comes to play. Thus, the indigenous knowledge of medicinal and wild edible plants recorded and analyzed in this study has also captured some of the ethnoecological knowledge of the people.

CHAPTER THREE

3. MATERIALS AND METHODS

3. 1. Description of the study area

3.1.1. Location and topography

The present study was conducted in Dugda Dawa District, Borana Zone of Oromia Regional State, southern Ethiopia. Dugda Dawa District is located at 502 km south of Addis Ababa - the capital of Ethiopia, and 70 km from Yabelo town, the capital of Borana Zone. The district is generally characterized by rough and rugged topography and lies between latitudes 5°53' N and 6°27' N, and longitudes 39°15' E and 40°38' E. The altitude ranges from 800 to 2300 m.a.s.l. Dugda Dawa District's Land Administration Office reported (unpublished annual report) that the total area of the district is 165,634.4 hectares (Figure 1).

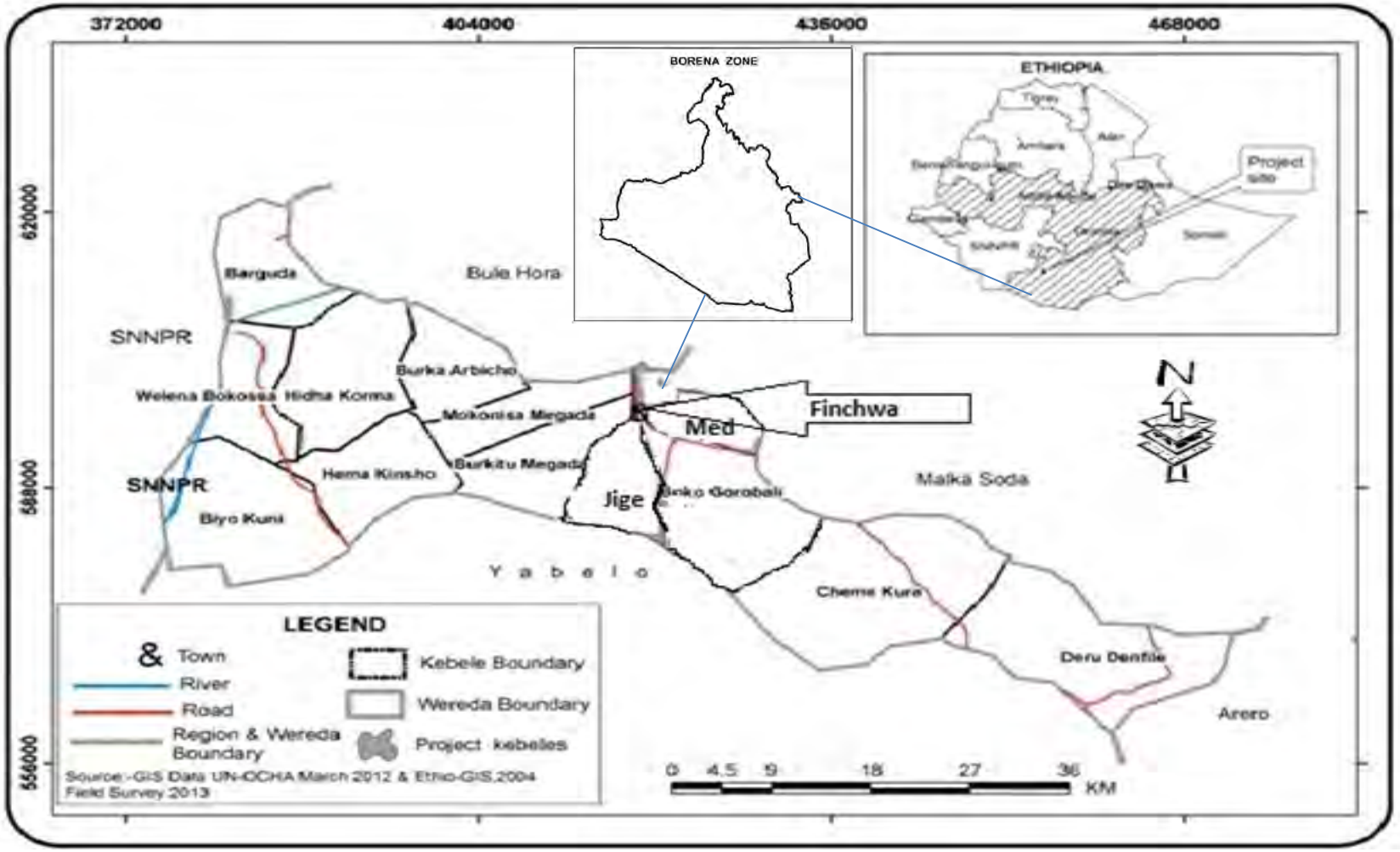

Figure1. Map of Ethiopia showing Oromia regional state, Borana Zone and the location of the study area (Dugda Dawa District)

3. 1.2. Agro-ecology and climatic condition

Dugda Dawa District is divided into two agro-ecological zones, namely the lowlands (from 800 - 1500 m a.s.l) locally called "gammoojjii" now described as "Warm semi- arid lowlands" agroecologic zone and the middle altitude ranging from 1501-2500 m a.s.l. locally known as "badadaree" which is identified this time as "Hot moist lowlands" agroecologic zone (EIAR, 2011). Accordingly, the proportion of the two agro-climatic zones in the district is mid-altitude or "Hot moist lowlands" (58.2%) and lowlands or "Warm semi- arid lowlands" (41.8%). Dugda Dawa District falls within the southern bimodal rainfall regime of Ethiopia (two season's rain, 'long rains' in March-May and the 'short rains' in October – December). It receives high rainfall between March and half of June as well as relatively good amount from half of September to half of December. The dry season extends from half of December to February and to some extent from half of June to half of September. The highest mean annual average rainfall of the study area within fifteen years was 111.6 mm recorded in April, whereas the lowest mean average was 3.3 mm recorded in July. The lowest mean average temperature over fifteen years was 12.7 □ recorded in December whereas the highest was 29.0□ recorded in February. The mean annual rainfall of the study area was 486 mm whereas the mean annual temperature was 20.5 □ (Figure 2).

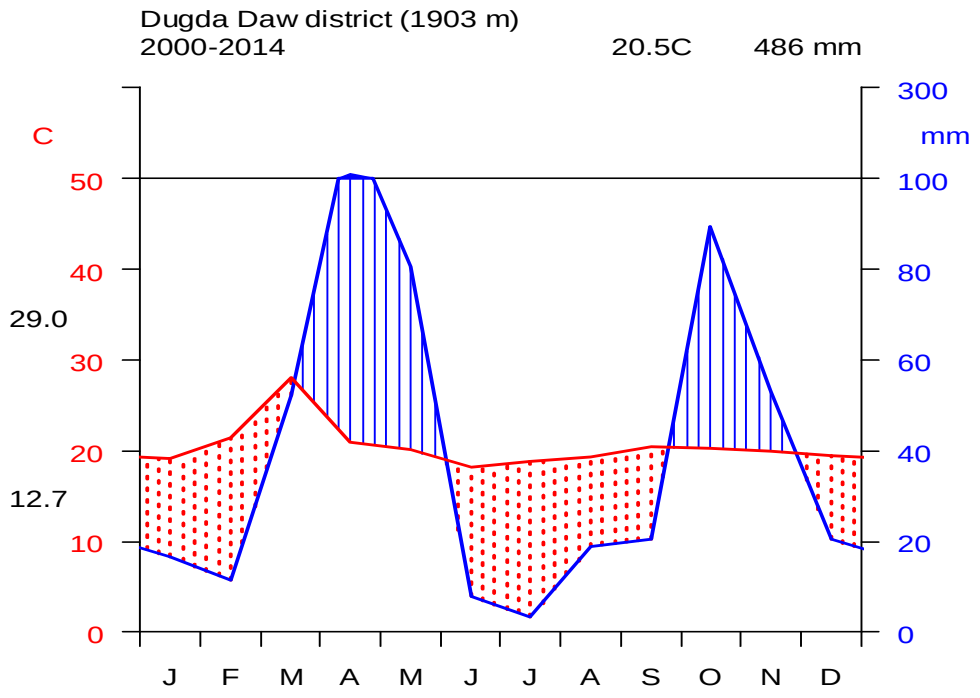

Figure 1. Climate diagram of Dugda Dawa District (From 2000 – 2014, 15 yrs) from Yabello. Meteorological Station (Source of data: National Meteorological Service Agency).

3.1.3. Demographics

Based on the 2007 Population and Housing Census of Ethiopia, Borana Zone had registered 962, 489 people in ten districts of which 487,024 were males and 475, 465 were females. Rural dwellers were 878, 161 of which 443, 286 were males and 434, 875 were females, whereas urban dwellers were 84, 328 of which 43, 738 were males and 40, 590 were females. Concerning Dugda Dawa District the total population was 147,327of which 75, 114 were males and 72, 213 were females. The District is predominantly (99%) occupied by Guji Oromo people who speak Oromo language with unique dialect. The remaining proportion is occupied with different ethnic groups. The majority of the residents, about 141, 767, live in rural areas of which 72, 258 were males and 69,509 were females. Urban dwellers were about 5, 560 out of which 2, 856 were males and 2, 704 females (CSA, 2007). The population density (Number of people/Land area) is 0.9 ≈ 1person/ hectare. Pastoralism with subsistence farming is the most common economic mainstay of the people. In one or the other way their livelihoods depend upon the presence of

different plant species and vegetation. Plants are used as sources of energy or fuel (being charcoal or firewood), food, medicine, construction material, forage, environmental regulators, household materials, cultural icons, etc.

3.1.4. Land use and agriculture

With respect to the information obtained from Dugda Dawa District Land Administration Office, the proportion of farming land, grazing and forest lands in Dugda Dawa District was 20%, 39.8% and 18% respectively. The remaining land area is either bush land, degraded or settlement land (Table 1). The dominant agriculture in Dugda Dawa District is livestock production and subsistence farming which form the major livelihoods of the rural community. The most widely cultivated crops are cereal crops such as *Zea mays* L., *Eragrostis tef (Zuccagni*) Trotter and *Triticum aestivum* L.and the legume crop *Phaseolus vulgaris* L. From the cash crops and vegetables *Coffea arabica* L., *Catha edulis* (Vahl) Forssk.ex Endl., *Ensete ventricosum* (Welw.) Cheesman., *Saccharum officinarum* L., and *Brassica oleracea* L. Honey production is also practiced in the forest area.

Table 1: Land use pattern of Dugda Dawa District

No.	**Land use Type**	**Area in hectare**	**%**
1	Farming land	33,126.8	20.0
2	Pasture land (Grazing land)	65,910.2	39.8
3	Degraded /Barren area/Non - usable land	8545.4	5.2
4	Forest land	29,815.0	18.0
5	Shrub/Bush land	26,091.0	15.7
6	Settlement and Home garden	2146.0	1.3
	Total	**165,634.4**	**100.0**

Source: The District Land Administration Office

3.1.5. Vegetation of the study area

Plants especially those found in a particular area or habitat are considered as vegetation. With reference to the classification of African vegetation into Phytochoria by White (1983) in the book titled “The Vegetation of Africa” this area falls in the Somalia - Maasai Regional Centre of endemism. Based on Friis *et al*. (2011) classification of Ethiopian vegetation the study area

vegetation is included in *Acacia - Commiphora* woodland and bushland, *Combretum-Terminalia* woodland and *Dry evergreen afro-montane forest* and *grassland complex*.

Acacia-Commiphora Woodland and Bushland vegetation type is characterized by drought resistant trees and shrubs occurring between 800 and 1800 meter a.s.l. in the study area. The trees and shrubs are dominating due to mostly bush encroachment and include species of *Acacia*, *Balanites*, *Commiphora* and this vegetation is currently under strong human-induced stress. Over grazing, extraction of fuel wood and charcoal as well as illegal timber production has increased the rate of deforestation and natural resource depletion currently in this area (Figure 3).

Figure 3. *Acacia-Commiphora* woodland and bushland vegetation- 15 km southeast of Finchwa town in Jigessa kebele at 1605 – 1624 m a.s.l. (Photograph taken by the researcher from the study area -- November, 2013)

Combretum - Terminalia woodland vegetation type (Figure 4a) is characterised by small to middle-sized trees with fairly large deciduous leaves occurring between 800 and 1800 meter a.s.l. and these include species of *Terminalia*, *Combretum,* and *Lannea* in this area. *Dry evergreen afro-montane forest* (Figure 4b) (small part of the District) vegetation type represents shrubs and small to large-sized trees. This forest has canopies usually dominated by *Podocarpus falcatus* with *Celtis africana* and *Croton macrostachyus* as co-dominant, followed by *Olea europaea* subsp. *cuspidata*. The forests have diminished due to human interference and replaced by bushlands in most places. This forest is under severe stress due to illegal timber production,

fuel wood collection, and grazing effects. There is a severe and increasing fuel wood extraction which leads to depletion of the remaining stock and, hence, further degradation of the last forest stands (Figure 4 a and b). The study area is the place where livestock density is one of the highest in the country (785,538 livestock population, District's Livestock Health and Marketing Agency unpublished annual report) thus exacerbating the degradation process.

Figure 4. Woodland vegetation and forest types in the study area (a). *Combretum-Terminalia* woodland vegetation – 50 km west of Finchwa town in Welena Bokosa and Barguda kebeles at an altitude of 1695 – 1953 m a.s.l. (b). *Dry evergreen afromontane* forest – 20 km to the north of Finchwa town in Magada Mokonisa kebele (in Magada forest) at an altitude of 1696 -1953 m a.s.l. (Photograph taken by the researcher from the study area -- November, 2013)

Even if there is some mobilization with respect to natural resources conservation in the study area, the forest resources is affected through years of deforestation activities side by side with an increasing human and livestock population pressure and its requirement for farm land and forest products. This might also lead to climatic change, shortage of rainfall, surface and ground water. Knowingly (to fulfill their day to day needs) and unknowingly (without understanding the negative side effect that will come by losing forests) the local people were severely using different forest products intensively most of the time illegally (Figure 5A - E).

A B C D E

Figure 5 A - E. On-going exploitation of plants in the natural forest of the study area – Picture "A" was taken from Goro Bali kebele, about 20 km to the east of Finchwa town at an altitude of 1615 – 1648 m.a.s.l. while pictures "B, C, D and D were taken from Magada Mokonisa kebele, about 15 km to the north of Finchwa town at an altitude of 1915 – 1968 m a.s.l in Magada forest-**(**Photograph taken by the researcher from the study area -- September, 2015)

3.1.6. Human health condition in the district

As most rural districts of Ethiopia, access to modern health services is poor. Based on 2013 - 2014 District's Health Office report (unpublished annual report, 2014), 81,030 people are assisted by modern health service which covers only 55% of the population. There are three governmental health centers and 16 health posts in Dugda Dawa District. Concerning human health professionals in the district, there are five health officers, two nurses, 40 clinical nurses, two laboratory technicians, one sanitarian, eight midwives, one pharmacist, 54 health extension workers, and 10 supportive staffs. The five common health problems in the district are acute respiratory tract infection, pneumonia, typhoid, internal parasitosis, and malaria.

3.1.7. Livestock population and their health status in the district

Since the dwellers of the district are pastoralists, livestock population of the area is very high. With reference to 2013 - 2014 District's Livestock Health and Marketing Agency report (unpublished) there are 785,538 heads of livestock of which 338,000 are cattle, 238,662 goats, 64,123 sheep, 27,138 camels, 21,093 donkeys, 1,589 mules, 187 horses, and 94,746 poultry. There are problems in the district associated with irregular climatic conditions, inadequate health services and facilities and occurrence of different diseases. There are people who choose traditional medicine even if possibilities for using modern medicine are within their reach because they believe in its effectiveness. The major livestock diseases as explained by the

veterinary personnel in the study area were contagious bovine pleuro - pneumonia (CBPP), bovine pasteurellosis, blackleg (ABBAA GORBAA), tick infection, trypanosomiasis (GANDII), babesiosis (HADHOOTU), anthrax (ABBAA SANGAA), foot and mouth disease or FMD (MAANSAA), skin and lamp disease (LSD) or Bagaa in Oromo language, internal and external parasites (MAXANTUU QAAMA KEESSA fi QAAMA ALAA), mastietis (NAQARSAA MUCHAA), blotting and constipation as well as nervous system problems which are caused commonly by poisonous plants. Goats and sheep are also affected commonly by viral diseases called CCPP - Contagious caprine pleuro - pneumonia (lung disease) and PPR which seems render pest disease. Veterinary health care coverage of the district is about 40 %. Concerning the standard of livestock clinics, there is one level C and 11 level D livestock clinics in the district. Regarding livestock health professionals there are 6 animal health assistants and 2 technicians.

3.1.8. Food security condition in the district

In pastoral and agro-pastoral areas in the southern regions where the study area is located, most of the time the main March-May rain gets delayed and become erratic which causes shortages of water and pastures. Most of the time very poor households fall in to food shortage conditions at certain times of the year, when irregular environmental conditions occur. This may be during the time when crops are growing in the fields, and supplies from the previous season are exhausted or in times of starvation. For these families, the natural vegetation provides an important safety net, and it is in these critical times that the significance of forest foods is of utmost importance. This situation is most prevalent in arid areas in which food shortages are common like this study area.

Fruits, roots, leaves, seeds, barks, flowers and gums of a variety of forest and woodland plants are consumed at different times in Dugda Dawa District.

3.2. Data collection methods

Both vegetation and ethnobotanical data were collected by using their respective methodologies as presented in this section**.** The rainfall and temperature data for this study were collected from Yabello Meteorological Station (the capital of Borana Zone), which has relatively similar agro-ecological conditions with Dugda Dawa District. The data from 2000 - 2014 collected by the National Meteorological Service Agency were taken to develop climate diagram using R-software for window version 2.10.1 statistical package (R-Development Core Team, 2007).

3.2.1. Vegetation study of the district

3.2.1. 1. Reconnaissance survey

A reconnaissance survey of the study area was conducted from August 12-27, 2013 to obtain information/data about agro-ecology of the area, status of the vegetation and indigenous knowledge of the local people in using plants for different purposes. In this survey the presence of two agro-ecological zones (lowland and middle land), different vegetation types and unique indigenous knowledge were known and fieldwork materials such as GPS (Geographical Position System), digital camera, plant press, and supportive letters were made ready and applied as necessary during the fieldwork.

3.2.1.2. Sampling design

Ecological investigations regularly aim at describing species richness and diversity (Palmer 1990, 1991), or more complex characteristics as in classifications, ordinations and other multivariate problems (Podani, 1994). Preferential sampling following Mueller - Dombois and Ellenberg (1974) was used for this study in which plots were placed on sites that were perceived as typical of given conditions indicated by homogeneity. Orloci (1993) considers preferential sampling a shortcut to pattern recognition and points out that much of the biological knowledge is rooted in non - statistical sampling. In the same way this sampling method was used for this study due to two reasons. The first reason is it enables to know the plant diversity of the district since the plots can be laid at any place in the 13 kebeles (the smallest administrative units) of the district which is a good option to collect both ecological and ethnobotanical data simultaneously and the second reason is that since there is no single dense forest in the district, systematic sampling with line transect could not be used.

Preferential sampling starts with the quick screening of vegetation variability in a certain locality, during which vegetation types are delimited in a researcher's mind. Such beginning classification may be taken as comfortable way of stratifying the statistical population. All distinguished vegetation types are then registered using vegetation releves that are placed subjectively, either without deliberate emphasis on some species combinations.

The apparent advantage of preferential sampling is that it tracks and samples nearly the full range of floristic dissimilarity in the vegetation of the study area, as well as the rare types. It

satisfies the requirement for the representation of the highest vegetation variability in the sample, whereas the survey resources are not wasted due to over - sampling of the existing vegetation types. The vital reservation against the preferential sampling is that the arrangement of the samples will, to an unknown degree, be influenced by the subjective decisions of the researcher. Some states of vegetation, though common, may be silently avoided. A total of 60 plots (20 m x 20 m) were laid for vegetation data collection. (The number of plots along with their location and altitude is given in Appendix 2). In addition, five 1 m x 1 m sub plots, one at each corner, and one at the center of the main plot were also laid to sample herbaceous plants.

3.2.1.3. Vegetation data collection

Data collection was conducted five times; from November 01 to December 30, 2013; June 02 to July 30, 2014; November 01 to December 30, 2014; June 02 to July 30, 2015 and November 01 to December 30, 2015. Samples were collected from all kebeles (13 kebeles) of the district by using preferential sampling method to study plant diversity of the study area efficiently. In fact, there could be bias in laying the plots but the researcher tried to minimize mistakes in selecting the representative sites in each kebele. This enabled the researcher to collect the data exhaustively. A complete list of trees, shrubs, lianas, climbing herbs and herbs including vascular epiphytes and two medicinal avascular species were collected from each preferentially selected plot (Appendix 2). Species occurring within 10 m distance from the plots boundaries were also recorded as present for floristic composition. In each plot structural attributes such as diameter and height were also recorded for all woody plants. Measure of diameter was taken for all individual trees and shrubs having DBH (Diameter at Breast Height) greater than or equal to 3 cm, as used by Abate Ayalew *et al*. (2006), using a diameter tape. In cases when the tree branched at breast height or below, the diameter was measured separately for the branches and averaged. Trees and shrub species with DBH less than 3 cm were counted. Height was measured for each tree and shrub with DBH greater than or equal to 3 cm using calibrated stick. Where topographic features made it difficult to measure height of trees and shrubs, it was estimated visually. The presence-absence and cover abundance data, explained here as the part of area in a plot covered by every species recorded and gathered from each plot were later converted to cover abundance values using the modified 1-9 Braun-Blanquet scale (as in van der Maarel, 1979) as follows.

1: Rare, generally one individual;

2: Occasional, with less than 5% cover of the total;

3: Abundant, with less than 5% cover of the total;

4: Very abundant, with less than 5% cover of the total;

5: 5-12% cover of the total area;

6: 12-25% cover of the total area;

7: 25-50% cover of the total area;

8: 50-75% cover of the total area;

9: 75-100% cover of the total area;

Investigation of the seedling and sapling density and regeneration of some selected species has been carried out within the same plot. In each of these plots, the numbers of all seedlings which start to germinate and that are less than 1 m in height were recorded. Individuals reaching 1 m and above with DBH less than 3 cm were considered as sapling and counted. Environmental variables such as altitudes and geographical coordinates were also measured for each plot using GPS 60 (Geographical Positioning System 60). Standard procedure was followed in pressing the specimens, which were then brought to the National Herbarium (ETH), Addis Ababa University where they were allowed to dry, deep-frozen and determinations made using taxonomic explanations and descriptions given in the relevant volumes of the Flora of Ethiopia and Eritrea. Further refining of determinations was made by visual comparison with authenticated herbarium specimens and finally checking the accuracy by a senior plant taxonomist (the late Professor Ensermu Kelbessa). The plant specimens with labels were finally deposited at the ETH and the resulting data of the study presented in tables, graphs, and percentages.

3.3. Ethnobotanical study of medicinal and wild edible plants

3.3.1. Informant sample size determination and selection

Informants for ethnobotanical data collection for this study included different age and sex groups from households of the 13 pastoralist kebeles in the district. The informant size for collecting quantitative data for medicinal plants research to ensure the required representative size of households from all pastoralist kebeles was determined using Cochran's (1977) formula as indicated by Bartlett *et al*. (2001) as follows:

$$n = \frac{N}{1+N(e)^2}$$

Where,

n = sample size for the research; N= total number of households in all the 13 kebeles.

e= maximum variability or margin of error 5% (.05); 1= the probability of the event occurring.

The total number of households in the 13 pastoralists' kebeles of the district was 18,709. Hence, the informant sample size comes to;

$$\mathbf{n} = \frac{N}{1+N(e)^2}$$

$$= \frac{18{,}709}{1+18{,}709(0.05)^2} = \frac{18{,}709}{47.7725} = \mathbf{392} \text{ informants}$$

Therefore, the required informants (respondents) size was 392. Informants' size for each kebele was calculated using the amount of the number of households in each kebele to the total number of households of the 13 kebeles i. e.

Informants from each kebele = Number of households of the kebele X Total number of informants/Total number of households. For example, the informant size of Berguda kebele with a total household of 797 was 17, i.e. (797 x 392/18,709 = 17). Same calculation was used for the other study kebeles and three to five key informants were taken purposefully from each kebele based on the size of the households (a total of 50 key informants) including healers, herbalists, elders and practitioners based on their knowledge as recommended by the local people. The purposive sampling technique is most effective when one wants to study a certain cultural domain with knowledgeable experts within the native people. The remaining 342 general informants (respondents) were taken by random sampling method to make sure that important informants categories from different age groups and sex are included (Table 2).

Table 2. Number of households and informants included for the ethnobotanical data collection

No.	Name of the kebele	Total number of households	Key informants			Randomly taken informants			Total informants		
			M	F	T	M	F	T	M	F	T
1	Berguda	797	2	1	3	10	4	14	12	5	17
2	Biiyyoo Qunii	1808	3	1	4	25	9	34	28	10	38
3	Boko Gorobali	1364	3	1	4	19	6	25	22	7	29
4	Burqa Arbicho	2194	3	2	5	30	11	41	33	13	46

5	Burqitu Magada	2931	3	2	5	40	16	56	43	18	61
6	Camee Kura	1448	3	1	4	20	6	26	23	7	30
7	Deeru Danfile	656	2	1	3	8	3	11	10	4	14
8	Hema Kinsho	1751	3	1	4	25	8	33	28	9	37
9	Hidha Korma	1695	3	1	4	24	7	31	27	8	35
10	Jigessa Nanessa	659	2	1	3	8	3	11	10	4	14
11	Mokonissa Magada	807	2	1	3	10	4	14	12	5	17
12	Walena Bokossa	1241	3	1	4	17	5	22	20	6	26
13	Walgayi Meadano	1358	3	1	4	19	5	24	22	6	28
	Total	18,709	35	15	**50**	255	87	**342**	290	102	**392**

The selected informants in these kebeles were interviewed using semi-structured interview (Appendix 1) on the identification, management and use of the traditional medicinal plants and they participated in showing where the traditional medicinal plants that they use to cure both human and livestock ailments were found.

A total of 130 informants from those selected for medicinal plants study were taken for wild edible plants study of which 26 were key informants, at least two key informants from each kebele, were selected using purposive sampling technique for those who are knowledgeable individuals about wild edible plants. The remaining 104 informants, eight informants from each kebele were selected randomly from the 13 kebeles. The selected informants in the sample site were interviewed using semi-structured interview (Appendix 1) regarding their knowledge on the wild edible plants, their management and use. The informats participated in showing the plants that they use as food through field walk interview.

3.3.2. Ethical considerations and interviewing protocol

To undertake the study in Dugda Dawa District, formal written permission was obtained from the Department of Plant Biology and Biodiversity Management, Addis Ababa University and the district administration and to create a positive interaction and develop a good understanding between informants and the researcher the objective of the study was explained briefly and clearly. The interview was administered in Oromo language using a translator after everything was made clear to the informants and the community collectively agreed to cooperate with the

researcher in providing the required information and each informant gave verbal in formed concent to the researcher. Therefore, ethnobotanical data were collected based on a comprehensive participation, good interactions and the willingness of informants. For ethical reasons, ethnobotanical data were collected in the presence of local administrators and with the permission of each informant for the publication of the research results.

3.3.3. Administration of semi-structured interview

Interview is the basis of most ethnobotanical data collection methods (Alexiades, 1996). Ethnobotanical data on the traditionally used medicinal plants and the associated indigenous knowledge as well as wild edible plants was collected from the study area using semi-structured interview from randomly and purposively selected informants including traditional medical practitioners, knowledgeable elders, and youth of both sexes (Figure 6). Semi-structured interviews were administered after the questions were translated into the local language –Oromo language where the informants were most comfortable and during the time they wanted or chose (Appendix 1). It was an important tool for the collection of both qualitative and quantitative data at the same time.

Figure 6. Interviewing informants with guided field walk (Photograph taken by the researcher from the study area -- November, 2013)

3.3.4. Plant specimen collection and identification

Good specimens (those bearing flowers and/or fruits) of all medicinal and wild edible plants identified by the informants were collected as voucher specimens. Collection was made with the informants during guided field walk. Along with collection, the field activities included taking notes on the plants and the associated indigenous knowledge with first round identification of the family and sometimes the species when possible. The required information about the plants such

as their use, habit, habitat, altitude, latitude and longitude and features that are specific to each plant were included. Each specimen was given a collection number and scientific and/or local name when possible. Information was also captured with photographs to document the sites, individual plants, the edible parts, and actions of users showing how they manage them. For plant collection and identification the same procedure as for plants collected in the vegetation study was used. Based on the information obtained from semi-structured interview preference ranking, direct matrix ranking, informant consensus factor (ICF) and fidelity level (FL) were computed.

3.3.5. Secondary data collection

Secondary data such as 15 years climate data from National Meteorology Service Agency, population data from Central Statistical Agency, health problem data from the local modern health centers and veterinary problems data from local modern veterinary clinics were collected by accepting written document and interviewing the responsible officers.

3.3.6. Field observation and group discussion

Field observation and group discussion was made during the study about the status of the vegetation, the acceptance of medicinal plants by the societies and usage of wild edible plants. Field observations were performed with the help of local guides and interviewed informants in the study area (Figure 7). A brief group discussion was made three times with the local people (3 to 7 informants) at each site about the status of the vegetation associated with their ethnomedicinal knowledge, level of plant diversity, status of threats and conservation attempt and effect of climate change including acceptance of traditional healers and full notes were recorded. During the discussion the informants were free to state their knowledge about the traditional medicinal and wild edible plants without being interfered.

Figure 7. Field observation with group discussion (Photograph taken by the researcher from the study area -- November, 2013)

3.3.7. Market survey

Markets are rich sources of ethnobotanical information, since they are sites at which medicinal, ornamental, wild edible and other useful plants are sold. It was done in the biggest market of the district (Finchuwa market) to observe and collect data on the marketability and trade of medicinal and wild edible plants. Hence, the necessary ethnobotanical information was gathered by asking questions like "Is there a trend to sell medicinal plants in Guji Oromo culture in the market? How do you return the favour of the healer after he/she cured the patients? Are medicinal plants sold for other purposes than their medicinal use?

3.4. Data analysis methods

Data collected for both vegetation and ethnobotanical study were analyzed by using their respective statistical and computer packages as mentioned below.

3.4. 1. Vegetation data analysis

3.4.1. 1. Community categorization

Categorization by means of hierarchical cluster analysis is the most common multivariate technique to analyze community data. Cluster analysis helps to group plots or vegetation samples together based on their characteristics or floristic resemblances (Kent and Coker 1992; McCune and Grace 2002). Accordingly, a hierarchical cluster analysis was done using PC-ORD for

windows version 5.0 (McCune and Mefford, 1999) to categorize the vegetation into plant community types based on cover data of the species in each plot and the Relative Euclidean Distance (RED) measures using Ward's method were used in this study. The data matrix contained 60 plots and 294 species collected from the sample plots (Figure 9).

The Euclidean Distance was used since it eliminates the variations in total cover among sample units and the Ward's method was used because it minimizes the total within group mean of squares or residual sum of squares (van Tongeren, 1995; McCune and Grace, 2002).

The groups were further tested for the hypothesis of no variation between the groups using the multiresponse permutation procedure (MRPP). Dufren and Legender's (1997) method of calculating species indicator values was used to sense the values of different species. Indicator species are described as the most characteristic species of each group found mostly in a single group of the typology and present in most of the sites belonging to that group (Dufren and Legender, 1997). Indicator values are measures of the fidelity of the occurrence of a species in a particular group (McCune and Mefford, 1999) and its value ranges from zero (no indication) to 100 (perfect indication). The clusters were chosen as plant community types and given names after one or two dominant or characteristic species. A species is regarded as an indicator of the group when its indicator value is significantly higher at $P<0.05$.

3.4.1.2. Diversity and similarity indices

Biological diversity can be quantified in different ways. Shannon-Wiener diversity index, species richness, and Shannon's evenness were computed to describe species diversity of the plant community types in the vegetation. Shannon - Wiener diversity index is the most popular measure of species diversity because it accounts both for species richness and evenness, and it is not affected by sample size (Kent and Coker, 1992; Krebs, 1999).

Shannon-Wiener diversity index was calculated as follows.

$$H' = - \quad PilnPi$$

Where,

H' = Shannon diversity index,

S = the number of species,

Pi = the proportion of individuals or the abundance of the i^{th} species expressed as a proportion of total cover and

ln = $\log base_n$

Evenness (Equitability) J=H'/H'max, where:

J=Evenness,

H'=Shannon-Wiener diversity index and

H'max =ln**s** where **s** is the number of species.

The higher the value of J, the more even the species is in their distribution within the community or the plots. Similarly, the higher the value of H', the more diverse the community or the plot are.

Sorensen's similarity index was used to determine the pattern of species turnover among successive communities and to compare the vegetation with other similar vegetation in the country. It is described using the following formula (Kent and Coker, 1992).

Ss = 2a/ (2a+b+c) Where:

Ss = Sorensen's similarity coefficient

a = Number of species common to both samples;

b = Number of species in sample 1;

c = Number of species in sample 2

Comparing communities: Jaccard's index

The researcher was also interested not just in the diversity of a single site, but in comparing biodiversity levels across sites. A sensitive measure of similarity between two samples can summarize the fraction of species they share.

Jaccard's index is the simplest summary of this, taking the following form:

$$J = \frac{Sc}{Sa + Sb + Sc}$$

Where Sa and Sb are the numbers of species unique to samples a and b, respectively, and Sc is the number of species common to the two samples. Jaccard's index of similarity is very straightforward since it is simply the fraction of species shared between the samples. It utilizes the richness component of diversity.

3.4.1.3. Structural analysis

The structure of the vegetation was explained using frequency distributions of DBH, height and Importance Value Index (IVI). Tree or shrub density and basal area values were computed on hectare basis. There is direct relationship between DBH and basal area.

Basal area = $(DBH/2)^2$ X 3.14 **Or** $BA = \pi d^2/4$, where, $\pi = 3.14$ and d = DBH (m).

Dominance = Mean basal area X the number of trees of a species

Tree

Relative dominance = Dominance of a species X 100

Dominance of all species (DBH $\geq$ 3 cm)

Density: Density is defined as the number of plants of a certain species per unit area. It is closely related to abundance but more useful in estimating the importance of a species.

Relative density = The number of all individuals of a species x 100

The total number of all individuals (DBH $\geq$ 3 cm)

Frequency: The frequency of plots occupied by a given species. It is calculated with this formula:

F = Number of plots in which a species occur X 100

Total number of plots

The frequencies of the tree species in all the 60 plots were computed. A better idea of the importance of a species with the frequency can be obtained by comparing the frequency of occurrences of all of the tree species present. The result is called the relative frequency and is given by the formula:

Relative frequency = Frequency of a species X 100

Total frequency of all species

Even though a high frequency value means that the plant is widely distributed through the study area, the same is not necessarily true for a high abundance value. This abundance is not always an indicator of the importance of a plant in a community.

Importance Value Index (IVI): Importance value index joins data for three parameters (relative frequency, relative density, and relative abundance) and was computed for dominant species to determine their dominance, as follows (Kent and Coker, 1992):

IVI = Relative Density + Relative Dominance + Relative Frequency,

It is useful to compare the ecological significance of species (Lamprecht, 1989).

3. 5. Ethnobotanical data analysis

3.5.1. Ranking and comparison

3.5.1.1. *Preference ranking*

Rank ordering of a set of objects such as medicinal/wild edible plants is used to determine their order of cultural importance across a community. The most important in the set is given the highest number, decreasing in number as the members of the set decrease in importance. Preference ranking was computed by taking 10 key informants to assess the degree of effectiveness on those medicinal and eight key informants to assess the degree of importance on those wild edible plants highly cited by the informants used to treat a particular disease/used as food at a particular time (Martin, 1995).

3.5.1.2. *Direct matrix ranking*

Direct matrix ranking is a more multifaceted version of preference ranking. Here informants order medicinal/wild edible plants by considering several attributes one at a time, i.e. it draws explicitly upon multiple dimensions. Direct matrix ranking can be performed as a group exercise in which participants reach consensus on the ranking of each item based on their individual evaluations (Martin, 1995). Ranking of threats on 10 medicinal/wild edible plants that were reported by most of the informants in the study area was conducted using ten key informants as described by Martin (1995) and Alexiades (1996). This information was used to determine the highest threats to traditional medicinal/wild edible plants in the study area and help to suggest appropriate conservation measures as considered.

3.5.1.3. Informant consensus on most frequently used medicinal and wild edible plants

In order to evaluate the reliability of information recorded during the interview all the 50 key informants were contacted at least two times for the same ideas and the validity of the information was proved and recorded. Consequently, if the idea of the informant deviates from the original information, it was rejected since it was considered as irrelevant information. As a result only the relevant once were taken into account and statistically analyzed. This method was adopted from Alexiades (1996).

3.5.1.4. *Informant consensus factor*

Informant consensus factor (ICF) was considered for each group of ailments to identify the agreement of the informants on the reported cures for the group of aliments of the plant. ICF was computed as follows: number of use citations in each group (n_{ur}) minus the number of species used (n_t), divided by the number of use citations in each group minus one (Heinrich *et al*., 1998).The mentioned ailments were grouped and then the ICF values were calculated as:

$$ICF = \frac{n_{ur} - n_t}{n_{ur} - 1}$$

Medicinal plants that were effective in treating groups of ailments had a higher informant consensus factor value. The same procedure was followed for wild edible plants.

3.5.1.5. *Fidelity level (FL)*

The FL computes the significance of a species for a given purpose. Most commonly used medicinal plants have high fidelity level value. The fidelity level (FL) among medicinal plants of the study area was computed based on the following formula: FL= Np/N. To calculate the percentage of Fidelity level: FL% = (Np/N) × 100 is used (Alexiades, 1996). Np is the number of informants who independently cited the importance of a species to treat a particular disease, and N is total number of informants who reported the plant to treat any given disease.

3.5.1.6. *Use value*

The local importance of each species cited in the study area was calculated using Use-Value (UV) technique following Phillips and Gentry (1993). Use-Value (UV) is a quantitative method

that demonstrates the relative importance of species known locally, which reflects the importance of each species to informants i. e.

$$\mathbf{UV_{is} = \Sigma U_{is}/n_{is}}$$

Where $\mathbf{UV_{is}}$ = use value of a species **s** for informant **i**,

$\mathbf{U_{is}}$ = the number of uses mentioned in each event by informant **i**, and

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

3.5.1.7. Determination of the extent of endemic plant species threat in Dugda Dawa District

Endemic plant species of Ethiopia and their extent of threat have been given in Ensermu Kelbessa *et al.* (1992) and Vivero *et al.* (2005). Hence, Dugda Dawa Districts' endemic plant species and the level of their threat was determined based on the reports of these scholars and considering restricted geographical range as one of the criteria to take species as endemic which helped the researcher to identify those plant species that should be given priority in the future conservation activities.

CHAPTER FOUR

4. RESULTS

This study brought information into view on the vegetation types, plant resources and ethnobotany of medicinal and wild edible plants of Dugda Dawa District. The findings are presented under the plant diversity of Dugda Dawa District, ethnomedicinal plants used in the district to treat human and livestock ailments as well as wild edible plant species used by the local people of the district as described in the following sections.

4.1. Biophysical factors

Biophysical factors refer to local climate, topography, bedrock and soil type, surface and ground water. Dugda Dawa District obtains relatively minimum amount of mean annual rainfall (about 486 mm) in two different seasons (bimodal type) and its mean annual temperature is about 20.5 □. The topography is rugged and highly degraded due to intensive overgrazing and other natural resource exploitation. Natural forests are converted into grazing areas for livestock production. The remnant forest patches and the woodland in the lowland areas indicate that the area was formerly rich in plant diversity (Figure 8).

Figure 8. Level of degradation due to intensive overgrazing and forest clearance for different purposes – 20 km to the southeast of Finchwa town at an altitude of 1605 – 1650 m a.s.l in Jigessa Nanessa and Boko Gorobali kebeles (Photograph taken by the researcher from the study area -- December, 2013)

There are different types of soils such as sandy soil having light grey to light red color (BIYYEE CIREECHA), clay soil having brown to black grey color (BIYYEE KUSMANKA OR SUPHEE), silt soil having grey to light brown color (MAKOO), loam soil having gery color (BIYYEE GABATAA) FAO (1994); streams in three kebeles (Walgaayii Medanoo, Burqiituu Magaadaa, and Burqaa Arbiichoo) and seasonal ponds at the different corners of the district.

4.2. Plant diversity in Dugda Dawa District

4.2.1. Plant species composition

A total of 343 plant species belonging to 227 genera and 81 families whose habits or growth forms are indicated in Figure 8 were recorded and identified from Dugda Dawa District (Appendix 3). Of all the families; the Fabaceae was the most species rich with 41 species (11.9%) followed by Asteraceae with 28 species (8.1%). Acanthaceae, Lamiaceae, and Rubiaceae with 13 (3.8%) species each, Euphorbiaceae and Solanaceae with 12 (3.5%) species, Malvaceae with 11 species (3.2%) and Combretaceae with 10 (2.9%) species were also very important families in terms of species richness. Four of the collected species; *Cussonia ostinii* Chiov., *Echinops ellenbeckii* O.Hoffm, *Hippocratea pallens* Planchon ex Oliver. and *Warburgia ugandensis* Sprague were new records for the floristic region. The number of species and genera for these and the rest of the families are given in Appendix 5. In addition, of all the species collected, 93.8% were dicots, 4.7% were monocots, and 0.3% was fern. The large percentage of dicots could be due to the suitability of the study area for these groups of plants.

Analysis of the habit or growth forms of species recorded showed that the highest proportion (34.3%) was contributed by shrubs. This was followed by herbs and trees. In addition, lianas, climbing herbs and fern contributed different proportion as indicated in Figure 9.

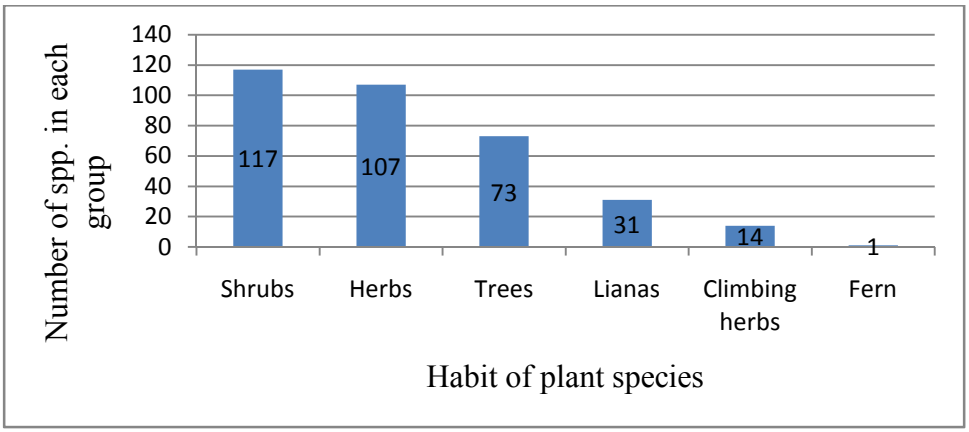

Figure 9. Habit of plant species collected from the study area

4.2.2. Endemic taxa of the study area

The study area encompasses 12 (3.5%) flowering plant species that are endemic to Ethiopia some of which are in the IUCN Red List (IUCN, 2010). These endemic species and the level of their threat are given in Table 3.

Table 3. Endemic plant species in Dugda Dawa District and their level of threat (EN= Endangered, LC= Least concerned, NT= Near threatened, VU= Vulnerable, CR= Critically endangered)

No.	Scientific Name	Family	Status	Medicinal	Wild edibles
1	*Acanthus sennii*	Acanthaceae	NT	-	✓
2	*Bothriocline schimperi*	Asteraceae	LC	✓	-
3	*Cussonia ostinii*	Araliaceae	NT	-	-
4	*Echinops ellenbeckii*	Asteraceae	EN	-	-
5	*Hibiscus boranensis*	Malvaceae	VU	-	-
6	*Kirkia burgeri* subsp.*burgeri*	Simaroubaceae	VU	-	-
7	*Leucas abyssinica*	Lamiaceae	LC	✓	-
8	*Lippia adoensis* var.*adoensis*	Verbenaceae	LC	✓	-
9	*Millettia ferruginea*	Fabaceae	LC	✓	-
10	*Rhus glutinosa*	Anacardiaceae	VU	-	✓
11	*Thunbergia ruspolii*	Acanthaceae	LC	✓	-
12	*Vepris dainellii*	Rutaceae	LC	-	-

4.2.3. Commercially important tree species

Dugda Dawa District vegetation contained eight major commercial indigenous tree species of Ethiopia. These tree species include *Albizia schimperiana, Cordia africana, Juniperus procera,*

Celtis africana, Croton macrostachyus, Ekebergia capensis, Syzygium guineense, and *Warburgia ugandensis* (Million Bekele and Leykun Berhanu, 2001).

4.2.4. Vegetation classification and community types

Four plant communities were seen from the hierarchical cluster analysis (Figure 10). As it was calculated with MRPP in the PC -ORD, the test statistics ***T*** value for the four groups was -6.78 ($P<0.0000015$), highly significant, and the agreement statistics ***A*** was 0.039. In community ecology, values of ***A*** (agreement) are commonly below 0.1 which describes within group homogeneity. The test statistics ***T*** describes the separation between the groups and the more negative ***T*** value, the stronger the separation. From this result, therefore, the null hypothesis "there are different plant community types" can be accepted. In the result, the probability value refers to Monte Carlo tests, while values under each group indicate the fidelity of occurrence of a species within a particular group. Values written in bold face indicate considerable indicator value ($P^*<0.05$) in each group (Table 6; Appendix 4).

Dominance was used to describe both the community and individual species. Hence, community names were given after two tree or shrub species that had higher cover value (Appendix 4). In all observed plant communities, species restricted to one or a few habitat types potentially represent better indicators than those habitat generalists owing to their greater susceptibility to local or regional extinction following environmental change. Thus the identified groups are more or less coinciding with the natural associations that could be observed while visiting the study area. The four plant communities identified were: *Nuxia oppositifolia - Calpurnia aurea* (Community type 1), *Faurea speciosa - Terminalia schimperiana* (Community type 2), *Boscia mossambicensis - Lannea schimperi* (Community type 3), and *Margaritaria discoidea - Maytenus undata* (Community type 4).

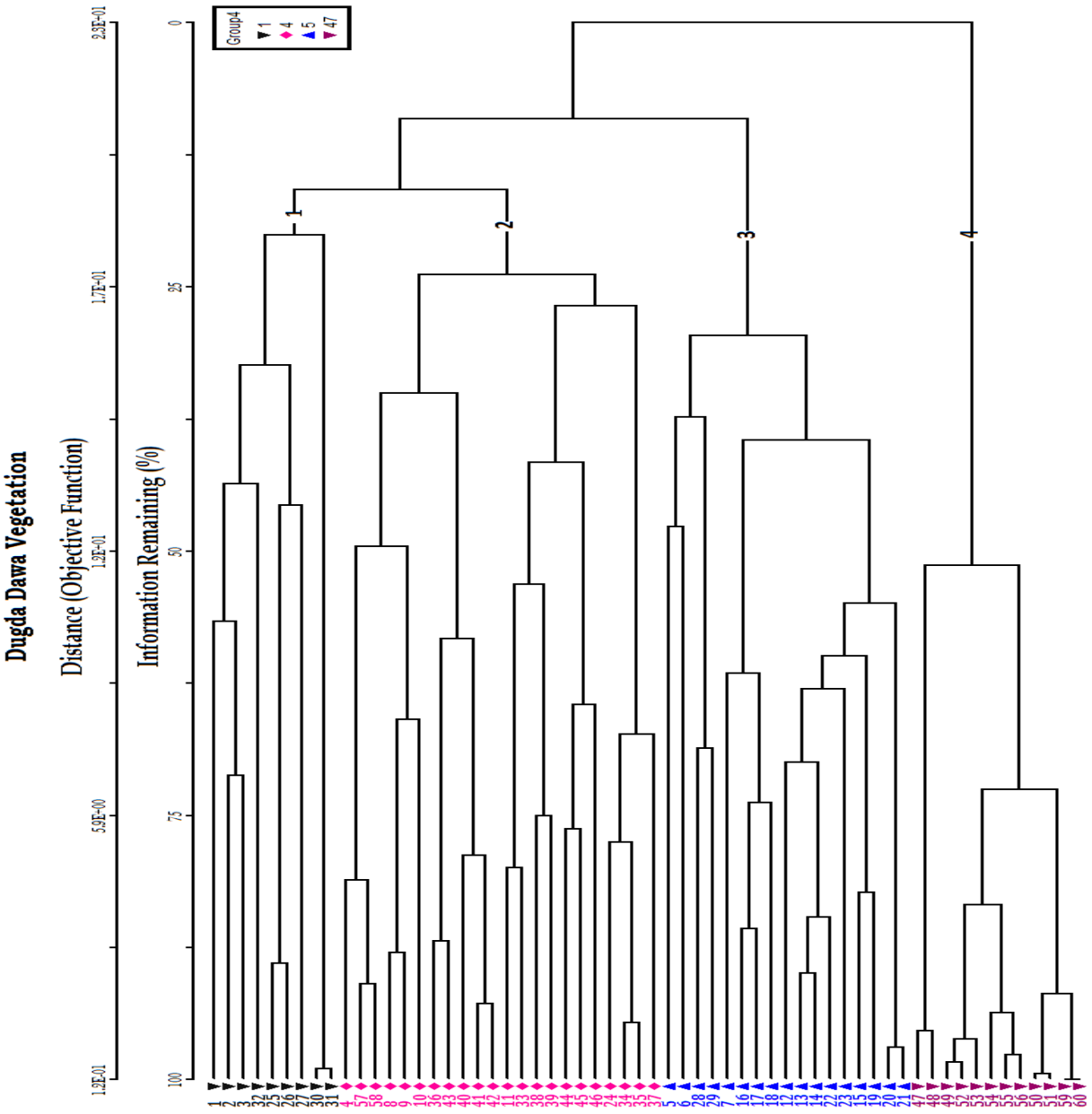

Figure 10. Classification of the vegetation according to similarities in sites using Ward's method and Euclidean distance **.** The level of grouping was based on about 20 % Information remaining. (1 = Community type 1, 2 = Community type 2, 3 = Community type 3 and 4 = Community type 4). Community types and their inclusion of plots are shown in Table 4.

Table 4. Community types and their member plots in the vegetation of Dugda Dawa District

Community type	Altitudinal range	Member plots	No.of plots per community	No. of species per community	Vegetation types in each community
1	1603 - 2283 m a.s.l.	1, 2, 3, 25, 26, 27, 30, 31, 32	9	100	*Acacia-Commiphora & Dry Evergreen Afromontane*
2	1637 - 1968 m a.s.l.	4,8,9,10,11,24,33,34,35,36,37,38,39, 40,41,42,43,44,45,46,57,58	22	130	*Combretum-Terminalia & Dry Evergreen Afromontane*
3	1273 - 1660 m a.s.l.	5, 6, 7, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 28, 29,	17	164	*Acacia – Commiphora & Combretum-Terminalia*
4	1915 - 1975 m a.s.l.	47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 59, 60.	12	65	*Dry Evergreen Afromontane*

Community 1. *Prunus africana - Calpurnia aurea* community type

This community was composed of 9 plots and 100 species. The community was distributed between the altitudinal ranges of 1603 and 2283 m a.s.l. It had nineteen indicator species (*Nuxia oppositifolia, Sida collina, Oplismenus hirtellus, Calpurnia aurea, Dovyalis abyssinica, Maesa lanceolata*, *Phoenix reclinata, Desmodium repandum, Prunus africana, Schefflera collina, Syzygium guineense* subsp. *afromontanum, Glycine wightii, Cyperus fischerianus, Achyrospermum schimperi, Laggera crassifolia, Rhamnus prinoides, Cassipourea malosana, Hippocratea pallens* and *Vernonia auriculifera*) with significant indicator values (Table 6). Woody species (trees, shrub and lianas) associated with this community were *Acacia tortilis, Cordia africana, Ficus sur, Ficus vasta, Millettia ferruginea* subsp. *darassana, Mimusops kummel, Maytenus heterophylla, Rhus vulgaris, Vepris dainellii, Ximenia caffra* and *Helinus mystacinus.* Herbs such as *Acalypha racemosa, Achyranthes aspera, Barleria quadrispina, Rumex abyssinicus* and *Oplismenus hirtellus* (grass) were also common in this community. This

community is the association of *Acacia- Commiphora* & *Dry Evergreen Afromontane* vegetation types.

Community 2. *Ehretia cymosa - Juniperus procera* community type

This community type was represented by 22 plots and 130 species. The community had five indicator species (*Faurea speciosa, Terminalia schimperiana, Rhoicissus revoilii, Fuerstia africana* and *Dodonea angustifolia*) (Table 6). The altitudinal range of this community was from 1637- 1968 m a.s.l. Woody species (trees, shrub and lianas) associated with this community were *Acacia horrida, Albizia schimperiana, Ehretia cymosa, Juniperus procera, Syzygium guineense* subsp. *macrocarpa, Canthium lactescens, Cordia ellenbeckii , Ozoroa insignis, Pavetta abyssinica, Phyllanthus leucanthus, Rhus natalensis* and *Jasminum streptopus.* Herbs such as *Gerbera piloselloides*, *Mentha pulegium* and *Physalis peruviana* were also common in this community. This community is the association of *Combretum-Terminalia* & *Dry Evergreen Afromontane* vegetation types.

Community 3. *Boscia mossambicensis - Lannea schimperi* community type

This community was dominated by woody climbers such as *Capparis fascicularis*, *Capparis tomentosa, Jasminum eminii* and *Jasminum grandiflorum*. The other indicator species with significant indicator values were *Boscia mossambicensis, Asparagus flagellaries, Hibscus ovalifolius, Themeda triandra, Lannea schimperi, Pyrostria phyllanthoidea, Grewia velutina, Commiphora terebinthina, Senna singueana, Acacia senegal, Terminalia brevipes, Clitoria ternatea, Acacia brevispica, Terminalia brownie, Lannea rivae, Hibiscus boranensis,Gardenia ternifolia, Digitaria volutina, Pappea capensis, Acacia goetzei*, *Acacia seyal, Asparagus africanus, Ziziphus abyssinica, Asparagus scaberulus, Ipomoea kituensis, Combretum molle, Dichrostachys cinerea, Crabbea velutina, Rhus vulgaris, Rhynchosia ferruginea* and *Myrsine africana* (Table 6). This community type lay along the altitudinal range of 1273 to 1660 m .a.s.l. Seventeen plots and 164 species were encountered. Along with the above indicator species, *Acacia bussei, Acacia etabaica, Balanites aegyptiaca, Balanites rotundifolia, Commiphora erythraea, Ficus sycomorus, Boswellia neglecta, Cadaba ruspolii, Combretum collinum, Commiphora africana, Commiphora rostrata, Commiphora schimperi, Cussonia holstii*, *Osyris quadripartita* and *Terminalia prunioides* are common woody species of this community

(Appendix 4 -indicator values of all spp.). *Amaranthus dubius, Barleria steudneri, Commelina latifolia, Euphorbia depauperata*, *Kalanchoe densiflora, Kalanchoe laciniata*, *Oxalis corniculata, Parthenium hysterophorus,* and *Tagetes minuta* were the dominant herbs of the community. This community is the association of *Acacia – Commiphora* & *Combretum-Terminalia* vegetation types.

Community 4. *Celtis africana - Podocarpus falcatus* community type

This community type was distributed and was situated at altitudinal ranges from 1915 to 1975 m a.s.l. The community was comprised of 12 plots and 65 species. The indicator species characterizing this community were *Euphorbia depauperata, Solanum incanum, Margaritaria discoidea, Dioscorea schimperiana, Maytenus undata, Ekebergia capensis, Olinia rochetiana, Vangueria apiculata, Grewia ferruginea, Celtis africana, Teclea salicifolia, Clutia lanceolata, Podocarpus falcatus, Nuxia congesta, Acokanthera schimperi, Pterollobuim stellatum, Premna schimperi* and *Monechema debile* (Table 5). The other woody species (trees, shrubs and lianas) associated with this community include *Syzygium guineense* var. *guineense, Olea capensis* subsp. *macrocarpa, Ochna holstii, Pittosporum viridiflorum*, *Scutia myrtina, Maytenus undata, Flacourtia indica, Ritchiea albersii*, *Acanthus eminens, Microglossa pyrifolia* and *Zehneria scabra* (Appendix 4). Herbs such as *Scadoxus multiflorus* and *Isoglossa somalensis* were also common in this community. This community is mainly dominated by *Dry Evergreen Afromontane* vegetation.

Table 5. Indicator values calculated with method of Dufrene and Legendrep (1997).

Name of species	**Communities**				**P***
	C_1	C_2	C_3	C_4	
Nuxia oppositifolia	**100**	0	0	0	0.0020
Sida collina	**100**	0	0	0	0.0020
Oplismenus hirtellus	**100**	0	0	0	0.0023
Calpurnia aurea	**100**	0	0	0	0.0170
Dovyalis abyssinica	**100**	0	0	0	0.0170
Maesa lanceolata	**100**	0	0	0	0.0170
Phoenix reclinata	**100**	0	0	0	0.0170
Desmodium repandum	**100**	0	0	0	0.0195
Prunus africana	**100**	0	0	0	0.0200
Schefflera collina	**100**	0	0	0	0.0200

Name of species	Communities				P*
	C_1	C_2	C_3	C_4	
Syzygium guineense	**100**	0	0	0	0.0200
Glycine wightii	**100**	0	0	0	0.0220
Cyperus fischerianus	**100**	0	0	0	0.0245
Achyrospermum schimperi	**83**	17	0	0	0.0098
Laggera crassifolia	**82**	7	11	0	0.0120
Rhamnus prinoides	**79**	21	0	0	0.0115
Cassipourea malosana	**70**	10	12	8	0.0273
Hippocratea pallens	**63**	5	24	8	0.0485
Vernonia auriculifera	**54**	8	0	38	0.0360
Faurea speciosa	0	**85**	15	0	0.0055
Terminalia schimperiana	0	**82**	18	0	0.0248
Rhoicissus revoilii	0	**58**	42	0	0.0418
Fuerstia africana	0	**49**	44	7	0.0030
Dodonea angustifolia	26	**48**	19	7	0.0125
Asparagus flagellaries	0	0	**100**	0	0.0003
Hibscus ovalifolius	0	0	**100**	0	0.0005
Themeda triandra	0	0	**100**	0	0.0005
Boscia mossambicensis	0	0	**100**	0	0.0010
Lannea schimperi	0	0	**100**	0	0.0035
Pyrostria phyllanthoidea	0	0	**100**	0	0.0040
Grewia velutina	0	0	**100**	0	0.0043
Commiphora terebinthina	0	0	**100**	0	0.0128
Senna singueana	0	0	**100**	0	0.0140
Acacia senegal	0	0	**100**	0	0.0150
Terminalia brevipes	0	6	**94**	0	0.0018
Clitoria ternatea	0	7	**93**	0	0.0038
Acacia brevispica	6	6	**88**	0	0.0003
Terminalia brownie	10	5	**85**	0	0.0003
Lannea rivae	0	15	**85**	0	0.0155
Hibiscus boranensis	0	15	**85**	0	0.0415
Gardenia ternifolia	0	18	**82**	0	0.0163
Digitaria volutina	18	0	**82**	0	0.0440
Pappea capensis	0	19	**81**	0	0.0013
Acacia goetzei	0	20	**80**	0	0.0160
Acacia seyal	0	22	**78**	0	0.0023

Name of species	Communities				P*
	C_1	C_2	C_3	C_4	
Asparagus africanus	0	23	**77**	0	0.0205
Ziziphus abyssinica	0	23	**77**	0	0.0260
Asparagus scaberulus	0	23	**77**	0	0.0273
Ipomoea kituensis	24	0	**76**	0	0.0003
Combretum molle	7	31	**62**	0	0.0005
Dichrostachys cinerea	22	16	**62**	0	0.0050
Crabbea velutina	8	33	**59**	0	0.0075
Rhus vulgaris	0	23	**58**	19	0.0005
Rhynchosia ferruginea	28	18	**54**	0	0.0240
Myrsine africana	21	8	**54**	17	0.0270
Euphorbia depauperata	0	0	0	**100**	0.0093
Solanum incanum	0	0	0	**100**	0.0095
Margaritaria discoidea	0	5	0	**95**	0.0005
Dioscorea schimperiana	0	10	0	**90**	0.0045
Maytenus undata	0	16	0	**84**	0.0003
Ekebergia capensis	8	7	9	**76**	0.0078
Olinia rochetiana	20	7	1	**72**	0.0018
Vangueria apiculata	23	0	9	**68**	0.0008
Grewia ferruginea	37	0	0	**63**	0.0120
Celtis africana	30	9	0	**61**	0.0003
Teclea salicifolia	17	15	7	**61**	0.0003
Clutia lanceolata	7	36	0	**57**	0.0003
Podocarpus falcatus	27	17	0	**56**	0.0003
Nuxia congesta	23	21	0	**56**	0.0078
Acokanthera schimperi	0	34	12	**54**	0.0003
Pterollobuim stellatum	10	22	15	**53**	0.0015
Premna schimperi	0	43	4	**53**	0.0220
Monechema debile	8	24	17	**51**	0.0003

Note: Indicator values (% of perfect indication, based on combining Relative Abundance and Relative Frequency) of each species for each of the four groups and the Monte Carlo test (P*) of the significance observed for each species. (Values in bold face show the indicator species at P*<0.05).

4.2.5. Similarity among plant communities

Sorensen's similarity coefficient and Jaccard's index of similarity were used to determine the similarities among the identified plant communities in Dugda Dawa District. Hence,

Communities 2 and 3 had the highest similarity ratio (Table 6). The least similarity was exhibited between communities 3 and 4.

Table 6. Sorensen's similarity coefficient among community types

Community	1	2	3	4
1	X			
2	0.31	X		
3	0.29	**0.36**	X	
4	0.28	0.31	0.18	X

Similar result was obtained by using Jaccard's index of similarity as it is simply the fraction of species shared between the samples (Table 7).

Table 7. Jaccard's index of similarity among community types

Community	1	2	3	4
1	X			
2	0.29	X		
3	0.26	0.**39**	X	
4	0.25	0.29	0.12	X

4.2.6. Species diversity, evenness, and richness of the plant communities

When communities are compared with each other, the highest species richness and diversity were observed in community type 3 (Table 8). Community type 1 was seen with the highest evenness although the second fewer species were recorded in this community. Community type 2 was with intermediate richness and diversity but lower than communities 3 and 1. Shannon-Wiener diversity index for the total community (H') was 4.87, H'max was 8.96 and evenness (J) was equals to 0.54.

Table 8. Shannon Wiener Diversity Index for the communities

Community	Average altitude (m a.s.l.)	Species richness	Diversity Index (H')	H' max (lns)	Evenness (H'/H' max)
1	1872	100	4.37	6.87	0.64
2	1808	130	4.35	7.91	0.55
3	1560	164	4.69	7.94	0.59
4	1947	65	3.63	7.19	0.51

4.3. Structure of the vegetation

4.3.1. Tree and shrub density

Average tree and shrub density, expressed as the number of individuals with DBH greater than 2.75 cm was 1027.92/ha and those trees and shrubs with DBH between 3 and 10 cm were 554.31 (53.9%); those with DBH between 10.5 and 20 cm were 316.36 (30.8%) and with DBH greater than 20 cm were 157.25 (15.3%) per hactare respectively.

4.3.2. Size class distributions

The frequency distribution of height classes of trees of Dugda Dawa District vegetation is given in Figure 11. The height class distribution of trees of the vegetation indicated that more than 50% of the individuals had height between 5 - 14 m (Height classes 1 and 2). About 27.4% of trees reached height 10 - 14 m indicating slight reduction of smaller individuals.

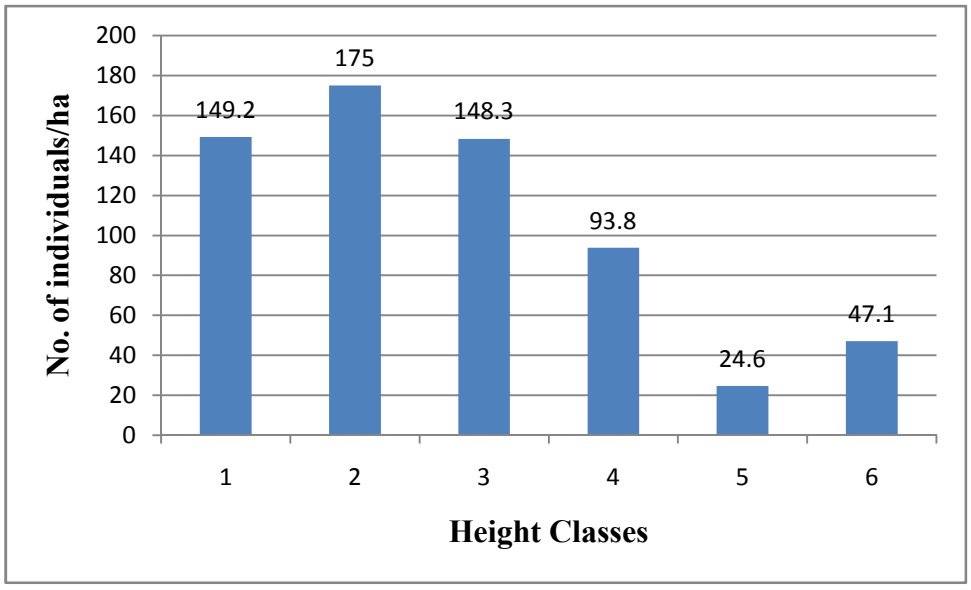

Figure 11. Height classes versus relative density/ha of Dugda Dawa District vegetation

Legend: 1 = 5 - 9 m, 2 = 10 - 14 m, 3 = 15 - 19 m, 4 = 20 - 24 m, 5 = 25 - 29 m and 6 >29 m

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DBH (the diameter at breast height) class distribution of the woody species is given in Figure 12. Here also the number of individuals in different DBH classes showed an irregular pattern (the frequency distribution of individuals in the different size classes in Dugda Dawa District vegetation is not uniform). It was decreasing in the 5th and 8th DBH classes (23 - 27 cm and 38 - 42 cm) and increasing in the 1st and 2nd DBH classes (3 - 7 and 8 - 12).

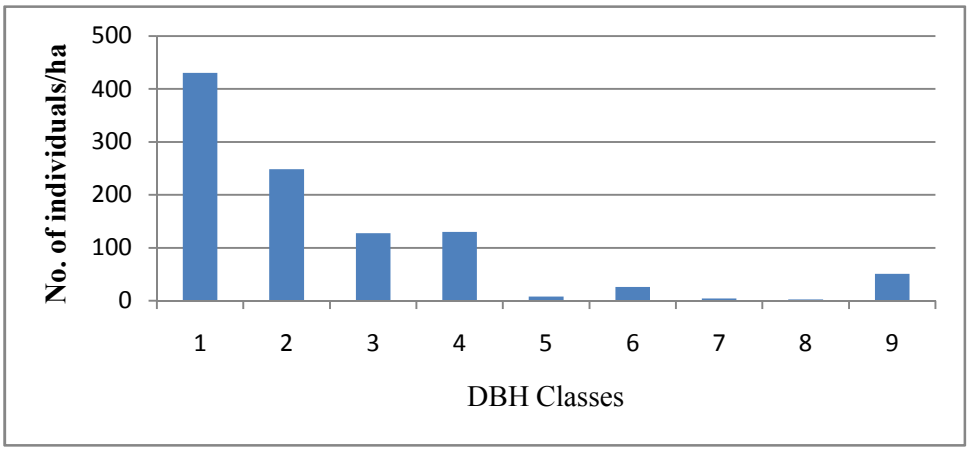

Figure 12. DBH class versus the number of individuals/ha

Legend: DBH class 1 = 3 - 7 cm, 2 = 8 - 12 cm, 3 = 13 - 17 cm, 4 = 18 - 22 cm, 5 = 23 - 27 cm, 6 = 28 - 32 cm, 7 = 33 - 37 cm, 8 = 38 - 42 cm, 9 = > 42 cm.

4. 3. 3. Basal area

The total basal area of representative tree species in Dugda Dawa District vegetation as calculated from DBH data was found to be 90.4 m^2/ha and this constitute 0.90% of the total ground area. Species with the largest contribution to basal area can be taken as the most important woody species in the vegetation. *Podocarpus falcatus* took the biggest share in the percentage contribution of basal area (36.6%) of the vegetation (Figure 13, Table 9). Other large trees such as *Syzygium guineense* var. *guineense* (11.2%), *Psydrax schimperiana* (9.2%), *Olea capensis* (5.8%), *Croton macrostachyus* (5%), *Celtis africana* (4.2%), *Faurea speciosa* (3.8%), *Cassipourea malosana* (3.6%), *Terminalia schimperiana* (3.2%), *Olea europaea* subsp. *cuspidate* (3.1%), and *Terminalia brownie* (3.1%) contributed to 88.8% of the total basal area. The trees with highest densities such as *Combretum molle, Acokanthera schimperi,* and *Scherebra alata* with basal area values of 2.6, 0.7 and 1.7 each did not contribute much to the total basal area of the vegetation, because area depends on the size of the tree.

Figure 13. *Podocarpus falcatus* (Podocarpaceae) - Photograph taken by the researcher from the study area -- December, 2013)

Table 9. Density, relative density (RD), frequency, relative frequency (RF), basal area and relative basal area (RBA) of representative tree species of Dugda Dawa District vegetation.

No.	Specie	Density/ha	RD	Frequ.	RF	BA/ha	RBA
1	*Acacia abyssinica*	8.33	1.49	5.00	0.7	1.60	1.80
2	*Acacia brevispica*	11.67	2.10	28.33	4.1	0.50	0.60
3	*Acacia goetzei*	8.33	1.49	13.33	1.9	0.70	0.80
4	*Acacia horrida*	7.08	1.26	6.67	1.0	1.40	1.50
5	*Acacia seyal*	12.50	2.23	20.00	2.9	0.30	0.30
6	*Acokanthera schimperi*	40.83	7.30	48.33	7.0	0.60	0.70
7	*Balanites aegyptiaca*	7.08	1.26	10.00	1.4	0.30	0.30
8	*Bersama abyssinica*	14.17	2.50	23.33	3.4	0.50	0.60
9	*Cassipourea malosana*	7.08	1.26	10.00	1.4	3.00	3.30
10	*Celtis africana*	26.25	4.70	30.00	4.3	3.40	3.80
11	*Combretum collinum*	15.00	2.68	11.67	1.7	1.50	1.70
12	*Combretum contractum*	2.08	0.37	5.00	0.7	0.10	0.10
13	*Combretum molle*	41.67	7.45	45.00	6.5	2.40	2.60
14	*Croton macrostachyus*	36.67	6.55	50.00	7.2	4.10	4.50
15	*Ekebergia capensis*	5.42	0.97	11.67	1.7	0.30	0.30
16	*Fagaropsis angolensis*	17.50	3.13	18.33	2.6	2.40	2.60
17	*Faurea speciosa*	22.08	3.95	16.67	2.4	3.10	3.40
18	*Flacourtia indica*	6.25	1.12	6.67	1.0	0.20	0.20
19	*Lannea rivae*	4.58	0.82	6.67	1.0	0.10	0.10
20	*Lannea schimperi*	5.83	1.04	10.00	1.4	0.20	0.20
21	*Nuxia congesta*	20.42	3.65	25.00	3.6	1.10	1.20
22	*Olea capensis* subsp. *macrocarpa*	10.42	1.86	8.33	1.2	4.70	5.20
23	*Olea europaea* subsp. *cuspidata*	50.83	9.08	55.00	7.9	2.50	2.80
24	*Olinia rochetiana*	12.08	2.16	15.00	2.2	1.00	1.10
25	*Ozoroa insignis*	10.42	1.86	13.33	1.9	0.40	0.40
26	*Pappea capensis*	9.17	1.64	20.00	2.9	0.80	0.90
27	*Podocarpus falcatus*	45.42	8.12	40.00	5.8	29.90	33.10
28	*Psydrax schimperiana*	22.08	3.95	35.00	5.1	7.50	8.30
29	*Scherebra alata*	23.33	4.17	35.00	5.1	1.50	1.70
30	*Syzygium guineense*	8.33	1.49	11.67	1.7	9.10	10.10
31	*Terminalia brownie*	24.17	4.32	28.33	4.1	2.50	2.80
32	*Terminalia prunioides*	1.67	0.30	5.00	0.7	0.04	0.04
33	*Terminalia schimperiana*	15.00	2.68	13.33	1.9	2.60	2.90
34	*Ziziphus abyssinica*	5.83	1.04	11.67	1.7	0.03	0.03
			100		**100**	**90.37**	**99.97**

A comparative contribution of the different DBH classes to the total basal area is presented in Table 10.

Table 10. Contribution of different DBH classes to the total density and basal area/ha in Dugda Dawa District vegetation

DBH Class	Density		Basal Area	
	No. of stems	%	m^2	%
1	430.42	41.90	1.13	1.25
2	248.75	24.20	10.30	11.40
3	127.50	12.40	19.30	21.35
4	130.00	12.70	13.30	14.70
5	7.92	0.80	0.04	0.04
6	25.83	2.50	2.60	2.90
7	4.17	0.40	4.70	5.20
8	2.50	0.20	9.10	10.06
9	50.83	4.90	29.90	33.08
Total	**1027.9**	**100**	**90.4**	**99.98**

Legend: DBH class 1 = 3 -7 cm, 2 = 8 - 12 cm, 3 = 13 - 17 cm, 4 = 18 - 22 cm, 5= 23 - 27 cm, 6 = 28 - 32 cm, 7 = 33 - 37 cm, 8 = 38 - 42 cm and 9 > 42 cm.

4.3.4. Density, frequency and dominance

Analysis of the relative density indicated that *Olea europaea* subsp. *cuspidata*, *Podocarpus falcatus, Combretum molle,* and *Acokanthera schimperi* were the four most abundant species and constitute about 28.02% of the total density (Table 11). Therefore, *Olea europaea* subsp. *cuspidata, Croton macrostachyus, Acokanthera schimperi,* and *Combretum molle* were the most frequently occurring species in the study area.

4.3.5. Importance value indices

The Importance Value Index (IVI) was calculated for 34 of the species and the results showed that *Podocarpus falcatus, Olea europaea* subsp. *cuspidata, Croton macrostachyus, Combretum molle, Psydrax schimperiana, Acokanthera schimperi,* and *Celtis africana* were the first seven most important species with higher IVI values (Table 11).

Table 11. Importance Value Indices of the dominant tree species of Dugda Dawa District vegetation (RF = Relative Frequency, RD = Relative Density, RDO = Relative Dominance and IVI = Important Value Index)

Species	**RD**	**RDO**	**RF**	**IVI**
Acacia abyssinica	1.49	0.52	0.72	2.73
Acacia brevispica	2.10	0.23	4.09	6.42
Acacia goetzei	1.49	0.23	1.92	3.64
Acacia horrid	1.26	0.39	0.96	2.61
Acacia seyal	2.23	0.15	2.89	5.27
Acokanthera schimperi	7.30	0.96	6.97	15.23
Balanites aegyptiaca	1.26	0.08	1.44	2.78
Bersama abyssinica	2.50	0.28	3.37	6.15
Cassipourea malosana	1.26	1.52	1.44	4.22
Celtis africana	4.70	3.52	4.33	12.55
Combretum collinum	2.68	0.88	1.68	5.24
Combretum contractum	0.37	0.01	0.72	1.10
Combretum molle	7.45	3.93	6.49	17.87
Croton macrostachyus	6.55	5.91	7.21	19.67
Ekebergia capensis	0.97	0.07	1.68	2.72
Fagaropsis angolensis	3.13	1.66	2.64	7.43
Faurea speciosa	3.95	2.69	2.40	9.04
Flacourtia indica	1.12	0.05	0.96	2.13
Lannea rivae	0.82	0.01	0.96	1.79
Lannea schimperi	1.04	0.04	1.44	2.52
Nuxia congesta	3.65	0.88	3.61	8.14
Olea capensis	1.86	1.92	1.20	4.98
Olea europaea	9.08	5.00	7.93	22.01
Olinia rochetiana	2.16	0.48	2.16	4.80
Ozoroa insignis	1.86	0.16	1.92	3.94
Pappea capensis	1.64	0.29	2.89	4.82
Podocarpus falcatus	8.12	53.37	5.77	67.26
Psydrax schimperiana	3.95	6.48	5.05	15.48
Scherebra alata	4.17	1.38	5.05	10.60
Syzygium guineense	1.49	2.98	1.68	6.15
Terminalia brownii	4.32	2.38	4.09	10.79
Terminalia prunioides	0.30	0.003	0.72	1.023
Terminalia schimperiana	2.68	1.54	1.92	6.14
Ziziphus abyssinica	1.04	0.01	1.68	2.73
Total	**99.99**	**100**	**99.98**	

4.3.6. Dominant species

Dominant species were selected based on their rank of IVI values as indicated in Table 14. Species having IVI value above 5.00 were referred to as dominant because of the relative ecological importance they play in the vegetation and also their abundance in distribution, and high basal area within the vegetation. Figure 13 shows the distribution of abundance among species in the vegetation in the study area and the two red lines in the dominance curve indicate the range in which the abundance of the species increases as the number of subplots increase.

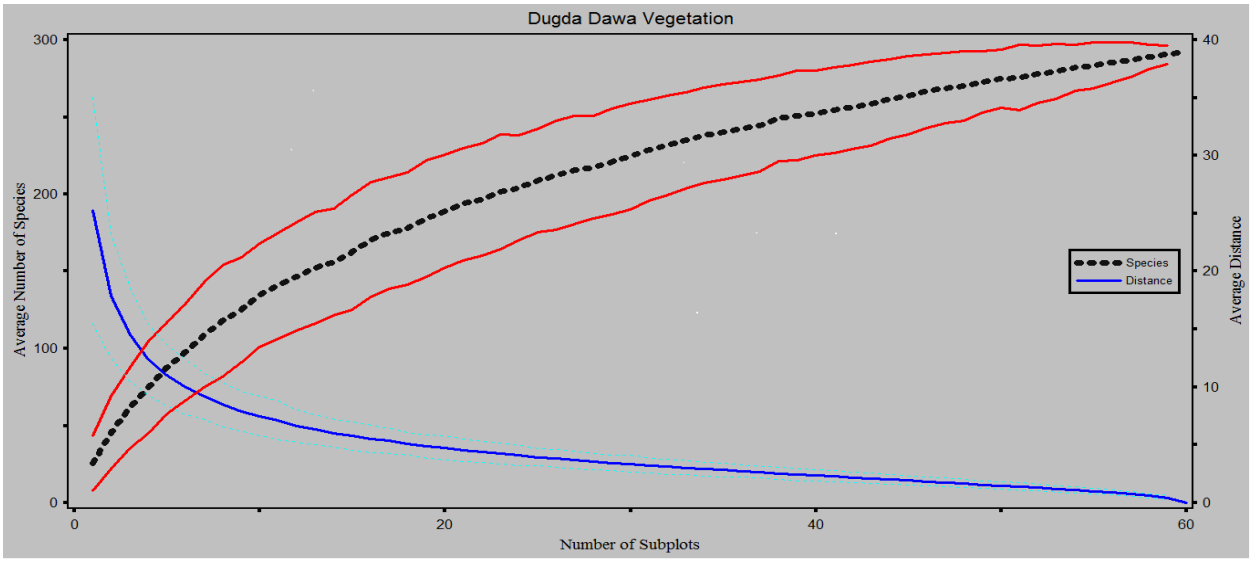

Figure 14. Dominance curve showing the distribution of abundance among species in the study area

4.3.7. Population structure

Analysis of the population structure of four representative tree species out of the 34 species taken for importance value indices investigation in the vegetation of Dugda Dawa District revealed four general patterns (Figure15a - d).

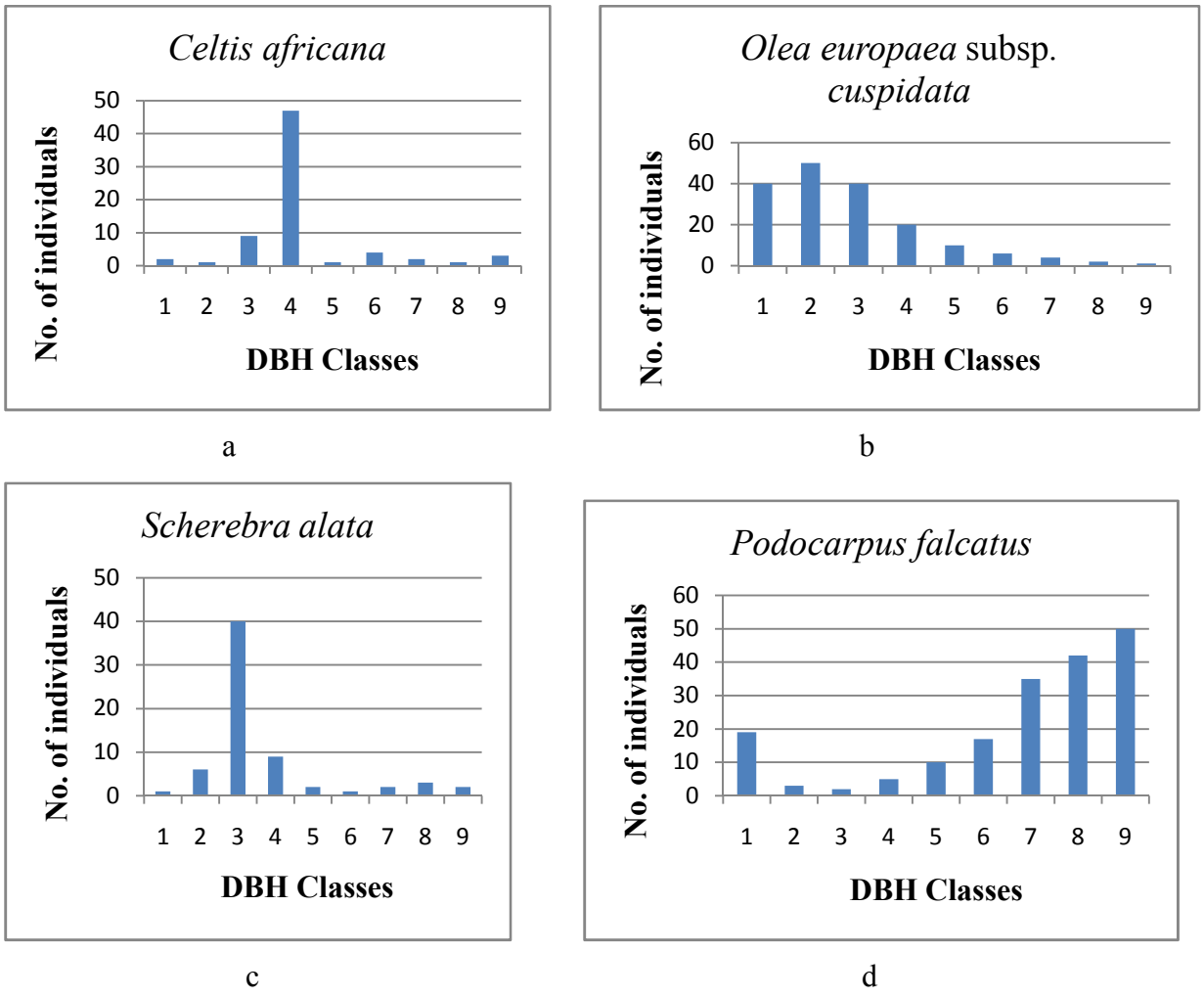

Figure 15 a - d. General patterns of the population structure of four representative tree species in the vegetation of the study area

4.3.8. Phytogeographic similarity

This vegetation was compared with other five dryland vegetations of the country by using Sorensen's Similarity index to know the similarity of species in the vegetation (Table 12).

Table 12. Phytogeographic similarity comparison of Dugda Dawa District vegetation with five other woodland vegetations in Ethiopia (Bold values indicate the highest similarity).

Where, **a** = Common species to Dugda Dawa District and the woodland vegetation in comparison.

b = Species found only in Dugda Dawa District vegetation (with an altitudinal range of 800 - 2300 m a.s.l.).

c = Species found only in the woodland vegetation which is in comparison with Dugda Dawa District vegetation and **Sc** = Sorensen's Similarity Coefficient.

No.	Woodland vegetation to be compared with	Alt.(m a,s.l)	a	b	c	Sc
1	Borana Woodlands Vegetation[2]	1000 - 1700	100	246	227	**0.30**
2	Dello Menna Woodland Vegetation[3]	800 - 2000	62	284	109	0.20
3	Gamo Gofa Woodlands Vegetation[5]	600 - 1900	73	273	143	0.26
4	Nechisar Woodland Vegetation[4]	601 - 1900	72	274	136	0.26
5	Sire Beggo Woodland Vegetation[1]	602 - 1900	83	263	102	0.**31**

Source: [1]Abiyot Dibaba *et al*. (2014), [2]Gemedo Dalle *et al*. (2005), [3]Motuma Didita *et al*. (2010), [4]Samson Shimelis *et al*. (2016), [5]Teshome Soromessa *et al*. (2004).

4.3.9. Regeneration status

The constituents and density of seedlings and saplings of selected tree species in Dugda Dawa District vegetation were included in this study. Regeneration of a particular species is poor if seedlings and saplings are much less than the mature trees. The total seedling, sapling, and mature woody tree densities of 34 selected tree species were about 410, 136, and 565.41 individuals per hectare respectively (Table 13). The composition, distribution, and density of seedlings and saplings are indicators of the future regeneration status of any vegetation.

Table 13**.** Selected tree species with their seedling, sapling and mature tree density/ha

Species	Seedling	Sapling	Mature tree
Acacia abyssinica	3	1	8.33
Acacia brevispica	3	1	11.67
Acacia goetzei	8	2	8.33
Acacia horrid	5	2	7.08
Acacia seyal	11	3	12.50
Acokanthera schimperi	25	8	40.83
Balanites aegyptiaca	3	1	7.08
Bersama abyssinica	7	3	14.17
Cassipourea malosana	11	4	12.92
Celtis africana	20	6	26.25
Combretum collinum	10	3	15.00
Combretum contractum	3	1	2.08
Combretum molle	32	11	41.67
Croton macrostachyus	20	7	36.67
Ekebergia capensis	5	1	5.42
Fagaropsis angolensis	9	3	17.50
Faurea speciosa	15	5	22.08
Flacourtia indica	3	1	6.25
Lannea rivae	3	1	4.58

Species	Seedling	Sapling	Mature tree
Lannea schimperi	5	2	5.83
Nuxia congesta	8	3	20.42
Olea capensis subsp. *macrocarpa*	10	3	10.42
Olea europaea subsp. *cuspidata*	24	10	50.83
Olinia rochetiana	6	2	12.08
Ozoroa insignis	5	2	10.42
Pappea capensis	10	3	9.17
Podocarpus falcatus	73	23	45.42
Psydrax schimperiana	15	5	22.08
Scherebra alata	16	5	23.33
Syzygium guineense	15	5	8.33
Terminalia brownie	13	4	24.17
Terminalia prunioides	1	1	1.67
Terminaliaschimperiana	10	3	15.00
Ziziphus abyssinica	3	1	5.83
Total/ha	**410**	**136**	**565.41**

4.4. Traditional medicinal plants in the study area

4.4.1. Taxonomic diversity of medicinal plants

Out of the 346 plant species collected from the study area, 127 medicinal plant species that belong to 123 genera and 82 families consisting of two bryophytes, one gymnosperm and 79 angiosperm families (two monocots and 77 dicots) were reported in the district. Concerning their source, 120 species were collected from the wild habitats whereas only seven of the medicinal plants were obtained from cultivated area (homegarden or farmland). Of the 127 species, 81 (64.6%) were cited for their uses to treat human ailments whereas 24 species (18.9%) were reported for treating livestock ailments and 22 species (16.5%) for their therapeutic uses against various ailments affecting both humans and livestock (Figure 16).

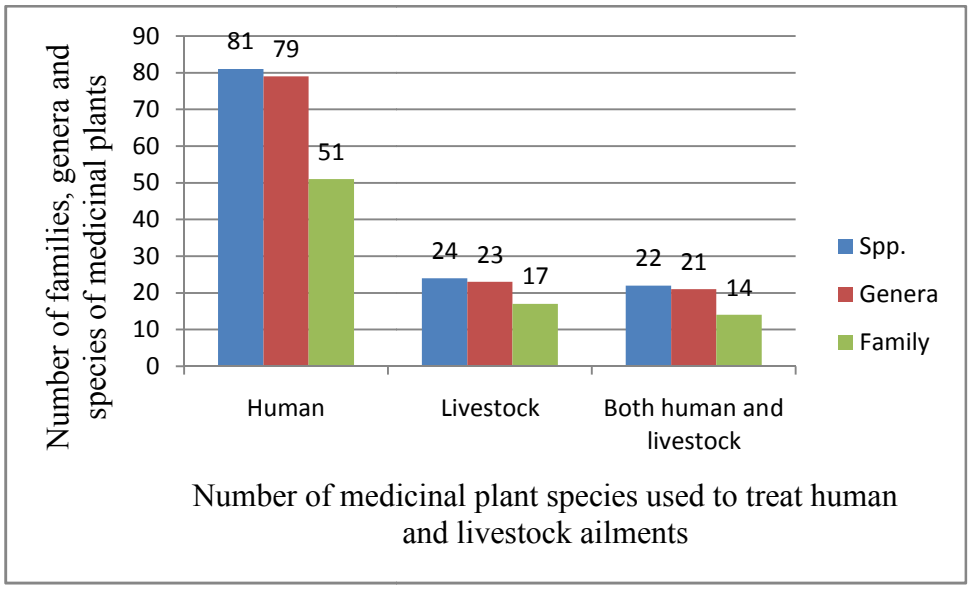

Figure 16. Number of families, genera and species of medicinal plants used to treat human, livestock or both human and livestock ailments in Dugda Dawa District

Fabaceae was with the highest number of medicinal plant species (13 species) followed by Asteraceae (9 species) and Lamiaceae (9 species). Forty four families of the medicinal plants contributed more than one species (Figure 17) and six of the medicinal plant species which were collected from this district were found to be endemic to Ethiopia (*Bothriocline schimperi, Erythrina brucei, Lippia adoensis, Millettia ferruginea, Leucas abyssinica* and *Thunbergia ruspolii)*.

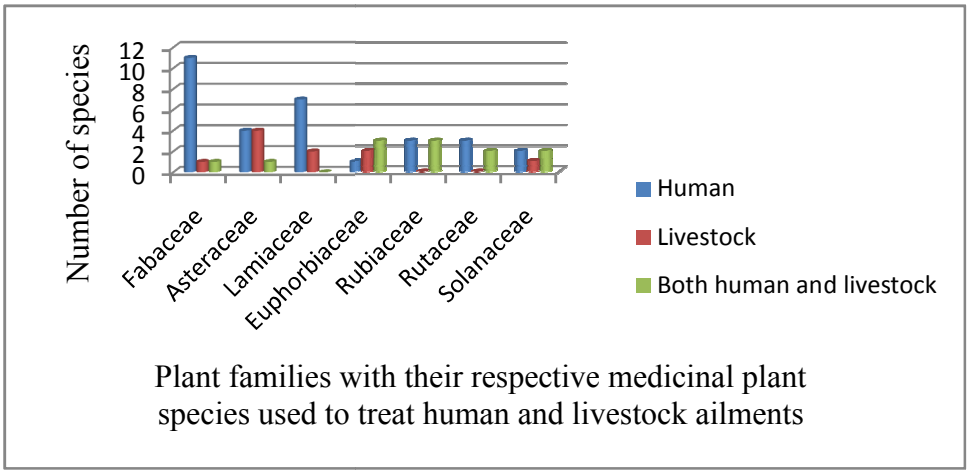

Figure 17. Plant families with high number of medicinal plant species used to treat human, livestock or both human and livestock ailments in Dugda Dawa District

4.4.2. Distribution of medicinal plant species across plant communities

Traditional medicinal plants mentioned for their remedial uses by people in Dugda Dawa District were found distributed in each of the identified plant community types in the vegetation. *Boscia mossambicensis - Lannea schimperi* community type was found to be the richest in medicinal plant species composition in that it contained 61 species of traditionally used remedial plants. The medicinal flora of this community includes *Acacia brevispica*, *Asparagus flagellaris*, *Balanites aegyptiaca*, *Cadaba ruspolii*, *Capparis tomentosa*, *Clitoria ternatea*, *Combretum collinum, Combretum molle*, *Commiphora schimperi*, *Dichrostachys cinerea*, *Lannea rivae*, *Osyris quadripartita*, *Pappea capensis*, *Rhynchosia ferruginea, Terminalia brownii, Terminalia prunioides,* and *Ziziphus abyssinica*. A total of 58 medicinal plant species was found in *Ehretia cymosa – Juniperus procera* community type. Some of the major medicinal plants in this community type were *Albizia schimperiana*, *Canthium lactescens, Dodonaea angustifolia*, *Ehretia cymosa*, *Fuerstia africana*, *Gardenia ternifolia*, *Gerbera piloselloides*, *Ozoroa insignis*, *Pavetta abyssinica*, *Rhoicissus revoilii,* and *Rhus natalensis.*

Prunus africana - Calpurnia aurea community type contained 39 different traditional medicinal plant species, of which *Calpurnia aurea*, *Maesa lanceolata*, *Millettia ferruginea* and *Prunus africana* were among the most cited species available in this community type. *Celtis africana-Podocarpus falcatus* community type was found to contain a total of 32 medicinal plant species. Some of the most-cited medicinal plant species available in this community type include *Acokanthera schimperi*, *Clutia lanceolata*, *Dioscorea schimperiana*, *Ekebergia capensis*, *Euphorbia depauperata*, *Flacourtia indica*, *Microglossa pyrifolia*, *Nuxia congesta, Olinia rochetiana*, *Pittosporum viridiflorum*, *Podocarpus falcatus*, *Premna schimperi*, *Syzygium guineense* var. *guineense, Teclea salicifolia,* and *Vangueria apiculata*.

The medicinal plant species richness, diversity and evenness values of each plant community type in Dugda Dawa District vegetation is summarized in Table 14.

Table 14. Medicinal plant species richness, diversity and evenness values of plant communities in Dugda Dawa District vegetation

Community type	Medicinal plant richness	Shannon - Wiener diversity index (H') of medicinal plants	H' max (lns)	Evenness (H'/H' max) of medicinal plants
Boscia mossambicensis Lannea schimperi community (Commu. 3)	61	3.77	7.29	0.52
Faurea speciosa Terminalia schimperiana community(Comm.2)	58	3.79	7.34	0.52
Nuxia oppositifolia Calpurnia aurea community (Community 1)	39	3.43	6.69	0.51
Margaritaria discoidea Maytenus undata community (Community 4)	32	3.19	6.39	0.50

4.5. Medicinal plants used to treat only human ailments

4.5.1. Diversity of reported medicinal plants

A total of 81 medicinal plant species belonging to 77 genera and 51 families (48 angiosperms, one gymnosperm, and two bryophytes) were reported to be used for treating human ailments in Dugda Dawa District (Appendix 6). Family Fabaceae was represented by the highest number of species (10 species, 7.9%), followed by Lamiaceae (seven species, 5.5%), Asteraceae and Rubiaceae four species (3.2%) each, Combretaceae, Cucurbitaceae, and Sapindaceae three species (2.4%) each. Ten of the reported families, i.e. Acanthaceae, Anacardiaceae, Apocyanaceae, Capparidaceae, Euphorbiaceae, Flacourtiaceae, Oleaceae, Rutaceae, Solanaceae and Vitaceae were represented by two species each whereas the remaining 34 families had single-species representation. Thus, 33.3% of the families were represented by more than one medicinal plant species. Four of the medicinal plants which are used to treat human ailments were endemic to Ethiopia. Identified growth forms of medicinal plants indicated that shrubs (30; 37%) were more dominant than trees (23; 28.4%) and lianas (13; 16.1%). The lower forms such as herbs, climbing herbs and epiphytes were 10 species (12.5%), three species (3.7%), and two species (2.5%) respectively.

4.5.2. Parts of medicinal plants used for remedy preparation

Even though about eight different plant parts were reported to be used for remedy preparation in different ways, larger proportion (36.6%) of the preparations for treating human ailments were obtained from leaves followed by roots (21.9%) and barks (17.9%). In addition to this, the leaves were used in different preparations in mixture (7.2%) with other plant parts, whereas barks and roots were used in 2.4% and 2% of the preparations in mixture with other plant parts respectively in the district (Figure 18). Most of the remedy preparations (93.7%) were reported from freshly collected plant parts, whereas dried parts were used least (5.8%); the remaining 0.5% of remedies were reported to be prepared from dried or fresh parts of medicinal plant species.

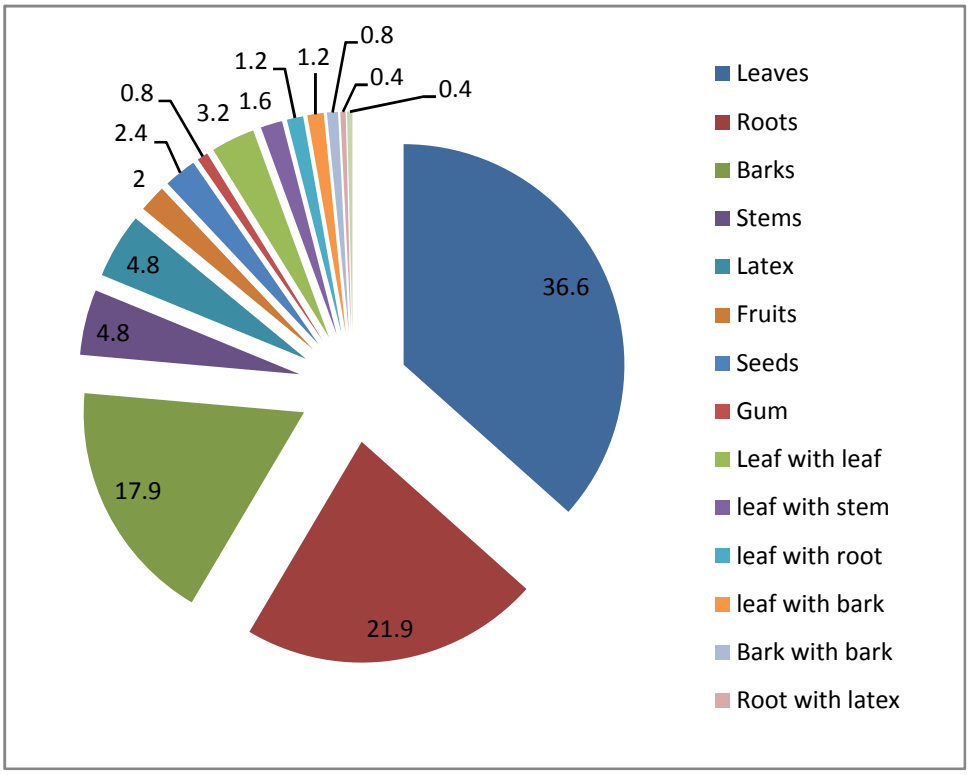

Figure 18. Parts of medicinal plants used (%) for remedy preparation to treat human ailments

4.5.3. Types of diseases and treatment methods

Fortynine disease types, affecting humans, were identified in Dugda Dawa District to be treated with traditional medicinal plants (Appendix 6). Gastro - intestinal diseases such as tooth ache, stomach ache, and diarrhea were the most frequently reported human ailments followed by skin and sexually transmitted diseases. As reported by informants these diseases were diagnosed commonly through interview and visual inspection of the patients before administering any

herbal medicine. Once the healer gets the required information, herbal medicines were prepared and administered following the proper route and the type of disease. Patients with gastro - intestinal problems, sexually transmitted diseases, malaria, hepatitis, hypertension, diabetics, TB, rabies, and poisons were commonly reported to be treated with liquid preparations or chewable plant parts given orally, whereas those with different skin diseases and tissue cancer were reported to be treated with crushed or chopped preparations through rubbing or pasting herbal preparations. Diseases such as febrile illness, head ache and evil eye were reported to be treated either through fumigation or washing the patient with liquid herbal preparations.

4.5.4. Mode of herbal medicine preparation and application

As herbalists reported in the study area, the mode of preparation and application of remedies varies based on the type of ailment which they identify with reference to symptoms observed on patients. The major mode of herbal medicine preparation for human ailments were chopping or pounding and homogenizing plant parts (35.6%) followed by crushing and put on plant parts (16.7%) and chopping, homogenizing and boiling plant parts (15%) (Figure 19).

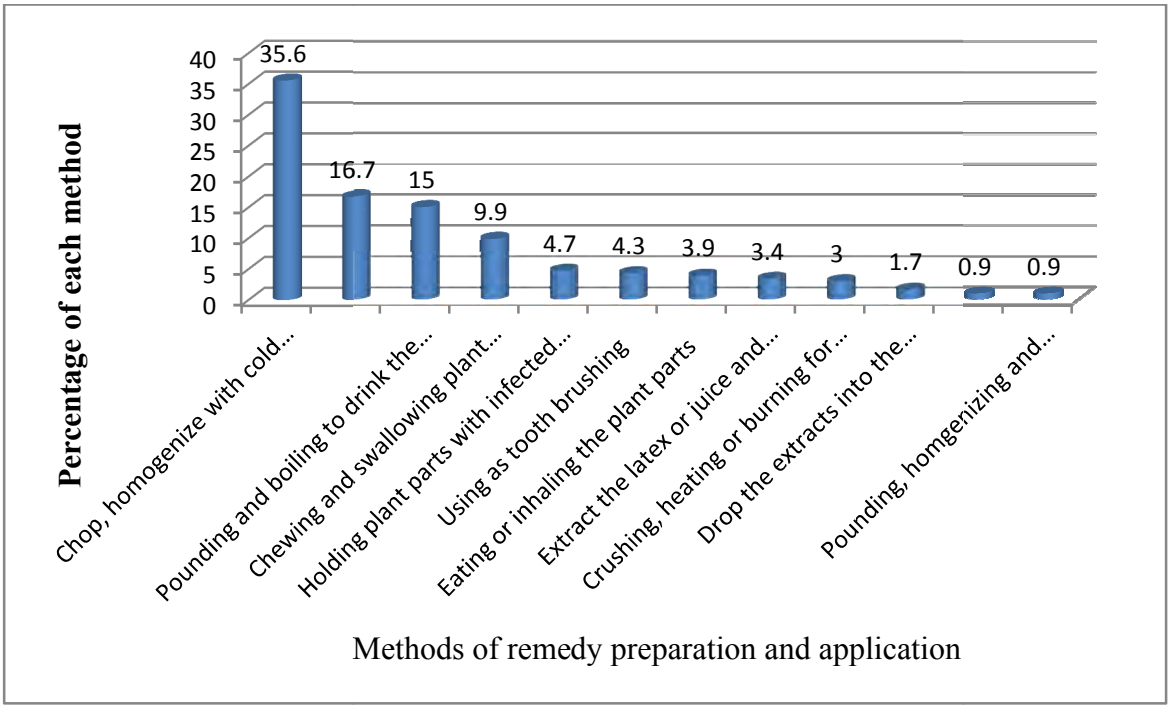

Figure 19. Modes of remedy preparation and application (%) to treat human ailments

4.5.5. Route of remedy administeration

Routes of administration of remedies used against different human ailments in traditional health care system of the study area were documented. Oral application was the most common route of administration (162 preparations, 70.1%) followed by dermal administration (49 preparations, 21.2%) and nasal administration (12 preparations, 5.2%). Other remedies were reported to be administered through deep opening on the body formed due to infection "Luxaa - in local Oromo language" (five preparations, 2.2%); aural (two preparations; 0.9%), or ocular (one preparation; 0.4%) routes with regard to the type of ailment reported by diagnosing patient.

4.5.6. Dosages and antidotes

It was reported that remedies were prescribed and given without fixed standards or doses. Nevertheless, approximate amount were mentioned to be determined based on gender, age and physical appearance of the patient. Remedies were reported to be measured in coffee cups, water glasses, liters while others were measured as handful or pieces of particles. Milk, yoghurt, honey, and coffee were mentioned as antidotes for traditional medicines with adverse side effects.

4.5.7. Marketability of medicinal plants

The result from the market survey of medicinal plants indicated that in the culture of Guji Oromo (ethnic group of the study area) it is forbidden to sell traditional medicine in the open market. Even if people coming from other areas usually sell them, the local people didn't accept it. In fact there are some medicinal plants sold in the market for different purposes other than their medicinal uses such as *Coffea arabica* and *Rhamnus prinoides* to be used in the preparation of drinks; *Ruta chalepensis* to be used as spice in milk preparation; *Combretum molle, Olea europaea* subsp. *cuspidata* and *Osyris quadripartita* for fumigation in producing good odor and feeling for the body and house.

4.5.8. The most preferred medicinal plants for treating human ailments

Preference ranking exercise on medicinal plant species that were reported to be used against tooth ache, which is one of the gastro – intestinal diseases common to the study area, showed the most effective medicinal plants (Table 15).

Table 15. Results of preference ranking of ten medicinal plants reported for treating tooth ache

Medicinal plants used for tooth ache	Informants designated A to J										Total	Rank
	A	B	C	D	E	F	G	H	I	J		
Acmella caulirhiza	8	5	6	7	4	2	3	1	8	0	44	10th
Capparis tomentosa	8	9	7	6	4	5	3	8	0	2	52	7th
Carissa spinarum	9	10	8	7	5	6	10	4	2	3	64	2nd
Clerodendrum myricoides	8	6	7	9	10	5	3	4	4	3	59	4th
Fagaropsis angolensis	8	9	7	10	6	4	5	3	1	7	60	3rd
Pappea capensis	7	6	5	8	4	8	3	0	3	2	46	9th
Pittosporum viridiflorum	8	7	9	6	4	5	9	1	4	3	56	5th
Premna schimperi	7	8	6	4	5	3	0	8	3	4	48	8th
Rhoicissus revoilii	9	7	6	8	5	4	2	9	3	1	54	6th
Scherebra alata	10	8	9	7	10	10	3	1	10	2	70	1st

N.B. Scores in the table indicate ranks given to medicinal plants based on their efficacy. Highest number (10) given for the medicinal plant which informants thought was most effective in treating tooth ache and the lowest number (0) for the least effective plant selected currently for this ranking purpose from numerous medicinal plants used to treat this disease.

4.5.9. Identification of multipurpose medicinal plants for their conservation priority

The result of direct matrix ranking exercise on the selected medicinal plants used for treating human ailments enabled to identify which of the multipurpose plants is under greater pressure than other species in the area besides the respective factors that threaten the plants (Table 16).

Table 16. Average direct matrix ranking score of ten key informants for ten medicinal plant species with additional uses

Medicinal plant species	Use categories					Total	Rank
	Ch	Co	Fr &Tl	Fw	Md		
Allophylus abyssinicus	3	3	0	3	2	11	8th
Combretum molle	5	3	2	3	2	15	4th
Ehretia cymosa	2	1	0	3	2	8	10th
Fagaropsis angolensis	3	5	2	4	2	16	3rd
Olea europaea subsp. *cuspidata*	3	3	3	5	4	18	2nd
Pappea capensis	1	3	2	3	3	12	7th
Podocarpus falcatus	1	1	2	4	1	9	9th
Schrebera alata	1	3	3	4	3	14	5th
Terminalia brownii	3	2	2	4	2	13	6th
Warburgia ugandensis	4	5	4	3	4	20	1st
Total	26	29	20	36	25	136	
Rank	3rd	2nd	5th	1st	4th		

Where, Ch = Charcoal, Co = Construction, Fr & Tl = Furniture and Tools, Fw = Firewood and Md = Medicinal

4.5.10. Consensuses on themost frequently used medicinal plants used for treating human ailments in the study area

This study clarified that some medicinal plants are well known in the study area than others. As a result, all key informants cited such plants repeatedly as a remedy of various diseases of humans. For example, *Ocimum urticifolium* and *Warburgia ugandensis* were cited by all (100%) key informants as sources of remedy for febrile illness and internal organ cancer respectively. *Combretum molle* and *Withania somnifera* were also cited by 49 (98%) key informants as sources of remedy for parasitic worms and snake venom respectively (Table 17).

Table 17. Key informants consensus on most commonly used medicinal plants

Botanical name of medicinal plants	**Disease treated**	**No. of informants**	**%**
Asparagus africanus	Breast disease	44	88
Clerodendrum myricoides	Gonorrhea	48	96
Combretum molle	Parasitic worms	49	98
Fagaropsis angolensis	Coughing	46	92
Ocimum urticifolium	Febrile illness	50	**100**
Pappea capensis	Hepatitis	47	94
Rhus vulgaris	Itching	45	90
Schrebera alata	Tooth cancer	48	96
Warburgia ugandensis	Internal organ cancer	50	**100**
Withania somnifera	Snake venom	49	98

4.5.11. Effectiveness of medicinal plants

Informant consensus means agreement among informants**.** Selecting traditional medicinal plants by using informant consensus was used to evaluate the reliability of the data. To simplify the analysis twelve disease categories were designated from the total 49 human ailments reported in the district and ICF values were computed based on the reported medicinal plant species and their use citations for each disease category and the following results were obtained (Table 18).

Table 18. ICF values of traditional medicinal plants used for treating human ailments in Dugda Dawa District

No.	**Disease category**	**No. of spp.**	**% all spp.**	**Use citation**	**% all use citation**	**ICF**
1	Dental, oral and pharyngeal	27	33.3	29	9.9	0.07
2	Dermatological	16	19. 8	17	5.8	0.06
3	Diabetics, hepatitis and hypertension	12	14.8	13	4.4	0.08
4	Evil spirit	7	8.6	8	2.7	0.14

5	External injuries and snake bite	23	28.4	24	8.2	0.04
6	Febrile	6	7.4	8	2.7	0.29
7	Gastro - intestinal and internal parasites	43	53.1	56	19.0	0.24
8	Musculoskeletal and nervous system	5	6.2	60	20.4	**0.93**
9	Respiratory	5	6.2	6	2.0	0.20
10	Sensorial	13	16.0	14	4.8	0.08
11	Tissue cancer and cold disease	29	35.8	34	11.6	0.15
12	Urogenital and venereal	19	23.5	25	8.5	0.25

4.5.12. Relative healing potential of medicinal plants used for treating human ailments

Fidelity level values of medicinal plants commonly reported against a given human ailment category was computed to know healing potential of the reported medicinal plants against the corresponding diseases and the following results were obtained (Table 19).

Table 19. Fidelity level values of medicinal plants commonly reported against a given human ailment category

No	**Medicinal plant**	**Therapeutic category**	**Ip**	**Iu**	**FL (%)**
1	*Carica papaya*	Diabetics, hepatitis and hypertension	11	14	79
2	*Clerodendrum myricoides*	Urogenital and venereal	20	21	95
3	*Combretum molle*	Gastro - intestinal and internal parasites	14	16	88
4	*Fagaropsis angolensis*	Respiratory	12	15	80
5	*Ocimum urticifolium*	Febrile	35	36	**97**
6	*Pappea capensis*	External injuries and snake bite	16	19	84
7	*Rhus vulgaris*	Dermatological	10	12	83
8	*Schrebera alata*	Dental, oral and pharyngeal	13	15	87
9	*Warburgia ugandensis*	Tissue cancer and cold disease	18	19	95
10	*Withania somnifera*	Evil spirit	23	24	96

Legend: FL= Fidelity Level, Ip = number of informants who independently cited the importance of a species for treating a particular disease, Iu = total number of informants who reported the plant for any given disease

4.5.13. Use diversity of medicinal plants used for humans

All the 81 medicinal plant species recorded for human ailments treatment in the district were cited for one or more uses other than their medicinal role. The proportion of medicinal plant species over different use categories is summarized in Figure 20.

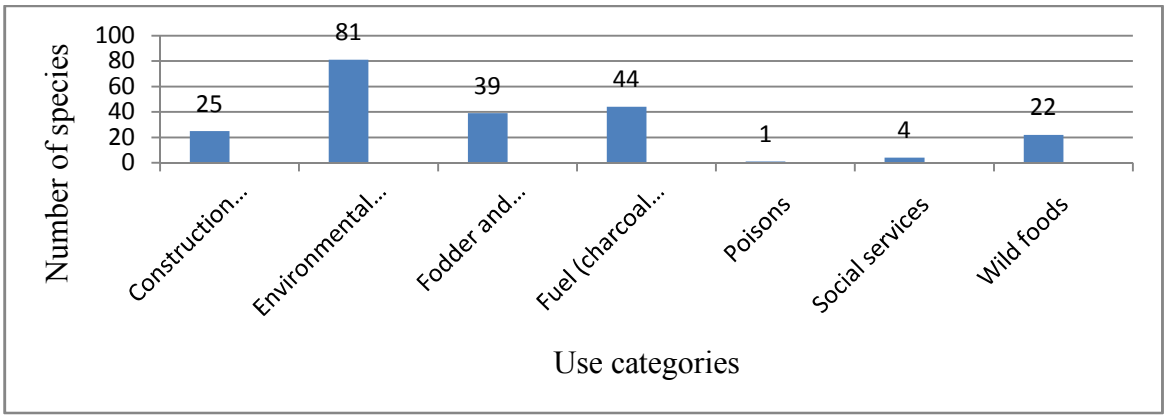

Figure 20. Proportion of human medicinal plants in Dugda Dawa District over different use categories

4.5.14. Medicinal use values of selected plant species

Traditional medicinal uses of 81 different medicinal plant species against a number of human ailments were compiled. Investigation of their use value indicated that some of these plants show high medicinal use value (UVmed) as indicated in Table 20.

Table 20. Medicinal use values (UVmed) of most-cited human medicinal plants in Dugda Dawa District

Medicinal plant species	**No. informants citing the species**	**Total citations**	**No. of ailments treated with**	**UVmed.**
Acmella caulirhiza	110	605	4	5.5
Carissa spinarum	118	980	5	8.3
Clematis hirsuta var. *hirsuta*	92	589	5	6.4
Clitoria ternatea var. *ternatea*	80	402	4	5.0
Ehretia cymosa	120	912	7	7.6
Fagaropsis angolensis	104	676	6	6.5
Pappea capensis	140	1232	8	8.8

N.B. UVmed= Medicinal use value

4.6. Ethnoveterinary plants

4.6.1. Medicinal plant diversity used only for ethnoveterinary purposes in Dugda Dawa District

A total of 24 ethnoveterinary medicinal plant species representing 24 genera and 17 families were identified in the district (Appendix 7). About 21% of the families (five families) were represented by more than one species. The highest number of species was recorded for

Asteraceae (4 species, 16.7%), followed by Acanthaceae, Anacardiaceae, Lamiaceae and Vitaceae (2 species, about 8.3% each). The remaining 19 (79.2%) families had single-species representation. About 8.3% (two species) of the ethnoveterinary medicinal plants of Dugda Dawa District were endemic to Ethiopia. Concerning the growth forms of plants used for livestock treatment, there were more climbers (8 species, 33.3%), followed by shrubs and herbs (5 species, 20.8% each), trees (4 species, 16.7%), sedge and epiphyte (one species, 4.2% each). All the documented ethnoveterinary plant species were harvested from the wild and overgrazing, deforestation; charcoal making and firewood collection were claimed as major factors affecting the ethnoveterinary plant species of the study area.

4. 6.2. Livestock ailments and their prevalence

A total of 35 veterinary ailment types were identified in the study area for which informants reported to use one or more medicinal plant species (Appendix 7). Twelve (34.3%) veterinary ailments types belong to diseases of the breathing system, followed by gastro - intestinal diseases (8, 22.9%), and black leg, hepatitis and FMD (Foot and mouth diseases) (7, 20%) disease categories. Diarrhea and breathing problems were found to be the most commonly reported types of livestock ailments in the district.

4.6.3. Applications of ethnoveterinary remedies

Even if ethnoveterinary medicinal plants of the district are asserted to be applied for ailments affecting chicken, sheep/goats, cattle, equines or camels, the majority of the reported medicinal plant species (21, 87.5%) were found to be applied to treat one or more of the fourteen different cattle ailments (Appendix 7). Eight (33.3%) species were mentioned to be used specifically against ailments of goats/sheep and camels respectively (Figure 21).

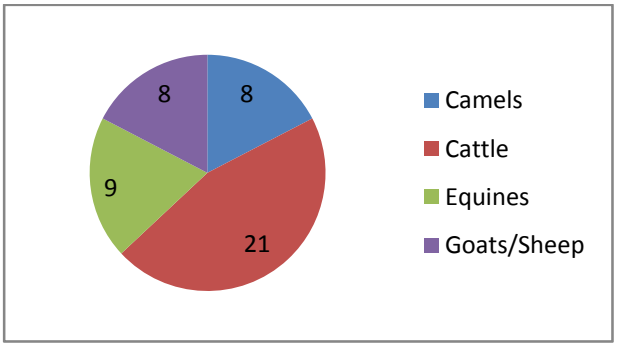

Figure 21. Number of ethnoveterinary plant species used for different livestock types in Dugda Dawa District

4.6.4. Medicinal plant parts used for ethnoveterinary remedy preparation

Regardless of different plant parts reported to be used for remedy preparation by the community, greater proportion (44.1%) of the preparations was found to be from leaves alone, followed by barks (14.7%) and from roots and mixtures of leaves (8.8%) and stems alone (5.9%) (Figure 22). Plants in which seeds, flower, mixtures of stem with bark, bark with leaves, bark with bark and leaves with stem were also frequent (totally cover about 17.4%) in the ethnoveterinary plant tradition of the district. All remedies (100%) were prepared from freshly harvested plant parts.

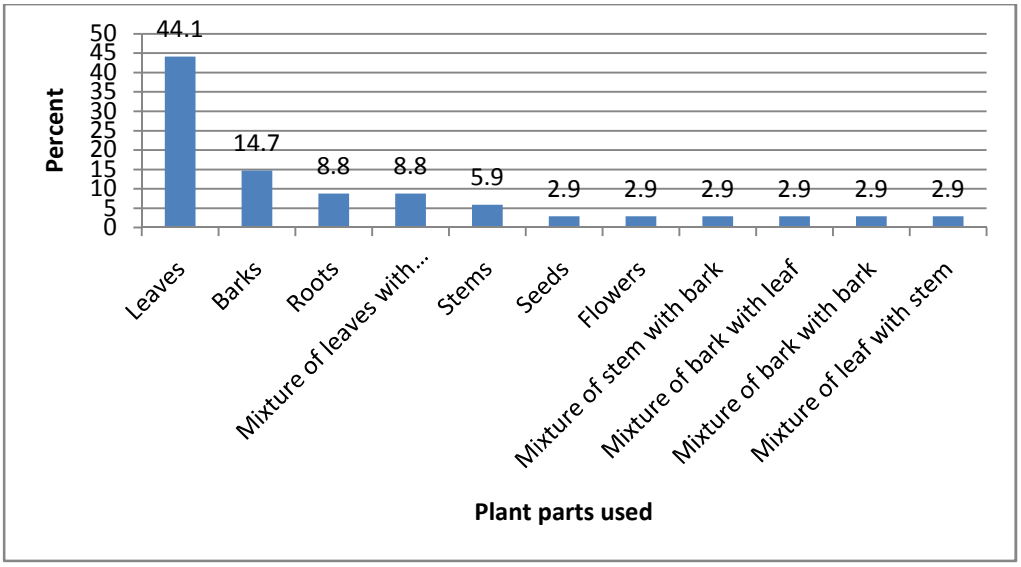

Figure 22. Plant parts used for ethnoveterinary remedy preparation in Dugda Dawa District

4.6.5. Approach of remedy preparation, routes of administeration and dosages

Different modes of ethnoveterinary remedy preparation were reported to be used in the district based on type and degree of complexity of livestock ailment. Pounding/chopping/crushing the remedial part and homogenizing it with cold water was found to be the major mode of remedy preparation (93.1%) and unprocessed forms cover only 6.9% (Figure 23).

Traditional plant preparations were reported to be given through oral, dermal, or nasal routes. Oral application was the most-cited route of administeration (20 preparations, 66.7 %), followed by nasal (six preparations, 20%), and dermal (four preparations, 13.3%) routes. Physical appearance of the diseased animal and visually confirmed degree of complexity of illness are used to determine the doses of the remedy prepared to treat livestock ailments. Some traditional practitioners reported use of coffee cup, water glasses and bottles to determine dosage for some

medicinal preparations, while others reported to use a handful or full of a small dish unprocessed parts to treat ailments. However, no standardised doses of herbal preparations were reported by traditional practitioners for any of the remedies used to treat livestock ailments in Dugda Dawa District.

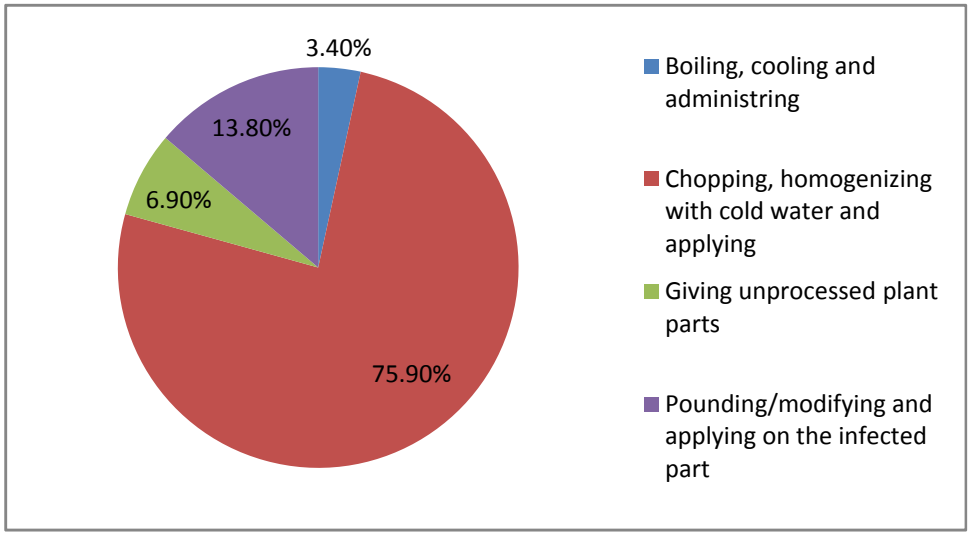

Figure23. Forms of remedy preparation and administeration for treating livestock ailments in Dudga Dawa District

4.6.6. Most preferred ethnoveterinary plants

Preference ranking exercise with 10 key informants for medicinal plants that were reported to be used against breathing system diseases showed that *Clematis simensis* and *Viscum congolense* were the most preferred species to treat the reported diseases (Table 21).

Table 21. Results of preference ranking exercise of medicinal plants reported for treating breathing system diseases of livestock

Plant spp. treating breathing system diseases of livestock	**Informants designated A to J**										**Total score**	**Rank**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**		
Ammocharis tinneana	4	3	4	5	5	6	7	6	5	5	50	7th
Clematis simensis	6	8	7	8	6	5	8	6	7	8	69	1st
Heteromorpha arborescens	7	6	8	5	4	6	5	3	6	7	57	5th
Lannea rivae	8	6	5	7	6	4	6	7	5	6	60	3rd
Leucas abyssinica	5	4	4	6	5	3	4	5	6	3	45	8th

Phytolacca dodecandra	6	5	5	6	7	4	5	6	3	6	53	6th
Senecio hadiensis	7	8	6	7	5	8	6	4	4	4	59	4th
Viscum congolense	8	7	6	8	5	4	6	5	7	6	62	2nd

N.B. Scores in the table indicate ranks given to medicinal plants based on their efficacy (highest number (8) was given for the medicinal plant which informants thought most effective in treating breathing system diseases and the lowest number (3) was given for the least effective plant.

4.6.7. Multipurpose medicinal plants used for livestock ailments and their conservation status

The output of average direct matrix ranking score of ten key informants for five medicinal plant species with six use diversities indicated that some multipurpose medicinal plant species are currently exploited more for firewood, charcoal, and construction purposes than for their medicinal uses (Table 22).

Table 22. Average direct matrix ranking score of ten key informants for five medicinal plant species with six use diversities

Medicinal plant species	**Use categories**						**Total**	**Rank**
	Ch	**Co**	**Fr &Tl**	**Fw**	**Md**	**We**		
Combretum collinum	5	2	2	5	3	0	17	3rd
Dichrostachys cinerea	5	4	1	3	3	0	16	4th
Lannea rivae	2	2	1	3	3	2	13	5th
Prunus africana	4	5	4	5	5	0	23	1st
Syzygium guineense var. *guineense*	3	5	3	5	3	3	22	2nd
Total	19	18	11	21	17	5	91	
Rank	2nd	3rd	5th	1st	4th	6th		

Where, Ch = Charcoal, Co = Construction, Fr & Tl = Furniture and Tools, Fw = Firewood, Md = Medicinal and We = Wild edible

4.6.8. Informant consensus on most frequently used medicinal plants used for treating livestock ailments in the study area

This study clarified that some medicinal plants are well known in the study area than others. As a result, all key informants cited such plants repeatedly as a remedy of various diseases of livestock. For example, *Cyphostemma serpens* and *Syzygium guineense* were cited by all (100%) key informants as sources of remedy for foot and mouth disease and leech infection respectively.

Dichrostachys cinerea and *Viscum congolense* were also cited by 49 (98%) key informants as sources of remedy for hepatitis and shivering and abnormal breathing respectively (Table 23).

Table 23. Informant Consensus on most commonly used medicinal plants

Botanical name of medicinal plants	Disease treated	No. of informants	%
Cissus quadrangularis	Black leg	48	96
Cyphostemma serpens	Foot and Mouth Disease	50	100
Dichrostachys cinerea	Hepatitis	49	98
Microglossa pyrifolia	Dermal wound	48	96
Prunus africana	Coughing in cattle	47	94
Syzygium guineense	Leech infection	50	100
Tragia cinerea	Diarrhea	48	96
Viscum congolense	Shivering and abnormal breathing	49	98

4.6.9. Effectiveness of ethnoveterinary medicinal plants

Five main livestock ailment categories were identified from the total of 35 veterinary diseases reported in the District. The highest Informants' Consensus Factor (ICF) values were recorded for breathing system diseases (0.90), dermatological diseases (0.87), black leg, hepatitis and FMD (0.83) and gastro - intestinal disease (0.82) categories (Table 24). Hence, the highest plant use citation (30%) was recorded for breathing system diseases.

Table 24. ICF values of traditional medicinal plants used for treating livestock ailments in Dugda Dawa District

No	Disease category	No. of species	% of all species	Use citations	% of use citations	ICF
1	Breathing system diseases	5	20.8	42	30.0	**0.90**
2	Gastro - intestinal diseases	8	33.3	40	28.6	0.82
3	Black leg, hepatitis and FMD	5	20.8	24	17.1	0.83
4	Dermatological diseases	3	12.5	16	11.4	0.87
5	Muscular - nervous system diseases	7	29.2	10	7.1	0.33
6	Tooth ache, leech infection and cold	4	16.7	8	5.7	0.57

4.6.10. Comparative healing potential of ethnoveterinary medicinal plants

Cyphostemma serpens revealed the highest fidelity level value (97%) for black leg, hepatitis and FMD disease category, followed by *Viscum congolense* (96%) for breathing system diseases. In the dermatological therapeutic category, the highest fidelity level value was recorded for *Prunus*

africana (92%). *Ozoroa insignis* (87%) also showed relatively high healing potential under the muscular - nervous system diseases category (Table 25).

Table 25. Fidelity level values of medicinal plants commonly reported against certain livestock ailment category

No.	Medicinal plant	Healing category	Np	N	FL value (%)
1	*Cyphostemma serpens*	Black leg, hepatitis and FMD	32	33	**97.00**
2	*Viscum congolense*	Breathing system diseases	22	23	96.00
3	*Prunus africana*	Dermatological diseases	24	26	92.00
4	*Ozoroa insignis*	Muscular -nervous system diseases	26	30	87.00
5	*Tragia cinerea*	Gastro - intestinal diseases	20	24	83.00
6	*Syzygium guineense*	Tooth ache, leech infection and cold	12	16	75.00

N.B. FL= Fidelity Level, Np = number of informants who independently cited the importance of a species for treating a particular disease, N = total number of informants who reported the plant for any given disease

4.6.11. Use diversity of medicinal plants used for livestock

All the 24 medicinal plant species recorded for livestock ailments treatment in the district were cited for one or more uses other than their medicinal role. The proportion of medicinal plant species over different use categories is summarized in Figure 24.

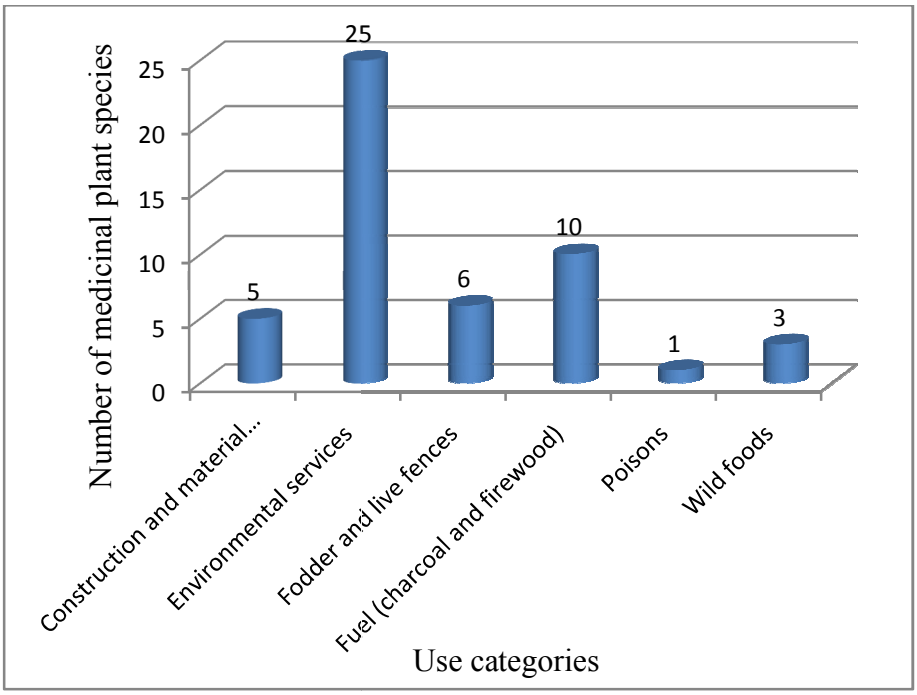

Figure 24. Proportion of livestock medicinal plants in Dugda Dawa District over different use categories

4.6.12. Medicinal use values of selected ethnoveterinary plants

Traditional medicinal uses of 24 different medicinal plant species against a number of livestock ailments were compiled. Of these species, the highest medicinal use values (UVmed) were recorded for *Lannea rivae* (8.0), *Dichrostachys cinerea* (7.8), and *Ozoroa insignis (*6.6) (Table 26).

Table 26. Medicinal use values of selected ethnoveterinary plants

Medicinal plant species	**No. informants citing the species**	**Total citations**	**No. of ailments treated with**	**UVmed.**
Cyphostemma serpens	84	504	2	6.0
Dichrostachys cinerea	96	749	2	7.8
Lannea rivae	118	944	2	8.0
Ozoroa insignis	102	673	2	6.6
Solanum coagulans	68	374	2	5.5

N.B. UVmed = Medicinal use value

4.7. Ethnobotanical study of medicinal plants used for treating both human and livestock ailments in Dugda Dawa District

4.7.1. Diversity of medicinal plants used for both humans and livestock

A total of 22 medicinal plant species representing 20 genera and 14 families which are used for both humans and livestock were identified in the district (Appendix 8). About 38.5% of the families (five families) were represented by more than one species. The families with more species (three) were Euphorbiaceae, Rubiaceae and Rutaceae followed by Apiaceae and Solanaceae (two species each). The remaining nine families were represented by single-species. Regarding the growth forms of these medicinal plants, there were more shrubs (ten species, 45.3%), followed by trees (six species, 27.3%), herbs (four species, 18.2%), succulent and sedge (one species, 4.5% each). About 90.9% (20 species) of the documented common medicinal plant species were harvested from the wild, whereas 9.1% (two species) were cultivated. A representative of wild species is shown in Figure 25. Factors such as overgrazing, deforestation, charcoal making, firewood collection, and agricultural expansion were claimed as major factors affecting these medicinal plant species.

Figure 25. *Acokanthera schimperi* - Apocyanaceae (traditional medicinal plant used by the community to treat human and livestock ailments and a wild edible fruit in the study area)

4.7.2. Ailments treated with medicinal plants used for both humans and livestock

A total of 33 human and 27 veterinary ailment types were identified for which informants reported to use one or more medicinal plant species to treat them (Appendix 8). Seven ailment types (21.2%) in humans and six ailment types (22.2%) in livestock belong to the gastro - intestinal and internal parasite disease category, followed by urogenital diseases in humans (five ailments, 15.2%) and tissue cancer and cold diseases in livestock (four ailments, 14.8%) disease categories. Diarrhea and tooth ache in humans and coughing in livestock were found to be the most commonly reported form of ailments in the district. Healers treat these ailments based on observation, and/or information obtained by interviewing the patient or livestock owners about major symptoms shown by the diseased animals. Chewing medicinal parts and/or applying pounded remedies on the infected tooth and oral administration of homogenized herbal preparations for diarrhea and coughing were reported as the main treatment methods.

4.7.3. Composition and application of remedies for both humans and livestock

Remedial plants used to treat both human and livestock ailments are equally important for both groups of animals. The majority of human and livestock medications (78.3%) were reported to comprise of a single medicinal plant. The remaining 21.7% were prepared using formulations from two or more species. Amongst all plants reported, the highest proportion of species was claimed to treat tooth ache and diarrhea/stomach ache (40.9%, nine species each), followed by breathing problems (22.7%, five species). The highest number of multiple medicinal uses was recorded for *Croton macrostachyus* (used against 13 ailment types), followed by *Aloe trichosantha, Calpurnia aurea* and *Teclea salicifolia* (each used against five ailment types) (Appendix 8).

4.7.4. Medicinal plant parts used for both human and ethnoveterinary remedy preparation

Though different plant parts were reported to be used for remedy preparation by the community, 30.2% of the preparations were found to be from leaves alone, followed by roots (20.9%) and barks (13.9%) and all other parts of medicinal plants contributed about 35% (Figure 26). Of these remedies 92.1% were prepared from freshly harvested plant parts, whereas 7.9% were from dried forms.

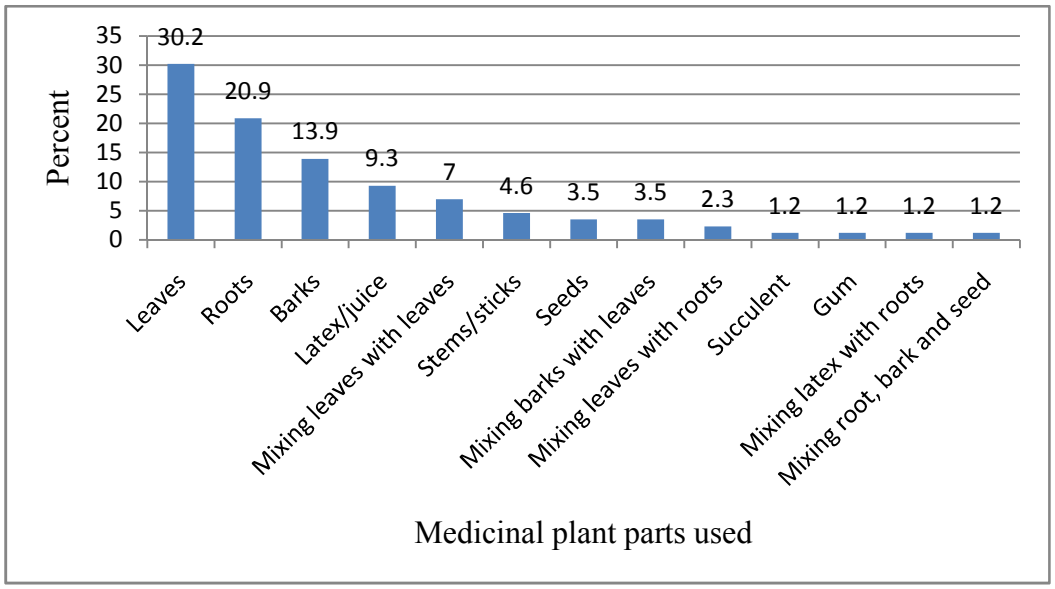

Figure 26. Plant parts used for both human and livestock remedy preparation in Dugda Dawa District

4.7.5. Mode of remedy preparation, routes of administration and dosages

Diverse modes of medicine preparation were reported to be used in the district for both humans and livestock based on type and degree of complexity of ailments. Pounding the remedial part and homogenizing it with cold water was found to be the major mode of remedy preparation (58.2%) followed by homogenized, boiled and cooled preparation (17.7%) and unprocessed forms (16.5%), whereas pounding and applying directly cover only 7.6% (Figure 27).

Oral application was the most cited route of administration (67 preparations, 77 %), followed by dermal (15 preparations, 17.2%), nasal (three preparations, 3.4%) aural and ocular (one preparation, 1.2% each). Physical observation and information from the patient or the owner of diseased animal are used to determine doses to treat both humans and livestock ailments. Traditional practitioners reported use of coffee cup, water glasses and bottles to determine dosage for some medicinal preparations, while others reported to use a handful or full of a small dish unprocessed parts to treat ailments. No standardized doses of herbal preparations were reported by traditional healers for any of the preparations used to treat both human and livestock ailments in Dugda Dawa District.

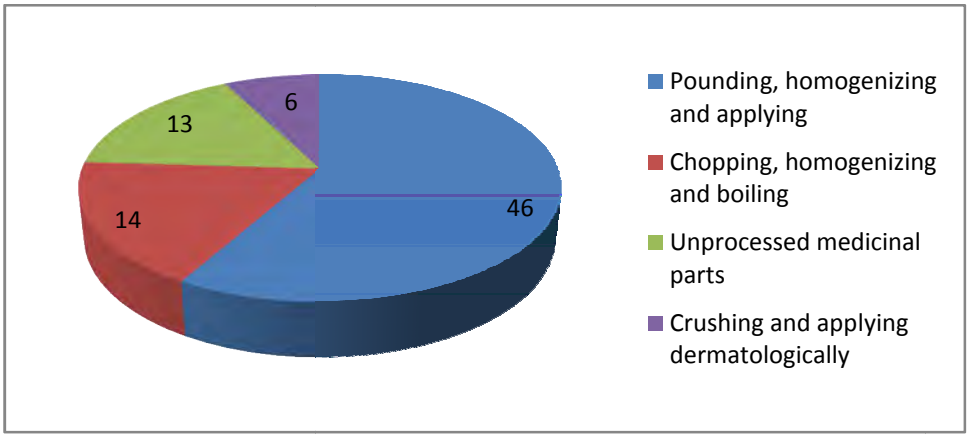

Figure 27. Amounts of remedy preparation and forms of administration of traditional medicines for treating both human and livestock ailments in Dudga Dawa District

4.7.6. Preferences of medicinal plants used for both humans and livestock

Preference ranking exercise with 10 key informants taken randomly for medicinal plants that were reported to be used against hepatitis showed that *Vangueria apiculata* and *Croton macrostachyus* were the most preferred species to treat the reported diseases (Table 27).

Table 27. Results of preference ranking exercise of medicinal plants reported for treating hepatitis in both humans and livestock

Plant species treating Hepatitis in humans and livestock	**Informants designated A to J**										**Total score**	**Rank**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**		
Aloe trichosantha	3	5	4	2	3	1	4	2	5	1	30	5th
Calpurnia aurea	5	3	4	4	4	3	5	3	4	4	39	4th
Croton macrostachyus	4	5	4	4	5	4	5	3	4	3	41	2nd
Teclea salicifolia	5	4	3	3	4	5	4	3	5	4	40	3rd
Vangueria apiculata	3	4	4	5	5	5	4	4	5	4	43	1st

4.7.7. Conservation status of multipurpose medicinal plants used for both humans and livestock

Five multipurpose medicinal plant species were selected out of the 22 identified medicinal plants for direct matrix ranking as mentioned by the informants. Six use diversities of these plants were listed for ten randomly selected key informants to assess their use diversity in their respective localities. The result of this ranking exercise on the selected medicinal plants used for treating both human and livestock ailments enabled to identify which of the multipurpose plants is under greater pressure than other species in the area besides the respective factors that threaten the plants (Table 28). Accordingly, *Calpurnia aurea* was ranked first (most - threatened) followed

by *Balanites aegyptiaca*. The output indicated that these multipurpose medicinal plant species are currently exploited more for firewood and charcoal purposes than for their medicinal uses.

Table 28. Average direct matrix ranking score of ten key informants for five medicinal plant species with additional uses

Medicinal plant species	**Use categories**						**Total**	**Rank**
	Ch	**Co**	**Fr &Tl**	**Fw**	**Md**	**We**		
Balanites aegyptiaca	4	3	2	4	2	3	18	2nd
Calpurnia aurea	4	4	2	5	4	0	19	1st
Croton macrostachyus	2	2	3	4	3	0	14	3rd
Zanthoxylum chalybeum	2	1	2	2	2	2	11	5th
Ziziphus abyssinica	2	2	2	2	2	2	12	4th
Total	14	12	11	17	13	7	74	
Rank	2nd	4th	5th	1st	3rd	6th		

Where, Ch = Charcoal, Co = Construction, Fr & Tl = Furniture and Tools, Fw = Firewood

Md = Medicinal and We = Wild edible

4.7.8. Informant consensuses on most frequently used medicinal plants of both humans and livestock in the study area

This study clarified that some medicinal plants are well known in the study area than others. As a result, all key informants cited such plants repeatedly as a remedy of various diseases of humans and livestock. For example, *Datura stramonium* was cited by 46 (92%) of informants as a source of remedy for rabies and *Croton macrostachyus* was cited by 45 (90%) of informants as a source of remedy for hepatitis (Table 29).

Table 29. Informant consensus on most commonly used medicinal plants of both humans and livestock

Botanical name of medicinal plants	**Disease treated**	**No. of informants**	**%**
Acokanthera schimperi	Itching	44	88
Aloe trichosantha	Skin cancer and wound	42	84
Balanites aegyptiaca	Breast cancer	40	80
Calpurnia aurea	Hepatitis	42	84
Croton macrostachyus	Hepatitis	45	90
Datura stramonium	Rabies	46	92
Euphorbia ampliphylIa	Reproduction organ infection	38	76
Solanum dennekense	Tissue cancer	42	84
Teclea borenensis	Bloody diarrhea	38	76
Vangueria apiculata	Liver disease	43	86

4.7.9. Efficacy of medicinal plants used for both humans and livestock

Six main ailment categories which are common to humans and livestock were identified from the total 60 diseases of the two groups reported in the district. The highest Informants' Consensus Factor (ICF) values were recorded for gastro - intestinal and internal parasites (0.83), urogenital diseases (0.82), and dermatological diseases (0.81) categories (Table 30). In addition, the highest plant use citation (27.7%) was recorded for gastro - intestinal and internal parasites.

Table 30. ICF values of traditional medicinal plants used for treating both human and livestock ailments in Dugda Dawa District

No.	Disease category	No. of species	% of all species	Use citation	% of use citations	ICF
1	Gastro - intestinal and internal parasites	12	54.5	66	27.7	**0.83**
2	Urogenital diseases	9	40.9	46	19.3	0.82
3	Dermatological diseases	6	27.3	28	11.8	0.81
4	Tissue cancer and cold	9	40.9	42	17.7	0.80
5	Hepatitis, muscular - nervous system and snake bite	11	50.0	45	18.9	0.77
6	Sensorial diseases	4	18.2	11	4.6	0.70

4.7.10. Comparative healing potential of medicinal plants used for both humans and livestock

Solanum dennekense showed the highest fidelity level value (93%) for tissue cancer and cold disease category, followed by *Croton macrostachyus* (92%) for urogenital diseases. In the dermatological therapeutic category, the highest fidelity level value was recorded for *Aloe trichosantha* (90%). *Teclea borenensis* (87%) also showed relatively high healing potential under gastro - intestinal and internal parasites diseases category (Table 31).

Table 31. Fidelity level values of medicinal plants reported against common human and livestock ailment category

No.	Medicinal plant	Remedial category	Np	N	FL value (%)
1	*Solanum dennekense*	Tissue cancer and cold	14	15	**93**
2	*Croton macrostachyus*	Urogenital diseases	24	26	92
3	*Aloe trichosantha*	Dermatological diseases	18	20	90
4	*Teclea borenensis*	Gastro - intestinal and internal parasites	21	24	87
5	*Vangueria apiculata*	Hepatitis, muscular - nervous system and snake bite	11	13	85
6	*Calpurnia aurea*	Sensorial diseases	12	18	67

N.B. FL= Fidelity Level, Np = number of informants who independently cited the importance of a species for treating a particular disease, N = total number of informants who reported the plant for any given disease.

4.7.11. Use diversity of medicinal plants used for both human and livestock

All the 22 medicinal plant species recorded for both human and livestock ailments treatment in the district were cited for one or more uses other than their medicinal role. The proportion of medicinal plant species over different use categories is summarized in Figure 28.

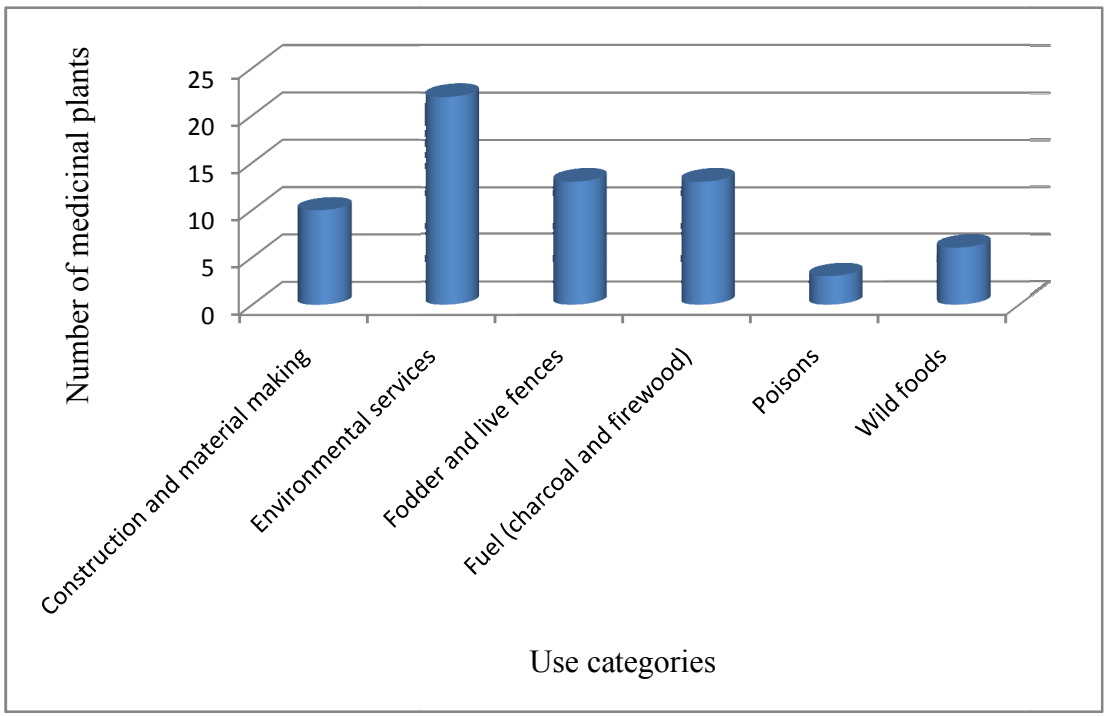

Figure 28. Proportion of medicinal plants for both humans and livestock in Dugda Dawa District over different use categories

4.7.12. Medicinal use values of selected medicinal plant species used for treating both human and livestock ailments

Of the traditional medicinal plant species used against human and livestock ailments, the highest medicinal use values (UVmed) were recorded for *Croton macrostachyus* (9.2), *Calpurnia aurea* (8.5), and *Zanthoxylum chalybeum* (8.2) (Table 32).

Table 32. Medicinal use values (UVmed) of most cited remedial plants in Dugda Dawa District

Medicinal plant species	No. of informants citing the species	Total citations	No. of ailments treated with	UVmed.
Croton macrostachyus	160	1472	13	9.2
Calpurnia aurea	142	1207	6	8.5
Zanthoxylum chalybeum	124	1017	6	8.2
Teclea salicifolia	130	1014	6	7.8
Teclea borenensis	112	829	6	7.4
Aloe trichosantha	116	754	6	6.5
Solanum dennekense	96	596	5	6.2

N.B. UVmed= Medicinal use value

4.7.13. Solvent and additives used in traditional herbal medicines preparation in the study area

Almost in all ethno formulations of traditional medicines, water served as 'solvent' whenever dilution is required. Different additives are incorporated in 23.4% of the whole ethno formulations and magado salt (locally produced salt) is the most commonly used additive (Figure 29).

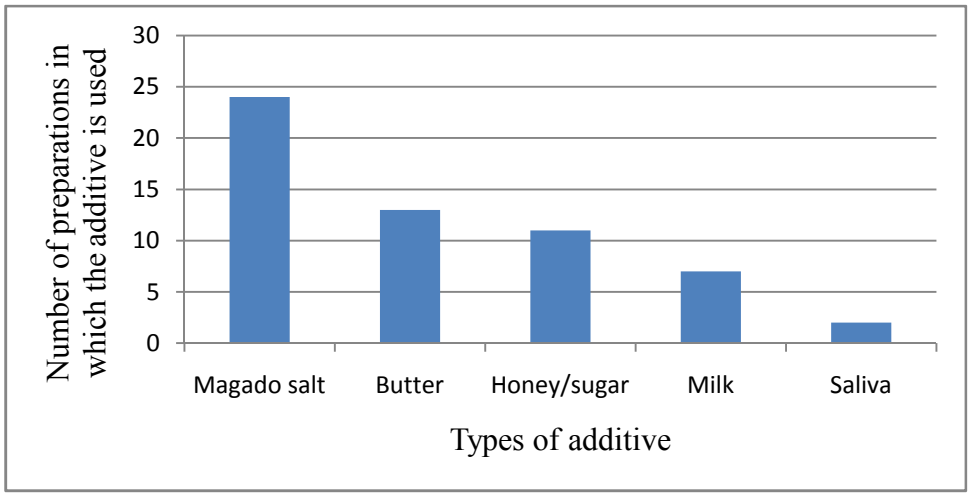

Figure 29. Additives used in traditional herbal remedy preparation in the study area

4.8. Distribution of indigenous knowledge on medicinal plants among different social groups in the community of the study area

Although more medicinal plants were reported by men (290) than women (102), the difference was not significant (P >0.05) when the average number of medicinal plants mentioned by each group was compared. There was no significant difference seen in the number of medicinal plants listed by informants living around health centers and those living relatively far away from these

health centers. However, there was a significant difference (P< 0.05) in the number of medicinal plants reported by senior members of the community (> 40 years old) and young- to middle-aged members (< 40 years old); key informants and randomly taken informants, illiterate and literate informants (Table 33). More number of medicinal plants was reported by elders (> 40 years old), illiterates, and key informants than by young, literates, and randomly taken informants.

Table 33. Statistical test of significance on average number of medicinal plants among different informant groups in Dugda Dawa District

Considerations	Informant groups	N	Average ± SD	t -value**	p –value
Gender	Males	290	6.62 ± 2.65	1.97	0.97
	Females	102	6.05 ± 2.18		
Age	Youngsters	208	5.16 ± 2.07	-12.87	0.00*
	Elders	184	7.96 ± 2.19		
Literacy	Illiterates	292	7.22 ± 2.31	12.92	0.00*
	Literates	100	4.28 ± 1.82		
Proximity to health center	Near to health center	22	6.00 ± 2.37	-0.94	0.36
	Far away from health center	370	6.5 ± 2.57		
Informant category	Key informants	50	10.76 ± 1.09	25.75	0.00*
	Randomly taken informants	342	5.85 ± 2.04		

*Significant difference (p<0.05); ** t(0.05) (two tailed), degree of freedom (df) = 223,

N= number of respondents

4.9. Ethnobotany of wild edible plants in Dugda Dawa District

4.9.1. Taxonomic diversity of wild edible plants

Out of the total collected plant species, 71 wild edible plant species that belong to 52 genera and 37 angiosperm families (two monocots and 35 dicots) were reported in the district. Concerning their source only *Moringa stenopetala* was semi-wild where as the remaining 70 species were collected from the wild. Regarding their growth forms, 26 species (36.6%) were trees, 26 species (36.6%) were shrubs, five species (7%) were lianas, 13 species (18.3%) were herbs, one species (1.4%) was climbing herb. Of all the families, Fabaceae and Anacardiaceae were the most dominant with seven species (9.9% each) and followed by Burseraceae and Rubiaceae with five

species (7% each). Moraceae, Myrtaceae, Sapindaceae, and Tiliaceae were with three species (4.2% each). Six families were with two species and the remaining 23 families were with single species (Appendix 9).

4.9.2. Distribution of wild edible plant species across plant communities in Dugda Dawa District vegetation

Out of the four identified plant communities in the study area, community three contains the highest number of wild edible plant species (41 species) followed by community two which contains 28 species. Species richness, diversity, and evenness values of each community are presented in Table 34.

Table 34. Wild edible plant species richness, diversity and evenness values of plant communities in Dugda Dawa District vegetation

Community type	Wild edible plant richness	Shannon - Wiener diversity index (H') of wild edible plants	H' max (lns)	Evenness (H'/H' max) of wild edible plants
1	17	2.57	5.48	0.47
2	28	3.02	6.38	0.47
3	41	3.22	6.86	0.47
4	18	2.67	5.86	0.46

4.9.3. The role of wild edible plants in household food security and food use categories

Out of the total wild edibles, 78.9% of the species were said to be used to fill the gap of seasonal food shortage, 14.1% of the species during famine, and 7% of the species during periods of ample food production to supplement the staple diet, (Figure 30).

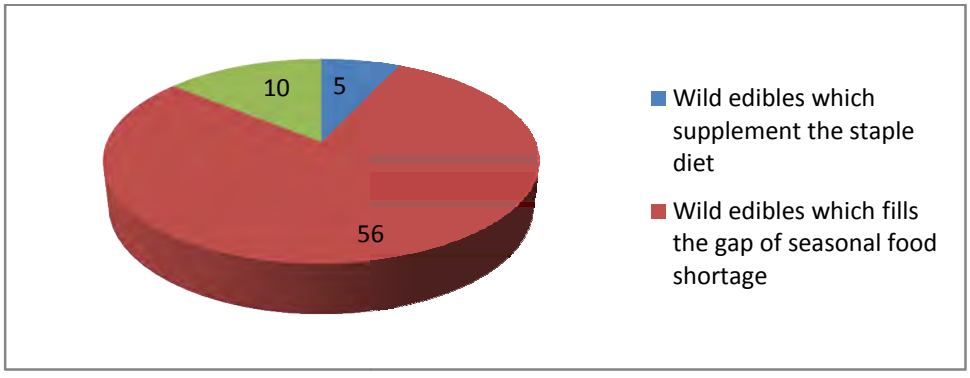

Figure 30. Food use categories of wild edible plant species in Dugda Dawa District

4.9.4. Distribution of indigenous knowledge on wild edible plants among the different social group in the local community

Although more wild edible plants were reported by women (17.12 per individual in average) than men (16.99 per individual in average), the difference was not significant (P >0.05) when the average number of wild edible plants reported by each group was compared. There was no significant difference observed in the number of wild edible plants listed by illiterates and literates informants as well as between informants near to and far away from the center. However, there was a significant difference (P< 0.05) in the number of wild edible plants reported by elders (> 36 years old) and youngsters (< 37 years old); key informants and randomly taken informants (Table 35). More number of wild edible plants was reported by youngsters (< 37 years old) and key informants.

Table 35. Statistical test of significance on average number of wild edible plants among different informant groups in Dugda Dawa District

Considerations	Informant groups	N	Average ± SD	t -value**	p –value
Gender	Males	79	16.99 ± 2.89	- 0.27	0.79
	Females	51	17.12 ± 2.49		
Age	Youngsters	99	17.36 ± 2.64	2.36	0.02*
	Elders	31	16.00 ± 2.81		
Literacy	Illiterates	68	16.60 ± 2.72	-1.53	0.13
	Literates	62	17.35 ± 2.82		
Proximity to the center	Near to the center	22	16.36 ± 3.18	-1.1	0.28
	Far away from the center	108	17.17 ± 2.62		
Informant category	Key informants	26	18.92 ± 1.73	5.36	0.00*
	Randomly taken informants	104	16.57 ± 2.74		

*Significant difference (p<0.05); ** t(0.05) (two tailed), Average degree of freedom (df) = 75.44, N= number of respondents

4.9.5. Plant parts used and mode of consumption

Eighty one plant parts were mentioned as food sources; 54 fruit types, eight root types, eight bark types, seven leaf types and one each of seed, stem, nectar, and gum (Figure 31). Concerning their mode of consumption 70 plant parts (86.4%) were consumed uncooked and seven (13.6%) were consumed in their cooked form. Representatives of wild edibles are shown with Figure 32.

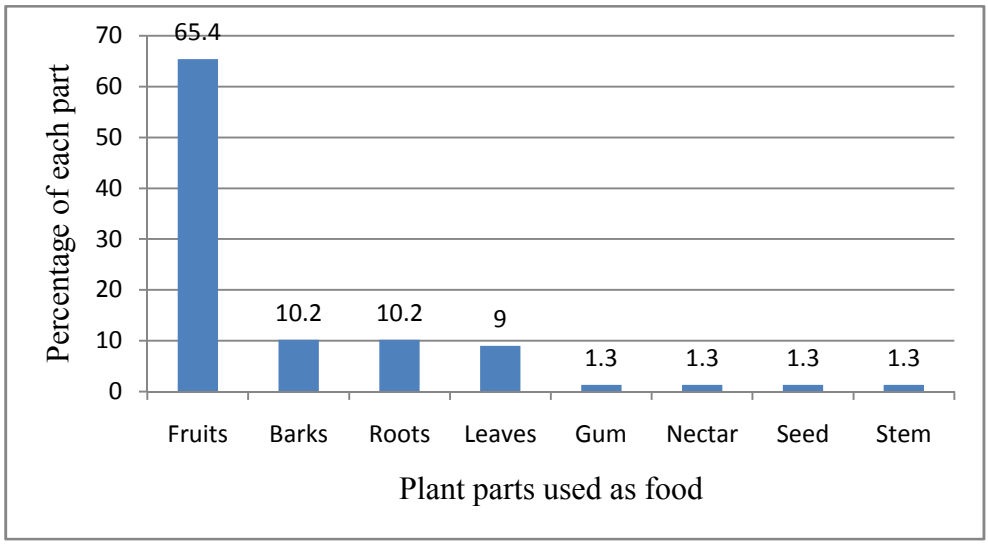

Figure 31. Plant parts used as wild food

Figure 32. *Flacourtia indica* - Flacourtiaceae, *Ziziphus abyssinica* - Rhamnaceae, *Amaranthus dubius* - Amaranthaceae

4.9.6. Preferences for wild edible plants in the district

Preference and value ranking exercise with eight key informants taken randomly for wild edible plants that were reported to be used commonly as wild food showed that *Solanum nigrum* and *Psophocarpus grandiflorus* were the most preferred species used as wild food (Table 36).

Table 36. Results of preference and value ranking exercise of wild edible plants used as food

Plant species used as wild food (part consumed)	Informants designated A to H								Total score	Rank
	A	B	C	D	E	F	G	H		
Lannea rivae (Fruits)	3	4	3	3	4	4	3	3	27	5th
Psophocarpus grandiflorus (Fruits)	4	5	4	4	5	4	4	5	35	2nd
Rhus longipes (Fruits)	3	4	4	3	4	3	4	4	29	4th
Rhus vulgaris (Fruits)	3	5	4	4	5	3	4	4	32	3rd
Solanum nigrum (Fruits and leafy vegetable)	5	4	5	5	4	5	5	4	37	1st

4.9.7. Determination of multipurpose wild edible plants for their conservation priority

Ten multipurpose wild edible plant species were selected out of the 71 identified wild edible plants for direct matrix ranking exercise as reported by the informants. The result of this ranking exercise was used to identify which of the multipurpose wild edible plants was under greater pressure than other species in the area besides the respective factors that threaten the plants. Accordingly, *Allophylus abyssinicus* was ranked first (most - threatened) followed by *Olea europaea* subsp. *cuspidata.* The output indicated that these multipurpose wild edible plant species are currently exploited more for firewood, charcoal, and construction purposes than for their food uses (Table 37).

Table 37. Average direct matrix ranking score of ten key informants for ten wild edible plant species with additional uses.

Wild edible plant species	Use categories						Total	Rank
	Ch	Co	Fr &Tl	Fw	Md	We		
Albizia schimperiana	3	2	2	3	2	2	14	10th
Allophylus abyssinicus	5	5	3	5	3	3	24	1st
Balanites aegyptiaca	4	3	2	3	3	3	18	7th
Cordia africana	3	5	5	5	0	4	22	3rd
Fagaropsis angolensis	3	5	2	5	2	2	19	6th
Lannea rivae	3	2	2	3	3	3	16	8th
Mimusops kummel	3	2	2	4	0	4	15	9th
Olea europaea subsp. *cuspidata*	4	4	3	5	4	3	23	2nd
Pappea capensis	5	2	2	5	2	4	20	5th
Syzygium guineense subsp. *guineense*	3	4	2	5	2	5	21	4th
Total	36	34	25	43	21	33	192	
Rank	2nd	3rd	5th	1st	6th	4th		

Where, Ch = Charcoal, Co = Construction, Fr & Tl = Furniture and Tools, Fw = Firewood, Md = Medicinal and We = Wild edible

4.9.8. Use value of selected wild edible plants species in the district and their domestication

Of the total wild edible plant species, the highest food use values (UVfo) were recorded for *Psophocarpus grandiflorus* (9.4)*, Solanum nigrum* (8.8), and *Moringa stenopetala (*7.5) (Table 38).

Table 38. Food use values (UVfo) of most cited wild edible plants in Dugda Dawa District

Wild edible plant species	No. of informants citing the species	Total citations	No. of parts used	UVfo.
Amaranthus dubius	82	542	2	6.6
Dioscorea schimperiana	73	446	1	6.1
Moringa stenopetala	94	705	1	7.5
Psophocarpus grandiflorus	110	1034	2	9.4
Solanum nigrum	102	898	2	8.8

N.B. UVfo= Food use value

4. 10. Other use diversities of all collected plant species from the study area

Even though some of the collected plant species mentioned with respect to their usage as medicine for humans and livestock as well as wild edibles, all these plant species have their own uses in the ecosystem in which they are found. These uses include being forage for livestock, sources of materials, sources of fuel wood, useful for social services, provider of environmental services, and poison.

4. 10.1. Plants used as fodder/forage

Plants reported for having uses as feed for livestock account for 165 species of all the species collected and which belong to 117 genera and 50 families. Of these, the Fabaceae and Poaceae were with 12 species (7.3%) and 10 species (6.1%) respectively, and Rubiaceae seven species (4.2%), Asteraceae, Burseraceae and Capparidaceae contributed six species (3.6%) each amid those used as fodder plants. Shrubs were found to be the dominant sources of forage (35.1%) followed by herbs (28.5%).

4.10. 2. Plants used for materials and construction

A number of plant species were also reported for their uses in construction, household furniture, beehives, and other locally used materials. Thirty two (9.2%) of the total species distributed in 32 genera and 24 families were cited for construction and material uses (Appendix 10). Araliaceae, Boraginaceae, Fabaceae, Myrtaceae, Oleaceae, Rutaceae, Sapindaceae, and Sapotaceae were

among the most frequently mentioned (8.3% each) families for this use category. The remaining sixteen families were represented with single species. Of the reported plant species, 27 species (84.4%) were trees and five species (15.6%) were shrubs and all of them were obtained from the wild. Stem and root parts of these plants were mentioned for their role in local construction or materials making. Most of these plants (53.1%)) were reported for their uses in local construction (Figure 33).

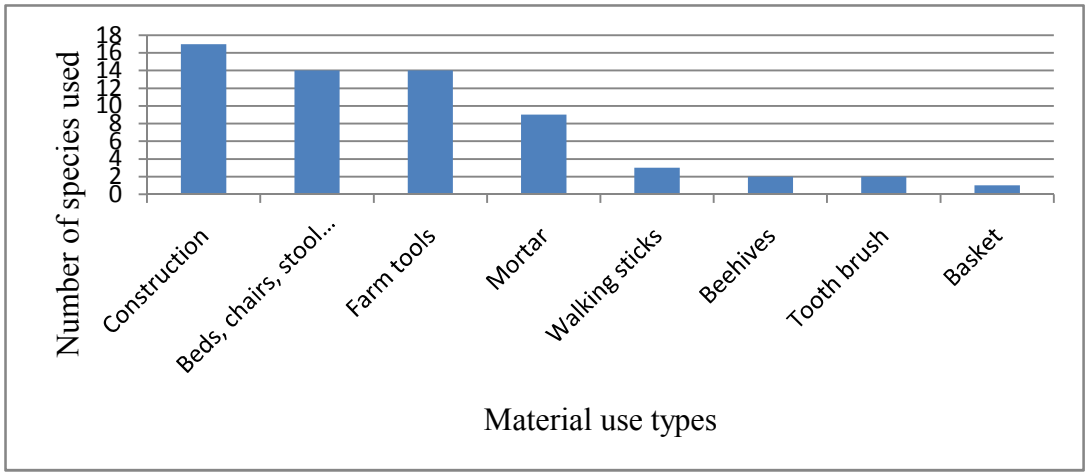

Figure 33. Number of species used in construction and materials making in Dugda Dawa District

4.10.3. Use value of most cited material and construction plants

Ten plant species were found with relatively high material and construction use values (Table 39). The highest use values (UVmat) were recorded for *Cordia africana, Podocarpus falcatus*, *Schefflera volkensii,* and *Phoenix reclinata.*

Table 39. Material and construction use values (UVmat) of most cited plants in Dugda Dawa District

Species	No. of informants citing the species	Total citations	Total number of material and construction uses	UVmat
Cordia africana	204	1938	6	9.5
Podocarpus falcatus	192	1709	5	8.9
Schefflera volkensii	194	1630	4	8.4
Phoenix reclinata	152	1231	4	8.1
Polyscias fulva	187	1440	4	7.7
Balanites aegyptiaca	126	945	4	7.5
Ekebergia capensis	112	829	4	7.4
Millettia ferruginea	138	938	4	6.8
Ehretia cymosa	162	1037	4	6.4
Cassipourea malosana	145	885	4	6.1

N.B. UVmat = Material and construction use value

4.10.4. Plants used for fuel (charcoal and firewood)

In the rural area plants are the basis to fulfill fuel requirement as it was cited by all informants in the study area. Using leaves of large plants as well as herbaceous species for fuel was not seen in the study area. So, one hundred forty nine woody plant species (43.1% of all collected species) distributed in 92 genera and 46 families were mentioned for their local fuel uses. Highly used families as fuel sources in the study area include Fabaceae (20, 13.4%) species followed by Combretaceae (10, 6.7%), Rubiaceae (9, 6%), and Anacardiaceae (8, 5.4%). Twenty nine fuel source families (63%) were represented by more than one species (Appendix 11).

4.10.5. Plants used for social activities

Some plants were also reported for different public uses including cultural ceremonies (Figure 34). Thirty two species of plants (9.2%) belonging to 28 genera and 23 families were cited for one or more social purposes in the study area and examples of common species in this category include *Ficus sycomorus, Lippia adoensis, Olea europaea* subsp. *cuspidata, Podocarpus falcatus* and the full list is given in Appendix 12.

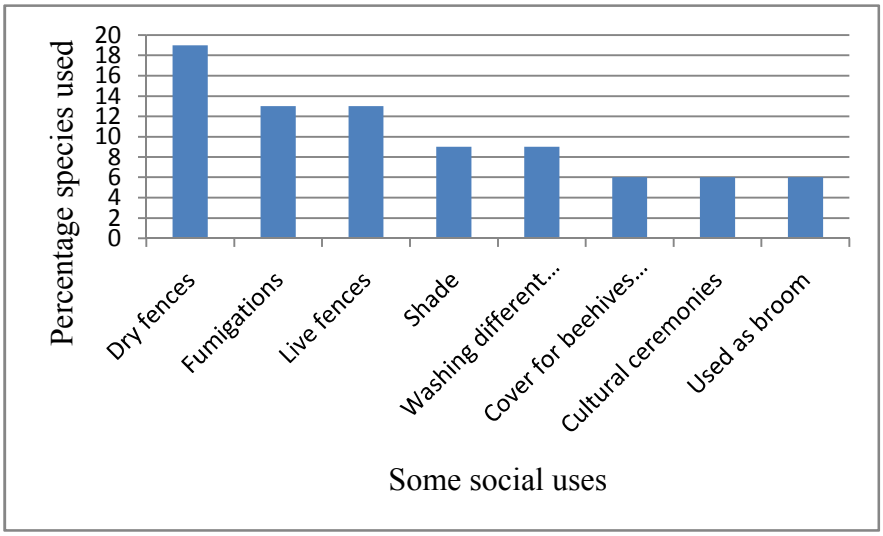

Figure 24. Some social use types and corresponding proportion of species used in Dugda Dawa District

4.10.6. Plants used for environmental services

Environmental services refer to the role of plants in erosion control, soil improvement (making it fertile), being food and shelter for wild animals, and balancing climatic conditions. All plant species in the study area have their own role in providing these services in different degrees and this requires separate detailed study.

4.10.7. Plants used as poison

Acokanthera schimperi (Apocynaceae), *Datura stramonium* (Solanaceae), *Euphorbia depauperata* (Euphorbiaceae), *Millettia ferruginea* (Fabaceae) and *Momordica foetida* (Cucurbitaceae) were reported for their poison contents and the extracts of these plant species are used for different purposes forexample in killing rodents and insect repelling like fleas.

4.10.8. Plant species mentioned for most of the usevalues discussed in this study

About 13 plant species were mentioned for their five or more use values out of the eight use values discussed in this study as indicated in Table 40.

Table 40. Plant species mentioned for their different uses in the study area

No.	Plant species	Number of uses	Use types (values)
1	*Acacia abyssinica*	6	Midicinal, fuel, fodder, material making,communal, evrironmental services
2	*Acokanthera schimperi*	5	Medicinal, edible, fuel, poison, evrironmental services
3	*Albizia schimperiana*	6	Medicinal, fodder, construction, fuel, communal, evrironmental services
4	*Allophylus abyssinicus*	5	Medicinal, edible, construction, fuel, evrironmental services
5	*Balanites aegyptiaca*	6	Medicinal, edible, construction, fuel, fodder, evrironmental services
6	*Carissa spinarum*	5	Medicinal, edible, fodder, fuel, communal, evrironmental services
7	*Cordia africana*	5	Edible, construction, fuel, fodder, evrironmental services
8	*Flacourtia indica*	6	Medicinal, edible, construction, fuel, fodder, evrironmental services
9	*Pappea capensis*	6	Medicinal, edible, construction, fuel, fodder, evrironmental services
10	*Rhus vulgaris*	6	Medicinal, edible, construction, fuel, fodder, evrironmental services
11	*Scherebra alata*	5	Medicinal, construction, fuel, fodder, evrironmental services
12	*Syzygium guineense*	5	Medicinal, edible, construction, fuel, evrironmental services
13	*Ziziphus abyssinica*	5	Medicinal, edible, fodder, fuel, evrironmental services

CHAPTER FIVE

5. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1. Discussion

When the vegetation of an area is studied together with ethnobotany of the same area ethnoecology comes to play. If the researcher's question addresses the general diversity of vegetation use versus species diversity in an area, he/she must conduct interviews to identify which species are used and a quantitative floristic survey of the area's vegetation to identify the species that occur in the area and their abundances as it was done in this study. Shannon–Wiener's index was applied to the total dataset resulting from the survey, allowing calculation of the species diversity in the area, and to the data only on the species indicated as useful. Through these calculations, it was possible to evaluate how much the diversity of used species corresponds to the total diversity in the area (Araújo and Ferraz, 2010). Thus, the indigenous knowledge of medicinal and wild edible plants recorded and analyzed in this study has also captured some of the ethnoecological knowledge of the people.

5.1.1. Plant species composition of the vegetation of the study area

Results of this study showed that the vegetation of Dugda Dawa District is rich in species composition as shown by the collection and authentication of large number of plant species (343 species) (Appendix 3). Even if some studies suggested as the number of monocot plant species increase over time, dicots were seen prevailed in the study area (Joppa *et al*., 2010). Of the collected plant species 21% were wild edibles, 37% were medicinal, and 48% were feed for livestock. The highest representation of species from the family Fabaceae in Dugda Dawa District vegetation could be related to the fact that it is one of the species rich families in the floral area of Ethiopia (Thulin, 1989; Mesfin Tadesse, 2004; Ryding, 2006). Fabaceae was also shown being well represented in other study areas in Ethiopia including vegetation of Gamo Gofa Zone (33 species, 15%) (Teshome Soromessa *et al*., 2004); Nechisar National Park (26 species, 13%) (Samson Shimelse *et al*., 2010); Dello Menna (26 species, 15.2%) (Motuma Didita *et al*., 2010); Sire Beggo (23 species, 12.4%) (Abyot Dibaba *et al*., 2014); Metema Area (16 species, 18%) (Haile Adamu *et al*., 2012); and Wayu Tuka (15 species, 12%), (Moa Megersa *et al*., 2013). Thulin (1989) expressed that Fabaceae is a family of great economic importance containing besides the pulse crops many species used for forage, pasture improvement, charcoal production, timber, gums, medicine, and ornamentals. The ability of most members of the family

to form associations with symbiotic bacteria which fix atmospheric nitrogen contributes greatly to improving soil fertility.

The occurance of shrubs in large proportion in the study area might be due to bush encroachment and cutting large/big trees for timber, construction and other purposes contribute its own part for shrub dominance. This finding is in line with the reports of Mirutse Giday and Gobena Ameni (2003) and Fikadu Erenso *et al*. (2014). There are different causes of encroachment such as uprooting grasses and herbaceous species due to overgrazing which gives chance for the germination of woody plant species from the soil seed bank, prolonged and recurrent drought, as well as ban of traditional controlled burning. These affect the growth of grasses and herbaceous species which are the main forage for livestock (cattle) and in turn affect the production of cattle. Due to this problem pastoralists are shifting towards raising goats and camels (browsers) and the current market value of any livestock is becoming very high. The diversity of species and composition of endemic species in Dugda Dawa District vegetation is in line with the typical feature of the Somalia - Maasai regional centre of endemism which encompasses the study area (eastern and southern Ethiopia - except the mountains) (White, 1983). This regional centre of endemism takes a large part of the African mainland between 16^0N and 9^0 S and 34^0 E and 51^0 E, encompassing about 1250 endemic plant species even if they are under great threat especially due to overgrazing with highly increased population of livestock of pastoralists.

As rightly reported by Ensermu Kelbessa *et al.* (1992) and Vivero *et al.* (2005), the endemic plant species of Ethiopia and their extent of threat were also of concern in the present study area. Twelve endemic plant species found in this study area which are in the IUCN Red Data List and hence are of conservation priority. It was also identified that Dugda Dawa District vegetation is a pool of large number of traditional medicinal plants. This finding is in line with the finding of Jin-Ming *et al*. (2003) who reported that most tropical forests are sources of vital traditional medicinal plants, and even serve as the basis for at least 25% of modern drugs. When we compare the vegetation of Dugda Dawa District with some other woodland vegetation in Ethiopia, it has higher species richness (Table 41).

Table 41. Comparison of species richness among different woodland vegetation in Ethiopia

No.	Woodland vegetation in Ethiopia	Number of spp.	Authors	Rank
1	Borana Woodlands Vegetation	327	Gemedo Dalle *et al*., 2005	2nd
2	Dello Menna Woodland Vegetation	171	Motuma Didita *et al*., 2010	6th
3	Gamo Gofa Woodlands Vegetation	216	Teshome Soromessa *et al*., 2004	3rd
4	Nechisar Woodland Vegetation	208	Samson Shimelis *et al*., 2016	4th
5	Sire Beggo Woodland Vegetation	185	Abiyot Dibaba *et al*., 2014	5th
6	The present study area	344		1st

No one reported such a high number of plant species diversity from a single district. Chen *et al.* (2003) reported that the difference in species composition among places (vegetations) to be compared could be due to topographic differences, environmental heterogeneity, and regeneration success, competition in the respective vegetation, climatic factors, and level of exploitation.

Even if Magada forest, part of which is found in Dugda Dawa District, is managed by Oromia Forest and Wild Life Enterprise, it is not well protected and highly disturbed. The surrounding pastoralists let their livestock freely in the forest all the time and the people extract different forest products from the forest for both income generation and their own domestic requirements. Illegal settlement in the forest was also seen.

5.1.2. Plant communities in the vegetation of the study area

Using the dominant species in naming plant communities, four different plant communities were identified in this study in which large numbers of species were composed. As Urban *et al*. (2000) reported the distinction in vegetation prototype among communities could be due to differences in environmental gradients such as elevation, soil heterogeneity, and microclimate, biotic responses to these gradients and human-induced and/or environmental disturbances in a region. The observed community structure in Dugda Dawa District vegetation can be explained by differences in soil heterogeneity and microclimate (FAO, 1994), biotic responses to these gradients and human-induced and/or environmental disturbances. Since these interacting ecological factors directly influence growth and development of plants and the corresponding patterns of vegetation distribution it can result in showing variation among communities. There was no plot that become ungrouped in the communities.

The presence of *Juniperus procera, Olea europaea* subsp. *cuspidata,* and *Podocarpus falcatus* in communities two and four indicated sufficient presence of characteristic species of dry afromontane vegetation in the study area. These taxa were also mentioned in different dry montane vegetation in Ethiopia (Tamrat Bekele, 1993; Demel Teketay and Tamrat Bekele, 1995; Haile Yineger *et al.*, 2008c). But these species have been subjected to anthropogenic pressure (due to their multipurpose role) as proved by a number of stumps of the species observed in the vegetation. It was observed that various degrees of intermingling of similar species across communities. This can be attributed to an overlap in altitudinal ranges of different communities, and the resulting relatively small differences in environmental gradients across adjacent plots forming different communities.

Small differences in species composition across plant communities reflect that adaptations of species to similar environmental conditions coupled with efficient dispersal of the respective species forming the communities. Identified species composition, plant communities and altitudinal ranges of the vegetation and climatic setting of the study area showed that part of the vegetation belongs to the category of dry evergreen afromontane forest (Condit *et al.,* 2002). Dry evergreen afromontane forests lie between altitudinal ranges of 1800 - 2300 m a.s.l., and consist of canopies dominated by *Podocarpus falcatus, Juniperus procera* and *Olea europaea* subsp. *cuspidata* in part of Dudga Dawa District vegetation (Friis *et al*., 2011).

5.1.3. Similarity among plant communities

The similarity of Communities 2 and 3 could be associated to slope, aspect, anthropogenic and other natural factors such as soil type and properties which were not considered in this study. The least similarity was exhibited between communities 3 and 4 which may be due to variation in slope, aspect and other environmental factors.

Species richness and species evenness together constitute its diversity. Species diversity for the total community in the study area was relatively very high (4.87) which can be confirmed from the collected total species, in turn shows that species richness is a measure of the total number of species in a community. This value was found to be higher than that of other Ethiopian dry afromontane forests such as Kumuli Forest (Gideon Woldemariam *et al.*, 2016), and Boda Forest (Fikadu Erenso *et al*., 2014). Findings also showed significant overall species evenness in Dugda

Dawa District vegetation which is much better than Boda Forest and a little less than Kumuli Forest.

The higher the value of **H',** the more diverse the plots or communities and the Shannon index increase as both the richness and evenness of the communities increase. In community wise comparison both species richness and diversity was the highest in community three. The possible reason for high species richness and diversity in this community may be due to the differences in soil heterogeneity and microclimate as well as biotic responses to the gradients. The highest species evenness was seen in community one although the second fewer species were recorded in this community. The higher the values of evenness, the more even the species are in their distribution within the community. As the community is composed of economically very important species, anthropogenic impacts such as selective removal of important trees species for different purposes could have likely contributed to the low species richness and diversity. For example, many big trees were seen cut down for their timber products in the forest in community four.

5.1.4. Structure of the vegetation

5.1.4.1. Tree and shrub density

Concerning size class distribution of vegetation Grubb *et al.* (1963) stated that the proportion described as a/b is taken as the measure of size class distribution. Dugda Dawa District vegetation showed relatively high woody species density (1,038 individuals ha-1) when compared to some other dry afromontane forests such as Denkoro dry afromontane forest (526 individuals ha-1) (Abate Ayalew *et al*., 2006) and Nechisar (NNP) woodland vegetation (886.78 individuals ha-1) (Samson Shimelse *et al*., 2010)), whereas its density was found to be lower than that of some other vegetation such as Sire Beggo woodland vegetation (1845 individuals ha-1) (Abyot Dibaba *et al*., 2014) and Dindin dry afromontane forest (1,750 individuals ha-1) (Simon Shibru and Girma Balcha, 2004). Variations in density distributions can be attributed to variations in habitat preferences of species forming the forest, topographic gradients and the degree of anthropogenic influences (Whittaker *et al*. 2003). Accordingly, the proportion of individuals with DBH between 10 and 20 cm (a) to DBH > 20 cm (b) indicates that the proportion of medium-sized individuals (DBH between 10 and 20 cm) is greater than the large sized individuals (DBH > 20 cm) but the proportion is relatively lower than the results obtained

for other forests such as Chilimo dry afromontane forest and Menagesha Suba dry afromontane forest (Tamrat Bekele, 1993), but larger than Denkoro dry afromontane forest, Dindin dry afromontane forest, Dodola dry afromontane forest, Gedo dry afromontane forest, Nechisar (NNP) woodland vegetation, Sire Beggo woodland vegetation, and Wof-Washa dry afromontane forest. The proportion of small-sized individual (DBH<10 cm) was much larger indicating that Dugda Dawa District vegetation is dominated by smaller shrubs. Higher values for the ratio of small-sized individuals to large-sized individuals are mentioned as indicators of a predominance of small-sized individuals that start to grow following excessive cuttings or other anthropogenic disturbances (Grubb *et al*., 1963). Comparisons of tree densities with DBH between 10 and 20 cm (a), DBH > 20 cm (b) and the ratio (a/b) for Dugda Dawa vegetation with other nine vegetation formations in Ethiopia is given in Table 42.

Table 42. Comparisons of tree densities with DBH between 10 and 20 cm (a) and tree density with DBH > 20 cm (b) from Dugda Dawa District vegetation with eight other vegetation types in Ethiopia.

Forest/Woodland	a	b	a/b	Vegetation types
Chilimo[7]	638	250	**2.55**	Dry Afromontane
Denkoro[1]	526	285	1.85	Dry Afromontane
Dindin[6]	437	219	1.99	Dry Afromontane
Dugda Dawa[4]	316	157	**2.01**	Woodland vegetation
Gedo[3]	832	464	1.79	Dry Afromontane
Menagesha[7]	484	208	**2.30**	Dry Afromontane
Nechisar (NNP)[5]	572	342	1.67	Woodland vegetation
Sire Beggo[2]	430	410	1.05	Woodland vegetation
Wof-Washa[7]	329	215	1.50	Dry Afromontane

Source: : [1]Abate Ayalew *et al*. (2006), [2]Abyot Dibaba *et al*. (2014), [3]Birhanu Kebede *et al.* (2012), [4]Present study, [5]Samson Shimelse *et al*. (2010), [6]Simon Shibru and Girma Balcha (2004), and [7]Tamrat Bekele (1993)

5.1.4.2. Size class distributions

The frequency distribution of individuals in different height classes showed an irregular pattern. The relative density was decreasing in the 5th and 6th height classes (25 - 29 m and > 29 m) and increasing in the height classes 2nd and 3rd (10 - 14 and 15 - 19). This could be attributed to irregular recruitment which may be due to selective cuttings at different size such as size classes

5 and 6. Feyera Senbeta and Demel Teketay (2003) also stated that the dominance of shrubs and small trees in the floristic composition of the forest suggest that bigger tree species are selectively removed or exploited.

About 91.2% of the individuals have DBH less than 23 cm (DBH class 1 - 4) and about 8.8% of the individuals have DBH greater than 22 cm (DBH classes 5 - 9). Only 4.9% of the total individuals have DBH greater than 42 cm indicating the dominance of small-sized individuals in the vegetation. This might be due to selective cutting of individuals at specific size. For example, medium sized individuals of *Juniperus procera* tree are highly hunted by the local people mainly for houses construction and material making (field observation and information from the local people).

5.1.4.3. Basal area

Species contributing large number of individuals in basal area can be considered as the most important woody species in the vegetation. Consistent with Cain and Castro (1959) the results of basal area analysis are used to measure the relative dominance of woody species in a forest. In this study eleven species (*Podocarpus falcatus, Syzygium guineense* var. *guineense*, *Psydrax schimperiana*, *Olea capensis, Croton macrostachyus*, *Celtis africana*, *Faurea speciosa*, *Cassipourea malosana*, *Terminalia schimperiana*, *Olea europaea* subsp. *cuspidata* and *Terminalia brownii)* were identified to be more dominant than others. The results showed that *Podocarpus falcatus* was about 3.3 times more important than *Syzygium guineense* var. *guineense,* and *Syzygium guineense* var. *guineense* was about 1.2 times more important than *Psydrax schimperiana*.

Even though about 42% of all the individuals had DBH less than 8 cm (DBH class 1), the percentage contribution of these classes to the total basal area was only 1.25%. Conversely, individuals in the DBH classes greater than 42 cm had a density of about 4.9% of the total, but they contributed to about 33.08% of the total basal area computed for the vegetation. Similar results were also obtained in the analyses of the contribution of the different DBH classes to the basal area in different vegetation formations of Ethiopia as in Dodola Forest (Kitessa Hundera *et al.,* 2007), and Belete Forest (Kitessa Hundera and Tsegaye Gadissa, 2008) that few large sized individuals contributed larger proportion of the total basal area. Therefore, large sized individuals have very significant importance in Dugda Dawa vegetation.

The total basal area calculated for Dugda Dawa District vegetation was 90.37 m^2/ha, of which more than 33% (29.9 m^2/ha) was contributed by *Podocarpus falcatus.* The predominance of this species in the vegetation was probably because it is found in the relatively protected site of the study area even though it is still under serious threat. *Podocarpus falcatus* was also the dominant species in Angada Forest (Shambel Alemu, 2011).

The basal area of Dugda Dawa District vegetation is compared with the basal area of 10 other dry montane forests and woodland vegetation in Ethiopia. It was greater than most of the dry montane forests and woodland vegetation types which are in comparison with it and less than Wof - Washa forest (Tamirat Bekele, 1993) (Table 43).

Table 43. Comparison of Dugda Dawa District vegetation with other 10 dry montane forests and woodland vegetations in Ethiopia with respect to basal area per hectare

(Note: Ag = Angada, Cl = Chilimo, Dk = Denkoro, Dd = Dindin, DDD = Dugda Dawa District, Gd = Gedo, Ms = Menagesha, Mt = Metema, Ns= Nechisar, SB = Sire Beggo, WW= Wof - Washa vegetations)

Vegetation	[7]Ag	[9]Cl	[1]Dk	[8]Dd	[5]DDD	[3]Gd	[10]Ms	[4]Mt	[6]Ns	[2]SB	[9]WW
Basal area/ha	80	30	45	49	**90**	36	36	43	50	19	**102**

Source: [1]Abate Ayalew *et al*. (2006); [2]Abyot Dibaba *et al*. (2014); [3]Birhanu Kebede (2010); [4]Haile Adamu *et al*. (2012); [5]Present study; [6]Samson Shimelse *et al*. (2010); [7]Shambel Alemu (2011); [8]Simon Shibru and Girma Balcha (2004); and [9]Tamirat Bekele (1993).

5.1.4.4. Density, frequency and dominance

Concerning the density and frequency of species; *Olea europaea* subsp. *cuspidata*, *Podocarpus falcatus, Combretum molle,* and *Acokanthera schimperi* were the four most abundant species and constitute about 28.02% of the total density while *Olea europaea* subsp. *cuspidata, Croton macrostachyus, Acokanthera schimperi* and *Combretum molle* were the most frequently occurring species. As said by Rey *et al*., 2000; Masresha Fetene and Yonas Feleke, 2001 and Tamrat Bekele, 2005 the highest density value for *Olea europaea* subsp. *cuspidata* could be attributed to its relatively good regeneration capacity under shaded conditions in dry environments. The same is true for high density of *Podocarpus falcatus* which has good regeneration capacity under its own canopy (Tamrat Bekele, 1993). The most frequent woody species in Dugda Dawa District vegetation were *Olea europaea* subsp. *cuspidata, Croton*

macrostachyus, Acokanthera schimperi, and *Combretum molle*. The higher the frequency, the more important the plant is in the community. In addition, Rey *et al*. (2000) expressed that high frequency of a species always depends on factors which relate to habitat preferences, adaptation, and degree of exploitation and availability of suitable conditions for regeneration.

5.1.4.5. Importance value index

Importance value index analysis is used for setting conservation priority. Those species which receive lower IVI values need high conservation efforts while those with higher IVI values need monitoring management. Distribution of species among different IVI classes showed that most of the species were in the lower IVI classes. The seven species (*Podocarpus falcatus, Olea europaea* subsp. *cuspidata, Croton macrostachyus, Combretum molle, Psydrax schimperiana, Acokanthera schimperi,* and *Celtis africana*), which accounted for 20.59% of the plants taken for IVI analysis, contributed about 56.68% of the total importance values. This may be due to their high dominance and density since they were found in relatively protected area. The remaining woody species (79.41%) had importance value indices of about 43.32%. In keeping with Mueller-Dombois and Ellenberg (1974) and Curtis and McIntosh (1950), the relative ecological significance and/or dominance of a tree species in a forest ecosystem could best be identified from IVI analysis. Hence, in this investigation, the IVI results also confirmed that *Podocarpus falcatus* and *Olea europaea* subsp. *cuspidata* were the most important species in the study area (Table 13).

5.1.4.6. Dominant species of the vegetation of Dugda Dawa District

Species having IVI value above 5.00 are referred to as dominant because of the relative ecological importance they played in the vegetation and also their abundance in distribution, and high basal area within the vegetation. Therefore, *Podocarpus falcatus, Olea europaea* subsp. *cuspidata, Croton macrostachyus, Combretum molle, Psydrax schimperiana, Acokanthera schimperi, Celtis africana, Terminalia brownii, Scherebra alata, Faurea speciosa, Nuxia congesta, Fagaropsis angolensis, Acacia brevispica, Bersama abyssinica, Syzygium guineense, Terminalia schimperiana, Acacia seyal* and *Combretum collinum* were identified as dominant species of the vegetation (Table 12). As the number of plots increases, the number of species also increases. But the diversity of species decreases because most of the species repeatedly found in

the subplots taken. The two red lines in the dominance curve indicate the range in which the abundance of the species increases as the number of subplots increase.

5.1.4.7. Population structure

Diameter class distribution patterns indicate the general trends of population dynamics and recruitment processes of a given species. Plant population structures help to understand population dynamics and regeneration status of species in a forest (Popma *et al*., 1988). Although population structure analysis become meaningful if the individauls of the species to be investigated are found in tens or hundreds of thousands the researcher do so with this restriction.With this drawback the analysis of the population structure of four representative tree species showed four general patterns. The first pattern was bell-shaped distribution formed by species with high number of individuals in the middle DBH classes (Figure 14a). Species such as *Celtis africana* and *Croton macrostachyus* are characterized by this distribution pattern. This pattern indicates a poor reproduction and recruitment of species which may be associated with strong competition from the surrounding trees. Feyera Senbeta *et al.* (2007) have earlier reported similar justification for bell-shaped population structures.

The second pattern was formed by species with positively skewed distribution (inverted J-curve). These species had the highest density in the lower DBH with gradual decrease in density towards the bigger sizes, which suggested good reproduction and healthy regeneration potential in the vegetation (Figure 14b). *Nuxia congesta, Olea europaea* subsp. *cuspidata, Psydrax schimperiana, Terminalia brownii,* and other similar species had inverted J-curve structure. In line with the explanation of Getachew Tesfaye *et al.* (2010) such population patterns are indication of a stable population structure and depict good regeneration status.

The third pattern (Figure 14c) was formed by species having irregular distribution over diameter classes. Some diameter classes were poorly represented indicating selective removal of specific sized individuals while other diameter classes are well represented. Such population structure indicates poor reproduction (Tamrat Bekele, 1993), and also a decline in number of big trees until they become wipedout (Gauss-type distribution pattern). *Cassipourea malosana, Fagaropsis angolensis, Faurea speciosa, Scherebra alata* and some other species had this type of population pattern.

The fourth pattern was a U-shaped curve (Figure 14d) formed by species with little or no representatives in the middle DBH classes and represented only by the lower and higher DBH

classes. Species with this type of population structure are *Podocarpus falcatus, Syzygium guineense* var. *guineense*, *Olea capensis* subsp. *macrocarpa* and others. The intermediate diameter classes are poorly represented and this may be due to selective removal of medium sized individuals. For example, many stumps of *Podocarpus falcatus*, the very important timber tree species in the area, were observed in the forest, which suggest a further risk of removal of the remaining individuals.

Most of the species with irregular distributions are tree species that are hunted by the local people selectively for logging, house construction, firewood and charcoal production or over grazing which affects the seedlings under the mother tree. For example, *Fagaropsis angolensis* at its medium size is highly needed for construction (field observation and information from the local people). The complete absence of individuals in some diameter classes indicates that the regeneration of species was hindered during one or several phases of their life cycle. These might be caused by crushing seeds/seedlings by livestock, selective cutting for construction, timber, or firewood purposes.

5.1.4.8. Regeneration status of Dugda Dawa District's vegetation

As Popma *et al*. (1988) suggested that more specific information about regeneration status of individual species can be obtained through the analysis of the population structure of individual tree and shrub species. Based on the results of regeneration status study, almost all the 34 selected woody plant species had low number of seedlings and saplings. Possible reasons for insufficient seedling and sapling for these selected tree species in the vegetation might be grazing and browsing (disturbance) effect, lack of safe site for seed recruitment, nature of seeds of certain trees which seek dormancy period, seed predation, litter accumulation, pathogens, species specificity, and moisture stress or probably they might have other alternative adaptations for propagation and reproduction rather than seed germination. Similar findings were reported by Simon Shibiru and Girma Balcha (2004). Therefore, these species have relatively little regeneration status which may suggest that they are either under threat of local extinction or may prefer other strategy of survival. This implies a need to develop and implement effective vegetation management system in the area to promote healthy regeneration and the sustainable use of these species.

5.1.4.9. Phytogeographic comparison

Many authors have studied the dry land and dry afromontane vegetation in the country. Although direct comparison of the species diversity with other vegetation is not realistic due to differences in climatic conditions, survey methods, and aim of the study, the overall species richness of the vegetation can give comparatively a general idea of their diversity and phytogeographical similarity. In this regard, Dugda Dawa District vegetation was compared with five other dry land vegetations in the country to know the similarity of species in the vegetation and indicated to which vegetation type it is related. These vegetations were: Borana Woodlands vegetation, Dello Menna Woodland vegetation, Gamo Gofa Woodlands vegetation, Nechisar Woodland vegetation (National Park) and Sire Beggo Woodland vegetation (In Arsi Zone, Gololcha District). The whole species were used for similarity comparisons. The similarity index used for this comparison was Sorensen's Similarity index. The result of this comparison revealed that Dugda Dawa District vegetation shared better amount of species with Sire Beggo woodland vegetation (Abiyot Dibaba *et al*., 2014) with Sorensen's coefficient of similarity value of 0.31 and followed by Borana Woodlands vegetation (Gemedo Dalle *et al*., 2005) with Sorensen's coefficient of similarity value of 0.30. Better similarity observed among these vegetations formations could be due to similar altitudinal ranges and climatic conditions. Lower number of species was shared between Dugda Dawa District and Dello Menna Woodland Vegetation with Sorensen's similarity value of 0.20. Dissimilarities between these vegetations might arise from their location, altitudinal differences, and climatic conditions. The most characteristic tree species of dry evergreen afromontane vegetations the study area were *Podocarpus falcatus, Celtis africana, Croton macrostachyus, Olea capensis* subsp. *macrocarpa, Olea europaea* subsp. *cuspidata* and *Juniperus procera*.

5.1.5. Taxonomic diversity of medicinal plants in the study area

The findings revealed the presence of considerable amount of medicinal plants species in Dugda Dawa District vegetation which is in line with the overall observed species diversity in the study area. Fabaceae was with the highest number of medicinal plant species followed by Asteraceae and Lamiaceae and this result is in agreement with the report of Mirutse Giday and Gobena Ameni, 2003; Tesfaye Hailemariam *et al*., 2009; Anteneh Belayneh *et al*., 2012. These findings also showed that how much is the contribution of traditional medicinal plants in assisting the primary healthcare needs of the local people of the study area and is an indication that there has

been a continued transfer of plant based traditional knowledge for generations. The number of medicinal plants harvested in the district was found to be relatively higher than that of some other areas in the country investigated for their traditional health care in humans and livestock such as Anteneh Belayneh *et al*., (2012) 51 species; Getaneh Gebeyehu *et al.*, (2014) 107 species; Teferi Flatie *et al*., (2009) 40 species; Seyoum Getahun and Zerihun Girma, (2014) 83 species; Tadesse Beyene, (2015) 121 species.

Cultural and way of life factors might have been the most important reasons in using such large number of medicinal plants maintained as a highly valued inheritance of the local people although economic, ease of accessibility and effectiveness related factors might have played major roles for Dugda Dawa District people to rely on traditional medicine.

5.1.5. 1. Distribution of medicinal plant species across plant communities

Traditional medicinal plants mentioned for their remedial uses were found distributed in each of the identified plant community types in different proportion but the larger amount (richness) was seen in community three. Diversity of medicinal plant species was highest in community two and evenness was similar in community two and three. This could be due to the difference in the preference of habitat by these medicinal plants. When we consider this condition in the whole vegetation of the study area, community three has the highest value in species richness and species diversity and this may be due its inclusion of Acacia – Commiphora and Combretum – Terminalia vegetation types and community one is with the highest species evenness. These findings confirmed that the study area is rich in medicinal plant wealth even if we couldn't compare it with other studies in community wise distribution of these plants due to absence of such studies.

5.1.6. Medicinal plants used to treat only human ailments

5.1.6.1. Diversity of reported medicinal plants used for human ailments

Large number of medicinal plants used for treating human ailments in Dugda Dawa District were reported in the district and this finding indicated the presence of a considerable diversity of plant species in the area and the existence and utilization of such a large number of medicinal plants by people in the study area may indicate that the majority of the people continue to employ indigenous medicinal practices to date. Four of the medicinal plants which are used to treat human ailments were endemic to Ethiopia. Identified growth forms of medicinal plants indicated

that shrubs were more dominant which is in agreement with other studies in Ethiopia such as Bayafers Tamene (2000); Debela Hunde (2006); Kebu Balemie *et al*. (2004); Anteneh Belayneh *et al*. (2012); Alemayehu Kefalew *et al*. (2014); Mersha Ashagre *et al*. (2016) followed by trees (23; 28.4%) and lianas (13; 16.1%). This could be due to the dominant occurrence and impact tolerance capacity of shrubs in the study area. The majority of medicinal plants were obtained from the wild and only seven species were from cultivated or semi - cultivated sources. But, the wild habitats are highly depleted due to an increased human and livestock population which will result in the loss of many medicinal plant species growing in the wild. This finding is in agreement with reports of almost all other studies on wild habitats for harvesting an ample of medicinal plants such as Fisseha Mesfin *et al*. (2009); Teferi Flatie *et al*. (2009); Getaneh Gebeyehu *et al*. (2014); Solomon Araya *et al*. (2015).

5.1.6. 2. Parts of medicinal plants used for remedy preparation

A variety of plant parts were reported for remedial preparation in the district but about 36.6% of the preparations for treating human ailments were obtained from leaves which is also commonly reported by other ethnomedicinal studies elsewhere in Ethiopia, Fisseha Mesfin *et al*. (2014); Getaneh Gebeyehu *et al*. (2014); Seyoum Getaneh and Zerihun Girma (2014); Getu Alemayehu *et al*. (2015); Mersha Ashagre *et al*. (2016) followed by roots and barks. In addition to this the leaves, barks and roots were used in different preparations in mixture with other plant parts in the district. The higher usage of leaves in traditional remedy preparations could partly be due to its easy availability and the usage of roots in the second place could be due to the fact that these parts remain in the soil which enables them to be taken at any time even during the long dry season especially in arid and semi - arid areas like the present study area. One might say that usage of leaves in a number of traditional remedy preparations could not be destructive to the natural vegetation of the study area as these parts of the plant could be replaced soon easily. On the other hand, it could lead to the conclusion that harvesting roots could be destructive to the natural vegetation because it affects the survival of the plant since aerial parts of the plant are highly dependent on roots for physiological processes and physical support as these parts are the second most frequently used parts in the study area. Most of the remedy preparation was reported from freshly collected plant parts. Using freshly harvested medicinal plant parts could be due to the belief that this form could attain high efficacy since it could contain higher bioactive ingredients (curative elements, a knowledge which could be obtained from long and repeated

experience). This finding is also in line with other ethnomedicinal studies elsewhere in the country (Ermias Lulekal *et al*., 2008a; Haile Yineger *et al*., 2008a; Fisseha Mesfin *et al*., 2014; Seyoum Getaneh and Zerihun Girma, 2014) whereas dried parts were used least and certain amount of remedies was reported to be prepared both from dried or fresh parts of medicinal plant species.

5.1.6. 3. Types of disease, medicine preparations and treatment methods

Forty nine disease types, affecting humans, were identified in Dugda Dawa District to be treated with traditional medicines. Diseases such as tooth ache, stomach ache, and diarrhea (Gastro - intestinal diseases) were the most frequently reported human ailments followed by skin and venereal diseases. Similar research findings were reported by Seyoum Getaneh and Zerihun Girma (2014). These diseases were diagnosed commonly through interview and visual inspection of the patients' before any herbal medicine administration. Similar reports were made by Mirutse Giday *et al*., 2003; Ermias Lulekal *et al*., 2008b; Fisseha Mesfin *et al*., 2009. Once the healer gets the required information herbal medicines will be prepared and administered following the proper route and the type of disease. The major mode of herbal medicine preparation for human ailments were chopping or pounding and homogenizing plant parts, findings which were similar to the reports of Seyoum Getaneh and Zerihun Girma (2014). This was followed by crushing and put on plant parts and chopping, homogenizing, and boiling plant parts. Oral application was the most common route of administration, a report similar to Fisseha Mesfin *et al*., 2009; Teferi Flatie *et al*., 2009 which was followed by dermal and nasal administrations. Other remedies were reported to be administered through deep opening on the body formed due to infection "Luxaa - in local Oromo language", aural and ocular routes with regard to the type of ailment reported by diagnosing patient. It was reported that determination of remedies dose for various ailments was based on physical appearance, age, and gender of the patient (no standardized measurements) except determining it based on the long term experiences of traditional healers. Similar findings were reported in other parts of the country (Haile Yineger *et al*., 2008a; Ketema Tolossa *et al*., 2013). Remedies were reported to be measured in coffee cups, water glasses, liters while others were measured with tip of fingers or pieces of particles. As said by Dawit Abebe (2001) lack of standardization and precision has been a global shortcoming of the traditional healthcare system. Milk, yoghurt, honey, and coffee were mentioned as antidotes for traditional medicines with adverse side effects such as vomiting, diarrhoea, and feeling of burning and sometimes

weakening of the patient. Similar findings were reported by Haile Yineger *et al*., 2008a; Mirutse Giday *et al*., 2010; Ermias Lulekal *et al*., 2014. Patients with gastro - intestinal problems, venereal diseases, malaria, hepatitis, hypertension, diabetics, TB, rabies, poisons, etc were commonly reported to be treated with liquid preparations or chewable plant parts given orally. This finding was in agreement with reports of Ketema Tolossa *et al*., 2013. Those with different skin diseases and tissue cancer were reported to be treated with crushed or chewed preparations through rubbing or pasting herbal preparations. Diseases such as febrile illness, head ache, evil eye, etc. were reported to be treated either through fumigation or washing the patient with liquid herbal preparations. Culture, efficacy, availability, and economic factors were reported as the key factors which lead the community to use traditional medicines other than modern healthcare systems with their unaffordable high prices and unavailability. These findings were in agreement with the findings of Fisseha Mesfin *et al*. 2009 and Ermias Lulekal *et al*., 2013.

5.1.6. 4. Marketability of medicinal plants

The finding from the market survey of medicinal plants indicated that in the culture of Guji Oromo (ethnic group of the study area) it is forbidden to sell traditional medicine in the market. Even if people coming from other areas usually sell them, the local people didn't accept it. When traditional healers cure a patient they will be given certain amount of dried and pounded tobacco, coffee with salt or sugar and if it is critical disease a goat or heifer not money as the cultural rule permits (in kind form of payment). Sometimes the cured person returns the favor through inviting the healer and his family overnight in his house. This cultural trend might cause the local healers not to sale traditional medicines in the market which is confirmed by the market survey. But some traditional medicinal plants can be sold for other purposes such as *Coffea arabica* and *Rhamnus prinoides* to be used in the preparation of drinks; *Ruta chalepensis* to be used as spice in milk preparation; *Combretum molle, Olea europaea* subsp. *cuspidata* and *Osyris quadripartita* for fumigation in producing good odor and feeling for the body and house.

5.1. 6. 5. The most preferred plants for treating human ailments

The output of preference ranking exercise on medicinal plants that were reported to be used against tooth ache showed that *Zanthoxylum chalybeum* is the most preferred species to treat tooth ache followed by *Scherebra alata* and *Carissa spinarum*. This indicates that indigenous

people of the study area have sufficient knowledge on the healing potential of medicinal plants for different diseases.

5.1.6. 6. Identification of multipurpose medicinal plants for their conservation priority

Direct matrix ranking exercise for ten selected multipurpose medicinal plants in five use diversities (charcoal, construction, furniture and tools, firewood and medicinal) indicated that *Warburgia ugandensis* was ranked first (most - threatened) which is followed by *Olea europaea* subsp. *cuspidata* and *Fagaropsis angolensis.* Since stem bark of *Warburgia ugandensis* is highly and unwisely used in treating different diseases in Guji Oromo traditional medication its population is reaching nearly zero (lost through drying) with the effect of disturbances (grazing, browsing and selective cutting) which seriously affect the emergence of seedlings and their growth to saplings. In the same way poor reproduction ability, selective cutting mostly for construction purpose, overgrazing and browsing affect the existence of *Fagaropsis angolensis*. Even if *Olea europaea* subsp. *cuspidata* has good reproduction ability, stable population structure and good regeneration status, cutting of bigger individuals for firewood and the destruction of seedlings and saplings due to overgrazing and browsing this plant is highly affected. Therefore, the output indicated that these multi-use medicinal plant species are currently exploited more for their non-medicinal uses than for the reported human medicinal values such as for firewood, construction, and charcoal purposes than for their medicinal uses. Hence, these findings reflect the requirement of an urgent harmonizing conservation action to save the fast eroding multipurpose medicinal plant species of the study area. Ermias Lulekal *et al*. (2013) had also reported the same pattern of high exploitation of multipurpose medicinal plants.

5.1.6.7. Effectiveness of medicinal plants

Among the twelve categorized human ailments the highest informant consensus factor values (ICF values) was for musculoskeletal and nervous system diseases. High ICF values are important to name plants of particular interest in the search for bioactive compounds (Heinrich *et al*., 1998). The highest plant use citation was seen for gastro-intestinal diseases. The observed high informant agreement together with high plant use citations for these disease categories could also indicate the relatively high occurrence of the diseases in the area (about 43 medicinal plant species were cited for treating gastro-intestinal disease categories).

5.1.6.8. Relative healing potential of medicinal plants used for treating human ailments

The highest fidelity level value record for *Ocimum lamiifolium* was obtained under the febrile therapeutic category, while the highest fidelity level value of *Withania somnifera* was found in the evil spirit disease category (Table 20). These values could be a clue for the high healing potential of these plants against the corresponding diseases.

In this study, informant consensus factor values (ICF values) were used to identify the harmony of the informants on the reported cure for the group of ailments (musculoskeletal and nervous system diseases) of the plant while fidelity level (FL) computes the significance of a species (*Ocimum urticifolium)* to treat a given disease (febrile diseases). Hence, their analyses values become different; high for fidelity level than ICF.

5.1.6. 9. Use diversity of medicinal plants used for humans

Medicinal plant species recorded for human ailments treatment in the district were cited for one or more uses other than their medicinal role. All medicinal plant species were considered as useful for environmental services such as erosion control, soil improvement, being food and shelter for wild animals, and balancing climatic conditions and this is the general truth with no compromise. Dominance of plants cited for environmental services is proper from the stand point that every plant species has its own role in maintaining balanced biophysical systems. About 44 woody medicinal plant species of the district were used as fuel (charcoal and fire wood) for the local people and 39 medicinal plant species cited for additional uses as fodder indicating their supplementary role in supporting the livestock wealth of the district, on which most people depend for their livelihoods. Others such as 25 medicinal plant species were reported for construction and material making, 22 medicinal plant species were cited as wild edible plants, four medicinal plant species were indicated as plants giving social services and two medicinal plant species were reported as being poisonous. These results indicated how much the indigenous knowledge of the local people is used in using plant resources for different purposes to ensure their existence through fulfilling their requirements. On the other hand, the highest proportion of plant species used across different use categories reflects the relative importance of different plant species in the people's daily life (Thomas, 2008).

5.1.7. Ethnoveterinary medicinal plants

5.1.7. 1. Medicinal plant diversity used only for ethnoveterinary in Dugda Dawa District

The reported ethnoveterinary medicinal plants of Dugda Dawa District showed that the study area is relatively rich in ethnoveterinary medicinal plants diversity and indigenous knowledge related with each traditionally used species (Appendices 7). Comparatively a high diversity of ethnoveterinary medicinal plant species were recorded in other cultural communities of Ethiopia (Haile Yineger *et al*., 2008b; Damtew Bekele *et al*., 2012; Mirutse Giday and Tilahun Teklehaymanot, 2013; Ermias Lulekal *et al*., 2014; Berhane Kidane *et al*., 2014). All the documented ethnoveterinary plant species were harvested from the wild. This finding is in agreement with the reports of Mirutse Giday *et al*., 2003; Barboza *et al*., 2007; Farooq *et al*., 2008; Berhane Kidane *et al*., 2014; Hassan *et al*., 2014, in which more than three fourth of the medicinal plants were collected from the wild. Overgrazing, deforestation, charcoal making, and firewood collection were claimed as major factors affecting the ethnoveterinary plant species of the study area.

5.1.7. 2. Specification of livestock ailments, number, and part of plant species used

Even though livestock traditional medicinal plants of the district are asserted to be applied for ailments affecting chicken, sheep/goats, cattle, equines or camels the majority of the reported medicinal plant species were found to be applied to treat one or more of the fourteen different cattle ailments (Appendix 7). Eight species were mentioned to be used specifically against both goats/sheep and camels ailments respectively.

The majority of ethnoveterinary medications were reported to comprise medicinal parts of a single medicinal plant. This finding is in line with the reports of Mirutse Giday *et al*., 2003; Debela Hunde *et al*., 2004; Mirutse Giday *et al*., 2010; Mirutse Giday and Tilahun Teklehaymanot 2013; Moa Megersa *et al*., 2013; Hassan *et al*., 2014; Getu Alemayehu *et al*. 2015; Mersha Ashagre *et al*., 2016. The remaining were prepared using formulations from two or more species. Dawit Abebe, 1986; Haile Yineger and Delenasaw Yewhalaw, 2007 also reported that healers used multiple plants in mixture in order to increase the strength and efficacy of the drug. Amongst all plants reported, the highest proportion of species was claimed to treat breathing problem followed by diarrhea. The highest number of multiple ethnoveterinary uses was recorded for *Prunus africana* and *Viscum congolense* (each used against three ailment types)

(Appendix 7). The efficacy of the preparations, techniques, and practices need to be investigated to identify promising plants for use in livestock development plans.

Similar to some other previous findings such as Mirutse Giday *et al*. (2003); Haile Yineger *et al*. (2008b); Tesfaye Hailemariam *et al*. (2009); Firaol Tamiru *et al*. (2013); Gebremedhin Gebrezgabiher *et al*. (2013); Hassan *et al*. (2014); Gebremedhin Romha *et al*. (2015), leaves were the most widely used plant parts for ethnoveterinary medicine preparations followed by barks in the study area (Figure 17). On the other hand, other findings forinstance, Dawit Abebe and Ahadu Ayehu, 1993; Fisseha Mesfin *et al*., 2009; Ermias Lulekal *et al.*, 2014 reported different results which showed that roots were the most frequently utilized plant parts in their respective research areas. The possible reason could be that people living in different ecological zones could use different plants and plant parts in their treatment system. Almost all remedies were prepared from freshly harvested plant parts. This finding is in line with the reports of Tilahun Teklehaymanot and Mirutse Giday, 2007; Haile Yineger *et al*., 2007; Ermias Lulekal *et al*., 2008a; Fisseha Mesfin *et al*., 2009; Moa Megersa *et al*., 2013; Ermias Lulekal *et al*., 2014; Seyoum Getaneh and Zerihun Girma, 2014. As reported by informants, from their long experience high efficacy is attained from freshly collected plant parts since they contain much active ingredients in the form of secondary metabolites.

Clematis simensis, Viscum congolense, and *Lannea rivae* were ethnoveterinary medicinal plants identified and the most preferred species to treat breathing system diseases which were the most prevalent animal health problems reported in the study area (Table 22).

5.1.7. 3. Livestock ailments, remedy preparation, routes of administration and dosages

Most of the veterinary ailments belong to the breathing system disease category followed by gastro - intestinal diseases. Diarrhea and breathing problem were known to be the most commonly described forms of veterinary ailments in the district. This result corroborate with the report of Mersha Ashagre *et al*., 2016. Healers treat veterinary ailments based on observation of the animals or evidence obtained by asking the livestock owners about major symptoms shown by the diseased animals and medicines are commonly given only after the diseased animal is visually examined by a traditional healer for any symptom on its suspected body part (physical appearance of the diseased animal and visually confirmed degree of complexity of illness are used to determine doses of traditional medicines in treating livestock ailments).

Diverse modes of ethnoveterinary remedy preparation were mentioned to be used in the district based on the type and degree of complexity of livestock ailment. Pounding/chopping/crushing the remedial part and making its solution with cold water was found to be the major method of local remedy preparation (Figure 18). This finding is in agreement with the reports of many studies such as Mirutse Giday *et al*., 2007; Ermias Lulekal *et al*., 2008a; Firaol Tamiru *et al*., 2013; Solomon Araya *et al*., 2015.

Oral administration of traditional medicines was reported as the main treatment method for most diseases. This finding is in line with the reports of Mirutse Giday *et al*., 2003; Teshale Sori *et al*., 2004; Ermias Lulekal *et al*., 2008a; Fiseha Mesfin *et al*., 2009; Firaol Tamiru *et al*., 2013; Ermias Lulekal *et al*., 2014; Gebremedhin Romha *et al*., 2015; Solomon Araya *et al*., 2015. This is followed by nasal administration and rubbing or pasting herbal preparations were commonly reported treatment methods for handling dermatological diseases.

Some traditional practitioners reported use of coffee cup, water glasses and bottles to determine dosage for some traditional medicines, while others reported to use their finger tip or full of a small dish unprocessed parts to treat ailments. However, no standardised doses of herbal preparations were reported by traditional healers for any of the preparations used to treat livestock ailments in Dugda Dawa District even if they used such various units of measurements. Similar findings have been reported in other studies in Ethiopia such as Ermias Lulekal *et al*., 2008a; Shewit Kalayou *et al*., 2012; Ermias Lulekal *et al*., 2013; Gebremedhin Romha *et al*., 2015; Yibrah Tekle, 2015**.**

Since informant consensus is used to identify the most cited plant species with respect to its particular importance the highest plant use citation was recorded in the present study for breathing system diseases with the highest ICF value (Table 25). *Cyphostemma serpens* was identified as having the highest healing potential in treating black leg, hepatitis, and FMD (Foot and Mouth Diseases), whereas *Viscum congolense* was highly effective in treating breathing system diseases with FL tests (Table 26).

In the same way as medicinal plants study of humans, informant consensus factor values (ICF values) were used to identify the harmony of the informants on the reported cure for the group of ailments (breathing system diseases) of the plant while fidelity level (FL) computes the

significance of a species (*Cyphostemma serpens)* to treat a given disease (febrile diseases). Hence, their analyses values become different; high for fidelity level than ICF in this study.

5.1.7. 4. Use diversity of medicinal plants used for livestock

With direct matrix ranking exercise made among five ethnoveterinary medicinal plant species to identify those having multipurpose, *Prunus africana* was ranked first (most - threatened) followed by *Syzygium guineense* var. *guineense* and *Combretum collinum.* Higher direct matrix ranking values indicate that the plants have used for different purposes and vice versa. The output indicated that these multipurpose medicinal plant species were exploited more for firewood, charcoal, and construction purposes than for their medicinal uses.

All ethnoveterinary medicinal plant species in the district were cited for one or more uses other than their medicinal role such as used for environmental services, construction and material making, fodder and live fences, fuel wood (charcoal and firewood), as wildfood or poison (Figure 23). Out of the 24 different medicinal plant species used for livestock ailments treatment, the highest medicinal use values (UVmed) were recorded for *Lannea rivae* followed by *Dichrostachys cinerea* (Table 27).

5.1.8. Ethnobotanical knowledge of medicinal plants used for both humans and livestock in Dugda Dawa District

5.1.8.1. Diversity of medicinal plants used

Traditional medicine has long been known as one of the oldest forms of remedies used by humans (Eisenberg *et al*., 1998; Nkechi *et al*., 2011). Beliefs about causes of health problems are determining of treatment seeking decisions, CSA (1989). Hence, one of the alternatives for the solution of health problem rises in a large segment of rural population and their livestock is employing traditional medicine in general and medicinal plants in particular.

The present investigation has shown 22 medicinal plant species most of which were shrubs used to treat both humans and livestock ailments in the district (Appendices 8). Similar findings were reported by Getaneh Gebeyehu *et al*., 2014; Alemayehu Kefalew *et al*., 2015. About 90.9% of the documented common medicinal plant species were harvested from the wild. This finding is in line with the reports of Teferi Flatie *et al*., 2009; Nasir *et al*., 2011; Fisseha Mesfin *et al*., 2014; Seyoum Getaneh and Zerihun Girma, 2014.

5.1.8. 2. Ailments treated with medicinal plants used for both humans and livestock

In this study 33 human and 27 veterinary ailment types were identified for which informants reported to use one or more medicinal plant species to treat them (Appendix 8) and this clearly indicated the presence of a wealth of indigenous knowledge about traditional medication in the study area. Seven ailment types in humans and six ailment types in livestock belong to the gastro - intestinal and internal parasite disease category followed by urogenital diseases in humans (five ailments) and tissue cancer and cold diseases in livestock (four ailments) disease categories. Diarrhea and tooth ache diseases in humans and coughing in livestock were found to be the most commonly reported forms of ailments in the district. This finding is in line with the reports of Teferi Flatie *et al*., 2009; Seyoum Getaneh and Zerihun Girma, 2014. Healers treat these ailments based on observation, or information obtained by interviewing the patient or livestock owners about major symptoms shown by the diseased animals. This type of diagnosis was also reported in other studies such as Ermias Lulekal *et al*., 2013; Alemayehu Kefalew *et al*., 2015. Chewing medicinal parts and/or applying pounded remedies on the infected tooth and oral administration of homogenized herbal preparations for diarrhea and coughing were reported as the main treatment methods.

5.1.8. 3. Composition of remedies for both humans and livestock

The majority of human and livestock medications were reported to comprise medicinal parts of a single medicinal species. This finding is in line with the reports of Ragunathan and Solomon Mequanente, 2007; Getu Alemayehu *et al*., 2015; Mersha Ashagre *et al*., 2016. The remaining were prepared using formulations from two or more species. Amongst all plants reported, the highest proportion of species was claimed to treat tooth ache and diarrhea/stomach ache followed by breathing system problems. Similar to the reports of Mirutse Giday *et al*., 2003; Debela Hunde *et al*., 2006; Tilahun Teklehaymanot and Mirutse Giday, 2007 the highest number of multiple ethnoveterinary uses was recorded for *Croton macrostachyus* (used against 13 ailment types), followed by *Aloe trichosantha, Calpurnia aurea* and *Teclea salicifolia* (each used against five ailment types) (Appendix 8).

5.1.8.4. Medicinal plant parts used for remedy preparation

Even if different plant parts reported to be used for remedy preparation by the community, most of the preparations was found to be from leaves alone, followed by roots and from barks

(Figure25). This might be due to their consistent supply of fresh metabolites. Similar findings were reported by Tesfaye Hailemariam *et al*., 2009; Nasir *et al*., 2011; Getaneh Gebeyehu *et al*., 2014; Seyoum Getaneh and Zerihun Girma, 2014; Getu Alemayehu *et al*., 2015; Mersha Ashagre *et al*., 2016. Of these remedies 92.1% were prepared from freshly harvested plant parts, whereas 7.9% were from dried forms. This result is in line with Getaneh Gebeyehu *et al*., 2014; Seyoum Getaneh and Zerihun Girma, 2014; Getu Alemayehu *et al*., 2015; Mersha Ashagre *et al*., 2016.

5.1.8.5. Mode of remedy preparation, routes of administration and dosages

Different modes of remedy preparation were reported to be used in the district for both humans and livestock based on type and degree of complexity of ailments. Pounding the remedial part and homogenizing it with cold water was found to be the major mode of remedy preparation, findings which are similar with the reports of Seyoum Getaneh and Zerihun Girma, 2014, followed by homogenized, boiled and cooled preparation (Figure 26).

Oral administration was the most cited route of administration followed by dermal. Similar findings were reported by Ragunathan and Solomon Mequanente, 2007; Getaneh Gebeyehu *et al*., 2014; Alemayehu Kefalew *et al*., 2015. Physical observation and information from the patient or owner of diseased animal were used to determine preparation doses to treat both humans and livestock ailments. Traditional practitioners reported use of coffee cup, water glasses and bottles to determine dosage for some medicinal preparations, while others reported to use a handful or full of a small dish unprocessed parts to treat ailments. Anyways, no standardized doses of herbal preparations were reported by traditional healers for any of the preparations used to treat both human and livestock ailments in Dugda Dawa District. This finding is in line with the reports of Ermias Lulekal *et al*., 2008a; Tesfaye Hailemariam *et al*., 2009; Shewit Kalayou *et al*., 2012; Ermias Lulekal *et al*., 2013; Gebremedhin Romha *et al*., 2015; Yibrah Tekle, 2015**.**

With preference ranking execise *Vangueria apiculata* and *Croton macrostachyus* were the most preferred species from five medicinal plants that were reported to be used against hepatitis in both humans and livestock to treat the reported diseases (Table 28). Direct matrix ranking exercise made on five selected multipurpose medicinal plant species revealed that *Calpurnia aurea* was ranked first (most threatened) followed by *Balanites aegyptiaca.* The output indicated

that these multipurpose medicinal plant species are currently exploited more for firewood and charcoal purposes than for their medicinal uses (Table 29).

In computation of Informants' Consensus Factor (ICF) values for six main ailment categories which were common to humans and livestock in the district the highest ICF value was recorded for gastro - intestinal and internal parasites followed with urogenital diseases and dermatological diseases categories (Table 31). In addition, the highest plant use citation was recorded for gastro - intestinal and internal parasites. This result is in line with the reports of Ermias Lulekal *et al*., 2013; Alemayehu Kefalew *et al*., 2015.

Fidelity level (FL) quantifies the importance of a species for its healing power and accordingly those species with high FL are thought to be more health giving for the respective ailments. Thus, those traditionally used medicinal plants with high FL can be a focus for further phytochemical analysis. Hence, *Solanum dennekense* showed the highest fidelity level value for tissue cancer and cold disease category, followed by *Croton macrostachyus* for urogenital diseases. In the dermatological therapeutic category, the highest fidelity level value was recorded for *Aloe trichosantha*. *Teclea borenensis* also showed relatively high healing potential under gastro - intestinal and internal parasites diseases category (Table 32).

In addition being used as medicine for both humans and livestock all the 22 medicinal plant species recorded in the district were cited for one or more uses other than their medicinal role such as providing services in construction and material making, environmental protection, used as fodder and life fence, for fuel (charcoal and fire wood), as wild food and poison. The highest medicinal use values (UVmed) were recorded for *Croton macrostachyus* followed by *Calpurnia aurea* (Table 33).

Water served as ‘solvent’ almost in all ethno formulations of traditional medicines whenever dilution is required. Different additives are incorporated in 23.4% of the whole ethno formulations. Informants reported that certain additives are frequently used to improve the suitability of some remedies that are taken orally either through reducing their bitterness and bad flavor or increasing their efficacy. The highest usage of additive was reported for magado salt (locally produced salt) followed by butter (Figure 28).

5.1.8. 6. Distribution of indigenous knowledge on medicinal plants among different social groups in the community of the study area

While more medicinal plants were reported by men than women, the difference was not significant (P >0.05) when the average number of medicinal plants mentioned by each group was compared. This could be due to the fact that both men and women are knowledgeable on use of traditional plant remedies regardless of the relative dominance of medicinal plant tradition by men which could be related to the transfer of traditional knowledge along the male line in the study area. Similar results were reported by Begossi *et al*., 2002; Collins *et al*., 2006; Tilahun Teklehaymanot, 2009. Furthermore, Almeida *et al*., 2010 reported as there was relatively equivalent medicinal plants knowledge among men and women traditional medicine practitioners among three communities in northeastern Brazil and Ayantunde *et al*., 2008 reported similar information for a community in southwest Niger. There was no significant difference observed in the number of medicinal plants listed by informants living around health centers and those living relatively far away from these health centers. However, there was a significant difference (P = 0.00) in the number of medicinal plants reported by senior members of the community (> 39 years old) and young- to middle-aged members (< 40 years old) - more number of medicinal plants was reported by elders than by youngsters. This could be due to their high degree of opportunity for more cultural contact and experience with plants and associated therapeutic uses than that of younger people or due to the absence of sharing indigenous knowledge freely because of its secrecy and if it presents being along the preferred male line of the family of the ethnic group of the study area. Similar reports were made by Begossi *et al*., 2002; Uniyal *et al*., 2006; Ermias Lulekal *et al*., 2008a; Haile Yineger *et al*., 2008a; Mirutse Giday *et al*., 2009; Tilahun Teklehaymanot, 2009; Silva *et al*., 2011. Similarly significant differences were also seen in the number of medicinal plants reported by key informants and randomly taken informants, illiterate and literate informants. More number of medicinal plants were reported by illiterates and key informants than literates and randomly taken informants (Table 34). This could again be related to the impact of life long experience and serious secrecy in using medicinal plants in the former, and modernization in the latter case. Similar results were reported by Teferi Gedif and Hahn, 2003; Mirutse Giday *et al*., 2009; Tilahun Teklehaymanot, 2009.

Large number and types of humans and livestock diseases (82 and 62 disease types respectively) for which patients were visited by traditional healers indicated a preference of local people in the

study area to use traditional medicines. The reported reasons for this to happen were efficacy and availability of these medicines, cultural trend, and life standard (being poor), factors which forces the community to visit traditional healthcare practitioners than modern healthcare centres with unreasonable prices. Similar findings were reported by Ermias Lulekal *et al*., 2008a; Fisseha Mesfin *et al*., 2009; Tesfaye Hailemariam *et al*., 2009.

5.1. 9. Ethnobotanical study of wild edible plants in Dugda Dawa District

5.1.9.1. Taxonomic diversity of wild edible plants

The present investigation has shown that the study area is generally endowed with various and rich sources of wild edible plants which serve the local communities as food sources and for other purposes. The total number of wild edible plants species reportedly consumed in the study area is greater than reported by Tilahun Teklehaymanot and Mirutse Giday, 2010 who documented 38 wild edible species in Lower Omo River Valley, Debub Omo Zone, SNNPR, Ethiopia; Assegid Assefa and Tesfaye Abebe, 2011 who documented 30 wild edible species of trees and shrubs in the semi-arid lowlands of Benna - Tsemay, South Omo, Southern Ethiopia; Debela Hunde *et al*., 2011 who documented 37 wild edible species in semiarid East Shewa, Ethiopia; Tinsae Bahru *et al*., 2013 who documented 55 wild edible species in and the buffer area of Awash National Park, Ethiopia; Tena Regassa *et al*., 2014 who documented 58 wild edible species in Chelia District, West-Central Ethiopia; Ahmad and Pieroni, 2016 who documented 51 wild edible species among the tribal communities of Thakhte- Sulaiman Hills, North-West Pakistan. Such a large number of wild edible plant species was not seen registered from a single district in the country. Concerning their growth forms, trees and shrubs contributed equal number of wild edible plant species (26 species each), followed by herbs (10 species) (Figure 30). Of all the families which yielded these wild edible plant species, the Fabaceae and Anacardiaceae were the most dominant with seven species each and followed by Burseraceae and Rubiaceae with five species each (Appendix 9). Similarly, Tinsae Bahru *et al*., 2013 also reported, from all plant families collected Fabaceae and from the growth forms shrubs contributed the highest number of wild edible plant species in their study of wild edible plant usage by Afar and Oromo communities in and the buffer area of Awash National Park.

5.1.9. 2. Distribution of wild edible plant species across plant communities in Dugda Dawa District vegetation

Traditional wild edible plants mentioned for their uses by people in Dugda Dawa District were found distributed in each of the identified plant community types but the larger proportion was found in community three. Comparison of species richness, diversity and evenness with reference to the composition of plant communities in the study area revealed that wild edible plant species richness and diversity were the highest in community three but evenness values were similar in communities one, two and three. When we consider this condition in the whole vegetation of the study area, community three has the highest value in species richness and diversity while community one was with the highest species evenness.

5.1.9. 3. The role of wild edible plants in household food security and food use categories of the people of the study area

The major cause of challenge to household food security in the study area is climatic conditions disturbance. Very short and irregular rain happened for the past many years. This caused the subsistence agricultural activities to diminish and unsuccessful. The lifestyle of pastoralists was environmental friendly. They have higher exposure to different wild edible plants which can be used as an asset for diversifying livelihood sources to enhance flexibility for coping and adaptation to climate change. The rural people in the study area hold more than enough indigenous knowledge about how and when to use wild edible plants. Even if consumption of wild edible plants is commonly associated with poverty and low self regard among rural people, large number of the local people uses them. Hence, these plants are important to household food security and dietary diversification in different rural areas of the country, particularly in the dry lands including Dugda Dawa District, to supplement the staple food, to fill the gap of seasonal food shortages and as emergency food during famine or during prolonged drought time or social unrest. Similar notions were reported by Amare Getahun, 1974; Minnis, 1991; Turner and Davis, 1993; Ezeagu *et al.*, 1996; Guinand and Dechassa Lemessa, 2001; Zemede Asfaw and Mesfin Tadesse, 2001; Getachew Addis *et al*., 2005; Kebu Balemie and Fassil Kebebew, 2006; Getachew Addis *et al*., 2009; Demel Teketay *et al*., 2010; Tilahun Teklehaymanot and Mirutse Giday, 2010; Debela Hunde *et al*., 2011b; Neudeck *et al*., 2012. Of the total wild edibles 7% of the species used during periods of ample food production to supplement the staple diet, 78.9% of

the species used to fill the gap of seasonal food shortage and 14.1% of the species used during famine (Figure 29).

5.1.9.4. Distribution of indigenous knowledge on wild edible plants among the different social group in the local community

Even though more wild edible plants were reported by women than men, the difference was not significant (P >0.05) when the average number of wild edible plants reported by each group was compared. There was no significant difference observed in the number of wild edible plants listed by illiterates and literates informants as well as between informants near to and far away from the center (Table 36). However, there was a significant difference (P< 0.05) in the number of wild edible plants reported by elders (> 36 years old) and youngsters (< 37 years old). Indigenous knowledge on use of wild edible plants is strong with younger generation (17.36 ± 2.64) than in the elderly people (16.00 ± 2.81). The observed strongly significant difference (P=0.02) could be due to more exposure and being harmoniously integrated with wild edible plants of youngsters especially livestock herders. This finding is in line with the reports of Tigist Wondimu *et al*. (2006) and Fentahun Mengistu and Hager (2008) where younger generations were more knowledgeable of wild edible in Arsi Zone and Northern Ethiopia respectively as well as Setalaphruk & Price, 2007; Styger *et al*., 1999 from abroad. But in contrast to these reports, the study results of Tena Regassa *et al*., 2014 reported as elderly people were more knowledgeable of wild edibles than youngsters.

Similarly, there was a significant difference (P=0.00) in the number of wild edible plants reported by key informants and randomly taken informants. More number of wild edible plants was reported by key informants. This could be related to long term experience and maximum degree of knowledge acquisition of wild edible plants in the former. Similar findings were reported by Tena Regassa *et al*., 2014.

In addition to this, those informants who involved in both medicinal and wild edible plants study showed variation in their knowledge of the two groups of plants. The number of wild edible plants reported per individual informant was much greater than that of the number of medicinal plants mentioned with the same informant. As the informants reported the reason for this to happen was the difference in the degree of secrecy in transferring the knowledge for wild edibles and medicinal plants. As a cultural law of Guji Oromo people, knowledge of medicinal plants could be transferred only along the selected male line of the family (highly secreted) whereas

knowledge of wild edible plants has no such restrictions and could be told for every body of the local community freely. Hence, an individual could have more knowledge on wild edible plants than on medicinal plants.

5.1.9.5. Plant parts used and mode of consumption

The dominant plant parts used were fruits, followed by roots and barks (Figure 30). This result is in agreement with Getachew Addis *et al*., 2005; Fentahun Mengistu and Hager, 2008; Tilahun Teklehaymanot and Mirutse Giday; 2010; Tinsae Bahru *et al*., 2013; Tena Regassa *et al*., 2014; Ahmad and Pieroni, 2016. Concerning their mode of consumption, most of them were consumed uncooked and only seven were consumed in their cooked form.

The edible plant parts were gathered from the wild at different time of the year and the majority were gathered and consumed from March 'BITTOTTESSA' to May 'CAAMSA' and from September 'FULBBANA' to November 'SADASSA'. These two durations are rainy seasons at the study area when most of the plants bloom and produce fruit. The main rainy season is between March and May and a smaller one is between half of September and half of December. Closely related reports were made at different times and places by Bussmann *et al*. (2006); Kebu and Fassil (2006); Getachew (2009). Over 75% of the wild edible plants were consumed to fill the gap of seasonal food shortage from March 'BITTOTTESSA' to April 'EBLAA' where the stored cultivated food crops are decreasing gradually. These plants are used as alternative and fill the gap of food deficiency that happens between harvesting seasons. Similar reports were made by Campbell (1987); Carr (1998); Grivetti and Ogle (2000); Zemede Asfaw and Mesfin Tadesse (2001).

Preference and value ranking exercise revealed that *Solanum nigrum* and *Psophocarpus grandiflorus* were the most favorite species used as wild food (Table 37). Direct matrix ranking exercise showed that *Allophylus abyssinicus* was exploited more in the study area because of its multidimensional function (most threatened) which is followed by *Olea europaea* subsp. *cuspidata.* The result revealed that these multi-use wild edible plant species are currently exploited more for firewood, charcoal, and construction purposes than for their food uses (Table 36). Although all identified wild edible species have their own food use values (UVfo), the highest food use value was registered for *Psophocarpus grandiflorus* followed by *Solanum nigrum* (Table 39).

5.1. 10. Other use diversities of all collected plant species from the study area

Albeit some of the collected plant species identified in their usage as medicine for humans and livestock as well as wild edibles, the whole plant species have their own uses in the ecosystem that they are found. Many species (165 species) of trees found in forest as well as shrubs and grasses are used for animal feed as browse. Silage trees contribute in several ways to the general food and nutritional security of households such as; they make a significant contribution to household livestock production (milk and meat production) as well as they maintain draught animals. Tree fodder and browse may consist of leaves, small twigs, seeds, pods and fruits, all of which support other foods and which can be a crucial component of livestock diets during the dry season.

Thirty two trees and shrubby species were cited for construction and material uses and stem and root parts of these plants were mentioned for their role in local construction or materials making. Most of these plants were reported for their uses in local construction (Figure 32). Among the most cited material and construction plants the highest use values (UVmat) were recorded for *Cordia africana, Podocarpus falcatus*, *Schefflera volkensii,* and *Phoenix reclinata* (Table 40). As it was reported by all informants', plants are the bases to fulfill fuel requirement in the study area which is the common trend in all rural parts of Ethiopia. As it is reported by Million Bekele and Leykun Berhanu (2001) woody biomass is the country's single largest source of energy supply. Hence, out of the collected plant species one hundred forty nine species (43.1%) were mentioned for their local fuel uses. Eighty one species of the best fuel plants were shrubs, sixty four species were trees, and the remaining four species were lianas.

The main fuel type used in the study area was firewood while charcoal was produced mainly to generate income. Of the total fuel source species, 25 species were frequently reported for making charcoal (Appendix 11). About 98% of fuel source plants were harvested from the wild and stems, branches, and barks were reported as major plant parts used for this purpose.

Thirty two plant species were also reported for their different public uses including cultural ceremonies in the study area (Figure 33). Trees were the dominant growth form followed by shrubs in social use plants (Appendix 12). Only three species of social use plants were reported as to be found under cultivation where as 29 species were harvested entirely from the wild. Stem, branches, and leaves were the most cited in the social use plant part categories. Some social uses types and the corresponding proportion of species used is indicated in Figure 33.

All plant species in the study area have their own role in providing environmental services such as erosion control, soil improvement (making it fertile), being food and shelter for wild animals, and balancing climatic conditions in different degrees. *Acokanthera schimperi* (Apocynaceae), *Datura strmonium* (Solanaceae), *Euphorbia depauperata* (Euphorbiaceae), *Millettia ferruginea* (Fabaceae) and *Momordica foetida* (Cucurbitaceae) were reported for their poison contents. The root extracts of *Acokanthera schimperi* and *Momordica foetida* was reported as killer of pests such as rodents and other animals including humans, whereas the latex of *Euphorbia depauperata* was reported as poison if it touches the skin of humans. Pounded seeds solution of *Millettia ferruginea* was reported to act as insect repellent like fleas.

5.1.11. Vegetation types with their composition of medicinal and wild edible plant species diversity and community types

The findings of this study revealed the presence of three vegetation types (*Acacia* - *Commiphora* woodland and bushland vegetation, *Combretum-Terminalia* woodland vegetation and *Dry evergreen afro-montane forest* vegetation) with their composition of species diversity, medicinal and wild edible plants diversity as well as communities in different proportion as indicated in Table 44.

Table 44. Vegetation types and different plant species composition

No.	Vegetation type	Plant community type included	Total number of species	Total number of MPs	Total number of WEs	Rank
1	*Acacia* - *Commiphora* woodland and bushland vegetation	3	164	61	41	3rd
2	*Combretum-Terminalia* woodland vegetation	2 and 3	294	119	45	2nd
3	*Dry evergreen afro-montane forest* vegetation	1, 2 and 4	295	129	63	1st

Dry evergreen afro-montane forest vegetation consists of higher number of medicinal and wild edible plant species diversity which is followed by *Combretum-Terminalia* woodland vegetation. This could be due to comparative differences in disturbance among these vegetation types and

preference of conducive environment by these plant species. Hence, priority for conservation action should be given accordingly for this vegetation.

5.1.12. Indigenous knowledge transfer

Using wild plants for medicine or food traditionally is an indigenous science. Indigenous knowledge systems are the multifaceted assortments of knowledge, know-how, practices, and representations that guide human societies in their numerous interactions with the natural environment such as agriculture and animal husbandry; struggles against disease and injury; and strategies for coping with changing environments. It is through this day to day and inevitable interplay between people and surroundings that indigenous knowledge systems have developed miscellaneous structures and content; complication, flexibility and practicality; and distinctive patterns of interpretation anchored in specific worldviews (Nakashima and Rou´e, 2002).

Knowledge is produced and transferred through communications within specific social and agro-ecological contexts. Hence, ethnobiological information and practice within any customs has been reported to vary by factors such as geographical basis, traditions, belief, livelihood, educational background, social status and relations, income class, age and gender (Pfeiffer and Butz, 2005; Gisella, 2006; Setalaphruk and Price, 2007). The flow of knowledge from seniors to children and its enrichment subsequently is directly conveyed through observation, imitation, free flow of information among community members, history telling, and myths (Getachew Addis *et al*., 2013).

The main system of traditional knowledge transfer on types of medicinal plants, traditional concepts of disease and ways of diagnosis among traditional healers in Dugda Dawa District was through word of mouth (no written documents obtained), with maximum secrecy following mainly the selected male line of the family. The way they are sharing their indigenous knowledge to their descendants was also found to be similar. This may cause indigenous knowledge to be threatened in the near future unless certain measures are taken which is also clearly seen in other parts of the country and abroad (Ermias Lulekal *et al*., 2008a; Haile Yineger *et al*., 2008a; Mirutse Giday *et al*., 2009; Tilahun Teklehaymanot, 2009; Begossi *et al*., 2002; Silva *et al*., 2011; Uniyal *et al*., 2006).

Traditional knowledge is built with years of experiences so elders were more knowledgeable in traditional medicines than youngsters in the study area. The depth and width of traditional knowledge on medicinal plants become lesser and lesser due to its secrecy, unwillingness of

young generation to gain the knowledge, influence of modern education which all results in its gradual disappearance. Ethnomedicinal knowledge diminishes with the death of elderly knowledgeable members of the society, since less and less young people are willing to acquire this knowledge. That is why Caniago and Siebert (1998) said that erosion of knowledge on medicinal plants is more significant in species collected from forests for use in treating rare and unusual ailments. This finding is in line with the reports of Firaol Tamiru *et al*. (2013); Gebremedhin Gebrezgabiher *et al*. (2013); Hassan *et al*. (2014). But in the case of traditional knowledge in wild edible plants the reverse is true where youngsters are more knowledgeable than elders. This could be due to differences in wild edible species preferences (children may use more diverse species), adapting some species that were not known to be edible in earlier days, their direct and regular contact to the forest and natural landscape which enables them to have more experience in gathering many edible species (high familiarity to wild edible species), their high chance to obtain more wild edible knowledge from their peers when performing different activities such as playing, herding, wood and fruit collection, hunting, schooling, and water fetching. This finding is in line with the reports of Tigist Wondimu *et al.* (2006); Setalaphruk and Price (2007); Fentahun Mengistu and Hager (2008).

5.1.13. Conservation practices

Dwellers of Dugda Dawa District and their livestock population depend mainly on the natural resources of the area for their existence. Deforestation for timber production or construction, overgrazing, charcoal production and fuel wood collection were claimed to be the anthropogenic causes of resource depletion. This finding is in line with the reports of Mirutse Giday *et al*. (2007); Solomon Araya *et al*. (2015). Even if about 29,000 hectares of the district lies in the "Magada Forest, the supposed Protected Regional Forest," there is no proper management and controlling mechanism so that the forest is highly disturbed and affected. The remaining woodland area is also severely degraded due to overgrazing with large number of livestock population and illegal charcoal production and fuel wood collection. Not only medicinal and wild edible plant species are affected but also the vegetation as a whole was in a critical condition. Some conservation practices were implemented in a very specific area of the district but this does not guarantee the wellbeing of plant diversity and their contribution to the perpetuation of life in the area (no pronounced conservation effort).

Inhabitants of the study area simply went to the forest, woodland, or grazing area to collect medicinal plants and wild edible plants as their need arose and did not worry about the long-term survival of these plants. Most of these informants gave the reason that the medicinal plants were easily accessible in their surrounding and hence no need of personal effort to conserve these plants. Because of this many plants in the study area were highly threatened with anthropogenic and natural factors. The natural factor affecting medicinal plant species was irregular and very short rainy season, prolonged and recurrent drought. Hence, sustainable land management which involve both the conservation and improvement of the present vegetation cover, such as through enrichment planting, enhancing soil fertility and rehabilitating degraded lands is required to reduce pressure on and destructive use of the natural resources. This could be achieved by solving the problems associated with open access to forest resources through sustainable forest management involving the local communities neighboring this vegetation as co-managers and co-beneficiaries of the generated revenues.

5.2. Conclusion

As observed from the results and discussion, our findings give a broad support to the six central alternative hypotheses set for this research. The study area is composed of *Acacia* - *Commiphora* woodland and bushland, *Combretum* - *Terminalia* woodland and *Dry evergreen afromontane* forest vegetation types. Dugda Dawa District is very rich in plant diversity and that is why such large number of plant species was collected from there. But consideration given to the conservation of the plant resources has not been commensurate with the magnitude of the degradation. In this study it was possible to document significant number of traditional medicinal and wild edible plants and other categories of useful plants. The study area being found in the Somalia - Maasai centre of endemism, as expected, 12 endemic species which are in the IUCN Red Data List were registered in this study.

The PC-ORD analysis shows the presence of four plant community types in the vegetation, all of which consist of traditionally used medicinal and wild edible plants beside other multipurpose species. Community type three exhibited the highest species richness and diversity and the least species richness and diversity was seen in community type four while community type two was with intermediate species richness and diversity. These findings are in line with the alternative hypotheses "the vegetation of the study area has high species diversity and different plant communities; different plant communities found in each vegetation type maintain useful plants (medicinal plants, wild edible plants and plants of other uses)." The difference in species composition and diversity among communities could be associated with different factors such as soil properties, aspect, slope and disturbance. The density of woody species in Dugda Dawa District vegetation decreases with increasing DBH and height classes. The total basal area for Dugda Dawa District vegetation was 90.37 m^2/ha, but most of the basal area was contributed by few large sized individuals. Analysis of population structure of selected species of trees discovered four different patterns (bell shaped, inverted J-shaped, irregular and U-shaped), population structure indicated a high variation among species population dynamics within the vegetation.

Phytogeographical comparison of this vegetation with other woodland vegetation in the country showed that Dugda Dawa District vegetation revealed better similarity with Sire Beggo

woodland vegetation (in Gololcha District, Arsi Zone, Oromia Region) which clarifies that the study area vegetation is more of woodland vegetation even if it consist of dry evergreen afromontane vegetation in a small area. The analysis of regeneration of some selected woody species showed that almost all species are with limited number of seedling and sapling generations. This may imply that the vegetation is currently under strong anthropogenic and environmental stress. Extraction of fire wood and charcoal were the factors which facilitated the rate of deforestation and natural resource depletion. Increased livestock population and its overgrazing further enhanced its vulnerability and the failure to manage the expansion of exotic invasive species, such as *Parthenium hysterophorus and Argemone mexicana* which are threatening the native herbaceous plant diversity also have their own influence on the vegetation. Dry evergreen afromontane forest vegetation was highly threatened by illegal timber production and fuel wood collection especially for income generation. For instance, *Olea europaea* subsp. *cuspidata* is exploited for marketing it as fire wood and *Podocarpus falcatus* and *Fagaropsis angolensis* are used to generate income by selling their timber. Releasing livestock in the so called protected dry evergreen afromontane forest especially in the dry season was another great problem in this area. Currently, theoretically a lot is said by different scholars about green revolution in natural resource conservation but its implementation is not satisfactory.

Even if pastoralists usually follow wise use of existing vegetation and water since their survival is dependent on its continued usage, this practice is minimizing nowadays due to different reasons. In addition to this, bush encroachment is one major problem in the study area and its surroundings. The major triggering factors of bush encroachment in this area were severe overgrazing, lack of prescribed fire and recurrent drought. Accordingly, there is a change in the species composition of livestock that pastoralists keep from grazers (cattle and sheep) to browsers (camels and goats). The major encroaching species in the study area rangeland are species of *Acacia* and *Commiphora*. In some places adversely invasive species such as *Dodonea angustifolia* is seen. This might happen when originally existing plant species disappear due to overgrazing or forest clearance the seeds of such easily colonizing species might get good opportunity to occupy large areas. In this ways *Dodonea angustifolia* has invaded two thirds of five kebeles in the study area. *Argemone mexicana* and *Parthenium hysterophorus* invaded the wooded grassland of the study area. These findings are in agreement with the hypothesis

"different factors drive the depletion of plant diversity and little consideration is given to its conservation."

Most of the medicinal plants and wild edible plants of the study area were found to play multipurpose role across different use categories and consequently some are under serious pressure challenging their survival. Hence, recorded high use value indices of multipurpose plant species in the study area can be used as signals of high use pressure and can be used as keys to design and implement well coordinated complementary *in situ* and *ex situ* conservation activity to save these widely used plant species. These findings are in agreement with the hypothesis "the local people are equipped with unique indigenous knowledge and culture in using wild plants for different purposes." Findings of this study indicated that there is higher usage of leaves of most medicinal plants to prepare various traditional remedies. Even though collecting these parts seems not harming much the regular physiological activities of the plant, those plants only with limited number of leaves (one leaf as in some Orchids) can be endangered unless proper consideration is given. Hence, conservation work in the area needs to give prior attention to protect such types of plant species. Traditional practitioners diagnose their patients through observation and asking the patient about the feelings of the disease and then prepare the medicine to administer it accordingly based on their cultural knowledge on symptoms, corresponding illnesses, and therapeutic medicinal species held in the knowledge of indigenous people. This may be more effective if these people obtain certain training from modern health professionals about how to identify some diseases based on their symptoms especially those which are easily communicable to minimize the possible severe problems that could happen on the local community and how to determine the doses of the preparations.

Traditional practitioners in the district also showed varying degrees of traditional medicinal plant use knowledge based on differences in age, experience, gender and education level. More ethnomedicinal knowledge was observed in elderly members of the community than in younger groups; experienced/key practitioners than the general public; and more with the illiterate than the literate. Because of the cultural norm and secrecy of traditional medication system, this knowledge is transmitted along the selected male line of the family members due to which males could be more knowledgeable than females even if the difference in knowledge with respect to gender is not exaggerated in the study area. Oral transmission of traditional knowledge and its

flow only through the selected male line of the family for its secrecy may cause it to be depleted in the near future with respect to modernization and ignorance of the new generation. High ICF, FL and medicinal use values testing exercises result showed that the selected medicinal plants of Dugda Dawa District have promising bioactivity elements. These findings are in line with the hypothesis "the traditional herbalists in the community are knowledgeable about healing plants, their preparation and applications."

The study area is gifted with diverse wild edible plants and these serve to the local communities as food sources and other purposes which helped them to resolve food insecurity problems. With respect to indigenous knowledge, the local people has a strong tradition, practice and skill associated with using wild edible plants but no trend is seen in domesticating and cultivating them. The tradition and opportunity of using wild edible plants (fruits, leafy vegetables, starchy roots, etc) as supplements to their diet is wide. Based on the information obtained from the local people, wild edible plants are consumed more by youngsters and women than older ones at any time. These plants are valuable resources in the study area to supplement the staple food, ensure food security and dietary diversification. The edible plant parts were gathered from the wild at different time of the year and the majority were gathered and consumed from March 'BITTOTTESSA' to May 'CAMSA' and from September 'FULBBANA' to November 'SADASSA'. These two durations are rainy seasons at the study area when most of the plants bloom and produce fruits.

5.3. Recommendations

Life in dryland areas like Dugda Dawa District become very difficult unless natural resources especially plants are properly managed. Plants afford a great economic and social value for the rural communities living as pastoralists being used as forage for their livestock and wild food for humans, medicine for both humans and livestock, source of both timber and other non-timber products as well as regulators of climatic conditions. Therefore, to ease the present human influence on the natural vegetation and for its future management on a sustainable basis in the district, the following recommendations are forwarded:

- Even if all the three vegetation types of the study area are at risk currently, *Dry evergreen afro-montane forest* vegetation which encompasses community one, two and four should be given priority for conservation either through avoiding disturbances for their natural regeneration or rehabilitating them by reforestation;
- *Ocimum urticifolium* and *Solanum nigrum* should be given cultivation priority for their wide usage in traditional medication and nutrition respectively;
- Conservationists should set up medicinal plant nursery sites in co-operation with the District's Agriculture and Rural Development Office so as to propagate seedlings of the most-preferred medicinal plants, followed by a parallel distribution of seedlings to farmers as a possible means of reducing pressure on natural stands and conserve useful medicinal plant species;
- The indigenous knowledge of pastoralists about plants (traditional system of range land management) and livestock (breeding different species of livestock (grazers with browsers) as well as their environmental management system (traditional forest, soil and water conservation system) should be incorporated in the planning and implementation of developmental interventions;
- Medicinal plants such as *Warburgia ugandensis* and wild edible plants such as *Allophylus abyssinicus* should be given conservation priority for their multipurpose uses;
- Conservation measures which might be designed for vegetation resources of Dugda Dawa District by policy makers, natural resource managers or stakeholders would need to take into account special protection and monitoring of the endemic taxa as well as the most important useful species (medicinal plants such as *Warburgia ugandensis* and wild edible plants such as *Solanum nigrum*) found in the vegetation;

- Good effort should be made by stakeholders to close the observed generation gap in indigenous knowledge (between elders and youngsters) through uninterrupted professional support and training of local communities with an objective of preserving their traditional knowledge and practices through systematic documentation;
- Bioactive and nutritive chemicals of *Warburgia ugandensis* and *Psophocarpus grandiflorus* should be screened out in scientific works for their pharmacological and nutritional potentials.

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APPENDICES

Appendix 1. Semi-structured interview questions employed in the research project, Dugda Dawa District

1. Facts about respondents

1.1. Identification

1.1.1 Name …… 1.1.2. Sex ……

1.1.3. Age …….. 1.1.4. Marital status …….

1.1.5. Educational status ……1.1.6. Ethnic group ……1.1.7. Religion ……

1.2. Address

1.2.1. Region ……. 1.2.2. Zone …….

1.2.3. District …… 1.2.4. Kebele …… 1.2.5. Locality …….

2. Information about the plant to be recorded

2.1. Common /vernacular name of the plant ……

2.2. How wide spread is the medicinal or wild edible plant? ……

2.3. Location of the plant (everywhere, wild, home garden, both wild and home garden, cultivated, others) …….

2.4. In what type of habitat/community is the medicinal/wild edible plant found? …….

2.5. Description of the plant (Habit, height, flower color, mature fruit color, mature seed color, other unique features) …….

2.6. How plant parts are used / fresh, dried, both, cooked or uncooked)? ……..

2.7. Health problem for which the plant is used as a remedy? …….

2.8. Which plant part /s is used as medicine or food? ……..

2.9. Methods of preparation of medicine (Decoction, infusion, etc.) ……..

2.10. Are there any plant and /ingredient added? If yes what type? …….

2.11. Dose or amount and other determiner factors of the medicine ……

2.12. Method of usage, including time (ointment, drink/at certain interval within a day or per day)? …….

2.13. Any noticeable adverse/ side effect /s ……

2.14. Any anti dotes for adverse / side effect /s? ……..

2.15. Any other use of the medicinal/ wild edible plants? ……..

3. **Additional information about the plant that will be recorded**

3.1. Collection # …..3.2. Local name/vernacular name and the language in which the name is used ….

3.3. Scientific name …… 3.4. Family Name ……..

3.5. Brief description of the plant

Habit: …….. Habitat: ……..

3.6. Site /area name……. Distance …… Date: ……

Alt. …….. Time: …… Lat. …….. Long. ……

4. **History of traditional healers /informants**

4.1. Year of services …….

4.2. From whom did you acquire the knowledge? ……..

4.3. What are the main health problems /ailments of human? ……..

4.4. What are the causes of human ailments? ……

4.5. What are the main livestock health problems / ailments? ……

4.6. How do you control /prevent health problems / ailments? ……..

4.7. How do you diagnose each ailments / health problems? ……..

4.8. What types of plants are used to treat human and livestock diseases? ……..

4.8. What are the causes of livestock ailments? ……..

4.9. Symptoms of livestock ailments ……..

4.10. How do you treat human health problems / ailments? ……..

4.11. How do you treat livestock health problems / diseases? …….

4.12. What plant parts are used (fresh only, dried only, both)? ……..

4.13. How do you prepare them? ……..

4.13. How do you determine the dose / amount? …….

4.14. How much the traditional medicine is accepted by the community you live in (Acceptance, no acceptance, I don't know)?.....

4.15. If not accepted why? …….

4.16. If it is accepted why? (Effectiveness of traditional medicine, cheapness of traditional medicine, lack of access to modern medicine, all of the above, other reasons, I don't know) ……

4.17. To whom do you want to share your knowledge? ……..

4.18. Do you collaborate with other traditional healers? …….

4.19. You document your traditional medicinal practice? ……..

5. Concern of the informants to the medicinal plants

5.1. How wide spread the medicinal plant/s in the area? (Common, scarce, absent) ……

5.2. If disappeared, name the disappeared medicinal plants …….

5.3. How do you preserve the traditional medicine? ……

5.4. Any restriction or taboos in collecting medicinal plants ……..

5.5. How do you conserve traditional medicinal plants? ……..

5.6. Are medicinal plants marketable? ……..

5.7. Are there any threats to the medicinal plant? (List them) ……..

5.8. What methods need to conserve the plants? ……

5.9. How is the knowledge on the traditional medicine passed to the family members or younger generation? ……

5.10. How does modernization interfere with traditional medicinal knowledge? …….

5.11. Could you tell me seven medicinal plants of your preference to treat the common disease occurring frequently in this area based on their rank of effectiveness?.....

5.12. Which five plant species are selected by the local communities to be used for different purposes (medicine, food, fuel, forage, construction and craft)?.....

5.13. When you compare these five medicinal plants in their effectiveness of treating

the common disease in this area which comes 1st, 2nd , 3rd 4th and 5th ?.....

6. Concern of the wild edible collectors/users

6.1. How do you know such plants can be eaten? ……..

6.2. From where do you collect them? ……

6.3. How can you identify plant parts to be used as food? ……

6.4. How can you manage if these plants cause negative side effect on users? ……

6.5. Which plant is more preferable in its test and use? …….

6.6. How do you know time of maturity and habitat of different wild edible plants and their future? ……..

6.7. Have you got any economic benefit from wild edibles? …….

6.8. Do you have any tendency to cultivate some selected wild edible plants? ……..

6.9. What do you suggest about the current conservation status of these plants? ……..

7. Concern of the informants to wild edible plants

7.1. How widespread the wild edible plant/s in the area? (Common, scarce, absent) …….

7.2. If disappeared, name the disappeared wild edible plants / local name or number of disappeared plants) …….

7.3. Any restriction or taboos in collecting wild edible plants……..

7.4. How do you conserve wild edible plants? ……

7.5. Are wild edible plants marketable? ……..

7.6. Is there any trend to cultivate some of these wild edible plants? ……

7.7. Are there any threats to the wild edible plants? (List them) ……

7.8. What are the contributions of wild edible plants in fulfilling food shortage or missed nutrients in the diet? …….

7.9. Which group of the community commonly collect and use wild edibles (adult & old men, women or children)? ……

7.10. When do these plants used as a food? During food shortage or every time? ……..

7.11. Could you tell me five wild edible plants of your preference to be eaten commonly based on their rank of delicious or importance? ……..

7.12. Which five plant species are selected by the local people to be used for different purposes (medicine, food fuel, forage, construction and craft)? ……

7.13. If you compare these five wild edibles in their order of delicious or importance which comes first ? ……..

Appendix 2. Sample plots together with the corresponding altitude and location

Plot	Altitude (m.a.s.l.)	Latitude	Longitude		Plot	Altitude (m.a.s.l.)	Latitude	Longitude
1	1624	UTM0609154	37N0418023		31	1605	UTM0588937	37N0421316
2	1696	UTM0609459	37N0418517		32	1648	UTM0600479	37N0417506
3	1876	UTM0610066	37N0418583		33	1637	UTM0598650	37N0416604
4	1875	UTM0604446	37N0417874		34	1765	UTM0600566	37N0408687
5	1340	UTM0573530	37N0447373		35	1769	UTM0600641	37N0408697
6	1273	UTM0570353	37N0450709		36	1825	UTM0601392	37N0404182
7	1615	UTM0591796	37N0427715		37	1848	UTM0601315	37N0404280
8	1707	UTM0601268	37N0424711		38	1780	UTM0613572	37N0411330
9	1697	UTM0601180	37N0425273		39	1766	UTM0613676	37N0411359
10	1650	UTM0601204	37N0423954		40	1799	UTM0613754	37N0412160
11	1754	UTM0601204	37N0423954		41	1807	UTM0412204	37N0412204
12	1642	UTM0592649	37N0425460		42	1903	UTM0605137	37N0391733
13	1630	UTM0592734	37N0425385		43	1923	UTM0605148	37N0391675
14	1592	UTM0592485	37N0425119		44	1964	UTM0605316	37N0391503
15	1587	UTM0592562	37N0425045		45	1789	UTM0607643	37N0393655
16	1621	UTM0588103	37N0428358		46	1759	UTM0609130	37N0394306
17	1620	UTM0588168	37N0428352		47	1938	UTM0609150	37N0417626
18	1614	UTM0586832	37N0428551		48	1953	UTM0609073	37N0417756
19	1613	UTM0586883	37N0428583		49	1975	UTM0608454	37N0417771
20	1574	UTM0592472	37N0426397		50	1966	UTM0608521	37N0417630
21	1572	UTM0592361	37N0426397		51	1972	UTM0608171	37N0417705
22	1570	UTM0585006	37N0389685		52	1973	UTM0608186	37N0417792
23	1660	UTM0585021	37N0389856		53	1921	UTM0604919	37N0418364
24	1830	UTM0589149	37N0387156		54	1915	UTM0605012	37N0418373
25	2230	UTM0597164	37N0384651		55	1934	UTM0605055	37N0418563
26	2283	UTM0598564	37N0384263		56	1948	UTM0605105	37N0418715
27	1624	UTM0609154	37N0418517		57	1968	UTM0605905	37N0418105
28	1696	UTM0609459	37N0418583		58	1952	UTM0605720	37N0418094
29	1500	UTM0584067	37N0420986		59	1935	UTM0605470	37N0418212
30	1603	UTM0588900	37N0421352		60	1927	UTM0605456	37N0418291

N.B. Vegetation types and their plot inclusion are indicated as follows:

Vegetation types	Plot numbers belonging to each vegetation type
Acacia – Commiphora vegetation type	5,6,7,14,15,16,17,18,19,20,21,22,23,27,28,29,30,31,32,33
Combretum – Terminalia vegetation type	8,9,10,11,12,13,34,35,36,37,38,39,40,41,42,43,44,45,46,47
Dry Evergreen Afromontane vegetation type	1,2,3,4, 24,25,26, 48,49,50,51,52,53,54,55,56,57,58,59,60

Appendix 3. Plant species collected from Dugda Dawa District, Borana Zone, Oromia Regional State, Ethiopia

Key: **Habit**; T - Tree, S - Shrub, Li - Liana, Ch - climbing herb, H - Herb,Sedge and Grass, Suc - succulent, * - Endemic sp.

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
1	*Abutilon fruticosum* Guill & Perr.	Malvaceae	------	S	1340	37N0447399	UTM0573517	MA43
2	*Acacia abyssinica* Hochst. ex Benth.	Fabaceae	HONDODDEE/WAACCU	T	1615	37N0427715	UTM0591796	MA108
3	*Acacia brevispica* Harms	Fabaceae	HAMARROO	S	1340	37N0447399	UTM0573517	MA47
4	*Acacia bussei* Harms ex sjostedt	Fabaceae	HALLOO	T	1273	37N0450709	UTM0570353	MA79
5	*Acacia drepanolobium* Harms ex Sjostedt	Fabaceae	LALLATTOO	T	1707	37N0424711	UTM0601268	MA55
6	*Acacia etabaica Schweinf.*	Fabaceae	QABEESSA	T	1340	37N0447399	UTM0573517	MA88
7	*Acacia goetzei* Harms	Fabaceae	BURRA	T	1615	37N0427715	UTM0591796	MA82
8	*Acacia horrida* (L.) Wild.	Fabaceae	HURBBU	T	1650	37N0423954	UTM0601204	MA33
9	*Acacia senegal* (L.) Wild	Fabaceae	HIDHADHOO	T	1340	37N0447399	UTM0573517	MA155
10	*Acacia seyal* Del.	Fabaceae	WAACCU ADII	T	1273	37N0450709	UTM0570353	MA76
11	*Acacia tortilis* (Forssk) Hayne	Fabaceae	DHADACHAA	T	1500	37N0420986	UTM0584067	MA176
12	*Acalypha racemosa* Baill.	Euphorbiaceae	----------	H	1648	37N0417506	UTM0600479	MA167
13	*Acanthus sennii** Chiov.	Acanthaceae	GOORIISSAA	S	1935	37N0418212	UTM0605470	MA343
14	*Achyranthes aspera* L.	Amaranthaceae	DANGEE	H	1642	37N0425459	UTM0592650	MA205
15	*Achyrospermum schimperi* (Hochst.ex Briq.) Perkins	Lamiaceae	DANIIGOLAA	H	1696	37N0418583	UTM0609459	MA136
16	*Acmella caulirhiza* Del.	Asteraceae	JILLOO QALDHAA	H	1696	37N0418583	UTM0609459	MA14
17	*Acokanthera schimperi* (A.DC) Schweinf	Apocyanaceae	QARAARRU	S	1273	37N0450709	UTM0570353	MA63
18	*Ageratum conyzoides* L.	Asteraceae	FAKKATTA DARGU	H	1615	37N0427715	UTM0591796	MA09
19	*Albizia schimperiana* Oliv.	Fabaceae	GARBII	T	1707	37N0424711	UTM0601268	MA13

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
20	*Allophylus abyssinicus* (Hochst.) Rodlkofer	Sapindaceae	SAARAJII	T	1953	37N0417756	UTM0609073	MA302
21	*Allophylus macrobotrys* Gilg	Sapindaceae	--------	S	1615	37N0427715	UTM0591796	MA255
22	*Allophylus rubifolius* (Hochst. ex A.Rich).Engl.	Sapindaceae	-----	S	1273	37N0450709	UTM0570353	MA74
23	*Aloe trichosantha* Berger	Aloaceae	HARGISSA	Suc	1340	37N0447399	UTM0573517	MA280
24	*Alternanthera pungens* Kunth	Amaranthaceae	QUM'WADUU	H	1603	37N0421352	UTM0588900	MA182
25	*Alysicarpus glumaceum* (Vahl) DC.	Fabaceae	SINGO	H	1340	37N0447399	UTM0573517	MA117
26	*Alysicarpus rugosus* (Wild.) DC.	Fabaceae	KILICCU	H	1340	37N0447399	UTM0573517	MA124
27	*Amaranthus dubius* Thell.	Amaranthaceae	RAAFFU	H	1615	37N0427715	UTM0591796	MA02
28	*Ammocharis tinneana* (Kotschy & Peyr.) Milne-Redh. &Schweick	Amaryllidaceae	BUTTE WERABESSA	H	1650	37N0423954	UTM0601204	MA281
29	*Amphicarpa africana* (Hook.f.) Harms	Fabaceae	GAALLEE	Ch	1660	37N0389856	UTM0585021	MA191
30	*Argemone mexicana* L.	Papaveraceae	QOREE ADII	H	1603	37N0421352	UTM0588900	MA30
31	*Arisaema schimperianum* Schott.	Araceae	DANICHAA BOYEE	H	1696	37N0418583	UTM0609459	MA140
32	*Asparagus africanus* Lam.	Asparagaceae	HIDDOO	Li	1617	37N0427715	UTM0591796	MA67
33	*Asparagus flagellaris* (Kunth) Baker	Asparagaceae	SARRITTI	Li	1340	37N0447399	UTM0573517	MA17
34	*Asparagus scaberulus* A. Rich.	Asparagaceae	HIDDOO	Li	1617	37N0427715	UTM0591796	MA25
35	*Aspilia mossambicensis* (Oliv.) H.Wild.	Asteraceae	HADAA	H	1696	37N0418583	UTM0609459	MA151
36	*Balanites aegyptiaca* (L.) Del.	Balanitaceae	BADANAA	T	1615	37N0427715	UTM0591796	MA23

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
37	*Balanites rotundifolia* (van Tieghem) Blatter	Balanitaceae	BADANA OKOLEE	T	1340	37N0447399	UTM0573517	MA93
38	*Barleria quadrispina* Lindau	Acanthaceae	QILXIIPHEE	H	1340	37N0447399	UTM0573517	MA91
39	*Barleria steudneri* C.B.Clarke	Acanthaceae	QILXIIPHEE	H	1340	37N0447399	UTM0573517	MA303
40	*Berkheya spekeana* Oliv.	Asteraceae	GOGODHUU	S	1650	37N0423954	UTM0601204	MA249
41	*Bersama abyssinica* Fresen.	Melianthaceae	XIIBIRROO	T	1696	37N0418583	UTM0609459	MA152
42	*Blumea caffra* (DC.) O.Haffm	Asteraceae	-------	S	1769	37N0408697	UTM0600641	MA352
43	*Boscia mossambicensis* Klotzsch	Capparidaceae	QALQALCHAA	S	1642	37N0425459	UTM0592650	MA210
44	*Boswellia neglecta* S. Moore	Burseraceae	DAKKARA	S	1340	37N0447399	UTM0573517	MA149
45	*Bothriocline schimperi** Oliv. & Hiern ex Benth.	Asteraceae	FAKKATA ANCABBI	S	1624	37N0418517	UTM0609154	MA01
46	*Brachiaria eruciformis* (J. E. Smith) Griseb.	Poaceae	ARERII	H	1492	37N 0421065	UTM0584133	MA181
47	*Cadaba ruspolii* Gilg	Capparidaceae	SAPHANSA	S	1340	37N0447399	UTM0573517	MA59
48	*Calpurnia aurea* (Alti) Benth.	Fabaceae	CEEKATTA	S	1642	37N0425459	UTM0592650	MA58
49	*Canthium lactescens* Hiern	Rubiaceae	KORBOO	S	1875	37N0418023	UTM0604446	MA132
50	*Canthium oligocarpum* Hiern	Rubiaceae	---------	S	1642	37N0425459	UTM0597650	MA188
51	*Canthium setiflorum Hiern*	Rubiaceae	--------	S	1340	37N0447399	UTM0573517	MA87
52	*Capparis fascicularis* Dc.	Capparidaceae	GORRA GAALLA	Li	1642	37N0425459	UTM0597650	MA301
53	*Capparis sepiaria* L.	Capparidaceae	GORRA GALLA	Li	1642	37N0425459	UTM0592650	MA203
54	*Capparis tomentosa* Lam.	Capparidaceae	GORRA GALLA	Li	1642	37N0425459	UTM0592650	MA201
55	*Caralluma priogonium* K. Schum	Asclepidaceae	4 SIDED SEEMING EUPHORBIA (HADAMA)	Suc	1340	37N0447399	UTM0573517	MA242

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
56	*Carica papaya* L.	Caricaceae	PAPAYA	T	1605	37N0421316	UTM0588937	MA304
57	*Carissa spinarum* L.	Apocynaceae	AGANSSAA	Li	1698	37N0418583	UTM0609459	MA113
58	*Cassipourea malosana* (Bak.) Alston	Rhizophoraceae	XILLOO	T	1614	37N0428551	UTM0586882	MA157
59	*Caucanthus auriculatus* (Radlk.) Niedenzu	Malpighiaceae	YABALLUU	Li	1340	37N0447399	UTM0573517	MA69
60	*Cayratia gracilis* (Guill. & Perr.) Suesseng	Vitaceae	AARAYEE (SANYII COOPHII)	Ch	1953	37N0417756	UTM0609073	MA300
61	*Celtis africana* Burm.f.	Ulmaceae	MOTOQOMMAA	T	1624	37N0418517	UTM0609154	MA123
62	*Chlorophytum gallabatense* Schweinf. ex Baker	Anthericaceae	----------	H	1696	37N0418583	UTM0609459	MA246
63	*Chlorophytum somaliense* Baker in Baker & Engl.	Anthericaceae	----------	H	1642	37N0425459	UTM0597650	MA276
64	*Cissus petiolata* Hook. f.	Vitaceae	COOPHII	Li	1953	37N0417756	UTM0609073	MA299
65	*Cissus quadrangularis* L.	Vitaceae	GAALLE ARBAA	Li	1660	37N0389856	UTM0585021	MA196
66	*Cissus rotundifolia* (Forssk.) Vahl	Vitaceae	COOPHII	Li	1273	37N0450709	UTM0570353	MA278
67	*Clematis hirsuta* Perr. & Guill. var. *hirsuta*	Ranunculaceae	FIITTI	Li	1876	37N0417873	UTM0610265	MA159
68	*Clematis simensis* Fresen.	Ranunculaceae	FIITTI	Li	1876	37N0417873	UTM0610265	MA103
69	*Cleome gynandra* L.	Capparidaceae	SHANACHAA/MIKKIDHII	H	1938	37N0417626	UTM0609150	MA341
70	*Clerodendrum myricoides* (Hochst.) Vatke	Lamiaceae	MARDHISSISAA	S	1273	37N0450709	UTM0570353	MA29
71	*Clitoria ternatea* L. var. *ternatea*	Fabaceae	DINGATAGNA	Ch	1650	37N0425954	UTM0601204	MA191
72	*Clutia lanceolata* Forssk. subsp. *lanceolata*	Euphorbiaceae	KUTTADHIIGGA	S	1696	37N0418583	UTM0609459	MA127
73	*Coffea arabica* L.	Rubiaceae	BUNAA	S	1968	37N0418105	UTM0605905	MA305
74	*Combretum adengonium*	Combretaceae	RUKKENSSA NADHE	T	1273	37N0450709	UTM0570353	MA93

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
	Steud. ex A.Rich.							
75	*Combretum aculeatum* Vent.	Combretaceae	RUKKENSSA	T	1707	37N0424711	UTM0601268	MA52
76	*Combretum collinum* Fresen. subsp.*binderianum* (Kotschy) Okafor	Combretaceae	DHANDHASSA	T	1615	37N0427715	UTM0591796	MA38
77	*Combretum contractum* Engl.& Diels	Combretaceae	LU'OO	T	1650	37N0423954	UTM0601204	MA63
78	*Combretum hereroense* Schinz.	Combretaceae	KENNOO	S	1273	37N0450709	UTM0570353	MA80
79	*Combretum molle* R. Br. ex G. Don.	Combretaceae	RUKKENSSA	T	1707	37N0424711	UTM0601268	MA52
80	*Commelina latifolia* Hochst. ex A. Rich.	Commelinaceae	QAAYYO (WEFANQIR)	H	1615	37N0427715	UTM0591796	MA305
81	*Commicarpus plumbagineus* (Cav.) Standl	Nyctaginaceae	DHAKAAJII	Li	1273	37N0450709	UTM0570353	MA152
82	*Commiphora africana* (A.Rich.) Engl.	Burseraceae	HAMEESSA	S	1340	37N0447399	UTM0573517	MA66
83	*Commiphora erythraea* (Ehrenb.) Engl.	Burseraceae	HAGARSSU	T	1340	37N0447399	UTM0573517	MA71
84	*Commiphora rostrata* Engl.	Burseraceae		S	1340	37N0447399	UTM0573517	MA291
85	*Commiphora schimperi* (Berg) Engl.	Burseraceae	HAMEESSA DAALACHAA	S	1340	37N0447399	UTM0573517	MA56
86	*Commiphora terebinthina* Vollesen	Burseraceae		S	1340	37N0447399	UTM0573517	MA290
87	*Conyza pyrropappa* Sch. Bip. ex A.Rich	Asteraceae	---------	S	1650	37N0423954	UTM0601204	MA35
88	*Cordia africana* Lam.	Boraginaceae	WODDESSA	T	1648	37N0417506	UTM0600479	MA175
89	*Cordia ellenbeckii* Gurke	Boraginaceae	MADHEEDHA	S	1615	37N0427715	UTM0591796	MA06
90	*Cordia gharaf* (Forssk.) Ehrenb.	Boraginaceae	--------	S	1340	37N0447399	UTM0573517	MA298

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
91	*Crabbea velutina* S.Moore	Acanthaceae	CIRRECHA/ CIRRALLE	H	1340	37N0447399	UTM0573517	MA94
92	*Crossandra mucronata* Lindau	Acanthaceae	----------	S	1340	37N0447399	UTM0573517	MA106
93	*Crotalaria lachnophora* Hochst. ex A.Rich.	Fabaceae	QORSA DIREYAA	H	1848	37N0404280	UTM0601315	MA236
94	*Crotalaria pallida* Ait. Var. *obovata* (G.Don)	Fabaceae	ATARA HANTUTA	S	1642	37N0425459	UTM0597650	MA39
95	*Crotalaria phillipsiae* Bak.	Fabaceae	----------	S	1615	37N0427715	UTM0591796	MA297
96	*Crotalaria pycnostachya* Benth. subsp. *pycnostachya*	Fabaceae	NITTII BUQATTA	S	1875	37N0418023	UTM0604446	MA118
97	*Croton macrostachyus* Del	Euphorbiaceae	MOKONNIISA	T	1624	37N0418517	UTM0609154	MA137
98	*Cucumiss aculeatus* Cogn	Cucurbitaceae	HADHOOTUU	Ch	1921	37N0418364	UTM0604919	MA289
99	*Cucumis humifructus* Stent	Cucurbitaceae	------	Ch	1273	37N0450709	UTM0570353	MA93
100	*Cussonia holstii* Harms ex Engl.	Araliaceae	BARANGATA	T	1660	37N0389856	UTM0585021	MA270
101	*Cussonia ostinii** Chiov.	Araliaceae		T	1572	37N0389685	UTM0585006	MA296
102	*Cycnium erectum* Rendle	Scrophulariaceae	-----	H	1848	37N0404280	UTM0601315	MA232
103	*Cynoglossum coeruleum* Hochst. ex A. DC. subsp. *geometricum* (Bak. & Wright) Edwards	Boraginaceae	----------	H	1340	37N0447399	UTM0573517	MA94
104	*Cyperus fischerianus* A. Rich.	Cyperaceae	QUNDII (INGICHA)	H	1624	37N0418517	UTM0609154	MA142
105	*Cyphostemma rivae* (Gilg) Desc.	Vitaceae	COOPHII DABASSITTI	Ch	1615	37N0427715	UTM0591796	MA226
106	*Cyphostemma serpens* (A.Rich.) Desc.	Vitaceae	COOPHII	Ch	1615	37N0427715	UTM0591796	MA250
107	*Dalbergia lacteal* Vatke	Fabaceae	FAKKAATA	S	1642	37N0425459	UTM0597650	MA295

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
			DHAADHATU					
108	*Dalbergia microphylla* Chiov.	Fabaceae	WAARSSAAMALA	S	1273	37N0450709	UTM0570353	MA58
109	*Datura stramonium* L.	Solanaceae	QOBBOO ARDAA	H	1953	37N0417756	UTM0609073	MA307
110	*Desmodium repandum* (Vahl) Dc.	Fabaceae	----------	H	1648	37N0417506	UTM0600479	MA179
111	*Dichrostachys cinerea* (L.) Wight & Arn.	Fabaceae	JIRMEE	S	1340	37N0447399	UTM0573517	MA85
112	*Dicliptera maculata* Nees	Acanthaceae	DARGU	H	1624	37N0418517	UTM0609154	MA154
113	*Digitaria volutina* (Forssk)	Poaceae		H	1624	37N0418517	UTM0609154	MA294
114	*Dioscorea schimperiana* Kunth	Dioscoreaceae	BAROODAA	Li	1650	37N0423954	UTM0601204	MA31
115	*Dodonaea angustifolia* L.f.	Sapindaceae	DHITACHAA	S	1605	37N0421316	UTM0588937	MA30
116	*Dolichos sericeus* E. Mey	Fabaceae	BOORANNOTA	Li	1572	37N0426309	UTM0592361	MA13
117	*Dombeya kirkii* Mast	Sterculiaceae	TILILACHAA	T	1340	37N0447399	UTM0573517	MA73
118	*Dombeya torrida* (J.F. Gmel.) P.Bamps	Sterculiaceae	DAANIISSAA/ WULKIFA	T	1921	37N0418364	UTM0604919	MA293
119	*Dovyalis abyssinica (*A. Rich.) Warb	Flacourtiacea	DHUGOO	S	2230	37N 0384651	UTM0597164	MA77
120	*Dregea schimperi* (Decne.) Bullock	Asclepiadacea e	YABALUU	Li	1340	37N0447399	UTM0573517	MA69
121	*Duosperma actinotricha* (Chiov.) Vollesen	Acanthaceae	----------	H	1615	37N0427715	UTM0591796	MA22
122	*Echidnopsis damanniana* Spreng.	Asclepiadacea e		suc	1340	37N0447399	UTM0573517	MA204
123	*Echidnopsis sharpei* White & Sloane Subsp. *sharpei*	Asclepiadacea e	SEEMING EUPHORBIA	suc	1340	37N0447399	UTM0573517	MA245
124	*Echinops ellenbeckii** O.Hoffm.	Asteraceae	BUNSA	S	2230	37N0384651	UTM0597164	MA288
125	*Ehretia cymosa* Thonn.	Boraginaceae	URAAGGA	T	1934	37N0418563	UTM0605055	MA308
126	*Ekebergia capensis* Sparrm	Meliaceae	ANONNU	T	1624	37N0418517	UTM0609154	MA143
127	*Endostemon tenuiflorus*	Lamiaceae	HAXAAWII	H	1340	37N0447399	UTM0573517	MA60

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
	(Benth.) M. Ashby							
128	*Entada leptostachya* Harms	Fabaceae	HANDAADA	Li	1340	37N0447399	UTM0573517	MA97
129	*Eriosema nutans* Schinz	Fabaceae	BOORRAA	H	1769	37N0408697	UTM0600641	MA239
130	*Erythrococca abyssinica* Pax	Euphorbiaceae	----------	H	1615	37N0427715	UTM0591796	MA292
131	*Eucalyptus camaldulensis* Dehnh.	Myrtaceae	BARGAMMOO DIMMA	T	1973	37N0417705	UTM0608172	MA309
132	*Euclea divinorum* Hiern	Ebenaceae	MI'EESSA	S	1275	37N0450709	UTM0570353	MA47
133	*Euphorbia ampliphylIa* Pax	Euphorbiaceae	HADAAMAA	T	1707	37N0424711	UTM0601268	MA48
134	*Euphorbia depauperata* A.Rich.	Euphorbiaceae	GURII/ANTERFA	H	1953	37N0417756	UTM0609073	MA310
135	*Fagaropsis angolensis* (Engl.) Dale	Rutaceae	SISSAA	T	1707	37N0424711	UTM0601268	MA49
136	*Faurea speciosa* Welw.	Proteaceae	HALLO (QAYYA BAYE)	T	1765	37N0408687	UTM0600566	MA238
137	*Ficus ovata* Vahl	Moraceae	QIILXXU	T	1637	37N0416604	UTM0598650	MA265
138	*Ficus sur* Forssk.	Moraceae	HARRUU	T	1648	37N0417506	UTM0600479	MA174
139	*Ficus sycomorus* L.	Moraceae	ODDA	T	1273	37N0450709	UTM0570353	MA262
140	*Ficus thonningii* Blume	Moraceae	DAMBII	S	1705	37N0420748	UTM0598301	MA28
141	*Ficus vasta* Forssk.	Moraceae	QILXAA	T	1648	37N0417506	UTM0600479	MA169
142	*Flacourtia indica* (Burm.f.) Merr.	Flacourtaceae	HAGALLAA	T	1694	37N0418583	UTM0609459	MA119
143	*Foeniculum vulgare* Miller	Apiaceae	GICHAA, INSILAALA, KALKALA	H	1934	37N0418563	UTM0605055	MA311
144	*Fuerstia africana* T. C. E. Fr.	Lamiaceae	QAYYAA DURAA	H	1875	37N0418023	UTM0604446	MA122
145	*Gardenia ternifolia* Schumach.& Thonn.	Rubiaceae	GAMBELLO	S	1642	37N0425459	UTM0592650	MA219
146	*Gerbera piloselloides* (L.) Casso	Asteraceae	ANQAREESSAA	H	1934	37N0418563	UTM0605055	MA312

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
147	*Gerbera viridifolia* (DC.) Sch. Bip	Asteraceae		H	1630	37N0423.85	UTM0592734	MA277
148	*Gladiolus candidus* (Rendle) Goldblatt	Iridaceae	SILINQQAA	H	1621	37N0428358	UTM0588103	MA275
149	*Gloriosa superba* L.	Colchicaceae	KORMA KUYYU	H	1340	37N0447399	UTM0573517	MA45
150	*Glycine wightii* (Wight& Am.) Verdc. Subsp.wightii	Fabaceae	------	Li	1572	37N0426309	UTM0592361	MA211
151	*Gnidia stenophylla* Gilg.	Thymelaceae	ARSSAA	H	1615	37N0427715	UTM0591796	MA24
152	*Grewia bicolor* Juss.	Tiliaceae	HARORESSA	S	1273	37N0450709	UTM0570353	MA53
153	*Grewia ferruginea* Hochst. ex A.Rich.	Tiliaceae	DHOQONUU	S	1876	37N0417875	UTM0610265	MA116
154	*Grewia velutina* (Forssk.) Vahl	Tiliaceae	HARORRESSA	S	1273	37N0450709	UTM0570353	MA158
155	*Guizotia schimperi* Sch.Bip.ex Walp.	Asteraceae	HADAA BUTII	H	1938	37N0417626	UTM0609150	MA313
156	*Haplocoelum foliolosum* (Hiern) Bullock	Sapindaceae	CANNAA	T	1620	37N0428358	UTM0588103	MA216
157	*Helichrysum foetidum* (L.) Moench	Asteraceae	----------	H	1630	37N0423.85	UTM0592734	MA200
158	*Helichrysum forsskahii* (J.F.Gmel.) Hilliard & Burtt	Asteraceae	----------	H	1650	37N0423954	UTM0601204	MA15
159	*Helichrysum glumaceum* DC.	Asteraceae	DARGUU ADII	H	1642	37N0425459	UTM0597650	MA202
160	*Helinus mystacinus* (Ait.) E. Mey.ex Steud.	Rhamnaceae	HOMACHEESSA/ MISIR HAREG	Li	1696	37N0418583	UTM0609459	MA138
161	*Heliotropium longiflorum* (A.DC.in DC.) Jaub. & Spach	Solanaceae	----------	H	1340	37N0447399	UTM0573517	MA08
162	*Heteromorpha arborescens* (Spreng.) Cham. & Schltdl.	Apiaceae	ALLI HANQQAA	S	1574	37N0426392	UTM0592472	MA218
163	*Heteropogon contortus* (L.) Beauv. R. & Sch.	Poaceae	SEERICHA	H	1340	37N0447399	UTM0573517	MA99

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
164	*Hibiscus aethiopicus* L.	Malvaceae	----------	H	1642	37N0425459	UTM0597650	MA193
165	*Hibiscus boranensis** Cufod.	Malvaceae	BUNGAALAA	H	1615	37N0427715	UTM0591796	MA17
166	*Hibiscus flavifolius* Ulbr.	Malvaceae	HINCIINII	H	1624	37N0418517	UTM0609152	MA12
167	*Hibiscus macranthus* Hochst. ex A. Rich.	Malvaceae	HINCIINII	H	1624	37N0418517	UTM0609152	MA27
168	*Hibiscus ovalifolius* (Forssk) Vahl	Malvaceae	DHEEKAA (GEBRESID MESEL)	H	1340	37N0447399	UTM0573517	MA100
169	*Hibiscus pycnostemon* Hochr.	Malvaceae	----------	S	1340	37N0447399	UTM0573517	MA287
170	*Hippocratea africana* (Wild.) Loes.	Celastraceae	XIXIXAA	Li	1696	37N0418583	UTM0609459	MA135
171	*Hippocratea pallens* Planchon ex Oliver.	Celastraceae	DIIKII	Li	1696	37N0418583	UTM0609459	MA137
172	*Hordeum vulgare L.*	Poaceae	GARBUU	H	1934	37N0418563	UTM0605055	MA314
173	*Hymenodictyon floribundum* (Hochst. & Steud.) Robinson	Rubiaceae	---------	S	1660	37N0389856	UTM0585021	MA282
174	*Hypoestes forsskaolii* (Vahl) R.Br.	Acanthaceae	QAXXEE	H	1340	37N0447399	UTM0573517	MA286
175	*Indigofera articulata* Gouan	Fabaceae	HAGAGARRO HARREE	S	1780	37N0411330	UTM0613572	MA136
176	*Indigofera brevicalyx* Bak.f.	Fabaceae	HAGAGARRO HANTUTA	S	1603	37N 0421352	UTM0588900	MA285
177	*Indigofera vohemarensis* Baill	Fabaceae	HAGAGARRO	S	1615	37N0427715	UTM0591796	MA91
178	*Ipomoea kituensis* Vatke	Convolvulaceae	-------	Li	1615	37N0427715	UTM0591796	MA225
179	*Ipomoea pogonantha* Thulin	Convolvulaceae	---------	Li	1340	37N0447399	UTM0573517	MA284
180	*Isoglossa somalensis* Lindau	Acanthaceae	SAYNI DARGU	H	1340	37N0447399	UTM0573517	MA283

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
181	*Jasminum abyssinicum* Hochst ex DC.	Oleaceae	XAMBALALII 1	Li	1780	37N0411330	UTM0613572	MA281
182	*Jasminum eminii* Gilg	Oleaceae	LABBEESSAA	Li	1340	37N0447399	UTM0573517	MA90
183	*Jasminum grandiflorum* L.	Oleaceae	XAMBALLLALL I 2	Li	1875	37N0418023	UTM0604446	MA96
184	*Jasminum schimperi* Vatke	Oleaceae	XAMBALALI 3	Li	1615	37N0427715	UTM0591796	MA98
185	*Jasminum streptopus* E. Mey	Oleaceae	XAMBALALI 4	Li	1642	37N0425459	UTM0597650	MA282
186	*Juniperus procera* Endl.	Cupressaceae	HADHEESSA	T	1830	37N0387156	UTM0589149	MA195
187	*Justicia caerulea* Forssk	Acanthaceae	----------	S	1273	37N0450709	UTM0570353	MA67
188	*Justicia schimperiana* (Hochst. ex Nees) T.Anders.	Acanthaceae	DUMUGA/ CIIGGAA	Sh	1605	37N0421316	UTM0588937	MA315
189	*Kalanchoe densiflora* Rolfe	Crassulaceae	HANCULLEE	Suc	1340	37N0447399	UTM0573517	MA279
190	*Kalanchoe laciniata* (L.) Dc.	Crassulaceae	HANCULLEE	Suc	1615	37N0427715	UTM0591796	MA276
191	*Kickxia elatine* (L.) Dum. Subsp. *crinite* (Mobille) W. Greuter	Scrophulariaceae	-------	H	1603	37N 0421352	UTM0588900	MA280
192	*Kirkia burgeri** Stannard. subsp. *burgeri*	Simaroubaceae	BISIIDHUGAA	S	1340	37N0447373	UTM0573530	MA72
193	*Kosteletzkya adoensis* (A.Rich) Mast	Malvaceae	----------	S	1615	37N0427715	UTM0591796	MA59
194	*Kosteletzkya begoniifolia* (Ulbr.) Ulbr	Malvaceae	HINCIINII	H	1624	37N0418517	UTM0609154	MA12
195	*Lagenaria siceraria* (Molina) Standl.	Cucurbitaceae	BUQQEE	Ch	1605	37N0421316	UTM0588937	MA54
196	*Laggera alata* (D.Don.) Oliv.	Asteraceae	TAMBOO LOOONII	H	1696	37N0418583	UTM0609459	MA19
197	*Laggera crassifolia* (Sch.Bip. ex A.Rich) Oliv. & Hiern	Asteraceae	TAMBOO LOOONII	H	1696	37N0418583	UTM0609459	MA141

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
198	*Lannea rivae* (Chiov.) Sacl.	Anacardiaceae	HANDARAKKU	T	1340	37N0447399	UTM0573517	MA148
199	*Lannea schimperi* (A.Rich.) Engl.	Anacardiaceae	HANDARAKU BADDA	T	1615	37N0427715	UTM0591796	MA239
200	*Lantana trifolia* L.	Verbenaceae	DUBARROO	S	1935	37N0418212	UTM0605470	MA17
201	*Lantana viburnoides* (Forssk.)Vahl	Verbenaceae	DUBARROO	S	1696	37N0418583	UTM0609459	MA115
202	*Lepidotrichilia volkensii* (Gurke) Leroy	Meliaceae	SAAWWAA	S	1807	37N0412204	UTM0412204	MA09
203	*Leucas abyssinica** (Benth.) Briq.	Lamiaceae	----------	H	1807	37N0412204	UTM0412204	MA23
204	*Leucas discolor* Sebald	Lamiaceae	XUXIYEE	H	1696	37N0418583	UTM0609459	MA316
205	*Lippia abyssinica* (Otto & Dietr.) Cufod.	Verbenaceae	UDDOO	S	1948	37N0418715	UTM0605105	MA85
206	*Lippia adoensis** Hochst. ex Walp. var. *adoensis*	Verbenaceae	UDDOO	S	1615	37N0427715	UTM0591796	MA04
207	*Maesa lanceolata* Forssk	Myrsinaceae	ABBAYYII	S	2230	37N0384651	UTM0597164	MA272
208	*Manilkara butugi* Chiov.	Sapotaceae	WOOLLATII	T	1650	37N0423954	UTM0601204	MA21
209	*Margaritaria discoidea* (Bail.) Webster var. *nitida* (pax) A. Radel	Euphorbiaceae	BOBEE'AA	T	1806	37N0381958	UTM0589363	MA229
210	*Maytenus heterophylla* (Eckl. & Zeyh.) Robson	Celastraceae	FAKKAATA KOMO'LCHA	S	1273	37N0450709	UTM0570353	MA75
211	*Maytenus obscura* (A. Rich.) Cuf.	Celastraceae	KOMOL'CHAA	S	1948	37N0418715	UTM0605105	MA210
212	*Maytenus undata* (Thunb.) Blakelock	Celastraceae	OKKOLLU/JAJA BOO	S	1903	37N0391675	UTM0605148	MA162
213	*Mentha pulegium* L.	Lamiaceae	--------	H	1650	37N0423954	UTM0601204	MA228
214	*Microglossa pyrifolia* (Lam.) O. Kuntze	Asteraceae	QORSSAA GAANGEE	Li	1650	37N0423954	UTM0601204	MA35
215	*Millettia ferruginea* *(Hochst) Bak. Subsp.	Fabaceae	DHADHATUU	T	1648	37N0417506	UTM0600479	MA173

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
	darassana (Cuf.) Gillett							
216	*Mimusops kummel* Bruce. ex A. DC.	Sapotaceae	OLLATII	T	1648	37N0417506	UTM0600479	MA163
217	*Momordica foetida* Schumach.	Cucurbitaceae	SURUPHAA BOFAA	Ch	1948	37N0418715	UTM0605105	MA317
218	*Monechma debile* (Forssk.) Nees	Acanthaceae	DARGUU	H	1650	37N0423954	UTM0601204	MA156
219	*Moringa stenopetala* (Bak.f.) Cuf.	Moringaceae	SHALQEEDA/ SHIFARAA	T	1605	37N0421316	UTM0588937	MA216
220	*Myrsine africana* L.	Myrsinaceae	DHIIRRII	S	1948	37N0418715	UTM0605105	MA142
221	*Nuxia congesta* R.Br.ex Fresen.	Loganiaceae	UDDEESSA	T	1875	37N0418023	UTM0604446	MA158
222	*Nuxia oppositifolia* (Hochst.) Benth.	Loganiaceae	----------	T	1648	37N0417506	UTM0600479	MA172
223	*Ochna holstii* Engl.	Ochnaceae	XILLO	T	1614	37N0428551	UTM0586882	MA104
224	*Ochna insculpta* Sleumer	Ochnaceae	KORAYU/WACCAA	T	1948	37N0418715	UTM0605105	MA192
225	*Ochna schweinfurthiana* F. *Hoffm.*	Ochnaceae	BALDHIQQEESSA	S	1754	37N0420746	UTM0598362	MA26
226	*Ocimum americanum* L.	Lamiaceae	DIKITTO	H	1615	37N0427715	UTM0591796	MA27
227	*Ocimum forskolei* Benth.	Lamiaceae	SIXAA	H	1642	37N0425459	UTM0592650	MA223
228	*Ocimum spicatum* Deflers	Lamiaceae	HANCABBII	S	1615	37N0427715	UTM0591796	MA07
229	*Ocimum urticifolium* Roth.S.Lat.	Lamiaceae	HANCABII	S	1273	37N0450709	UTM0570353	MA03
230	*Olea capensis* L. subsp. *macrocarpa* (C. H. Wright) Verdc.	Oleaceae	GAGAMMAA	T	2230	37N0384651	UTM0597164	MA192
231	*Olea europaea* L. subsp. *cuspidata* (Wall. ex G.Don) Cif., L 'Olivicoltore	Oleaceae	EJEERSSA	T	1875	37N0418023	UTM0604446	MA126
232	*Olinia rochetiana* A. Juss.	Oliniaceae	QADIIDDAA	T	1975	37N0417771	UTM0608455	MA318

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
			DALACHAA					
233	*Oplismenus hirtellus (*L.) P. Beaur	Poaceae	----------	H	1624	37N0418517	UTM0609154	MA219
234	*Opuntia ficus - indica* (L.) Miller	Cactaceae	GAMBORA	Su	1500	37N0421316	UTM0588937	MA337
235	*Ormocarpum trichocarpum* (Taub.) Engl.	Fabaceae	BUDULLEE	S	1642	37N0425459	UTM0592650	MA213
236	*Osyris quadripartita* Decn.	Santalaceae	WATTO	S	1642	37N0425459	UTM0592650	MA224
237	*Oxalis corniculata* L.	Oxalidaceae	SODDAA RE'EE	H	1697	37N0425273	UTM0601180	MA41
238	*Ozoroa insignis* Del.	Anacardiaceae	GARRII	T	1642	37N0425459	UTM0592650	MA222
239	*Pancratium tenuifolium* A. Rich.	Amaryllidacea e	LIQAAQAA	H	1615	37N0427715	UTM0591796	MA264
240	*Panicum maximum* Jaq.	Poaceae	LIQAA	H	1492	37N 0421065	UTM0584133	MA168
241	*Pappea capensis* Eckl. & Zeyh.	Sapindaceae	BIIQQAA	T	1615	37N0427715	UTM0591796	MA05
242	*Parthenium hysterophorus* L.	Asteraceae	ARAMMA PARTY	H	1492	37N 0421065	UTM0584133	MA164
243	*Pavetta abyssinica* Fresen.	Rubiaceae	KOMOQORSSA	S	1875	37N0418023	UTM0604446	MA18
244	*Pavetta oliveriana* Hiern	Rubiaceae	-----	S	1642	37N0425459	UTM0592650	MA194
245	*Pellaea calomelanos* (Sw.) Link	Sinopteridace ae	------	Fern	1630	37N0425385	UTM0592734	MA212
246	*Persicaria setosula* (A.Rich.) K.L. Wilson	Polygonaceae	----------	H	1648	37N0417506	UTM0600479	MA154
247	*Phoenix reclinata* Jacq.	Arecaceae	MEEXXII	T	2230	37N0384651	UTM0597164	MA187
248	*Phyllanthus leucanthus* Pax	Euphorbiacea e	DHIIRRI	H	1630	37N0423.85	UTM0592734	MA203
249	*Phyllanthus sepialis* Muell. Arg.	Euphorbiacea e	DHIIRRI ARBBAA	S	1273	37N0450709	UTM0570353	MA37
250	*Physalis peruviana* L.	Solanaceae	HAWUXI	H	1875	37N0418023	UTM0604446	MA133
251	*Pittosporum viridiflorum* Sims	Pittosporaceae	IRBAA/BUDIICH AA	S	1948	37N0418715	UTM0605105	MA12
252	*Plectranthus tenuiflorus* (Vatke) Agnew	Lamiaceae	BARBARREESS A	H	1340	37N0447399	UTM0573517	MA235

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253	*Podocarpus falcatus* (Thunb.) R.B. ex Mirb.	Podocarpacea e	BIIRBIIRSSA	T	1624	37N0418517	UTM0609154	MA114
254	*Polygonum decipiens* (R. Br.) K. L. Wilson	Polygonaceae	----------	H	1648	37N0417506	UTM0600479	MA166
255	*Polyscias fulva* (Hiern) Harms	Araliaceae	GUDUBAA/WAR QOO	T	1953	37N0417756	UTM0609073	MA320
256	*Polysphaeria parvifolia* Hiern	Rubiaceae	MIQQEE	S	1696	37N0418583	UTM0609459	MA164
257	*Premna schimperi* Engl.	Lamiaceae	XULANGGEE	S	1615	37N0427715	UTM0591796	MA29
258	*Prunus africana* (Hook.f.) Kalkm	Rosaceae	SUKKEE	T	2230	37N0384651	UTM0597164	MA178
259	*Psiadia incana* Oliv. & Hiern	Asteraceae	QAXXEE	H	1642	37N0425459	UTM0592650	MA197
260	*Psophocarpus grandiflorus* Wilczek	Fabaceae	QOOQEE/WOKK ALLAA	Ch	1938	37N0417626	UTM0609150	MA92
261	*Psydrax schimperiana* (A. Rich.) Bridson subsp. *schimperiana*	Rubiaceae	GAALLOO	T	1875	37N0418023	UTM0604446	MA129
262	*Pterolobuim stellatum* (Forssk.) Bridson	Fabaceae	QAJIMAA	Li	1935	37N0478212	UTM0605470	MA30
263	*Pyrostria phyllanthoidea* (Bail) Bridson	Rubiaceae	NANDHALLA	S	1340	37N0447399	UTM0573517	MA89
264	*Raphionacme borenensis* Venter & M. G. Gilbert	Asclepiadacea e	--------	Suc	1650	37N0425954	UTM0601204	MA254
265	*Rhamnus prinoides* L' Herit	Rhamnaceae	GEESHEE	S	1624	37N0418517	UTM0609154	MA16
266	*Rhamnus staddo* A. Rich.	Rhamnaceae	QADIIDAA	S	1697	37N0425273	UTM0601180	MA10
267	*Rhoicissus revoilii* Planch	Vitaceae	LAALLUU	Li	1875	37N0418023	UTM0604446	MA14
268	*Rhus glutinosa* A. Rich.	Anacardiaceae	----------	S	1875	37N0418023	UTM0604446	MA48
269	*Rhus longipes* Engl.	Anacardiaceae	XAXEESSA	S	1875	37N0418023	UTM0604446	MA125
270	*Rhus natalensis* Kraus	Anacardiaceae	IRQAAQAMMO O	S	1876	37N0417873	UTM0610265	MA335
271	*Rhus tenuinervis* Engl.	Anacardiaceae	IRQAAQAMMO	S	1876	37N0417873	UTM0610265	MA334

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
			O					
272	*Rhus vulgaris* Meikle	Anacardiaceae	DABOBEESSA	S	1875	37N0418023	UTM0604446	MA134
273	*Rhynchosia ferruginea* A. Rich.	Fabaceae	KALLAALTU	Ch	1340	37N0447399	UTM0573517	MA86
274	*Ricinus communis* L.	Euphorbiacea e	QOOBBOO	H	1948	37N0418715	UTM0605105	MA322
275	*Ritchiea albersii* Gilg	Capparidaceae	JIBAATAA	S	1968	37N0418105	UTM0605905	MA170
276	*Rubus steudneri* Schweinf.	Rosaceae	GORRA	Li	1876	37N0417873	UTM0610265	MA109
277	*Rumex abyssinicus Jacq*.	Polygonaceae	DHANGAGOO	H	1938	37N0417626	UTM0609150	MA323
278	*Ruta chalepensis* L.	Rutaceae	CIRAKOTA	S	1948	37N0418715	UTM0605105	MA324
279	*Sansevieria ehrenbergii* Schweinf. ex Baker	Dracaenaceae	CAAKKEE	H	1340	37N0447399	UTM0573517	MA243
280	*Sarcostemma viminale* (L.) R.Br.	Asclepiadacea e	HANGAYYA	Suc	1273	37N0450709	UTM0570353	MA247
281	*Scadoxus multiflorus* (Martyn) Raf.	Amaryllidacea e	MIIRTUU	H	1492	37N 0421065	UTM0584133	MA269
282	*Schefflera volkensii* (Engl.) Harms	Araliaceae	GATAMA	T	2230	37N0384651	UTM0597164	MA268
283	*Scherebra alata* (Hochst.) Welw.	Oleaceae	DHAMMEE	T	1875	37N0418023	UTM0604446	MA325
284	*Scutia myrtina* (Burm.f.) Kurz	Rhamnaceae	SIIDAMUU	S	1934	37N0418563	UTM0605055	MA158
285	*Senecio hadiensis* Forssk	Asteraceae	WALGABISSA	Li	1340	37N0447399	UTM0573517	MA262
286	*Senecio lyratus* Forssk	Asteraceae	---------	H	1572	37N0426309	UTM0592361	MA35
287	*Senna didymobotrya* (Fresen) Irwin & Barneby	Fabaceae	----------	S	1276	37N0417873	UTM0610065	MA153
288	*Senna longiracemosa* (Vatke) Lock	Fabaceae	GURRAACHAA	S	1650	37N0423954	UTM0601204	MA252
289	*Senna singueana* (Del.) Lock	Fabaceae	CEEKATTA HARREE	S	1615	37N0427715	UTM0591796	MA81
290	*Setaria megaphylla* (Steud.) Th. Dur. & Schinz	Poaceae	MARA DABASIITII	H	1624	37N0418517	UTM0609154	MA246
291	*Sida collina* Schlechtend.	Malvaceae	HARXUMEE	H	1875	37N0418023	UTM0604446	MA107

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
			KARABA					
292	*Sida schimperiana* Hochst. ex A. Rich.	Malvaceae	HAGAGARRO RE'EE (CHIFRIG)	H	1650	37N0423954	UTM0601204	MA34
293	*Solanum coagulans* Forssk.	Solanaceae	XUXIYYEE	H	1615	37N0427715	UTM0591796	MA14
294	*Solanum cordatum* Forssk.	Solanaceae	HIIDII	S	1825	37N0404182	UTM0601392	MA234
295	*Solanum dasyphyllum* Schumach.	Solanaceae	HIIDII ARBBA	S	1624	37N0418517	UTM0609154	MA121
296	*Solanum dennekense* Dammer	Solanaceae	HIIDII	S	1273	37N0450709	UTM0570353	MA78
297	*Solanum giganteum* Jacq.	Solanaceae	HIIDII	S	1934	37N0418563	UTM0605055	MA11
298	*Solanum incanum* L.	Solanaceae	HIIDDII	H	1934	37N0418563	UTM0605055	MA327
299	*Solanum lanzae* J. - P. Lebrun & Stork	Solanaceae	HIIDII RE'EE	S	1492	37N0421065	UTM0584133	MA183
300	*Solanum nigrum* L.	Solanaceae	HADHA'AA/XU NAYE	H	1938	37N0417626	UTM0609150	MA333
301	*Sonchus bipontini* Asch	Asteraceae	---------	H	1273	37N0450709	UTM0570353	MA53
302	*Sonchus oleraceus* L.	Asteraceae	--------	H	1615	37N0427715	UTM0591796	MA19
303	*Sporobolus sp.* R. Br.	Poaceae	SUTTAA	H	1707	37N0424711	UTM0601268	MA242
304	*Steganotaenia araliacea* Hochst.	Apiaceae	LUQAALUQQEE	S	1615	37N0427715	UTM0591796	MA237
305	*Stephania abyssinica* (Dill. & A. Rich.) Walp.	Menispermaceae	-------	Ch	1696	37N0418583	UTM0609459	MA42
306	*Sterculia stenocarpa* H. Winkler	Sterculiaceae	QARARII	T	1614	37N0428552	UTM0586832	MA221
307	*Stylosanthes fruticosa* (Retz.) Alston	Fabaceae	----------	H	1848	37N0404280	UTM0601315	MA227
308	*Suregada procera* (Prain) Croizat	Euphorbiaceae	---------	S	1614	37N0428551	UTM0586832	MA214
309	*Syzygium guineense* (Wild.) DC. subsp.	Myrtaceae	AWAJO	T	1875	37N0418023	UTM0604446	MA178

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
	afromontanum F. White							
310	*Syzygium guineense* (Wild.) DC. subsp. *guineense*	Myrtaceae	BADDESSA	T	2230	37N0384651	UTM0597164	MA128
311	*Syzygium guineense* (Wild.) DC. subsp. *macrocarpa* (Engl.) F. White	Myrtaceae	AWAJO	S	1650	37N0423954	UTM0601204	MA171
312	*Tagetes minuta* L.	Asteraceae	HADAA (GIMEE)	H	1642	37N0425459	UTM0592650	MA209
313	*Tarenna graveolens (*S. Moore) Bremek	Rubiaceae	----------	S	1642	37N0425459	UTM0597650	MA274
314	*Teclea borenensis* M.Gilbert	Rutaceae	HADHEESSA	S	1273	37N0450709	UTM0570353	MA275
315	*Teclea salicifolia* Engl.	Rutaceae	HADHEESSA	S	1273	37N0450709	UTM0570353	MA77
316	*Tephrosia emeroides* A.Rich	Fabaceae	HAGAGARO HARREE	S	1825	37N0404182	UTM0601392	MA30
317	*Terminalia brevipes* Pampanini	Combretaceae	CIGIDDIIDA	S	1615	37N0427715	UTM0591796	MA31
318	*Terminalia brownii* Fresen	Combretaceae	BIDHEESSAA	T	1273	37N0450709	UTM0570353	MA70
319	*Terminalia prunioides* Law	Combretaceae	QOROBBOO	T	1340	37N0447399	UTM0573517	MA64
320	*Terminalia schimperiana* Hochst	Combretaceae	DABAQQA	T	1875	37N0418023	UTM0604446	MA105
321	*Thalictrum rhynchocarpum* Dill. & A.Rich	Ranunculaceae	------	H	1642	37N0425459	UTM0597650	MA199
322	*Themeda triandra* Forssk	Poaceae	GAAGUROO	H	1642	37N0425459	UTM0592650	MA198
323	*Thunbergia ruspolii** Lindau	Acanthaceae	----	Li	2230	37N0384651	UTM0597164	MA189
324	*Tragia cinerea* (Pax) Gilbert & Radcl. Smith	Euphorbiaceae	LALLESSAA	Ch	1624	37N0418517	UTM0609154	MA14
325	*Tribulus cistoides* L.	Zygophyllaceae	MOGORREE	H	1340	37N0447399	UTM0573517	MA40
326	*Trichilia emetic* Vahl.	Meliaceae	XIRDHOO	S	1696	37N0418583	UTM0609459	MA92

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
327	*Triumfetta rhomboidea* Jacq.	Tiliaceae	----------	H	1642	37N0425459	UTM0592650	MA200
328	*Vangueria apiculata* K. Schum	Rubiaceae	BURURII	S	1624	37N0418517	UTM0609154	MA87
329	*Vepris dainellii* *(Pichi - Serm.) Kokwaro	Rutaceae	HADHEESSA ARABEE	S	1696	37N0418583	UTM0609459	MA185
330	*Vepris glomerata* (F.Hoffm.) Engl. var. *glomerata*	Rutaceae	KAARROO	S	1340	37N0447399	UTM0573517	MA57
331	*Vernonia amygdalina* Del.	Asteraceae	EEBIICHA	S	1696	37N0418583	UTM0609459	MA156
332	*Vernonia auriculifera* Hiern	Asteraceae	REEJII	S	1937	37N0417705	UTM0608172	MA329
333	*Vernonia unionis* Sch. Bip. ex Walp	Asteraceae	SOYAAMEE	S	1973	37N0417792	UTM0608186	MA115
334	*Viscum congolense* De Wild	Viscaceae	BALDDOO	Epiph.	1903	37N0391733	UTM0605137	MA71
335	*Viscum tuberculatum* A. Rich.	Viscaceae	DHERTOO	Epiph.	1923	37N0391675	UTM0605148	MA330
336	*Waltheria indica* L.	Sterculiaceae	FAKKATA HARXUME	S	1642	37N0425459	UTM0592650	MA204
337	*Warburgia ugandensis* Sprague	Canellaceae	BIITTII	T	2230	37N0384651	UTM0597164	MA331
338	*Withania somnifera* (L.) Dunal	Solanaceae	LALLAAAFFA	S	1615	37N0427715	UTM0591796	MA248
339	*Xanthium spinosum* L.	Asteraceae	QAQABATTOO(CHEGOGIT	H	1766	37N0411359	UTM0613676	MA230
340	*Ximenia caffra* Sond.	Olacaceae	HUDHAA	S	1806	37N0381958	UTM0589363	MA186
341	*Zanthoxylum chalybeum* Engl.	Rutaceae	GADDAA	S	1615	37N0427715	UTM0591796	MA16
342	*Zehneria scabra* (Linn. f.) Sond.	Cucurbitaceae	SURPHAA	Ch	1953	37N0417756	UTM0609073	MA332
343	*Ziziphus abyssinica* Hochst ex A. Rich.	Rhamnaceae	HUQUNQURAA	T	1615	37N0427715	UTM0591796	MA217

No.	Sceintific name	Familyname	Local name (Oromiffa)	Habit	Altitude	Latitude	Longitude	Vouch. No.
Bryophytes - Collected for their medicinal value								
344	*Hypnum sp*. Hedw (Moss)	Hypnaceae (Bryophyte)	SHAFUNDAA - STEM MOSS	Epiph.	1968	37N0418105	UTM0605905	MA344
345	Isothecium sp. Brid (Moss)	Lembophyllaceae (Bryophyte)	ARII MUKKAA/ARII BIIRBIIRSSA	Epiph.	1934	37N0418563	UTM0605055	MA345

Appendix 4. Synoptic cover abundance value (% of perfect indication, based on combining relative abundance and relative frequency) of each species for each group (the four groups) and the Monte Carlo test (P*) of the significance observed for each species. Bold values indicate indicator species (P*<0.05).

Name of species	**Communities**				
	1	**2**	**3**	**4**	**p***
Abutilon fruticosum	0	0	100	0	0.6327
Allophylus macrobotrys	100	0	0	0	0.1413
Acacia abyssinica	0	0	100	0	0.0495
Acacia brevispica	6	6	**88**	0	**0.0003**
Acacia bussei	0	0	100	0	0.6464
Acacia drepanolobium	0	47	53	0	1
Acacia etabaica	0	0	100	0	0.6327
Acacia goetzei	0	20	**80**	0	**0.016**
Acacia horrid	47	53	0	0	0.4844
Acacia senegal	0	0	**100**	0	**0.015**
Acacia senegal	37	0	63	0	0.2236
Acacia seyal	0	22	**78**	0	**0.0023**
Acacia tortilis	62	0	38	0	0.4689
Acalypha racemosa	72	0	28	0	0.3441
Acanthus eminens	0	35	0	65	0.6744
Achyranthes aspera	79	0	21	0	0.3623
Achyrospermum schimperi	**83**	17	0	0	**0.0098**
Acokanthera schimperi	0	34	12	**54**	**0.0003**
Albizia schimperiana	0	70	0	30	0.4956
Allophylus rubifolius	0	47	53	0	1
Aloe trichosantha	19	23	57	0	0.1933
Alysicarpus glumaceum	0	0	100	0	0.6327
Alysicarpus rugosus	0	56	44	0	1.0000
Amaranthus dubius	0	0	100	0	0.6367
Ammocharis tinneana	0	67	33	0	0.5421
Amphicarpa africana	0	100	0	0	1.0000
Asparagus africanus	0	23	**77**	0	**0.0205**
Asparagus flagellaris	0	0	**100**	0	**0.0003**
Asparagus scaberulus	0	23	**77**	0	**0.0273**
Aspilia mossambicensis	0	0	100	0	0.133
Balanites aegyptiaca	29	10	61	0	0.139
Balanites rotundifolia	0	0	100	0	0.6367
Barleria quadrispina	53	0	47	0	0.5736
Barleria steudneri	0	0	100	0	0.134
Berkheya spekeana	0	100	0	0	1.0000
Berkheya spekeana	0	78	22	0	0.1220

Name of species	Communities				
	1	2	3	4	p*
Blumea caffra	59	0	41	0	0.4846
Boscia mossambicensis	0	0	**100**	0	**0.001**
Boswellia neglecta	0	0	100	0	0.6327
Bothriocline schimperi	0	0	100	0	0.6224
Cadaba ruspolii	0	0	100	0	0.6327
Calpurnia aurea	**100**	0	0	0	**0.017**
Canthium lactescens	0	62	38	0	0.2698
Capparis fascicularis	0	0	100	0	0.6347
Capparis tomentosa	0	32	68	0	0.2993
Caralluma priogonium	0	0	100	0	0.6327
Cassipourea malosana	**70**	10	12	8	**0.0273**
Celtis africana	30	9	0	**61**	**0.0003**
Chlorophytum gallabatense	20	16	64	0	0.1275
Cissus quadrangularis	56	0	44	0	0.5001
Clematis simensis	23	17	60	0	0.1625
Clerodendrum myricoides	0	28	72	0	0.2906
Clitoria ternatea	0	7	**93**	0	**0.0038**
Clutia lanceolata	7	36	0	**57**	**0.0003**
Combretum collinum	0	32	68	0	0.0935
Combretum adengonium	0	44	56	0	1
Combretum contractum	0	28	72	0	0.3041
Combretum hereroense	0	0	100	0	0.1398
Combretum molle	7	31	**62**	0	**0.0005**
Commelina latifolia	0	36	64	0	0.2718
Commiphora erythraea	0	0	100	0	0.1398
Commiphora rostrata	0	0	100	0	0.6327
Commiphora schimperi	0	0	100	0	0.6327
Commiphora terebinthina	0	0	**100**	0	**0.0128**
Commiphora africana	0	0	100	0	0.6347
Cordia africana	100	0	0	0	0.1443
Cordia africana	0	0	100	0	0.6367
Cordia ellenbeckii	0	0	100	0	0.6367
Cordia ellenbeckii	0	100	0	0	1.0000
Crabbea velutina	8	33	**59**	0	**0.0075**
Crossandra mucronata	0	100	0	0	1.0000
Crotalaria lachnophora	100	0	0	0	0.1653
Crotalaria phillipsiae	0	100	0	0	0.2661
Cussonia holstii	0	0	100	0	0.6347
Cycnium erectum	0	100	0	0	1.0000

Name of species	Communities				
	1	2	3	4	p*
Cyperus fischerianus	**100**	0	0	0	**0.0245**
Cyphostemma rivae	0	0	100	0	0.6367
Cyphostemma serpens	0	43	57	0	0.0553
Dalbergia microphylla	50	0	50	0	0.2303
Datura sp.	0	56	44	0	0.1268
Desmodium repandum	**100**	0	0	0	**0.0195**
Dichrostachys cinerea	22	16	**62**	0	**0.005**
Digitaria volutina	18	0	**82**	0	**0.044**
Dioscorea schimperiana	0	10	0	**90**	**0.0045**
Dodonaea angustifolia	27	**48**	19	6	**0.0125**
Dolichos sericeus	0	100	0	0	1.0000
Dolichos sericeus	0	45	55	0	0.4344
Dombeya kirkii	0	0	100	0	0.1398
Dombeya torrida	69	0	0	31	0.3883
Dovyalis abyssinica	**100**	0	0	0	**0.017**
Dregea schimperi	0	0	100	0	0.6327
Duosperma actinotricha	0	0	100	0	0.6367
Echidnopsis damanniana	0	0	100	0	0.6327
Echidnopsis sharpie	0	0	100	0	0.1245
Echinops ellenbeckii	0	100	0	0	1.0000
Ehretia cymosa	100	0	0	0	0.156
Ehretia cymosa	0	100	0	0	1.0000
Ehretia cymosa	0	0	100	0	0.6367
Ekebergia capensis	15	0	9	**76**	**0.0078**
Endostemon tenuiflorus	0	20	80	0	0.2623
Entada leptostachya	100	0	0	0	0.1443
Erythrococca abyssinica	0	0	100	0	0.6367
Eucalyptus camaldulensis	0	0	0	100	0.3603
Euphorbia depauperata	0	0	100	0	0.6347
Euphorbia depauperata	0	0	0	**100**	**0.0093**
Faurea speciosa	0	**85**	15	0	**0.0055**
Ficus sycomorus	0	0	100	0	0.6464
Ficus sur	100	0	0	0	0.1443
Ficus sur	0	100	0	0	1.0000
Ficus thonningii	0	41	59	0	0.5006
Ficus vasta	100	0	0	0	0.1443
Flacourtia indica	16	27	0	57	0.3621
Fuerstia africana	0	**49**	44	7	**0.0030**
Gardenia ternifolia	0	18	**82**	0	**0.0163**

Name of species	Communities				
	1	**2**	**3**	**4**	**p***
Gerbera piloselloides	0	52	0	48	0.8335
Gladiolus candidus	0	0	100	0	0.6269
Gloriosa simplex	0	0	100	0	0.6327
Glycine wightii	**100**	0	0	0	**0.022**
Grewia bicolor	30	10	60	0	0.1515
Grewia ferruginea	38	0	0	**63**	**0.012**
Grewia velutina	0	0	**100**	0	**0.0043**
Haplocoelum foliolosum	0	0	100	0	0.1308
Helinus mystacinus	73	0	0	27	0.0883
Heliotropium longiflorum	0	36	64	0	0.4619
Heteromorpha arborescens	0	0	100	0	0.6254
Heteropogon contortus	0	47	53	0	1
Hibiscus aethiopicus	59	0	41	0	0.4951
Hibiscus boranensis	0	15	**85**	0	**0.0415**
Hibiscus flavifolius	67	21	12	0	0.093
Hibiscus ovalifolius	0	0	**100**	0	**0.0005**
Hippocratea africana	27	19	54	0	0.3776
Hippocratea pallens	**63**	5	24	8	**0.0485**
Hypoestes forsskaolii	0	0	100	0	0.6327
Indigofera articulate	0	100	0	0	0.2721
Indigofera vohemarensis	0	0	100	0	0.0533
Ipomoea kituensis	24	0	**76**	0	**0.0003**
Ipomoea pongonantha	0	0	100	0	0.6327
Isoglossa somalensis	100	0	0	0	0.1443
Jasminum eminii	0	0	100	0	0.6327
Jasminum grandiflorum	0	36	64	0	0.1283
Jasminum schimperi	0	38	62	0	0.892
Jasminum streptopus	0	74	26	0	0.4124
Juniperus procera	0	100	0	0	0.1403
Kalanchoe densiflora	0	0	100	0	0.6327
Kalanchoe laciniata	0	0	100	0	0.6367
Kickxia elatine	100	0	0	0	0.1443
Kirkia burgeri	0	0	100	0	0.0508
Laggera alata	56	0	44	0	0.4816
Laggera crassifolia	**82**	6	12	0	**0.012**
Lannea rivae	0	15	**85**	0	**0.0155**
Lannea schimperi	0	0	**100**	0	**0.0035**
Lantana viburnoides	0	37	63	0	0.899
Lepidotrichilia volkensii	0	100	0	0	1.0000

Name of species	Communities				p*
	1	2	3	4	
Leucas abyssinica	59	18	23	0	0.4111
Leucas abyssinica	0	0	100	0	0.1395
Leucas discolor	0	0	100	0	0.6484
Lippia adoensis	0	48	52	0	0.8657
Maesa lanceolata	**100**	0	0	0	**0.017**
Manilkara butugi	0	100	0	0	1.0000
Margaritaria discoidea	0	5	0	**95**	**0.0005**
Maytenus heterophylla	69	19	12	0	0.3493
Maytenus undata	0	16	0	**84**	**0.0003**
Mentha pulegium	0	100	0	0	0.2638
Microglossa pyrifolia	0	46	0	54	0.1118
Millettia ferruginea	100	0	0	0	0.1443
Mimusops kummel	100	0	0	0	0.1443
Monechema debile	8	24	17	**51**	**0.0003**
Myrsine africana	21	8	**54**	17	**0.027**
Nuxia congesta	23	21	0	**56**	**0.0078**
Nuxia oppositifolia	**100**	0	0	0	**0.002**
Ochna holstii	0	0	0	100	0.3368
Ochna insculpta	0	0	0	100	0.0578
Ochna schweinfurthiana	55	45	0	0	0.5691
Ocimum forskolei	55	26	19	0	0.182
Ocimum urticifolium	13	10	67	10	0.0645
Ocimuum spicatum	51	0	49	0	0.2508
Olea capensis subsp. *macrocarpa*	48	0	0	52	0.1605
Olinia rochetiana	20	7	0	**72**	**0.0018**
Oplismenus hirtellus	**100**	0	0	0	**0.0023**
Osyris quadripartita	0	0	100	0	0.6347
Oxalis corniculata	0	40	60	0	0.4899
Ozoroa insignis	0	54	46	0	0.2421
Pancratium tenuifolium	0	0	100	0	0.6367
Pappea capensis	0	19	**81**	0	**0.0013**
Parthenium hysterophorus	0	0	100	0	0.6304
Pavetta abyssinica	0	73	0	27	0.3018
Pavetta oliveriana	0	0	100	0	0.142
Pellaea calomelanos	0	34	66	0	0.8877
Phoenix reclinata	**100**	0	0	0	**0.017**
Phyllanthus leucanthus	0	52	48	0	1.0000
Physalis peruviana	0	100	0	0	1.0000
Pittosporum viridiflorum	0	15	0	85	0.4781

Name of species	Communities				
	1	**2**	**3**	**4**	**p***
Plectranthus tenuiflorus	15	34	52	0	0.3251
Podocarpus falcatus	0	0	0	100	0.3508
Podocarpus falcatus	27	17	0	**56**	**0.0003**
Polysphaeria parvifolia	54	24	0	22	0.1058
Premna schimperi	0	43	4	**53**	**0.022**
Prunus africana	**100**	0	0	0	**0.02**
Psophocarpus grandiflorus	0	0	0	100	0.3368
Pterollobuim stellatum	10	22	15	**53**	**0.0015**
Pyrostria phyllanthoidea	0	0	**100**	0	**0.004**
Rhamnus prinoides	**79**	21	0	0	**0.0115**
Rhamnus staddo	55	45	0	0	0.4161
Rhoicissus revoilii	0	**58**	42	0	**0.0418**
Rhus glutinosa	0	0	100	0	0.6464
Rhus longipes	0	62	29	9	0.0508
Rhus natalensis	0	65	35	0	0.5046
Rhus vulgaris	100	0	0	0	0.1413
Rhus vulgaris	0	23	**58**	19	**0.0005**
Rhynchosia ferruginea	28	18	**54**	0	**0.024**
Ritchiea albersii	0	0	0	100	0.3528
Rumex abyssinicus	69	0	0	31	0.3963
Sansevieria ehrenbergii	0	0	100	0	0.6327
Sarcostemma viminale	0	0	100	0	0.6327
Scadoxus multiflorus	0	0	100	0	0.0545
Schefflera volkensii	**100**	0	0	0	**0.02**
Scutia myrtina	0	0	0	100	0.053
Senecio hadiensis	0	0	100	0	0.6327
Senna didymobotrya	66	34	0	0	0.3606
Senna longiracemosa	0	35	0	65	0.6767
Senna singueana	0	0	**100**	0	**0.014**
Setaria megaphylla	68	32	0	0	0.0828
Sida collina	**100**	0	0	0	**0.002**
Sida schimperiana	0	100	0	0	1.0000
Solanum cordatum	100	0	0	0	0.1653
Solanum dasyphyllum	0	0	100	0	0.1235
Solanum incanum	0	0	0	**100**	**0.0095**
Solanum nigrum	0	0	0	100	0.3368
Sonchus bipontini	100	0	0	0	0.1408
Sonchus oleraceae	100	0	0	0	0.1528
Sporobolus sp.	0	63	37	0	0.5559

Name of species	Communities				p*
	1	2	3	4	
Steganotaenia araliacea	0	0	100	0	0.052
Stephania abyssinica	0	0	100	0	0.6347
Sterculia stenocarpa	0	47	53	0	1
*Syzygium guineense*s Subsp. *afromontanum*	**100**	0	0	0	**0.02**
*Syzygium guineense*s Subsp. *macrocarpa*	0	100	0	0	1.0000
Syzygium guineense var. *guineense*	38	10	0	51	0.4071
Tagetes minuta	0	0	100	0	0.6464
Teclea salicifolia	100	0	0	0	0.1528
Teclea salicifolia	17	15	6	**61**	**0.0003**
Terminalia brevipes	0	6	**94**	0	**0.0018**
Terminalia brownii	10	5	**85**	0	**0.0003**
Terminalia prunioides	0	0	100	0	0.1398
Terminalia schimperiana	0	**82**	18	0	**0.0248**
Thalictrum rhynchocarpum	0	100	0	0	1.0000
Themeda triandra	0	0	**100**	0	**0.0005**
Tragia cinerea	100	0	0	0	0.1653
Tribulus cistoides	0	0	100	0	0.6327
Trichilia emetic	34	66	0	0	0.2371
Vangueria apiculata	23	0	9	**68**	**0.0008**
Vepris dainellii	57	0	0	43	0.5306
Vepris glomerata	0	0	100	0	0.6327
Vernonia amygdalina	100	0	0	0	0.1498
Vernonia auriculifera	**54**	8	0	38	**0.036**
Vernonia unionis	0	0	0	100	0.3443
Viscum congolense	0	100	0	0	1.0000
Viscum tuberculatum	0	0	0	100	0.3443
Withania somnifera	0	33	67	0	0.3071
Xanthium spinosum	0	100	0	0	0.3123
Ximenia caffra	100	0	0	0	0.1413
Zanthoxylum chalybeum	0	0	100	0	0.6367
Zehneria scabra	0	0	0	100	0.3368
Ziziphus abyssinica	0	23	**77**	0	**0.026**

Appendix 5. Families with their corresponding genera and species number

Key: T = Tree, S = Shrub, Li = Liana, Ch = Climbing herb, H = Herb,

No	Family	No. of genera	No. of spp.	Growth form					
				T	S	Li	Ch	H	Fern
1	Acanthaceae	11	13		4	1		8	
2	Aloaceae	1	1					1	
3	Amaranthaceae	3	3					3	
4	Amaryllidaceae	3	3					3	
5	Anacardiaceae	2	8	1	7				
6	Anthericaceae	1	2					2	
7	Apiaceae	3	3		2			1	
8	Apocyanaceae	2	2		1	1			
9	Araceae	1	1					1	
10	Araliaceae	3	4	4					
11	Arecaceae	1	1	1					
12	Asclepiadaceae	5	6			1		5	
13	Asparagaceae	1	3			3			
14	Asteraceae	19	28	1	8	2		17	
15	Balanitaceae	1	2	2					
16	Boraginaceae	3	5	2	3				
17	Burseraceae	2	6	1	5				
18	Cactaceae	1	1					1	
19	Canellaceae	1	1		1				
20	Capparidaceae	5	7	3	3			1	
21	Caricaceae	1	1	1					
22	Celastraceae	2	5		3	2			
23	Combretaceae	2	10	8	2				
24	Commelinaceae	1	1					1	
25	Convolvulaceae	1	2			2			
26	Crassulaceae	1	2					2	
27	Cucurbitaceae	4	5				5		
28	Cupressaceae	1	1	1					
29	Cyperaceae	1	1					1	
30	Dioscoreaceae	1	1			1			
31	Dracaenaceae	1	1					1	
32	Ebenaceae	1	1		1				
33	Euphorbiaceae	9	12	2	4		1	5	
34	Fabaceae	23	41	13	14	4	4	6	
35	Flacourtiaceae	2	2		2				
36	Iridaceae	1	1					1	
37	Lamiaceae	9	13		4			9	
38	Liliaceae	1	1					1	
39	Loganiaceae	1	2	2					
40	Malpighiaceae	1	1			1			
41	Malvaceae	4	11		3			8	

No	Family	No. of genera	No. of spp.	Growth form					
				T	S	Li	Ch	H	Fern
42	Meliaceae	3	3	1	2				
43	Melianthaceae	1	1	1					
44	Menispermaceae	1	1				1		
45	Moraceae	1	5	4	1				
46	Moringaceae	1	1	1					
47	Myrsinaceae	2	2		2				
48	Myrtaceae	2	4	3	1				
49	Nyctaginaceae	1	1			1			
50	Ochnaceae	1	3	2	1				
51	Olacaceae	1	1		1				
52	Oleaceae	3	8	3		5			
53	Oliniaceae	1	1	1					
54	Oxalidaceae	1	1					1	
55	Papaveraceae	1	1					1	
56	Pittosporaceae	1	1		1				
57	Poaceae	9	9					9	
58	Podocarpaceae	1	1	1					
59	Polygonaceae	3	3					3	
60	Proteaceae	1	1	1					
61	Ranunculaceae	2	3			2		1	
62	Rhamnaceae	4	5		4	1			
63	Rhizophoraceae	1	1	1					
64	Rosaceae	2	2	1		1			
65	Rubiaceae	10	13	2	11				
66	Rutaceae	5	7	1	6				
67	Santalaceae	1	1		1				
68	Sapindaceae	4	6	3	3				
69	Sapotaceae	2	2	2					
70	Scrophulariaceae	2	2					2	
71	Simaroubaceae	1	1		1				
72	Sinopteridaceae	1	1						1
73	Solanaceae	5	12		6			6	
74	Sterculiaceae	3	4	2	2				
75	Thymelaceae	1	1					1	
76	Tiliaceae	2	4		3			1	
77	Ulmaceae	1	1	1					
78	Verbenaceae	2	5		5				
79	Viscaceae	1	2					2	
80	Vitaceae	4	7			3	3	1	
81	Zygophyllaceae	1	1					1	
	Total	**227**	**344**	73	118	31	14	107	1

Appendix 6. Medicinal plants used to treat human ailments in Dugda Dawa District

Key: (Hb=Habit, Pu=Parts used, Ut=Used to treat, Cp=Condition of preparation, Ra= Route of application, T=Tree, H=Herb, Sh=Shrub, Cl=Climber, Hu= Human, F=Fresh, D=Dried, F/D=Fresh/Dried, O=Oral, Dm=Dermal, Na=Nasal, Op=Optical, Er=Ear, L=Leaf, Rt=Root, St=Stem, Ba=Bark, Fl=Flower, Fr=Fruit, S=Seed, Bu=Bulb, Rh= Rhizome, La=Latex, Ds=Distribution, C=Common, R=Rare, *=Endemic).

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
1	*Acacia abyssinica* Hochst. ex Benth.	Fabaceae	HONDODDEE	T	R	Hu	D	Na & Dm	Evil eye (DRIYAA)	Taking dried root parts & fumigating the patient.	C	MA108
2	*Acacia brevispica* Harms	Fabaceae	HAMARROO	T	R	Hu	F	Dm & O	Swelling & forming wound on the body (LUXAA)	The root is crushed, some of it is boiled as tea, and 1 coffee cup is given for the patient. Some of the crushed root is put on the opening of the wound.	C	MA45 b
3	*Acmella caulirhiza* Del.	Asteraceae	JILLOO QALDHAA	H	L & R	Hu	F	O	Abdominal ache (GARAA BU'E) , Cold disease (GAMTOKKE) and breast ache. Inflammation of children's mouth (WAAN AFAAN) Tissue Cancer (LUXAA) Tooth ache	Chopping the leaves giving one tea cup once per day for the patient. The root is crushed, boiled as tea and 1 coffee cup is given to the breast cancer patient. Chopping the leaves, making s/n and giving ½ of coffee cup. Chopping the leaves, making s/n, inserting the s/n through the opening and closing	C	MA14

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
									(DHUKKUBBII ILKKAAN)	the mouth of the opening with the residue. Chopping the leaves and holding with the infected tooth.		
4	*Albizia schimperiana* Oliv.	Fabaceae	GARBII	T	Inner part of bark	Hu	F	O	Stomach ache Stomach cancer	Crushing the bark, making s/n and giving 1 water glass per day for 3 days. Crushing internal bark of this plant with that of *Ekebergia capensis* bark , making s/n and giving one water glass 2 times a day for one day.	R	MA09
5	*Allophylus abyssinicus* (Hochst.) Rodlkofer	Sapindaceae	SARAJII	T	Fr	Hu	F	O	Stomach ache (DHUKKUBA GARAA)	Eating the fruit.	R	MA302
6	*Asparagus africanus* Lam.	Asparagaceae	HIDDOO	Li	L	Hu	F	O	Swelling of the breast due to cold disease (GAMTOKKE)	Crushing the leaves, making s/n, adding honey and giving one water glass for the patient 2 times a day for 3 days.	C	MA25 b
7	*Asparagus flagellaris* (Kunth) Baker	Asparagaceae	SARRITTI	Li	L	Hu	F	O	Increased bile production due to malarial infection (HADHOOTTUU).	Crushing the leaves with megado salt and giving half of a coffee cup of the solution to the patient once. Crushing the leaves	C	MA17

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
									Wound (MADAA) and swelling of part of the body due to infection (DHULLAA).	with the leaves of *Cadaba ruspolii* and magado salt to apply on the wound or giving half of coffee cup of its s/n once per day for swelling.		
8	*Balanites rotundifolia* (van Tieghem) Blatter	Balanitaceae	BADANA OKOLEE	T	St, Gu	Hu	Dr	Fum	Head ache (BOWO). Gonorrhea (DHUKKUBA DHIIRAA) and Amoeboid (MEGEENAA)	Taking dried parts of the stem fumigating the patient for head ache. Crushing the gum, boiling it with butter and giving 1 coffee cup 2 times/day.	C	MA93
9	*Bersama abyssinica* Fresen.	Melianthaceae	XIIBIRROO	T	L	Hu	F	O	Amoeboid (MAGEENAA) and Ascaris (MAAGAA)	Chopping young leaves, making s/n and giving 1 water glass 2 times for 3 days.	C	MA152
10	*Bothriocline schimperi** Oliv. & Hiern ex Benth.	Asteraceae	FAKKATA ANCABII	Sh	L	Hu	F	O	Severe headache (BOCAA)	Chopping the leaves, squeezing by adding some water, drinking ½ of a coffee cup, and dropping 1 - 2 drops through the nose.	C	MA 01
11	*Cadaba ruspolii* Gilg	Capparidaceae	SAPHANSA	Sh	Ba	Hu	F	O	Hepatitis	Its bark is chopped and boiled with megado salt and 3 - 4 coffee cup solution is given to adult human patient/day.	R	MA59
12	*Canthium lactescens* Hiern	Rubiaceae	KORBOO	Sh	L	Hu	F	Dm	Itching (QANXOO/	Chopping the young leaves & applying on	R	MA132

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
									CIITTO)	the infected part.		
13	*Capparis tomentosa* Lam.	Capparidaceae	GORRA GALLA	Li	R Ba	Hu	F	O	Tooth ache Wound (NAQARSA NAFAA)	Chewing & holding the root with infected tooth. Chopping the root bark & applying on the infected part.	C	MA201
14	*Carica papaya* L.	Caricaceae	PAPAYA	T	L, Fr & Latex	Hu	F & Ripe	O & Dm	Hypertension Diabetics, hypertension and gastric ulcer Ringworm (BARRILLE), itching and any skin rash	Chopping the leaves, boiling it, adding little honey or sugar drinking one tea cup 3 times a day for one week. Eating the ripe fruit 2 times a day for 2 weeks or drinking 2 glasses of its juice daily for 2 weeks. Applying the leaf latex on the affected part.		MA304
15	*Carissa spinarum* L.	Apocynaceae	AGANSSAA	Li	L, R and Root bark	Hu	F	O	Cold disease (GAMTOKKE). Stomach cancer (NAQARSSA) Tooth ache Evil eye	Chewing 2 leaves once per day or Chewing the root bark with magado salt. Chewing small part of the root and swallowing the juice. Crushing the root and holding with the infected teeth or chewing the root with the infected tooth.	C	MA113

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
									(DRIYAA) Skin cancer for both human and cattle (NAQARSA NAFFAA)	Chewing the root bark. Crushing its root, combining it with the latex of *Euphorbia ampliphylIa* and applying on the wound.		
16	*Clematis hirsute* Perr. & Guill.	Ranunculacea e	FIITTI	Li	L	Hu	F	O Na & Dm	Swelling & forming wound on the body (LUXAA). Asthma (GURRO OR SHIINQAA). Head ache and coughing. Gland TB (XANACHAA)	Crushing the leaves and applying on the affected part. Chopping the leaves, making solution and applying a droplet through each nostrils**.** Inhaling the crushed leaves to treat head ache and coughing. Chopping the leaves, making s/n and giving 1 coffee cup 3 times a day for 1 week.	C	MA159
17	*Clerodendrum myricoides* (Hochst.) Vatke	Lamiaceae	MARDHISSIS A	Sh	L, R & St	Hu	F	Dm & O	Wound (MADAA) Gonorrhea (DHUKUBA DHIRA)	Chopping the leaves and applying on the wound. Chopping the root, making s/n, boiling it with magado and giving ½ water glass 2 times a day for 3 days. Smelling the crushed leaves for 1 day also facilitate the treatment.	C	MA20

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
									Tooth ache	Brushing the teeth with its stick.		
18	*Clitoria ternatea* L.	Fabaceae	DINGATAGNA	Li	L & R	Hu	F	O	Stomach cancer. Snake bite or venom (IDDANSAA BOFAA). Stomach and abdomen ache. Sore in the mouth	Chopping the root and boiling it with water to give 2 coffee cup once a day for cancer patient. Crushing the root with magado salt, making s/n and giving half to 1 coffee cup at once. Chewing the root and the leaves. Chewing the root for sore in the mouth.	R	MA191
19	*Clutia lanceolata* Forssk. subsp. *lanceolata*	Euphorbiaceae	KUTTAA DHIIGGA	Sh	R & L	Hu	F	O	Bloody Diarrhea (ALBAATTII). Wound (MADAA) Nerve disease (DHUKUBA ADUU)	Crushing the leaves and root together, making s/n and giving 1 coffee cup twice a day. Crushing the root and placing on the wound. Chopping the leaves, making s/n and giving 1 coffee cup at once.	C	MA127
20	*Coffea arabica* L.	Rubiaceae	BUNA	Sh	Fr L	Hu	Dr & F	O & Dm	Dizzy ness & headache. Wound	Roasting the fruits & leaves, crushing, boiling & drinking it by adding salt or sugar as necessary. Applying the powdered coffee on		MA305

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
										the wound.		
21	*Combretum molle* R.Br. ex G.Don	Combretaceae	RUKKENSAA	T	Rt & L	Hu Hu	D F	Na, Dm & O O	Evil eye (DRIYAA) Parasitic worms Stomach ache (DHUKKUBA GARA)	Fumigating the patient with dried and crushed root. Crushing dried root with magado salt, making s/n, adding Camel milk and giving 1 water glass at once. Chewing young leaves and swallowing the juice only.	C	MA52
22	*Commelina latifolia* Hochst ex A. Rich.	Commelinaceae	QAAYYO (WEFANQIR)	H	Latex	Hu	F	Dm	Wound	Dropping the latex on the infected part.	C	MA305
23	*Commicarpus plumbagineus* (Cav.) Standl	Nyctaginaceae	DHAKAAJII	Li	L	Hu	F	Dm	Wound	Chopping the leaves & applying on the wound	R	MA152
24	*Commiphora schimperi* (Berg) Engl.	Burseraceae	HAMEESSA DAALACHAA	Sh	L & R	Hu	F	O & Dm	Febrile illness (MICHII) and tooth ache	Crushing the leaves and rubbing on the face. Crushing the root with magado salt and holding with the infected tooth or heating the root and holding with the infected tooth.	R	MA127
25	*Crabbea velutina* S.Moore	Acanthaceae	CIRRECHA/ CIRRALLE	H	L & R	Hu	F	O	Stomach ache (GARAA DHUKKUBAA) Itching (QANXOO)	Chewing 2 leaves with magado salt once when there is feeling of ache. Chopping the leaves and applying on	R	MA94

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
										infected part.		
26	*Crotalaria lachnophora* Hochst. ex A.Rich.	Fabaceae	QORSA DIREYAA	Sh	Rt	Hu	F	Dm	Evil eye (pain of all parts of the body) - DRIYAA	Crushing the root, boiling it & washing part of the body where pain is feeling without touching the ground with legs.	R	MA236
27	*Cucumis pustulatus* Naud. Ex Hook.f.	Cucurbitaceae	HAADHATU	Li	Rt	Hu	F	O	TB & sharp pain on sides of the body (DHUKKUBA SOMBAA FI WARRANA)	Chewing the root or crushing the root, making s/n & drinking one coffee cup daily until cured.		MA306
28	*Dioscorea schimperiana* Kunth	Dioscoreaceae	BAROODAA	Li	R	Hu	Dr	Dm	Dizziness & adding beauty in females (DADHABUMAA FI BAARREDUMA A NADHOOTTA)	Digging out the root, drying it, crushing and fumigate the patient.	C	MA31
29	*Dovyalis abyssinica* (A.Rich.) Warb	Flacourtiaceae	DHUGOO	Sh	L Ba	Hu	F	O	Cold disease (GAMTOKKEE) Diarrhea in children	Pounding the leaves, making s/n & drinking one coffee cup. Chewing the internal bark.	R	MA 73B
30	*Ehretia cymosa* Thonn.	Boraginaceae	URAAGGA	T	L	Hu	F	Dm	Breast swelling (NAQARSSA MUCHA). Cold disease (GAMTOKKE). Inflammation	Chopping the leaves with sugar & giving 2 coffee cups of its solution twice/ day. Chopping young leaves, mixing it with	C	MA308

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
					Ba	Hu	F	O	of children's Mouth (WAAN AFAANII) and overflow of blood during menstruation. Stomach ache in children (DHUKKUBII GARA IJOOLEEN) Febrile illness (MICHII), Severe headache (BOCAA) Disturbed menstruation cycle.	honey and giving one tea cup for the patient for 3 days. Chopping the leaves, making s/n and giving ¼ litre for the patient. Chopping the leaves, making s/n and giving half to 1 coffee cup of it at once. Crushing this part, making s/n, boiling, adding butter or milk and giving 1 tea cup once per day for 3 days.		
31	*Ekebergia capensis* Sparrm	Meliaceae	ANONNU	T	Ba	Hu	F	O	Stomach cancer	Crushing internal bark of this plant with that of *Albizia schimperiana* bark, making s/n and giving one water glass 2 times a day for one day.		MA143

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
32	*Endostemon tenuiflorus* (Benth.) M. Ashby	Lamiaceae	HAXAAWII	H	R	Hu	F	O	Gonorrhea (DHUKUBA DHIRA) & amoeboid (MAGEANA)	Crushing the root, boiling it with butter giving 1 coffee cup of it for the patient daily for 3 days.	C	MA60
33	*Entada leptostachya* Harms	Fabaceae	HANDADDAA	Sh	R	Hu	F	O	Hepatitis (TIRUU)	Crushing the root with magado salt and giving 3 coffee cup of its s/n once per day.	R	MA97
34	*Erythrina brucei** Schweinf	Fabaceae	WALEENAA	T	Ba	Hu	F	O	Tooth ache (DHUKKUBA ILKAA)	Chewing internal part of stem bark if possible with *magado* salt.	R	MA359
35	*Eucalyptus camaldulensis* Dehnh.	Myrtaceae	BAARGAMODIIMA	T	L	Hu	F	O	Stomach ache (DHUKKUBA GARRA)	Chewing the young leaves & swallowing it.	R	MA309
36	*Euclea divinorum* Hiern	Ebenaceae	MI'EESSA	Sh	R Ba	Hu	F	O	Stomach ache (DHUKKUBA GARRA) Diarrhea (ALBAATTII) Gonorrhea (DHUKKUBA DHIIRAA)	Crushing the root, making s/n, boiling and giving 1 coffee cup once/day. Crushing inner bark, making s/n, boiling, adding milk or butter and giving 1 water glass 2 times a day for 3 days. Crushing internal bark, making s/n, boiling, adding butter and giving one coffee cup 2 times a day for one day.	C	MA47

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
37	*Euphorbia depauperata* A. Rich.	Euphorbiaceae	GURII	H	La	Hu	F	Dm	Skin rash & ring worm (KORMOMMAAN FI ROOBBII)	Taking the latex & applying on the infected part.		MA310
38	*Fagaropsis angolensis* (Engl.) Dale	Rutaceae	SISSAA	T	Ba, R, L & St	Hu	F	O	Gonorrhea (DHUKUBA DHIRA) & regulating menstrual cycle. Tooth ache (DHUKUBA ILKKA) Stomachache (GARA DHUKUBU) Coughing (QUFAA/YIIKEE) Shivering and abnormal breathing (CUMA'A)	Chopping the bark, boiling it with water, and giving 2 coffee cups for the patient twice a day. Crushing these parts and giving 2 coffee cups solution for an adult human patient once a day or brushing the teeth with its stick. Chopping the root, making s/n and giving one coffee cup at once. Chopping internal part of the bark, making s/n and giving one coffee cup 2 times a day for one week. Chopping its leaves with the leaves of *Viscum tuberculatum* , making s/n and giving one coffee cup 2 times a day for 3 days.	C	MA49
39	*Flacourtia indica* (Burm. f.) Merr.	Flacourtiaceae	HAGALAA	T	Ba	Hu	F	O	Swelling of part of the	Chopping bark of the stem, making s/n	C	MA119

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
									body due to cold disease (GAMTOKKE)	drinking one coffee cup 2 times a day until the patient is cured.		
40	*Fuerstia africana* T. C. E.Fr.	Lamiaceae	QAYYAA DURAA	H	L	Hu	F	Dm	Itching (QANXOO/CIITTO). Wound (MICHI)	Crushing the leaves and adding saliva to apply on the affected part. Crushing the leaves and putting on the wound. Crushing the leaves with the leaves of *Ocimum spicatum* and giving half a coffee cup to the patient and polishing some amount on the face and drinking the remaining.	C	MA122
41	*Gardenia ternifolia* Schumach.& Thonn.	Rubiaceae	GAAMBELLO	Sh	Ba	Hu	F	O	Severe headache (BOCAA), fever and disturbed menstrual cycle	Chopping internal part of the bark, making s/n, boiling, adding milk or butter and giving 1 water glass 2 times a day for 3 days.	C	MA219
42	*Gerbera piloselloides* (L.) Casso	Asteraceae	ANQAREESSA	H	L	Hu	F	O	Stomachache (GARA DHUKUBU)	Chopping the leaves, making s/n and giving one coffee cup at once.	C	MA312
43	*Gnidia stenophylla* Gilg.	Thymelaceae	ARSSAA	H	R	Hu	F	O	Gonorrhea (DHUKKUBA DHIIRAA)	Crushing the root, making s/n, adding milk, staying in the sunlight for 3 hours and giving one coffee cup only	C	MA24

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
44	*Haplocoelum foliolosum* (Hiern) Bullock	Sapindaceae	CANAA	Sh	Se	Hu	F	O	Ascaris (MAAGAA)	Chewing a handful of ripened seeds and swallowing it.	R	MA216
45	*Hypnum sp*. Hedw (Moss)	Hypnaceae (Bryophyte)	BIIQIILTUU JIIRMEE	Epi ph.	The whole part	Hu	Roasted	Dm	Itch (CACAA OR CHIFEE)	Roasting these plants on a plate, powdering them, adding butter and applying on the infected part.		MA344
46	*Isothecium* sp. Brid (Moss)	Lembophyllaceae (Bryophyte)	ARII MUKKAA	Epi ph.	The whole	Hu	Roasted	Dm	Itch (CACAA OR CHIFEE)	Roasting these plants on a plate, powdering them, adding butter and applying on the infected part.		MA345
47	*Justicia schimperiana* (Hochst. ex Nees) T. Anders.	Acanthaceae	CIIGGAA	Sh	L	Hu	F	O	Hepatitis (BEKEKKO YKN BIRTEE)	Chopping young leaves, making s/n & drinking half of water glass at once.	R	MA315
48	*Kalanchoe densiflora* Rolfe	Crassulaceae	HANCULLEE	H	L	Hu	F	Dm	Rheumatic pain (NAFAA BOCU)	Heating the leaves on fire & put on where pain is feeling.	C	MA279B
49	*Lagenaria siceraria* (Molina)Standl.	Cucurbitaceae	BUQQII	Li	Leaf latex	Hu	F	Er	Ear disease (DHUKKUBA GURRA)	Dropping the latex into the ear canal	C	MA354
50	*Lippia adoensis** Hochst. ex Walp. var. *adoensis*	Verbenaceae	UDDOO	Sh	L	Hu	F	Dm	Body swelling	Chopping the leaves and mixing with water to wash the infected part of the body.	C	MA04
51	*Millettia ferruginea** (Hochst.) Back	Fabaceae	DHAADHATU	T	L	Hu	F	O	Cold & flee infection (GAMTOKKEFI MUJALEE)	Chopping the leaves, making s/n, adding honey and drinking one water glass at	C	MA173

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
					Se		D	Dm		once for cold. Crushing the seeds, making thick s/n and applying on the infected toes & fingers for flee infection.		
52	*Momordica foetida* Schumach.	Cucurbitaceae	SURUPHAA BOFAA	Ch	Rt	Hu	F	O	Rabies &Gonorrhea (DHUKKUBA SAREE FI DHUKKUBA DHIIRAA)	Pounding the roots, making s/n drinking one coffee cup at once.	C	MA317
53	*Moringa stenopetala* (Bak. f.) Cuf.	Moringaceae	SHIIFARAA	T	L	Hu	F Dr	O O	Qoree (COLD DISEASE) Hypertension (DANFAA DHIIGAA)	Crushing the leaves, making s/n, filtering and giving one water glass before breakfast for 5 days. Powdering dried leaves, adding half a tea spoon of it on a cup of tea and drinking 2 times a day for a week.	R	MA338
54	*Nuxia congesta* R.Br. ex Fresen	Loganiaceae	UDDESSA	T	L	Hu	F	O	Cold disease (GAMTOKKE)	Pounding the leaves with the leaves of *Asparagus africanus*, making s/n & drinking one water glass at once.	R	MA158
55	*Ocimum spicatum*	Lamiaceae	HANCABBII	Sh	L	Hu	F	Dm	Febrile illness	Chopping the leaves,	C	MA03 b

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
	Deflers				& R				(MICHII). Wound (MADAA)	making solution and rubbing on the face and hands for febrile illness. The residue is used to treat the wound.		
56	*Ocimum urticifolium* Roth.S.Lat.	Lamiaceae	HANCABII	Sh	L	Hu	F	O & Dm	Febrile illness (MICHII) Stomach ache	Chopping the leaves, squeezing the juice, rubbing on the face and other body parts. By making solution with some of the crushed leaves half of a coffee cup is given to the patient. Chewing the leaves and swallowing the juice.	C	MA03 a
57	*Olea europaea* L. subsp. *cuspidate* (Wall. ex G.Don) Cif. L'Olivicoltore	Oleaceae	EJEERSSA	T	L Ba St	Hu	F	O	Bloody diarrhea and measles Tooth ache	Chopping the leaves, making s/n and giving 1 coffee cup for the patient. It is possible to use its boiled form. Or Crushing internal part of the bark, making s/n, boiling and giving one coffee cup for 3 days. Brushing the teeth with its stick.	C	MA126
58	*Olinia rochetiana* A. Juss.	Oliniaceae	QADIDA DALACHA	T	L	Hu	F	O	Headache (MATAA	Chopping the leaves making s/n and giving		MA318

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
									BOWUU)	half of a coffee cup for the patient at once.		
59	*Osyris quadripartita* Decn.	Santalaceae	WAATOO	Sh	L Rt	Hu	F	O	TB (DHUKKUBA SOMBAA)	Pounding these parts, making s/n & drinking one water glass daily for a month.	R	MA224
60	*Pappea capensis* Eckl. & Zeyh.	Sapindaceae	BIIQQAA	T	Ba & L	Hu	F	O	Hepatitis (BIIRTEE) Stomach pain after birth (MAARAA) Tooth ache Gonorrhea (DHUKKUBA DHIIRAA) and disturbed menstrual cycle. Breast cancer Snake venom and severe headache (BOCAA)	Crushing inner part of the bark and adding a coffee cup of honey and delay for three days then giving one coffee cup for the patient. Crushing the bark, making s/n, boiling it with butter and giving ¼ liter of it for the patient. Chopping inner part of the bark and holding with the diseased tooth. Crushing internal part of the bark, making s/n, boiling, adding milk or butter, and giving 1 water glass 2 times a day for 3 days. Chopping inner part of the bark, making s/n, boiling, adding sugar and giving 1 water glass 2 times a day for	C	MA05

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
										5 days. Chopping the leaves and inner bark together, making s/n and giving 1 coffee cup 2 times a day for 3 days.		
61	*Pittosporum viridiflorum* Sims	Pittosporaceae	IRBAA YKN BUDICHAA	Sh	R & St	Hu	F & Dr	O & Dm	Evil eye (DRIYAA) Tooth ache	Fumigating the patient with the dried root and spitting the chewed root on the face. Brushing the teeth with its stick.	R	MA319
62	*Plectranthus tenuiflorus* (Vatke) Agnew	Lamiaceae	BARBARREESSA	Ch	R	Hu	F	Dm	Wound	Chopping the root and applying on the wound.	C	MA235B
63	*Podocarpus falcatus* (Thunb.) R.B. ex Mirb.	Podocarpaceae	BIRBIRSSA	T	Ba	Hu	F	O	Gonorrhea (DHUKKUBA DHIIRAA)	Crushing the internal part of the bark with the bark of *Croton macrostachyus,* making s/n, boiling and giving 1 water glass 2 times a day for 3 days.	C	MA114
64	*Polyscias fulva* (Hiern) Harms	Araliaceae	GUDDUBA	T	L	Hu	F	O	Amoebiasis (MAGEANA)	Chopping the leaves, making s/n and drinking one coffee cup.	R	MA320
65	*Polysphaeria parvifolia* Hiern	Rubiaceae	MIQQEE	Sh	L	Hu	F	Dm	Wound (MADAA)	Pounding the leaves and put on the wound	R	MA164
66	*Premna schimperi* Engl.	Lamiaceae	XULANGGEE	Sh	St L	Hu	F & Dr	O	Tooth ache and testifying milk Stomach ache	Brushing the teeth with its stick and fumigating milk	C	MA29

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
										container to give good taste. Chewing young leaves and swallowing the juice.		
67	*Rhamnus prinoides L`He`rit*	Rhamnaceae	GEESHEE	Sh	L	Hu	F	O	Tonsilitis (WAAN AFAANI)	Chopping the leaves, making s/n and giving half a coffee cup at once	C	MA321
68	*Rhoicissus revoilii* Planch	Vitaceae	LAALLUU	Li	R	Hu	F	Dm	Tooth ache	Chopping the roots and applying on the infected tooth	C	MA07
69	*Rhus natalensis* Krauss.	Anacardiaceae	DABOOBESSAA	Sh	L	Hu	F	O	Snake bite (IDDANSAA BOFAA)	Chewing a handful of its leaves	R	MA335
70	*Rhus vulgaris* Meikle	Anacardiaceae	DABOBEESSA	Sh	L	Hu	F	Dm	Itching (QANXOO/CIITTO) Ring worm (BIIFAA YKN ROBBII)	Crushing the leaves with megado salt applying on the affected part. Crushing the leaves, making s/n and giving 1 coffee cup 2 times a day for 3 days.	C	MA134
71	*Rhynchosia ferruginea* A.Rich.	Fabaceae	KALLAALTU	Ch	L	Hu	F	O	Stomach ache (BOKOKA)	Chopping the leaves with magado salt, making s/n and giving one coffee cup for the patient.	C	MA86
72	*Rumex abyssinicus* Jacq.	Polygonaceae	DHANGAGO	H	Rt	Hu	F	O	Gonorrhea (DHUKKUBA DHIIRAA)	Pounding the roots, boiling, adding butter and drinking one water glass daily until cured.	R	MA323

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
73	*Ruta chalepensis* L.	Rutaceae	XEENAADAMI	Sh	L	Hu	F	O	Stomach ache & cold disease (DHUKKUBA GARAA FI GAMTOKKE)	Chopping the leaves, making s/n, adding honey and drinking or giving one water glass.	R	MA324
74	*Schrebera alata* (Hochst) Welw	Oleaceae	DHAMEE	T	St & Ba	Hu	F	O	Tooth ache and throat pain (NAQARSAA ILKAA FI QALXAA)	Brushing the teeth with its stick or chewing internal part of stem bark and not swallowing the juice for tooth ache but swallowing for throat pain.	R	MA325
75	*Solanum incanum* L.	Solanaceae	HIIDDI	Sh	Root Ba R	Hu Hu	F F	O O	Stomach ache (DHUKKUBII GARAA) Hepatitis (TABBIISA YKN TIRUU)	Chopping the root bark, making s/n and giving 1 coffee cup for the patient at once. Crushing the roots, making s/n and giving one coffee cup 2 times a day for a week.	C	MA327
76	*Terminalia brownii* Fresen	Combretaceae	BIDHEESSAA	T	Ba	Hu	F	O	Hepatitis/ BIIRTEE	Chopping the bark with megado salt and 1 coffee cup solution is given for adult human patient/day.	C	MA70
77	*Terminalia prunioides* Law	Combretaceae	QOROBBOO	T	L	Hu	F	Dm	Itching (QANXOO/CIITTO)	Crushing the leaves and applying on the affected part.	R	MA64
78	*Vernonia auriculifera* Hiern	Asteraceae	REEJII	Sh	L	Hu	F	Dm	Wound & stop bleeding during injury (clotting)	Crushing the leaves and putting on the affected part.	C	MA329

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease treated	Preparation & Application	Ds	Vouch. No.
					St	Hu	F	O	(MADAA FI DHIIGAA DHABUF) Amoebiasis (MAGEANA)	Peeling the young stem near the meristem and chewing it		
79	*Warburgia ugandensis* Sprague	Canellaceae	BIITTII	T	Ba	Hu	F	O	Internal cancer, stomach ache, weight loss and prolonged fever	Crushing internal part of the bark, making s/n, boiling and giving 1 tea cup 3 times a day for a week.	R	MA331
80	*Withania somnifera* (L.) Dunal	Solanaceae	LALLAAAFFA	Sh	R	Hu	F & Dr	O	Snake venom (HADHAA BUTTE YKN BOFAA). Stomach ache. Evil eye	Chopping the root, making s/n & giving 1 - 2 coffee cup of it to the victim. Chewing the root with magado salt. Fumigating with the dried root.	C	MA248
81	*Ximenia caffra* Sond.	Olacaceae	HUDHAA	Sh	Ba	Hu	F	Dm	Wound	Chopping the bark & applying on the wound.	R	MA186

Appendix 7. Medicinal plants used to treat livestock ailments in Dugda Dawa District

Key: (Hb=Habit, Pu=Parts used, Ut=Used to treat, Cp=Condition of preparation, Ra= Route of application, T=Tree, H=Herb, Sh=Shrub, Cl=Climber, Ls=Livestock, F=Fresh, D=Dried, F/D=Fresh/Dried, O=Oral, Dm=Dermal, Na=Nasal, Op=Optical, Er=Ear, L=Leaf, Rt=Root, St=Stem, Ba=Bark, Fl=Flower, Fr=Fruit, S=Seed, Bu=Bulb, Rh= Rhizome, La=Latex, Ds=Distribution, C=Common, R=Rare, *=Endemic).

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Co.No.
1	*Ammocharis tinneana* (Kotschy & Peyr.) Milne-Redh. & Schweick	Amaryllidaceae	BUTTE WERABESSA	Sedge	R	LS	F	O	Being breathless in cattle (TUMA)	Chopping the root, making s/n and giving 1 coffee cup/day for 2 days.	R	MA281
2	*Barleria steudneri* C.B.Clarke	Acanthaceae	QILXIIPHEE	H	L	LS	F	O	Internal parasite of the Camel	Feeding it (the whole upper part) to the Camel	R	MA303
3	*Cissus quadrangularis* L.	Vitaceae	GAALLE ARBAA	Li	Ba	Ls	F	Dm	Black leg (ABAGORBA)	Chopping it, and inserting into the dissected skin of the cattle.	R	MA196
4	*Clematis simensis* Fresen.	Ranunculaceae	FIITTI	Li	L	LS	F	O	Shivering and abnormal breathing (CUMA'A)	Crushing the leaves, making solution and giving one water glass of it to the sick animal.	C	MA103
5	*Combretum collinum* Fresen.	Combretaceae	DHANDHASSA	T	L	Ls	F	O	Diarrhea of calves (BUSOOTU)	Pounding the leaves, making s/n if possible adding *Megado* salt & giving small amt through the nostrils & one coffee cup orally once for all.		MA38
6	*Cyphostemma serpens* (A. Rich.) Desc.	Vitaceae	COOPHII (YEZIHON HAREG)	Li	St with Ba	LS	F	Dm	Blackleg (ABAA GOORBAA)	Chopping the stem with its bark, dissecting the skin of the cattle and inserting it.	C	MA250

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Co.No.
					Ba and L	LS	F	Dm	FMD (Foot and Mouth Disease)	Heating the bark and put on (place) on the infected part.		
7	*Datura sp.*L	Solanaceae	XUXIYYEE	H	L	LS	F	O	Diarrhea in calves (BUSOOTUU) Tissue cancer (LUXAA YKN XANDHACHA)	Crushing the leaves with the leaves of *Clematis simensis,* making s/n and giving 1 coffee cup for 1 day. Chopping the leaves, making thick s/n, inserting through the opening of the wound and covering the mouth of the opening with the residue.	C	MA14
8	*Dichrostachys cinerea* (L.) Wight & Arn.	Fabaceae	JIRMEE	Sh	R & Se	LS	F & Dr	O	Diarrhea in Calves (BIISSOTU). Hepatitis (BIIRTEE)	Chopping the roots, making solution and giving 1 coffee cup at once. Feeding the diseased animal with its seeds.	C	MA85
9	*Guizotia scabra* (Vis.) Chiov.	Asteraceae	HADAA BUTTI	H	L	Ls	F	O	Black leg (ABAGORBA)	Chopping the leaves, making s/n & giving one water glass.	C	MA313
10	*Heteromorpha arborescens* (Spreng.) Cham. & Schltdl.	Apiaceae	ALI-HANQAA	Sh	L	Ls	F	O	Shivering and abnormal breathing (CUMA'A)	Crushing its leaves with the leaves of *Ozoroa insignis, Croton macrostachyus, Calpurnia aurea* and *Senecio hadiensis*, making s/n & giving one liter orally at once.	R	MA218

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Co.No.
11	*Laggera crassifolia* (Sch.Bip. ex A. Rich) Oliv & Hiern	Asteraceae	TAMBOO LOOONII	H	R	LS	F	O	Tooth ache of livestock (QOORAA LOON)	Crushing the root, making s/n giving ½ liter once per day for 3 days.	C	MA141
12	*Lannea rivae* (Chiov.) Sacl.	Anacardiaceae	HANDARAKKU	T	Ba	LS	F	O	Shivering and abnormal breathing (CUMA'A) Breathing problem in cattle	Grinding the bark with megado salt and 1 liter solution is given per day for adult cattle for 3 days. Crushing the bark, making s/n and giving 1 liter per day for 3 days.	R	MA148
13	*Leucas abyssinica** (Benth.) Briq.	Lamiaceae	----------	H	L	Ls	F	Na	Coughing & sneezing of calves (BUSSOTU)	Pounding the leaves, making s/n & applying half of a coffee cup through the nose.	R	MA23
14	*Leucas discolor* Sebald	Lamiaceae	XUXIYEE	Sh	L	Ls	F	Na	Breathing problem in calves	Pounding the leaves, making s/n & applying half of a coffee cup through the nose.	C	MA316
15	*Maesa lanceolata* Forssk	Myrsinaceae	ABBAYYII	Sh	L	LS	F	O	Leech infection (ULAULA)	Chopping the leaves, making s/n, boiling and giving ½ liter 2 times a day for 3 days.	C	MA272
16	*Microglossa pyrifolia (*Lam.) O. Kuntze	Asteraceae	QORSSAA TARAABII	Li	L	Ls	F	Dm	Dermal wound of equines (BOOCCOQAA)	Pounding the leaves, making thick s/n & applying on the wound daily until it heal.	C	MA35
17	*Ozoroa insignis*	Anacardiaceae	GARRII	Sh	Ba	LS	F	O	Diseases of	Chopping internal part		MA222

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Co.No.
	Del.								equines (DHUKKUBA TARABII). Bloody diarrhea (GARAA KAASAA)	of the bark with the bark of *Pappea capensis* , making s/n, boiling it and giving ¼ - ½ liter to the equine. Crushing inner bark, making s/n and giving 1 water glass 2 times a day for 2 days.		
18	*Phytolacca dodecandra* L`He`rit	Phytolaccaceae	HARAANJA	Li	L	Ls	F	O	Coughing disease in equines. (GAMOJII TARAABII)	Chopping the leaves, making s/n & giving one water glass twice per week.	R	MA346
19	*Prunus africana* (Hook. f.) Kalkm.	Rosaceae	SUKKEE	T	L	Ls	F	O	Diarrhea, wound and coughing in cattle (SUMUXEE)	Pounding the leaves with the leaves of *Clematis hirsuta, Calpurnia aurea, Ehretia obtusifolia, Croton macrostachyus* and *Teclea simplicifolia*, making s/n and giving one water glass orally at once.	R	MA178
20	*Senecio hadiensis* Forssk	Asteraceae	WALGABISSA	Ch	L	Ls	F	O	Shivering and unable to breath normally in cattle (CUMA'A)	Chopping the leaves with the leaves of *Heteromorpha arborenscens, Croton macrostachyus,Calpurnia aurea* and *Lagenaria abyssinica*, making	R	MA326

No.	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Co.No.
										s/n and giving one liter orally at once.		
21	*Syzygium guineense* (Wild.) DC. var. *guineense*	Myrtaceae	BADDESSA	T	Ba	Ls	F	Na	Leech infection (ULAULAA)	Chopping internal part of stem bark, making s/n and giving half of a coffee cup through the nostrils.	R	MA128
22	*Thunbergia ruspolii** Lindau	Acanthaceae	----------	Li	L	Ls	F	Na	Diarrhea in calves (BUSOOTUU)	Chopping the leaves, making s/n and applying one coffee cup through the nostrils two times a day.	R	MA328
23	*Tragia cinerea* (Pax) Gilbert & Radcl. Smith	Euphorbiaceae	LALLESSAA	Ch	L	LS	F	O Na	Diarrhea in cattle (BUSOOTUU)	Pounding the leaves, making s/n and giving one liter orally and some droplets through the nostrils.	C	MA14
24	*Viscum congolense* DC. Wild.	Viscaceae	BALDDOO	Epi	L & St	LS	F	O	Shivering and abnormal breathing in cattle (CUMA'A). Cold and liver diseases of cattle (DHUKKUBA QORRA FI TIRUU LOONI)	Chopping these parts, making s/n and giving 1 water glass solution 2 times a day for adult cattle. Chopping the leaves, making s/n and giving one water glass to the cattle.	R	MA71

Appendix 8. Medicinal plants used to treat both human and livestock ailments in Dugda Dawa District

Key: (Hb=Habit, Pu=Parts used, Ut=Used to treat, Cp=Condition of preparation, Ra= Route of application, T=Tree, H=Herb, Sh=Shrub, Cl=Climber, Hu= Human, Ls=Livestock, F=Fresh, D=Dried, F/D=Fresh/Dried, O=Oral, Dm=Dermal, Na=Nasal, Op=Optical, Er=Ear, L=Leaf, Rt=Root, St=Stem, Ba=Bark, Fl=Flower, Fr=Fruit, S=Seed, Bu=Bulb, Rh= Rhizome, La=Latex, Ds=Distribution, C=Common, R=Rare, *=Endemic).

	Scientific name	**Family**	**Local name (Oromo language)**	**Hb**	**Pu**	**Ut**	**Cp**	**Ra**	**Disease tr.**	**Preparation & Application**	**Ds**	**Vouch. No.**
1	*Acokanthera schimperi* (A.DC) Schweinf	Apocyanaceae	QARAARRU	T	L	Hu Ls	F Dr	Dm Dm	Itching (QANXOO/ CIITTO) External parasites	Crushing the leaves and applying on the affected part. Fumigating the chicken and their overnight place with dried leaves.	C	MA63
2	*Aloe trichosantha* Berger	Aloaceae	HARGISSA	Su c	L & Lat	Hu & LS	F and heat ed	Dm O	Skin cancer and wound. Skin fungi (Ring Worm)-(BARRILLE) Hepatitis (BIIRTEE) and Increased bile production due to malarial infection (HADHOOT TUU) Eye disease Malaria (BUSAA)	Cutting and chopping the leaf or peeling the leaf and applying on the affected part. Applying the latex on the infected part. Crushing the leaves with magado salt and boiling it with water and giving 1 coffee cup once for humans and half a liter for animals. Dropping one drop of its s/n in to the infected eye 2 times a day for 3 days. Taking the latex about half of coffee cup adding some water and drinking at once.	R	MA280

	Scientific name	**Family**	**Local name (Oromo language)**	**Hb**	**Pu**	**Ut**	**Cp**	**Ra**	**Disease tr.**	**Preparation & Application**	**Ds**	**Vouch. No.**
3	*Balanites aegyptiaca* (L.) Del.	Balanitaceae	BADANAA	T	R & Fru. Gum (Hamphee)	Hu s	F	O	Tooth ache and stomach ache Gonorrhea (DHUKKUBA DHIIRAA) Stomach ache Breast cancer in human and cattle (MUCHA NAMA FI LONII)	Piece of root is chewed for tooth ache and the fruit is eaten for stomach ache. Crushing the root, making s/n and giving one water glass 2 times a day for 3 days. Chewing the gum. Crushing the root, making s/n and giving ½ a liter 2 times a day for 1 week forlivestock and one coffee cup for humans.	C	MA23
4	*Calpurnia aurea (Alti)* Benth.	Fabaceae	CEEKATTA	Sh	L	LS	F	O	Black leg (ABAGORBA), Anthrax (ABASENGA) Hepatitis (BIIRTEE) External parasites of chicken (ANDAQOO	Chopping the leaves, making s/n and giving 1 liter for adult cattle and ½ liter for calf 2 times/day for 3 days. Chopping the leaves with magado salt, making s/n and giving 1 liter for adult cattle and one coffee cup for humans at once. Chopping the leaves, making s/n and spreading on their body and their overnight site. Crushing the leaves,	C	MA59 b

	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Vouch. No.
						Hu	F	Er	) Ear ache (DHUKKUBI GURRA) Hypertensi on (Human)	making s/n, filtering and dropping 2 drops into the infected ear 2 times a day for 3 days. Toasting 7 seeds, crushing, adding to a cup of boiled coffee drinking it once/day for a week.		
5	*Croton macrostachyus* Del.	Euphorbiaceae	MOKONNIISA	T	Ba, Ba	Hu	F	O	Tooth ache Swelling and forming deep opening (LUUXAA) Cold disease (GAMTOKK EE) Gonorrhea (DHUKUBA DHIRA) Amoeboid (MAGENNA A) and Gonorrhea	Holding/ chewing internal part of the bark with the infected tooth. Crushing the internal bark, making thick s/n and adding to infected part. Chopping root bark, making s/n, boiling, adding honey and giving 1 tea cup 2 times a day for 3 days. Crushing internal part of the bark with its leaves, making s/n, boiling and 2 water glass 2 times a day for 3 days. Chopping internal part of its bark, making s/n, adding honey and giving 1 - 2 coffee cup 2 times a day for 3 days. Dropping the latex on the wound or infected part.	C	MA137

	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Vouch. No.
									(DHUKKUBA DHIIRAA) Wound and tetanus Abortion in cattle Kidney infection Ring worm (BARRILLE) Stomach ache Gonorrhea (DHUKUBA DHIRA) Hepatitis Shivering and abnormal breathing	Crushing the leaves, making s/n and giving 2 coffee cups of the s/n for tetanus. Crushing the leaves and internal part of the bark, making s/n and giving 3 coffee cups once. Or Crushing the leaves with the leaves of *Premna schimperi*, making s/n, and giving ½ liter 2 times a day for 1 week. Applying the latex on the infected skin once per day for 3 days. Chopping the root, making s/n and giving 1 coffee cup once. Crushing root bark, making s/n, boiling and giving 1 water glass 2 times a day for 3 days. Chopping the leaves with the leaves of *Calpurnia aurea*, making s/n and giving ½ a liter for livestock and one coffee cup for humans at once.		

	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Vouch. No.
					R				(CUMA'A)	Chopping inner bark, making s/n and giving 1 tea cup 2 times a day for 3 days.		
6	*Datura stramonium* L.	Solanaceae	QOBBOO ARDDAA	H	L	Hu Ls	F	O	Rabies (DHUKKUBA SAREE)	Pounding the leaves, making s/n & giving 1-2 coffee cup for adult human and livestock and half of it for children and calves.	C	MA307
7	*Dodonaea angustifolia* L.f.	Sapindaceae	DHITACHAA	Sh	L & St	Hu & LS	F	O	Cold disease (GAMTOKKEE) External parasites of livestock (TAFFI HORII) Tooth ache	Crushing the leaves, making s/n and giving 1 water glass of it for the patient. Chopping young leaves, making s/n and giving ½ - 1 water glass to the animal. Brushing the teeth with its stick.	C	MA30
8	*Euphorbia ampliphylIa* Pax	Euphorbiaceae	HADAAMAA	T	Latex	Hu & LS	F	Dm O	Wound (NAQARSSAA) Increased bile production (malaria) (HADHOOTTU) Tooth ache. Reproduction organ	Taking the latex, combining it with the crushed *Carissa spinarum* root and applying on the wound. Taking small amount of the latex, adding water and giving 1 water glass 2 times a day for the animal. Applying the latex on the infected tooth.	C	MA48

	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Vouch. No.
									infection in livestocks.	Applying the latex on the infected part.		
9	*Foeniculum vulgare* Miller	Apiaceae	KALKALA YKN INSILAALA	H	Rt	Hu Ls	F	O	Stomach ache in humans & to remove plastic materials from livestock stomach (DHUKKUBA GARRA)	Pounding the roots, making s/n & giving a coffee cup for humans and a liter for livestock.	R	MA311
10	*Hordeum vulgare* L.	Poaceae	GARBUU	H	Se	Hu Ls	Dr	O	Broken bones & worn out tissues (LAFEE CABAA FI NAFAA DADHABAA	Slightly toasting and grinding the seeds, preparing soup by adding milk or butter and drinking it as necessary for humans. Giving some amount of grains daily for sick equine.	R	MA314
11	*Pavetta abyssinica* Fresen.	Rubiaceae	KOMOQORSSA	Sh	Rt	Hu Ls	F	O Dm	Tooth ache & wounded Cancer/skin cancer (DHUKKUBA ILLKANI FI CACASSAA)	Chewing the root for tooth ache. Pounding the root & put on the infected part.	R	MA18
12	*Pavetta oliveriana* Hiern	Rubiaceae	KOMOQORSSA	Sh	L	Hu &	F	O & Dm	Urine retention	Chopping the leaves, making s/n & drinking	C	MA18

	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Vouch. No.
						Ls			(DHIDIINSA FINCAANII)	one coffee cup at once or smelling the chopped leaves.		
13	*Ricinus communis* L.	Euphorbiaceae	QOOBBOO	H	L	LS Hu & Ls	F	O	Urine retention Rabies (DHUKKUBA SAREE)	Crushing the leaves, making s/n and giving 1 liter to the diseased livestock. Pounding its leaves with the leaves of *Croton macrostachyus*, making s/n and giving one coffee cup for humans and one water glass for the livestock at once.	C	MA322

	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Vouch. No.
14	*Solanum dennekense* Dammer	Solanaceae	HIIDII	Sh	R & Se L & R Fr	Hu & LS & Hu	F	O	Goiter Swelling and forming deep opening (LUUXAA) Tonsilites (SIILLISSA) Stomach ache Gland TB (XANACHAA)	Crushing roots and seeds, making s/n and giving ¼ of coffee cup of its solution to the patient. Chopping the leaves and root together, making s/n, introducing through the opening and closing the opening with the residue. Crushing the root, making solution and giving 1 water glass at once. Chewing the root bark with magado salt Taking the juice of the fruit, making s/n and giving 1 water glass of it once a day for 1 week.	C	MA78
15	*Steganotaenia araliacea* Hochst.	Apiaceae	LUQAALUQQE	T	L R	LS Hu	F F	O O	Different diseases of equines including eye disease Over flow of menstruation	Chopping its leaves together with the leaves of *Gardenia ternifolia* and magado salt, 2 cup of its s/n is given to the diseased equine. Chopping the root, making s/n, boiling and giving ¼ litre 2 times a day.	R	MA237 b
16	*Teclea borenensis* M.Gilbert	Rutaceae	HADHEESSA	Sh	R & L	Hu and LS	F	O	Stomach ache (DHUKKUBI GARAA).	Chopping the root, making s/n, boiling it and giving half of coffee cup once per day.	C	MA275

	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Vouch. No.
									Diarrhea (GARAA KAASAA) Breast cancer (NAQARSSA HAARMEE) Bloody diarrhea in livestock (WORAANA) Evil eye Breathless in animals	Chewing the leaf with magado salt once per day. Crushing inner part of the root, making s/n and giving one coffee cup 3 times a day for 1 week. Crushing the root and leaves together with magado salt, making s/n and giving 1/3 of a liter for the animal once a day. Chopping the root, making s/n, boiling and giving 1 tea cup per day for 3 days. Crushing the leaves, making s/n and giving 1 liter at once.		
17	*Teclea salicifolia* Engl.	Rutaceae	HADHEESSA	Sh	L & St	Hu & LS	F	O	Diarrhea (ALBAATTII). Wound (CACCA) Trypanosomiasis (GANDII) Hepatitis (BIIRTEE)	Crushing the leaves giving 1 coffee cup of its solution for the patient. Heating the leaves on fire, adding butter and putting on the wound. Chopping the leaves, giving 1 liter of its solution to the diseased livestock to treat trypanosomiasis. Chopping the leaves, making s/n and giving 3 coffee cups for livestock	R	MA77

	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Vouch. No.
									Stomach ache Tooth ache of humans and livestock (DHUKUBII IILKAAN)	and one coffee cup for humans at once. Crushing the leaves, making s/n and giving half a liter to the diseased animal. Brushing the teeth with its stick or Chopping the leaves and holding it with the infected tooth.		
18	*Vangueria apiculata* K. Schum	Rubiaceae	BURURII	Sh	Root bumps L	LS Hu Ls	F	O O Na	Liver disease Urine retention (DHIDIINSA FINCAANII)	Chopping the root bumps, making s/n, and giving 1 tea cup for humans and half a liter for livestock. Chopping the leaves, making s/n & drinking one coffee cup at once or smelling the chopped leaves.	R	MA87
19	*Vernonia amygdalina* Del.	Asteraceae	EEBIICHA	Sh	R & L	Hu Ls	F	O	Cold disease (GAMTOKKEE) Tooth ache Blotting and urine retention (BOKKOKSAA FI DHIIBIINSA FIINCAANII)	Chopping the root, making s/n, adding honey and giving 2 coffee cups per day for a week. Chewing the root and holding with the diseased teeth. Chopping the leaves, making s/n and giving one coffee cup for humans and giving a liter for livestock at once.	C	MA156

	Scientific name	**Family**	**Local name (Oromo language)**	**Hb**	**Pu**	**Ut**	**Cp**	**Ra**	**Disease tr.**	**Preparation & Application**	**Ds**	**Vouch. No.**
20	*Viscum tuberculatum* A. Rich.	Viscaceae	DHERTOO	Epi	St & L	Hu & LS	F	O	Poisons, snake venom Shivering and abnormal breathing (CUMA'A)	Chopping the whole parts, making s/n and giving 1 coffee cup 2 times a day. Chopping the whole part with magado salt, making s/n and giving 1 water glass 2 times a day for 1 day for the cattle. Or Chopping its leaves with the leaves of *Fagaropsis angolensis* , making s/n and giving one coffee cup 2 times a day for 3 days.	C	MA330
21	*Zanthoxylum chalybeum* Engl.	Rutaceae	GADDAA	Sh	Ba, R, Se, L & St	Hu	F Dr	O	Tooth ache (NAQARSA ILKAAN). Amoebiasis (MAGEANA) & Typhus (GOGOSSA) Hypertension (DANFFA DHIIGAA)	Crushing the bark with magado salt and applying on the infected tooth or chewing the root or brushing the teeth with its stick. Crushing the seed, bark, and root, making s/n and giving 2 coffee cups/day for amoebiasis and typhus. Chopping the internal part of the bark and the leaves together, boiling and drinking like tea or powdering the dried form of these parts and boiling as tea and drinking 1 - 2	R	MA16

	Scientific name	Family	Local name (Oromo language)	Hb	Pu	Ut	Cp	Ra	Disease tr.	Preparation & Application	Ds	Vouch. No.
										tea cup 2 times a day.		
						Ls			Vertebral column pain (DHUKUBII DUBA) Diarrhea in goats (ALBAATTII RE'EE)	Chopping inner part of the bark, making s/n, boiling it, adding butter and giving 1 tea cup 2 times a day for 1 week. Chopping the leaves, making s/n and giving ½ liter per day for 3 days.		
22	*Ziziphus abyssinica* Hochst ex A. Rich.	Rhamnaceae	HUQUNQURA	T	Ba	LS	F	Na	Weight loss and being powerless livestock (XUXII).	Crushing internal part of the bark, making s/n and dropping 2 drops through the nostrils.	C	MA217b
						Hu		O	Severe headache (BOCAA), fever and disturbed	Chopping the bark, making s/n, boiling, adding milk or butter and giving 1 water glass 2 times a day for 3 days.		
					L	Hu	F	Dm	menstrual cycle Wound (MADAA)	Chopping the leaves and applying on the wound.		

Appendix 9. Wild edible plant species used by the local people of Dugda Dawa District

Key: Growth Forms (Gf), T=Tree, H=Herb, Sh=Shrub, Cl=Climber. Parts Used (Pu), Le=Leaf, Rt=Root, St=Stem, Ba=Bark, Fr=Fruit, Se=Seed, Ne=Nectars, Gu = Gum. Abundance (Ab), C=Common, R=Rare. Agro-ecology (Ae), Hl= Highland, Ml= Midland, Ll= Lowland. Additional Uses (Adu), Co= Construction, Fw= Firewood, Fo= Forage, Md= Medicine, Ut = Utensils, Lf = Life fence. (*=Endemic).

No.	Scientific name	Family	Local name (Oromo language)	Gf	Latitude	Longitude	Alt	Ae	Ab	Pu	Adu	Vouch. No.
1	*Acacia seyal* Del.	Fabaceae	WAACCU ADII	T	37N0450709	UTM0570353	1273	Ll	C	Ba	Fw, Co, Fo	MA76
2	*Acacia tortilis* (Forssk.) Hayne	Fabaceae	DHADACHAA	T	37N0420986	UTM0584067	1500	Ll	C	Ba	Fw, Co, Fo	MA176
3	*Acanthus eminens* C.B.Clarke	Acanthaceae	GOORISSA/ GOORDHISA	S	37N0418212	UTM0605470	1935	Ml		Ne	Fw	MA343
4	*Acokanthera schimperi* (A. DC.) Schweinf	Apocyanaceae	QARAARRU	T	37N0450709	UTM0570353	1273	Ll	R	Fr	Fw, Co, Md	MA63
5	*Albizia schimperiana* Oliv.	Fabaceae	GARBII	T	37N0424711	UTM0601268	1707	Ml	C	Ba	Fw, Co, Fo, Ut, Md	MA13
6	*Allophylus abyssinicus* (Hochst.) Rodlkofer	Sapindaceae	SAARAJII	T	37N0417756	UTM0609073	1953	Ml	R	Fr	Fw, Co, Fo, Ut	MA342
7	*Alysicarpus glumaceum* (Vahl) DC.	Fabaceae	SINGO	H	37N0447399	UTM0573517	1340	Ll	R	Rt	Fo, Md	MA117
8	*Alysicarpus rugosus* (Wild.) DC.	Fabaceae	KILICCU	H	37N0447399	UTM0573517	1340	Ll	R	Rt	Fo	MA124
9	*Amaranthus dubius* Thell.	Amaranthaceae	RAAFFU	H	37N0427715	UTM0591796	1615	Ml	C	Le, Se	Fo	MA02
10	*Balanites aegyptiaca* (L.) Del.	Balanitaceae	BADANAA	T	37N0427715	UTM0591796	1615	Ml	C	Fr	Fw, Co,	MA23

No.	Scientific name	Family	Local name (Oromo language)	Gf	Latitude	Longitude	Alt	Ae	Ab	Pu	Adu	Vouch. No.
											Fo, Ut, Md	
11	*Balanites rotundifolia* (van Tieghem) Blatter	Balanitaceae	BADANA OKOLEE	T	37N0447399	UTM0573517	1340	Ll	R	Fr	Fw, Co, Fo, Ut, Md	MA93
12	*Canthium lactescens* Hiern	Rubiaceae	KORBOO	S	37N0418023	UTM0604446	1875	Ml	R	Fr	Fw, Co	MA132
13	*Carissa spinarum* L.	Apocynaceae	AGANSSAA	S	37N0418583	UTM0609459	1698	Ml	C	Fr	Fw, Fo, Md	MA113
14	*Celtis africana* Burm.f.	Ulmaceae	MOTOQOMMAA	T	37N0418517	UTM0609154	1624	Ml	C	Fr	Fw, Co, Fo, Ut,	MA123
15	*Cleome gynandra* L.	Capparidaceae	MIKKIDHI/SHANACHAA	H	37N0417626	UTM0609150	1938	Ml		Le	Fo	MA341
16	*Commiphora africana* (A.Rich.) Engl.	Burseraceae	HAMEESSA	S	37N0447399	UTM0573517	1340	Ll	R	Fr	Fw, Fo	MA66
17	*Commiphora erythraea* (Ehrenb.) Engl.	Burseraceae	HAGARSSU	T	37N0447399	UTM0573517	1340	Ll	C	Ba	Fw, Fo, Co	MA71
18	*Commiphora rostrata* Engl.	Burseraceae	DABIISA	H	37N0447399	UTM0573517	1340	Ll	R	Rt	Fw, Fo	MA339
19	*Commiphora schimperi* (Berg) Engl.	Burseraceae	HAMEESSA DAALACHAA	S	37N0447399	UTM0573517	1340	Ll	C	Rt	Fw, Fo, Md	MA56
20	*Commiphora terebinthina* Vollesen	Burseraceae	CIM'AA	S	37N0447399	UTM0573517	1340	Ll	R	Rt	Fw, Fo, Co	MA340
21	*Cordia africana* Lam.	Boraginaceae	WODDESSA	T	37N0417506	UTM0600479	1648	Ml	R	Fr	Fw, Co, Fo, Ut,	MA175
22	*Cordia ellenbeckii* Gurke	Boraginaceae	MADHEEDHA	T	37N0427715	UTM0591796	1615	Ml	R	Fr	Fw, Fo	MA06A
23	*Cyphostemma rivae* (Gilg) Desc.	Vitaceae	COOPHII DABASSITTI	Li	37N0427715	UTM0591796	1615	Ml	C	Fr	-------	MA226

No.	Scientific name	Family	Local name (Oromo language)	Gf	Latitude	Longitude	Alt	Ae	Ab	Pu	Adu	Vouch. No.
24	*Cyphostemma serpens* (A.Rich.) Desc.	Vitaceae	COOPHII	Li	37N0427715	UTM0591796	1615	Ml	R	Fr	--------	MA250
25	*Dioscorea schimperiana* Kunth	Dioscoreaceae	BAROODAA	Li	37N0423954	UTM0601204	1650	Ml		Rt	Fo	MA31
26	*Eriosema nutans* Schinz	Fabaceae	KURTEE	H	37N0367162	UTM0594992	1494	Ll	R	Rt	Fo	MA40
27	*Euclea divinorum* Hiern	Ebenaceae	MI'EESSA	S	37N0450709	UTM0570353	1275	Ll	C	Fr	Fw, Co, Md	MA47
28	*Fagaropsis angolensis* (Engl.) Dale	Rutaceae	SISSAA	T	37N0424711	UTM0601268	1707	Ml	C	Ba	Fw, Co, Fo, Ut, Md	MA49
29	*Ficus sycomorus* L.	Moraceae	ODDA	T	37N0450709	UTM0570353	1273	Ll	C	Fr	Fw,Fo, Ut	MA262
30	*Ficus sur* Forssk.	Moraceae	HARRUU	T	37N0417506	UTM0600479	1648	Ml	R	Fr	Fw, Fo, Ut	MA174
31	*Ficus vasta* Forssk.	Moraceae	QILXAA	T	37N0417506	UTM0600479	1648	Ml	C	Fr, Gu	Fw, Fo, Ut	MA169
32	*Flacourtia indica* (Burm.f.) Merr.	Flacourtiaceae	HAGALLAA	S	37N0418583	UTM0609459	1694	Ml	C	Fr	Fw, Co, Fo, Md	MA119
33	*Gladiolus candidus* (Rendle) Goldblatt	Iridaceae	SILINQQAA	H	37N0428358	UTM0588103	1621	Ml	R	Rt	Fo	MA275
34	*Grewia bicolor* Juss.	Tiliaceae	HARORESSA	S	37N0450709	UTM0570353	1273	Ll	R	Fr	Fw, Co, Fo, Ut	MA158
35	*Grewia ferruginea* Hochst.ex A. Rich.	Tiliaceae	DHOQONUU	S	37N0417875	UTM0610265	1876	Ml	C	Fr	Fw, Fo	MA116
36	*Grewia velutina* (Forssk.) Vahl	Tiliaceae	HARORREESSA	S	37N0450709	UTM0570353	1273	Ll	C	Fr	Fw, Fo	MA158
37	*Haplocoelum foliolosum* (Hiern)	Sapindaceae	CANNAA	T	37N0428358	UTM0588103	1620	Ml	R	Fr	Fw, Co,	MA216

No.	Scientific name	Family	Local name (Oromo language)	Gf	Latitude	Longitude	Alt	Ae	Ab	Pu	Adu	Vouch. No.
	Bullock										Fo	
38	*Hibiscus ovalifolius* (Forssk.) Vahl	Malvaceae	DHEEKAA	S	37N0447399	UTM0573517	1340	Ll	R	Fr	Fo, Fw	MA100
39	*Lannea rivae* (Chiov.) Sacl.	Anacardiaceae	HANDARAKKU	S	37N0447399	UTM0573517	1340	Ll	R	Fr, Ba	Fw, Co, Fo, Md	MA148
40	*Lannea schimperi* (A. Rich.) Engl	Anacardiaceae	HANDARAKU BADDA	S	37N0427715	UTM0591796	1615	Ml	R	Fr	Fw, Co, Fo	MA239
41	*Lantana viburnoides* (Forssk.)Vahl	Verbenaceae	DUBARROO	S	37N0418583	UTM0609459	1696	Ml	C	Fr	Fw	MA115
42	*Mimusops kummel* Bruce. ex A. DC.	Sapotaceae	OLLATII	T	37N0417506	UTM0600479	1648	Ml	R	Fr	Fw, Co, Fo, Ut	MA163
43	*Moringa stenopetala* (Bak.f.) Cuf.	Moringaceae	SHIIFARAA/ SHALQEEDA	T	37N0421316	UTM0588937		Ml	R	Le	Fw, Md	MA338
44	*Olea europaea* L. subsp. *cuspidate* (Wall. ex G.Don) Cif. L'Olivicoltore	Oleaceae	EJEERSSA	T	37N0418023	UTM0604446	1875	Ml	C	Fr	Fw, Co, Fo, Ut, Md	MA126
45	*Opuntia ficus-indica* (L.) Miller	Cactaceae	GAMBORRAA	Su	37N0421316	UTM0588937		Ml & Ll	R	Fr	Lf	MA337
46	*Oxalis corniculata* L.	Oxalidaceae	SODDAA RE'EE	H	37N0425273	UTM0601180	1697	Ml	C	Le	Fo	MA41
47	*Pancratium tenuifolium* A.Rich	Amaryllidaceae	LIQAAQAA	Se	37N0427715	UTM0591796	1615	Ml	C	Le	Fo	MA264
48	*Pappea capensis* Eckl. & Zeyh.	Sapindaceae	BIIQQAA	T	37N0427715	UTM0591796	1615	Ml	R	Fr	Fw, Co, Fo, Md	MA05
49	*Physalis peruviana* L.	Solanaceae	HAWUXI	H	37N0418023	UTM0604446	1875	Ml	C	Fr	Fo	MA133
50	*Polysphaeria parvifolia* Hiern	Rubiaceae	MIQQEE	S	37N0418583	UTM0609459	1696	Ml	C	Fr	Fw, Co	MA164

No.	Scientific name	Family	Local name (Oromo language)	Gf	Latitude	Longitude	Alt	Ae	Ab	Pu	Adu	Vouch. No.
51	*Psophocarpus grandiflorus* Wilczek	Fabaceae	QOOQEE/ WOKKALLAA	Li	37N0417626	UTM0609150	1938	Ml	R	Fr, Le	Fo	MA336
52	*Psydrax schimperiana* (A. Rich.) Bridson subsp. *schimperiana*	Rubiaceae	GAALLOO	T	37N0418023	UTM0604446	1875	Ml	C	Fr	Fw, Co, Fo, Ut	MA129
53	*Pyrostria phyllanthoidea* (Bail) Bridson	Rubiaceae	NANDHALLA	S	37N0447399	UTM0573517	1340	Ll	C	Fr	Fw, Fo	MA89
54	*Rhus glutinosa* A. Rich.	Anacardiaceae		S	37N0418023	UTM0604446	1875	Ml	C	Fr	Fw, Co, Fo	MA48
55	*Rhus longipes* Engl.	Anacardiaceae	XAXEESSA	S	37N0418023	UTM0604446	1875	Ml	R	Fr, St.	Fw, Co, Fo	MA125
56	*Rhus natalensis* Kraus	Anacardiaceae	IRQAAQAMMO	S	37N0417873	UTM0610265	1876	Ml	C	Fr	Fw, Co, Fo, Md	MA335
57	*Rhus tenuinervis* Engl.	Anacardiaceae	IRQAAQAMMOO	S	37N0417873	UTM0610265	1876	Ml	C	Fr	Fw, Co, Fo	MA334
58	*Rhus vulgaris* Meikle	Anacardiaceae	DABOBEESSA	S	37N0418023	UTM0604446	1875	Ml	C	Fr, Le, St	Fw, Co, Fo, Md	MA134
59	*Rubus steudneri* Schweinf	Rosaceae	GORRA	Li	37N0417873	UTM0610265	1876	Ml	C	Fr	Lf	MA109
60	*Sarcostemma viminale* (L.) R.Br.	Asclepiadaceae	HANGAYYA	Su	37N0450709	UTM0570353	1273	Ll	R	Fr	Fo	MA247
61	*Solanum nigrum* L.	Solanaceae	HADHAA'AA	H	37N0417626	UTM0609150	1938	Ml		Le, Fr	Fo	MA333
62	*Syzygium guineense* (Wild.) DC. subsp. *afromontanum* F. White	Myrtaceae	BADDEESSA	T	37N0384651	UTM0597164	2230	Ml	R	Fr	Fw, Co,	MA178

No.	Scientific name	Family	Local name (Oromo language)	Gf	Latitude	Longitude	Alt	Ae	Ab	Pu	Adu	Vouch. No.
63	*Syzygium guineense* (Wild.) DC. var. *guineense*	Myrtaceae	AWAJO	T	37N0418023	UTM0604446	1875	Ml	R	Fr	Fw, Co, Fo, Md	MA128
64	*Syzygium guineense* (Wild.) DC.subsp. *macrocarpa* F. White	Myrtaceae	AWAJO	T	37N0423954	UTM0601204	1650	Ml	R	Fr	Fw, Co	MA171
65	*Teclea salicifolia* Engl.	Rutaceae	HADHEESSA	S	37N0450709	UTM0570353	1921	Ml	C	Ba, Fr	Fw, Co, Ut, Md	MA77
66	*Terminalia brevipes* Pampanini	Combretaceae	CIGIDDIIDA	S	37N0427715	UTM0591796	1615	Ml	R	Fr	Fw, Fo	MA31
67	*Trichilia emetic* Vahl.	Meliaceae	XIRDHOO	T	37N0418583	UTM0609459	1696	Ml	R	Fr	Fw, Co, Fo	MA92
68	*Vangueria apiculata* K. Schum	Rubiaceae	BURURII	S	37N0418517	UTM0609154	1624	Ml	C	Fr	Fw, Co, Md	MA87
69	*Ximenia caffra* Sond.	Olacaceae	HUDHAA	S	37N0381958	UTM0589363	1806	Ml	R	Fr	Fw, Fo Md	MA186
70	*Zehneria scabra* (Linn. f.) Sond	Cucurbitaceae	SURUPHAA	Ch	37N0417756	UTM0609073	1953	Ml	C	Fr	----	MA332
71	*Ziziphus abyssinica* Hochst ex A. Rich.	Rhamnaceae	HUQUNQURA	T	37N0427715	UTM0591796	1615	Ml	R	Fr	Fw, Fo Md	MA217 B

Appendix 10. Plant species of highly cited for construction and material making in Dugda Dawa District

No.	Scientific name	Family	Local name (Oromo language)	Used for	Vouch.No.
1	*Allophylus abyssinicus* Rodlkofer	Sapindaceae	SAARAJII	Local construction, yoke	MA302
2	*Balanites aegyptiaca* (L.) Del.	Balanitaceae	BADANAA	Farm tools, stools, mortar, chairs	MA23
3	*Calpurnia aurea* (Alti) Benth.	Fabaceae	CEEKATTA	Local construction	MA58
4	*Cassipourea malosana* Alston	Rhizophoracea	XILLOO	Tables, chairs, mortar, construction	MA157
5	*Celtis africana* Burm.f.	Ulmaceae	MOTOQOMMAA	Farm tools, chairs, tables	MA123
6	*Cordia africana* Lam.	Boraginaceae	WODDESSA	Bed, chairs, tables, roof, rope, mortar	MA175
7	*Croton macrostachyus* Del	Euphorbiaceae	MOKONNIISA	Farm tools and pole for local house	MA137
8	*Dodonaea angustifolia* L.f.	Sapindaceae	DHITACHAA	Local construction, tooth brush	MA30
9	*Dombeya torrida* P.Bamps	Sterculiaceae	DAANIISSAA	Chairs, yoke, rope,	MA293
10	*Ehretia cymosa* Thonn.	Boraginaceae	URAAGGA	Chairs, farm tools, mortar, yoke	MA308
11	*Ekebergia capensis* Sparrm	Meliaceae	ANONNU	Chairs, tables, mortar, farm tools	MA143
12	*Eucalyptus camaldulensis* Dehnh.	Myrtaceae	BARGAMMOO	Local construction	MA309
13	*Fagaropsis angolensis* Dale	Rutaceae	SISSAA	Local construction	MA49
14	*Faurea speciosa* Welw.	Proteaceae	HALLOO	Local construction	MA238
15	*Grewia velutina* (Forssk.) Vahl	Tiliaceae	HARORRESSA	Handle for farm tools, walking stick	MA158
16	*Juniperus procera* Endl.	Cupressaceae	HADHEESSA	Local construction	MA195
17	*Lannea schimperi* (A.Rich.) Engl.	Anacardiaceae	HANDARAKKU	Farm tools, chairs, mortar	MA148
18	*Manilkara butugi* Chiov.	Sapotaceae	WOOLLATII	Construction, mortar, farm tools	MA21
19	*Maytenus undata* Blakelock	Celastraceae	OKKOLLU	Handle for farm tools	MA162
20	*Millettia ferruginea* (Hochst) Bak.	Fabaceae	DHADHATUU	Farm tools, chairs, tables, mortar	MA173
21	*Mimusops kummel* Bruce ex A. DC.	Sapotaceae	OLLATII	Pole for local houses, chairs, tables	MA163
22	*Nuxia congesta* R.Br.ex	Loganiaceae	UDDEESSA	Farm tools and local construction	MA158

No.	Scientific name	Family	Local name (Oromo language)	Used for	Vouch.No.
	Fresen				
23	*Olea europaea* L. subsp. cuspidata (Wall.ex G. Don) Cif. L'Olivicoltore	Oleaceae	EJEERSSA	Comb, walking stick, tooth brush	MA126
24	*Phoenix reclinata* Jacq.	Arecaceae	MEEXXII	Basket, hat, mat, stool	MA187
25	*Podocarpus falcatus* (Thunb.) R.B. ex Mirb.	Podocarpaceae	BIIRBIIRSSA	Bed, tables, chairs, floor, roof	MA114
26	*Polyscias fulva* (Hiern) Harms	Araliaceae	GUDUBAA	Beehives, tables, chairs, mortar	MA320
27	*Prunus africana* (Hook.f.) Kalkm	Rosaceae	SUKKEE	Local construction, tables, chairs	MA178
28	*Schefflera volkensii* (Engl.) Harms	Araliaceae	GATAMA	Chairs, tables, beehives, farm tools	MA268
29	*Scherebra alata* (Hochst.) Welw.	Oleaceae	DHAMMEE	Farm tools, mortar, construction	MA325
30	*Syzygium guineense* (Wild.) DC.	Myrtaceae	BADDESSA	Local construction, shade	MA128
31	*Teclea salicifolia* Engl.	Rutaceae	HADHEESSA	Handle for farm tools, walking stick	MA77
32	*Terminalia brownie* Fresen	Combretaceae	BIDHEESSAA	Pole for local houses, shade	MA70

Appendix 11. Plant species highly cited for use as fuel (Charcoal and firewood) in Dugda Dawa District

No.	Species	Family	Growth forms			Use category	
			Shrub	Tree	Liana	Charcoal	Firewood
1	*Acacia abyssinica* Hochst. ex Benth.	Fabaceae		x		x	x
2	*Acacia brevispica* Harms	Fabaceae	x			x	x
3	*Acacia bussei* HarmsexSjostedt	Fabaceae		x		x	x
4	*Acacia drepanolobium* Harms ex Sjostedt	Fabaceae		x		x	x
5	*Acacia goetzei* Harms	Fabaceae		x		x	x
6	*Acacia horrid* (L.) Wild.	Fabaceae		x		x	x
7	*Acacia senegal* (L.) Wild.	Fabaceae		x		x	x
8	*Acacia seyal* Del.	Fabaceae		x		x	x
9	*Acacia tortilis* (Forssk) Hayne	Fabaceae		x		x	x
10	*Acanthus sennii* Chiov.	Acanthaceae	x				x
11	*Acokanthera schimperi* (A.DC.) Schweinf.	Apocyanaceae	x				x
12	*Albizia schimperiana* Oliv.	Fabaceae		x			x
13	*Allophylus abyssinicus* Rodlkofer	Sapindaceae		x		x	x
14	*Allophylus macrobotrys* Gilg	Sapindaceae	x			x	x
15	*Allophylus rubifolius* Engl.	Sapindaceae	x			x	x
16	*Balanites aegyptiaca* (L.) Del.	Balanitaceae		x		x	x
17	*Balanites rotundifolia* Blatter	Balanitaceae		x		x	x
18	*Bersama abyssinica* Fresen.	Melianthaceae		x			x
19	*Boscia mossambicensis* Klotzsch	Capparidaceae	x				x
20	*Boswellia neglecta* S. Moore	Burseraceae	x				x
21	*Cadaba ruspolii* Gilg	Capparidaceae	x				x
22	*Calpurnia aurea* (Alti) Benth.	Fabaceae	x				x
23	*Canthium lactescens* Hiern	Rubiaceae	x				x
24	*Canthium oligocarpum* Hiern	Rubiaceae	x				x
25	*Canthium setiflorum* Hiern	Rubiaceae	x				x
26	*Carissa spinarum* L.	Apocyanaceae			x		x

No.	Species	Family	Growth forms			Use category	
			Shrub	Tree	Liana	Charcoal	Firewood
27	*Cassipourea malosana* (Bak.) Alston	Rhizophoraceae		x			x
28	*Caucanthus auriculatus* Niedenzu	Malpighiaceae			x		x
29	*Celtis africana* Burm.f.	Ulmaceae		x			x
30	*Clerodendrum myricoides* Vatke	Lamiaceae	x				x
31	*Coffea arabica* L.	Rubiaceae	x				x
32	*Combretum adengonium* Steud.	Combretaceae		x		x	x
33	*Combretum capituliflorum* Schweinf.	Combretaceae		x		x	x
34	*Combretum collinum* Fresen.	Combretaceae		x		x	x
35	*Combretum contractum* Engl. & Diell	Combretaceae		x		x	x
36	*Combretum hereroense* Schinz	Combretaceae	x			x	x
37	*Combretum molle* R. Br. ex G. Don.	Combretaceae		x		x	x
38	*Commiphora africana* (A.Rich.) Engl.	Burseraceae	x				x
39	*Commiphora erythraea* (Ehrenb.) Engl.	Burseraceae		x			x
40	*Commiphora rostrata* Engl.	Burseraceae	x				x
41	*Commiphora schimperi* (Berg) Engl.	Burseraceae	x				x
42	*Commiphora terebinthina* Vollesen	Burseraceae	x				x
43	*Cordia africana* Lam.	Boraginaceae		x			x
44	*Cordia ellenbeckii* Gurke	Boraginaceae	x				x
45	*Cordia gharaf* (Forssk) Ehrenb	Boraginaceae	x				x
46	*Croton macrostachyus* Del.	Euphorbiaceae		x			x
47	*Cussonia holstii* Harms ex Engl.	Araliaceae		x			x
48	*Dalbergia lacteal* Vatke	Fabaceae	x				x
49	*Dalbergia microphylla* Chiov.	Fabaceae	x				x
50	*Dichrostachys cinerea* (L.) Wight & Arn.	Fabaceae	x				x
51	*Dodonea angustifolia* L.f.	Sapindaceae	x				x
52	*Dombeya kirkii* Mast	Sterculiaceae		x			x
53	*Dombeya torrida* (J.F. Gmel.) P.Bamps	Sterculiaceae		x			x

No.	Species	Family	Growth forms			Use category	
			Shrub	Tree	Liana	Charcoal	Firewood
54	*Ehretia cymosa* Thonn.	Boraginaceae		x			x
55	*Ekebergia capensis* Sparrm.	Meliaceae		x			x
56	*Eucalyptus camaldulensis* Dehnh.	Myrtaceae		x			x
57	*Euclea divinorum* Hiern	Ebenaceae	x				x
58	*Fagaropsis angolensis* (Engl.) Dale	Rutaceae		x			x
59	*Faurea speciosa* Welw.	Proteaceae		x			x
60	*Ficus sur* Forssk.	Moraceae		x			x
61	*Ficus sycomorus* L.	Moraceae		x			x
62	*Ficus thonningii* Blume	Moraceae	x				x
63	*Flacourtia indica* (Burm.f.) Merr.	Flacourtaceae		x			x
64	*Gardenia ternifolia* Schumach.& Thonn	Rubiaceae	x				x
65	*Grewia bicolor* Juss.	Tiliaceae	x				x
66	*Grewia ferruginea* Hochst.ex A.Rich.	Tiliaceae	x				x
67	*Grewia velutina* (Forssk.) Vahl	Tiliaceae	x				x
68	*Haplocoelum foliolosum* (Hiern) Bullock	Sapindaceae		x			x
69	*Hippocratea pallens* Planchon ex Oliver	Celastraceae			x		x
70	*Juniperus procera* Endl.	Cupressaceae		x			x
71	*Kirkia burgeri* Stannard.	Simaroubaceae	x				x
72	*Lannea rivae* (Chiov.) Sacl.	Anacardiaceae		x			x
73	*Lannea schimperi* (A.Rich)	Anacardiaceae		x			x
74	*Lepidotrichilia volkensii* (Gurke) Leroy	Meliaceae	x				x
75	*Lippia abyssinica* (Otto & Dietr.) Cufod.	Verbenaceae	x				x
76	*Lippia adoensis* Hochst. ex Walp	Verbenaceae	x				x
77	*Maesa lanceolata* Forssk.	Myrsinaceae	x				x
78	*Manilkara butugi* Chiov.	Sapotaceae		x			x
79	*Margaritaria discoidea* (Bail.) Webster	Euphorbiaceae		x			x
80	*Maytenus heterophylla* Robson	Celastraceae	x				x

No.	Species	Family	Growth forms			Use category	
			Shrub	Tree	Liana	Charcoal	Firewood
81	*Maytenus obscura* (A. Rich.) Cuf.	Celastraceae	x				x
82	*Maytenus undata* (Thunb.) Blakelock	Celastraceae	x				x
83	*Microglossa pyrifolia* (Lam.) O. Kuntze	Asteraceae			x		x
84	*Millettia ferruginea* (Hochst) Bak.	Fabaceae		x			x
85	*Mimusops kummel* Bruce. ex A. Dc.	Sapotaceae		x			x
86	*Moringa stenopetala* (Bak.f.) Cuf.	Moringaceae		x			x
87	*Myrsine africana* L.	Myrsinaceae	x				x
88	*Nuxia congesta* R.Br.ex Fresen.	Loganiaceae		x			x
89	*Nuxia oppositifolia* (Hochst) Benth	Loganiaceae		x			x
90	*Ochna holstii* Engl.	Ochnaceae		x			x
91	*Ochna insculpta* Sleumer	Ochnaceae		x			x
92	*Ochna schweinfurthiana* F. Hoffm	Ochnaceae	x				x
93	*Ocimum spicatum* Deflers	Lamiaceae	x				x
94	*Ocimum urticifolium* Roth.S.Lat.	Lamiaceae	x				x
95	*Olea capensis* L.	Oleaceae		x			x
96	*Olea europaea* (Wall. ex G.Don) Cif.	Oleaceae		x			x
97	*Olinia rochetiana* A.Juss.	Oliniaceae		x			x
98	*Ormocarpum trichocarpum* (Taub.) Engl.	Fabaceae	x				x
99	*Osyris quadripartita* Decn.	Santalaceae	x				x
100	*Ozoroa insignis* Del.	Anacardiaceae		x			x
101	*Pappea capensis* Eckl. & Zeyh.	Sapindaceae		x		x	x
102	*Pavetta abyssinica* Fresen.	Rubiaceae	x				x
103	*Pavetta oliveriana* Hiern	Rubiaceae	x				x
104	*Phyllanthus sepialis* Muell. Ar.	Euphorbiaceae	x				x
105	*Pittosporum viridiflorum* Sims	Pittosporaceae	x				x
106	*Podocarpus falcatus* (Thunb.) R.B. ex Mirb.	Podocarpaceae		x			x
107	*Polyscias fulva* Harms	Araliaceae		x			x

No.	Species	Family	Growth forms			Use category	
			Shrub	Tree	Liana	Charcoal	Firewood
108	*Polysphaeria parvifolia* Hiern	Rubiaceae	x				x
109	*Premna schimperi* Engl.	Lamiaceae	x				x
110	*Prunus africana* (Hook.f.)	Rosaceae		x			x
111	*Psydrax schimperiana* (A. Rich.)	Rubiaceae		x			x
112	*Pyrostria phyllanthoidea* (Bail) Bridson	Rubiaceae	x				x
113	*Rhamnus prinoides* L' Herit	Rhamnaceae	x				x
114	*Rhamnus staddo* A. Rich.	Rhamnaceae	x				x
115	*Rhus glutinosa* A. Rich.	Anacardiaceae	x				x
116	*Rhus longipes* Engl.	Anacardiaceae	x				x
117	*Rhus natalensis* Kraus	Anacardiaceae	x				x
118	*Rhus tenuinervis* Engl.	Anacardiaceae	x				x
119	*Rhus vulgaris* Meikle	Anacardiaceae	x				x
120	*Ritchiea albersii* Gilg	Capparidaceae	x				x
121	*Schefflera volkensii* (Engl.) Harms	Araliaceae		x			x
122	*Scherebra alata* (Hochst.) Welw.	Oleaceae		x			x
123	*Scutia myrtina* (Burm.f.) Kurz	Rhamnaceae	x				x
124	*Senna didymobotrya* Irwin & Barneby	Fabaceae	x				x
125	*Senna longiracemosa* (Vatke) Lock	Fabaceae	x				x
126	*Senna singueana* (Del.) Lock	Fabaceae	x				x
127	*Sterculia stenocarpa* H. Winkler	Sterculiaceae		x			x
128	*Suregada procera* (Prain) Croizat	Euphorbiaceae	x				x
129	*Syzygium guineense* subsp. afromontan	Myrtaceae		x			x
130	*Syzygium guineense* L. var. guineense	Myrtaceae		x			x
131	*Syzygium guineense* L. subsp. macrocarpa	Myrtaceae	x				x
132	*Tarenna graveolens (*S. Moore) Bremek	Rubiaceae	x				x
133	*Teclea borenensis* M.Gilbert	Rubiaceae	x				x
134	*Teclea salicifolia* Engl.	Rubiaceae	x				x

No.	Species	Family	Growth forms			Use category	
			Shrub	Tree	Liana	Charcoal	Firewood
135	*Tephrosia emeroides* A.Rich.	Fabaceae	x				x
136	*Terminalia brevipes* Pampanin	Combretaceae	x			x	x
137	*Terminalia brownii* Fresen.	Combretaceae		x		x	x
138	*Terminalia prunioides* Law	Combretaceae		x		x	x
139	*Terminalia schimperiana* Hochst	Combretaceae		x		x	x
140	*Trichilia emetic* Vahl.	Meliaceae	x				x
141	*Vangueria apiculata* K. Schum	Rubiaceae	x				x
142	*Vepris dainellii* (Pichi - Serm.) Kokwaro	Rutaceae	x				x
143	*Vepris glomerata* (F.Hoffm.) Engl.	Rutaceae	x				x
144	*Vernonia amygdalina* Del.	Asteraceae	x				x
145	*Vernonia auriculifera* Hiern	Asteraceae	x				x
146	*Vernonia unionis* Sch. Bip. ex Walp	Asteraceae	x				x
147	*Warburgia ugandensis* Sprague	Canellaceae	x				x
148	*Ximenia caffra* Sond.	Olacaceae	x				x
149	*Ziziphus abyssinica* Hochst ex A. Rich.	Rhamnaceae		x			x
	Total	**46 families**	80	65	4	25	**149**

Appendix 12. Plant species cited for social activities in the study area

No.	Scientific name	Family	Local Oromo name	Communal uses	Parts used
1	*Acacia abyssinica* Hochst. ex Benth.	Fabaceae	WAACCU	Shade in crop fields, dry fence and used as cover for beehive	The whole part, branches and bark
2	*Acacia etabaica* Schweinf.	Fabaceae	QABEESSA	Dry fence	Branches
3	*Acacia goetzei* Harms	Fabaceae	BURRA	Dry fence	Branches
4	*Acacia senegal* (L.) Wild	Fabaceae	HIDHADHOO	Dry fence	Branches
5	*Albizia schimperiana* Oliv.	Fabaceae	GARBII	Shade in crop fields	The whole part
6	*Carissa spinarum* L.	Apocynaceae	AGANSSAA	Dry fence	Stem and branches
7	*Coffea arabica* L.	Rubiaceae	BUNAA	Stimulant	Seeds
8	*Combretum molle* R. Br. ex G. Don.	Combretaceae	RUKKENSSA	Fumigating the house	Stem
9	*Cordia africana* Lam.	Boraginaceae	WODDESSA	Shade in crop fields	The whole part
10	*Croton macrostachyus* Del	Euphorbiaceae	MOKONNIISA	Soften local leather product	Leaves
11	*Cyperus fischerianus* A. Rich.	Cyperaceae	QUNDII	As mat during ceremonies	Leaves
12	*Dodonaea angustifolia* L.f.	Sapindaceae	DHITACHAA	Dry fence	The whole part
13	*Euphorbia ampliphylIa* Pax	Euphorbiaceae	HADAAMAA	Life fence	The whole part
14	*Ficus sycomorus* L.	Moraceae	ODDA	Gada ceremonies of Guji Oromo	Under its shade
15	*Ficus vasta* Forssk.	Moraceae	QILXAA	Beehive hanging	Branches
16	*Foeniculum vulgare* Miller	Apiaceae	KALKALA	Ornamental, good odor	Leaves
17	*Fuerstia africana* T. C. E.Fr.	Lamiaceae	QAYYAA DURAA	Dye for coloring hands	Leaves
18	*Gnidia stenophylla* Gilg.	Thymelaceae	ARSSAA	Used as broom to clean the house	The whole part
19	*Grewia velutina* (Forssk.) Vahl	Tiliaceae	HARORRESSA	Walking stick	Thin and strait stem
20	*Indigofera vohemarensis* Baill	Fabaceae	HAGAGARRO	Tooth brush	stem
21	*Justicia schimperiana* T.Anders.	Acanthaceae	CIIGGAA	Life fence	The whole part
22	*Lagenaria siceraria* Standl.	Cucurbitaceae	BUQQEE	Milk container	Fruits
23	*Lippia adoensis* Hochst.	Verbenaceae	UDDOO	Washing milk container	Leaves

No.	Scientific name	Family	Local Oromo name	Communal uses	Parts used
24	*Olea europaea* L. subsp. *cuspidate* (Wall. ex G.Don) Cif. L'Olivicoltore	Oleaceae	EJEERSSA	Fumigating the house and container	Dried stem
25	*Opuntia ficus - indica* (L.) Miller	Cactaceae	GAMBORA	Life fence	The whole part
26	*Osyris quadripartita* Decn.	Santalaceae	WATTOO	Body fumigating for females	Dried stem
27	*Podocarpus falcatus* (Thunb.) R.B. ex Mirb.	Podocarpaceae	BIIRBIIRSSA	An icon of good life	The live tree
28	*Premna schimperi* Engl.	Lamiaceae	XULANGGEE	Washing and fumigating container	Leaves and dried roots
29	*Pterollobuim stellatum* Bridson	Fabaceae	QAJIMAA	Life fence	The whole part
30	*Sida schimperiana* Hochst.	Malvaceae	HAGAGARRO RE'EE	Used as broom to clean the house	The whole part
31	*Themeda triandra* Forssk.	Poaceae	GAAGUROO	To cover the hut and beehives	The whole part
32	*Vernonia amygdalina* Del.	Asteraceae	EEBIICHA	To wash alcoholic beverage containers	Leaves

Declaration

I the undersigned, declare that this thesis is my original work, it has not been presented in other Universities, Colleges or Institutions, seeking for similar degree or other purposes. All sources of the materials used in the thesis have been onlyduly acknowledged.

Mersha Ashagre Eshete _____

Name Signature

The work has been done under my supervision.

1. Professor Zemede Asfaw _____
2. Dr. Ermias Lulekal _____