

**ADDIS ABABA UNIVERSITY
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DEPARTMENT OF ZOOLOGICAL SCIENCES



**PLANT SPECIES SUITABLE FOR DIRECT HUMAN USE (MEDICINE AND WILD
FOOD) AND FOR ECOSYSTEM CONSERVATION IN ADI ARKAY DISTRICT,
AMHARA REGION, ETHIOPIA: ETHNOBOTANICAL APPROACH**

**A THESIS SUBMITTED TO THE GRADUATE PROGRAMMES OF ADDIS ABABA
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DEGREE OF MASTER OF SCIENCE IN BIOLOGY**

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Plant Species Suitable for Direct Human Use (Medicine and Wild Food) and Ecosystem
Conservation in Adi Arkay Wereda, Amhara Region, Ethiopia: Ethnobotanical Approach

A thesis submitted to the Graduate Programmes of Addis Ababa University in partial fulfillment
of the requirements for the Degree of Master of Science in Biology

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This is to certify that the thesis prepared by Yibelital Moges Yigzie entitled: “*Plant Species Suitable for Direct Human Use (Medicine and Wild Food) and Ecosystem Conservation in Adi Arkay Wereda (District), Amhara Region, Ethiopia: Ethnobotanical Approach*” and submitted in partial fulfillment of the requirements for the Degree of Master of Science in Biology meets the regulations of the University and the accepted standards with respect to the originality and quality.

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ABSTRACT

Plant Species Suitable for Direct Human Use (medicine and Wild Food) and Ecosystem Conservation in Adi Arkay District, Amhara Region, Ethiopia: Ethnobotanical Approach

Yibelital Moges Yigzie, MSc Thesis

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This ethnobotanical study on useful plant species known as medicinal and wild food for the community as well as their role in ecosystem conservation was carried out in Adi Arkay Wereda, Amhara Region, Ethiopia in 2020. The ethnobotanical data was collected from a total of 60 informants sampled from 6 study sites. Field observation, semi-structured interview, and group discussion methods were employed to collect ethnobotanical data and ranking methods including preference ranking, paired comparison, and direct matrix ranking were used to analyze the data. A total of 94 species of useful plants belonging to 86 genera and 54 families were found and of these 73 were recorded as medicinal plant species belonging to 69 genera and 44 families, and 46 of them used to treat only human, 11 of them used to treat only livestock and 16 of them used for both according to the informants. There was high preference for Zingiber officinale for treating stomachache in humans while Maesa lanceolata was found to be the most preferred species for treating the problem of leeches in livestock by traditional healers. Herbs were the most used habit, accounting for 32.87%. The most frequently used plant parts were leaf, accounting for 41.04%. Most of the medicines, about 67.93%, were used in fresh condition. The most widely used method of preparation was squeezing, accounting for 17.33%. Most of the prepared remedies, about 35% were applied by drinking. Thirty wild plant species that belong to 20 families and 24 genera were used as food by the community. Most of the wild edible plants, about 57% of species were trees in their growth form. Fruit was found to be the most widely eaten plant part, accounting for 83.33%, and mostly taken as raw. The preference ranking shows that Diospyros mespiliformis was found to be the most preferred WEP on the basis of its sweet taste. There are also 48 plant species belonging to 27 families and 42 genera that are useful for the ecosystem. The preference ranking showed that Anogeissus leiocarpa is the most preferred species for the ecosystem on the basis of its capacity to adapt the environment. Paired comparison analysis showed that agricultural expansion was the major threat to the plant diversity. In order to protect destruction of plants as well as the ecosystems, the local community could be involved in conservation practice.

Key words/phrases: Adi Arkay, Anogeissus leiocarpa, Cordia africana, ecosystem conservation.

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LIST OF ACRONYMS

AAWAO	Adi Arkay Wereda Agricultural Office.
AAWHO	Adi Arkay Wereda Health Office
AAWVHO	Adi Arkay Wereda Veterinary Health Office
ASC	African Studies Centre
CSA	Central Statistical Agency
EFAP	Ethiopian Forestry Action Program
EPA	Environmental Protection Authority
FAO	Food and Agricultural Organization
GHASP	Galveston-Houston Association for Smog Prevention
HMPs	Human Medicinal Plants
IBC	Institute of Biodiversity Conservation
ICF	Informant Consensus Factor
IUCN	International Union for Conservation of Nature
LMPs	Livestock Medicinal Plants
M.Sc.	Master of Science
MEA	Millennium Ecosystem Assessment
MPs	Medicinal Plants
PLOS	Public Library of Science
SCBD	Secretariat of the Convention on Biological Diversity
SER	Society for Ecological Restoration
TMPs	Tradational Medicinal Plants
UNDP-EUE	United Nations Development Programme – Emergency Unit for Ethiopia.
UNESCO	United Nations Educational, Scientific and Cultural Organization
WEPs	Wild Edible Plants

CHAPTER ONE

1. INTRODUCTION

1.1. Background

Ethiopia is an important regional center for biological diversity due to its wide ranges of altitude, its great geographical diversity with high and rugged mountains, flat-topped plateaus and deep gorges, incised river valleys and rolling plains (Ensermu Kelbessa and Sebsebe Demissew, 2014) and is the fifth major country in tropical Africa in terms of the diversity of flora (Ensermu Kelbessa *et al.*, 1992). Biodiversity supports many ecosystem function that may provide ecosystem services crucial to human wellbeing and survival (Rands *et al.*, 2010; Thompson *et al.*, 2011). The indispensable dependency of humans up on plants for their livelihoods was primarily started by domestication (Martin, 1995).

Plants have been sources of traditional medicine for human beings and livestock. Traditional medicine is the primary health care system for almost 80% of the populations of the country with 95% of these medicines derived from plants even if there is an effort to expand modern medicine to different parts of Ethiopia (Dawit Abebe, 2001). Due to the interaction of culture and traditions; traditional medicine made from plants are demanded in Ethiopia (Fassil Kibebew, 2001).

Ethnobotanical studies of medicinal plants in Ethiopia indicated that peoples live in different parts of the country have a tendency of utilizing plants as a traditional medicine for themselves and their livestock. Some examples of these studies include Mirutse Giday *et al.* (2007) in Shinasha, Agew-Awi and Amhara people; Ermias Lulkal *et al.* (2008) in Mana Angetu Wereda; Gidey Yirga (2010) in and around Alamata; Moa Megersa (2010) in Wayu Tuka Wereda; Seble Wolde- Yohannis *et al.* (2018) in Menz Gera Midir Wereda; Amare Fssil and Getachew Gashaw (2019) in Chiro district; and Marshet Gijan and Gemedo Dalle (2019) in Negelle Arsi district. Like other places in Ethiopia, people of Adi Arkay Wereda have traditional practices of using plants for treating various health problems of human and livestock. They use different parts of plants to prepare remedies (root, bark, leaves, and other plant parts)

In addition of medicinal role, wild plants also play a critical role in ensuring food security for countless families and communities around the world (Cavender, 2006; Sekeroglu *et al.*, 2006; Bharucha and Pretty, 2010; Ermias Lulekal *et al.*, 2011 and Chakravarty *et al.*, 2016). In many parts of developing countries including Ethiopia, hundreds of wild edible plants are known to be

consumed by rural communities (Ermias Lulekal *et al.*, 2011 and Getachew Addis *et al.*, 2013)). These wild food plants were consumed at the times of food shortage as means of survival during times of drought, famine, shocks and risks (Getachew Addis *et al.*, 2005; Assegid and Abebe, 2011 and Ermias Lulekal *et al.*, 2011). They can also supplement nutritional requirements due to their better nutrition (Hunde *et al.*, 2011).

Besides their edibility and medicinal role; plants are also involved in ecosystem conservation. plants assist ecological recovery from prolonged anthropogenic disturbances (Carnus *et al.*, 2003) and improve soil conditions of degraded sites (Islam and Weil, 2000; Carnus *et al.*, 2003). The extensive root systems of higher plants and the networks formed by many grasses on the ground surface reduce flooding by holding the soil particles together (Usman *et al.*, 2014). This ethnobotanical study is, therefore, very crucial to document ethnobotanical knowledge of medicinal and wild edible plants as well as ecologically useful plants, to record the current status of useful plants and to raise the awareness of the community about useful plants for initiating them in conservation practice.

1.2. Statement of the Problem

Plants have very high importance in conserving the ecosystem including ethnobotanical value (medicinal and food) for the community. However, the influence of humans on plant resources causes loss of plants, their values, and habitats; which leads to species extinction and ecosystem destruction. The knowledge about useful plant is not known by most members of the community, part of the knowledge, especially traditional medicinal knowledge, is transferred secretly and orally. There is a gap in the documentation of knowledge of useful plants and conservation of the existing useful plant resources in the study area.

As a result, this study was aimed at facilitating raising of the awareness of young generation about the uses of plants for the community as well as the ecosystems and initiating the activity of protection and plantation of useful plants in the area that has been degraded and degrading. Furthermore, the study was aimed at documenting useful plants and their use value for the community especially in medicinal value as well as wild food source, and associated indigenous knowledge in Adi Arkay Wereda.

1.3. Research Questions, Hypotheses and Objectives

1.3.1. Research questions

The following major research questions were considered in this study:

1. What are the medicinal plant species used by indigenous people in Adi Arkay Wereda to treat various human and animal diseases? And which plants are more important for the people?
2. What are the wild edible plant species used by the local community and what part of the plant is used for household food security in Adi Arkay?
3. What major plant species are suitable for ecosystem conservation? In what way are they suitable and which ones are more important?
4. What are the major threatening factors that have significant impact on useful plants as well as the ecosystem?
5. What are the conservation practices of local people to manage and conserve useful plants and the ecosystems?

1.3.2. Hypotheses tested

1. There are diverse medicinal plants that are used by the local communities for treating different human and livestock ailments in the study area.
2. There are diverse wild plants that serve as a food source for the local community in the study area.
3. There are diverse plant species that serve for ecosystem conservation in the study area.
4. There are several threats that causes reduction of useful plant resources as well as land degradation in the study area.
5. There are different conservation methods used to conserve useful plants as well as the ecosystems in the study area.

1.3.3. Objectives of the study

1.3.3.1. General objective

- The main objective of this study was to document and analyze useful plant species and their use values for the community as well as for the ecosystem in Adi Arkay Wereda.

1.3.3.2. Specific objectives

1. To produce a checklist and analysis of the plant species useful to the community and the ecosystem in Adi Arkay Wereda.
2. To document ethnobotanical data on medicinal, edible and other uses of plants.
3. To study the current status of useful plants and to suggest how the community use plants in sustainable manner.
4. To find out which species are valued more by the people as medicine, as food and for the ecosystems.
5. To identify the existing threats of plants as well as the ecosystems and the methods used by the local peoples to conserve the local vegetation and the ecosystems.

1.4 Significant of the Study

Until this moment, no research on ethnobotanical study on useful plants (especially medicinal plants) was conducted in Adi Arkay Wereda and thus the finding of this study:

- Will help peoples of the study area to be aware of useful plants and their use value for the community as well as for the ecosystem. This awareness enables the community to give attention for the useful plant species.
- Will constitute a good documentation of the indigenous knowledge on useful plants and can be part of the information source for further research activities in ethnobotanical studies conducted in Adi Arkay Wereda.
- Will be a good input for local, regional and national level bodies concerned with plant biodiversity conservation

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Vegetation of Ethiopia

Vegetation is an assemblage of plants growing together in a particular area, or it is the group of plant that covers an area. In other words, vegetation is a spatial pattern of growth forms in a plant community, especially with respect to their height, abundance or coverage within the individual layer (Jennings *et al.*, 2003).

Vegetation formation is influenced by a combination of many nonliving factors (climate, geology, soil type etc.) and living factors including interference by humans during ecological succession. Climatic heterogeneity is a general characteristic of Ethiopia. Among the different climatic factors; temperature and rainfall are the most important for agricultural production in Ethiopia. Altitude is also another factor that influence the crops to be grown, natural vegetation types and their species diversity (Alemayehu Mengistu, 2003).

Ethiopia is rich in wide range of vegetation formations due to its varied ecological and climatic conditions in the country. There are twelve vegetation types in Ethiopia: These major vegetation types contain; Desert and Semi desert scrubland Forest; Acacia woodland and bushland; Wooded grassland of the Western Gambela region; Combretum - Terminalia woodland and wooded grassland; Dry Evergreen Afromontane forest and grassland complex; Moist Evergreen Afromontane forest and bushland; Transitional rain forest; Ericaceous belt; Afro-alpine belt; Riverine vegetation; Fresh - water lakes; and Salt Lakes vegetation (Friis *et al.*, 2010).

2.2. Importance of Forest and Forest Resource

Plants provide food, oxygen, shelter, recreation, and spiritual sustenance for us, and they are the source for over 5,000 commercially traded products, ranging from pharmaceuticals to timber and clothing (SCBD, 2010). Moreover, forests serving multiple functions, for example; Forests and woodlands of Ethiopia is a raw material for wood-based energy, home construction, wood-based industries, fuelwood and employment opportunities (Getachew Desalegn *et al.*, 2003). Non-timber forest products include coffee, spices, medicinal products, animal fodder, wild edible plants and many others (Demel Teketay, 2001).

Traditional medicine has an important role in the health care of Ethiopian population; around 80% of Ethiopian people rely on some form of traditional medicine for their primary healthcare. This large magnitude of use and interest in medicinal plants in Ethiopia is due to acceptability, accessibility and biomedical benefits (Dawit Abebe, 2001).

Edible plants that are available from the wild have been collected and consumed by peoples of the world and this culture of collecting wild edible plants has still continued in many parts of the world today (ASC, 2003). Ethiopia among these countries.

In every ecosystem Plants are the primary producers and also the primary source of direct and indirect goods and services to humans. The direct services of plant to humans are food, fodder, medicines, timber and fuelwood; while regulating services include moderating air and water quality and erosion control. Plant also play a vital role in supporting services (soil formation, and nutrient and water cycling) and the cultural services provided by the plant includes traditional human knowledge systems (MEA, 2003).

A great deal of indigenous knowledge arises from farmers and forest dwelling people during their utilization of forest resources. Forests are the source of many hidden treasures and a fertile ground for scientific research (SCBD, 2010). Ethnobotanical research might not be taking place if forest does not exist. So plants have a great value.

2.3. Origin and Development of Ethnobotany

Ethnobotany mainly focuses on plants used for food, medicine, cosmetics, dyeing, textiles, building, tools, currency, social life and music (Choudhary *et al.*, 2008). In the ancient times, plants have been used as a vital source of preventive and curative traditional medicine for human beings and livestock. Historical account shows that different medicinal plants were in use as early as 5000 to 4000 BC in China and 1600 BC by Syrians, Babylonians, Hebrews and Egyptians (Dery *et al.*, 1999). In the early 1500's, Indian fever bark was one of the first medicinal plants to find appreciative consumers in Europe which taken from the cinchona tree (*Cinchona officinalis*), the bark was used as an infusion by native people of the Andes and Amazon highlands to treat fevers. Jesuit missionaries brought the bark back to Europe. By the early sixteenth century, this medicine was known as "Jesuit fever bark," quite a transformation (Connive and Steven, 1996).

Now a day's ethnobotany has tended to become more analytical, quantitative, cross disciplinary, and multi institutional. Ethnobotanists have a great responsibility to share the information they collect from the local people with the great collection of human knowledge (Arihan and Mahin, 2007).

According to Cotton (1996), ethnobotany encompasses the mutual relationships between plants and traditional people. Indigenous knowledge on traditional medicine is one of the relationships of humans with plants. Around the world traditional people possess unique knowledge of plant resources on which they depend for food, medicine and general utility including tremendous botanical expertise (Martin, 1995).

Ethnobotany is a rapidly growing science, attracting people with widely varying academic background and interests (MacDonald, 2009). In general, ethnobotany is a multidisciplinary science that contributes to analyzing interactions between plant resources and people. (Khanal, 2006).

2.4. Plant and People Interaction

People depend on plants not only for food but also for preparation of remedies. Ethnobotanical research documents the knowledge on cultural interaction of people with plants, and figure out how local people have traditionally used plants for various purposes and how they incorporate plants into their cultural tradition and religion (Balick and Cox, 1996). Traditional people around the world have unique knowledge about plant resources on which they depend on plant for food, medicine and botanical expertise (Martin, 1995). This indicates that humans are dependent on other organisms (plants) for their life. Even though different animals and mineral products contribute to human wellbeing, plants are the most essential to human wellbeing especially in supplying basic needs. The dependency of human beings on plants for their existence (survival) was primarily started by domestication (Martin, 1995).

In Ethiopia traditional knowledge is passed from generation to generation verbally and necessary information concerned with useful plants can be lost before knowing by the rest of the community especially traditional medicinal plant knowledge. In addition to the traditional knowledge, valuable medicinal plants can be lost due to population pressure, agricultural expansion and deforestation as reported by different workers (Dawit Abebe, 2001).

2.5. Useful Plants and Plant Use Category

2.5.1. Medicinal plant resource

Traditional medicine is combination of knowledge and practices that can be used in prevention and elimination of physical, mental or social imbalance and depends entirely on practical experiences and observations passed down from generation to generation verbally or in written form (WHO, 2001). About 75-90 % of the rural population in the world (excluding western countries) depend on traditional medicines as their only health care system because of poverty cannot afford to buy expensive modern drugs and traditional systems are more culturally acceptable (Fassil Kibebew, 2001).

Trial and error experimentation resulted in developing the healing properties of plants during the course of long history of human struggle with the health problems like the miseries of pains, sickness and sustained injuries that they encountered (Teferi Flatie *et al.*, 2009).

2.5.1.1. Traditional medicine in Africa

Africa is considered to be the cradle of humankind with a rich biological and cultural diversity, and there are marked differences between different regions of this continent when it comes to healing practices (Gurib Fakim, 2006). A review on African traditional medicine and on the use of plants for medicine is written by Maurice Iwu, a Nigerian ethno pharmacologist (Iwu, 1993). The traditions of collecting plants as well as processing herbal remedies and applying them have been handed down from generation to generation (von Maydell, 1996).

Most of the African cultures have a verbal tradition, and therefore written information on cultural features in the past are not so readily available from Africa as from many other parts of the world (Hedberg & Staugård, 1989). The ethnobotanical information on the uses of the plants were sometimes documented on herbarium labels, and in this way ethnobotanical information on a number of plants began to accumulate (Hedberg & Staugård, 1989). A number of traditional national pharmacopeias have appeared, starting with Madagascar in 1957, and research in the field of ethnobotany and ethno pharmacology has developed rapidly in many African countries (Hedberg & Staugård, 1989).

2.5.1.2. Traditional medicine in Ethiopia

There is high biological diversity in Ethiopia due to its various climatic and topographic conditions and the country is believed to be home for about 6,000 higher plant species. Out of this, nearly 10-

12% are endemic (IBC, 2005). Medicinal plant species are the part of those many plant species of the country, 14% of the 6000 plant species are used as traditional medicines (Tesfaye Awas, 2004).

About 85% of the population in underdeveloped countries does not have access to modern health care services like western style and hence depends on traditional medicines (World Health Report, 2008). In Ethiopia around 80% of human population and 90% of livestock depend on traditional medicine for the treatment of diseases (Teshale Sori *et al.*, 2004). Because most modern drugs are expensive, the majority of Ethiopian farmers and pastoralists depend on their traditional knowledge practices and locally available materials (mainly plants) for controlling their livestock diseases (Mirutse Giday and Gobena Ameni, 2003).

Although plants have been used as source of medicine to treat both human and livestock ailments in Ethiopia, research and documentation on medicinal plants started only very recently (Mesfin Tadesse and Sebsibe Demissew, 1992). Among the research conducted on ethnobotanical study of medicinal plants in Ethiopia, Ermias Lulkal *et al.* (2008) collected the highest number of 230 plant species documented from Mana Angetu District, which is found in Bale Zone of Oromia Region. Of these, these authors showed that 181 (78.70%) were used as human medicine, 27 (11.74%) as livestock medicine and the remaining 22 (9.7%) were for treating both human and livestock ailments.

Studies in Ethiopia show different parts of plants are being used for medicine in order to cure human or livestock diseases in Ethiopia. Example; the finding of Gidey Yirga (2010), Moa Megersa (2010) and Sintayehu Tamene (2011) showed that leaves were the most commonly used parts for remedy preparation while Mirutse Giday *et al.* (2007) and Mesay Wolde-Mariam *et al.* (2015) reported that the local people prepare their remedy mostly from roots.

People use medicinal plant parts to treat different human or livestock ailments while they are fresh, dried or both. The study of Nigussie Amsalu *et al.* (2015) and Getu Alemayehu (2017) revealed majority of herbal medicine preparation uses fresh materials.

However, the study of Ethiopian medicinal plants has not been realized as fully as that of India or other traditional communities elsewhere (Iwu, 1993). Nowadays, researchers have given attention on medicinal plants.

2.5.2. Wild food plant resource

In many developing countries millions of people especially rural communities supplement their daily food and nutrition requirements by wild edible plants and combat the deficient they encounter in one or more micronutrients. Thus, they depend on wild resources to meet part of their requirements which they may use on a daily basis in some environments and cultures. Globally, an estimated 1.02 billion people are undernourished (FAO, 2010). Wild plants have been used as the main food supplement and means of survival during times of drought and famine in the developing world (Guinand and Dechassa Lemessa, 2000).

In Ethiopia wild plants are used as food source both at the times of excess food and also during food scarcity (Getachew Addis *et al.*, 2005). The amount of vitamins, minerals and other nutrients in wild food is greater than those that are domesticated (Hinnawi, 2010). Ermias Lulekal *et al.* (2011) compiled 413 wild edible plants belonging to 224 genera and 77 families.

2.6. Threats and Conservation of Ethiopian Vegetation

2.6.1. Threats to Ethiopian vegetation

The imbalance between supply of plant services and human demands, and deterioration of their habitats increases the rarity of plant biodiversity (Diaz *et al.*, 2006). Disturbance and over exploitation by humans are causing major global reduction of plant diversity (Bownder, 1987; IUCN, 1991). The growing need for farmlands and grazing lands, and fuel wood gap in Ethiopia causes severe pressure on vegetation formations in the country and the forest resource get depleted (EPA, 1997).

People use many wild species of plants for food, medicines, clothing, shelter, fuel, fiber, income generation and the fulfilling of cultural and spiritual needs (Zemedede Asfaw, 2001). Recent evidence from Ethiopia as well as other countries indicates that the existence of these indigenous resources are threatened. The most serious proximate threats generally are habitat loss, habitat degradation and over harvesting (Hamilton, 1997).

Environmental degradation, deforestation, agricultural expansion, over exploitation and population growth are the principal threats to medicinal plants in Ethiopia (Mirutse Giday, 2001; Zemedede Asfaw, 2001). Generally, there are two sources of threats to medicinal plants, i.e. manmade and natural causes. Rapid increase in population, the need for fuel, urbanization, timber production, over harvesting, invasive alien species, honey collection, land degradation, agriculture

expansion and habitat distraction cause threats to medicinal, wild edible and other useful plants. Likewise, natural causes include recurrent drought, bushfire, disease and pest outbreaks (Ensermu kelbessa *et al.*, 1992).

The loss of forests resource is severe in the Ethiopian highland that lies above 1500 m elevation (Deriba Geleti, 2006). These highlands cover about 44% of land area; and accommodate 88% of the total population because of their agricultural potential and low prevalence of diseases. They also contain about 95% cultivated land and more than 67% of the livestock (EFAP, 1994). Plant species that have high value as traditional medicines to Ethiopian societies especially for the rural community. However medicinal plants and associated indigenous knowledge is lost due to deforestation and expansion of modern education (Pankhurst, 2001).

2.6.2. Plant biodiversity conservation

Sustainable utilization and conservation of plant biodiversity are essential for the continuation of ecosystem functioning (Srivastava and Vellend, 2005). In addition to the three most widely accepted biodiversity conservation criteria (rarity, threat and endemism); historical, traditional and educational values should be considered while conserving biodiversity. Increasing industrialization and urbanization cause losses of traditional knowledge as the natural environment becomes degraded or as people move away from their native villages. Traditional ethno medicinal knowledge is a valuable form of indigenous knowledge; which can be used for the recognition and preservation of valuable species as well as the habitats in which they occur (Pieroni *et al.*, 2007).

Maintaining a high level of plant diversity is connected to the maintenance of ecosystem services provision and more species will be needed to provide ecosystem functioning under future environmental change scenarios (Haines-Young and Potschin, 2010). Thus, preserving much plant biodiversity across wide range of ecosystems has an indispensable approach to maintain the benefits that they provide to humans.

Anthropogenic pressures in the country resulted in loss of thousands of hectares of forest; This loss limit benefits gained from wild edible plants and losses of indigenous knowledge associated with these plants. The knowledge of using of WEPs is facing a problem because of change in the feeding culture of the people. The reviewed research outputs on WEPs of the country indicate the need for conservation as well as documentation (Tilahun Teklehaymanot and Mirutse Giday, 2010).

As time goes many wild edible and medicinal plant species and the associated indigenous knowledge are being eroded. The practice of using plant remedies by a community to treat different ailments is also declining from time to time because of continued deforestation; this results in loss of important medicinal plants in the area (Tesfaye Awas, 2004). Generally, there are some conservation measures that have been under taken around the world aimed at protecting threatened medicinal plant species from further destruction (Cunningham, 1993). This includes in-situ conservation (on their natural habitats like natural reserves and parks e.g. home gardens) and ex-situ (field gene bank, seed bank and botanical garden) conservation. In order to conserve useful plants which are threatened due to natural or manmade factors in Ethiopia, in-situ and ex-situ conservation strategies should be complimentarily implemented (Abebe Demissie, 2001).

2.7. The Role of Plants in Ecosystem Conservation

2.7.1. Ecosystem definition

The term ‘ecosystem’ was proposed by a British ecologist A.G. Tansley in 1935. Ecosystem represents the basic functional unit of ecology which comprises of the biotic communities mutually related with their nonliving environment. Thus a biotic community and its abiotic environment together represent an ecosystem. Ecosystems, therefore, include both the living organism (biotic community) and the nonliving environment (abiotic environment) which are inseparably inter-related and interact up on each other (Tansley, 1935). Every species and factors serve an important role or purpose in the community. Plants which serve as the primary producers play the major role in any ecological system by providing the primary source of food and oxygen as well as purifying the environment for the entire system (Tanner, 2001).

2.7.2. Ecological benefit of plants

2.7.2.1. Controlling erosion caused by rainfall

The key to controlling erosion caused by rainfall is to reduce the velocity and volume of runoff. This can be done by increasing vegetation. Leaves and branches take much of the force of the falling rain thereby reducing the potential of rain to loosen soil particles and cause soil erosion (Usman *et al.*, 2014). In dryland mountains, forests play key roles in regulating water flows and minimizing the damage caused by floods; undisturbed forests are generally regarded as the most efficient land-cover type for maintaining the hydrological balance (FAO, 2011).

2.7.2.2. Conserving soil fertility

Plants are involved in the return of nutrients to the ecosystem in the process of decomposition. Fortunately, nature has a continuous recycling system if plant leaves, twigs, branches, flowers, and grass clippings decomposed with the help of microorganisms and release nutrients to the soil and enhancing the fertility of the soil. If the seeds survive and the compost is incorporated into the soil, seeds will grow. Soil fertility can also be managed through the integration of leguminous plant species (CIRAD-CTFT, 1989).

2.7.2.3. Restoration of degraded ecosystems

As human impacts on ecosystems worldwide intensify, the restoration of degraded habitats increasingly becomes an urgent task and a difficult challenge (Choi *et al.*, 2008). Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER, 2004). An ecosystem is said to be degraded when it exhibits a loss of biodiversity and a simplification or disruption in ecosystem structure, function and composition caused by activities or disturbances that are too frequent or severe to allow for natural regeneration or recovery. Plantation forests can assist ecological recovery from prolonged anthropogenic disturbances (Carnus *et al.*, 2003). For example, tree plantations have been shown to improve soil conditions of degraded sites (Islam and Weil, 2000; Carnus *et al.*, 2003).

Lamb and Tomlinson (1994) believe that the first objective of degraded land rehabilitation should be the prevention of further degradation. Plantation forestry can be employed as a tool not only to arrest further site degradation but also to catalyze native forest flora restoration after prolonged anthropogenic disturbances.

2.7.3. Eco-benefit of restoration

Biological benefit: The biological benefit is first reflected in the woodland biomass accumulation and secondly increasing biodiversity, especially the plant diversity. Ecosystem biodiversity is built on the basis of plant diversity (S. Peng *et al.*, 2016).

Environmental benefit

The eco-benefit of restoration of degraded forest is largely reflected on the marked improvement of environmental benefits, mainly in the aspects of controlling of soil erosion, soil quality improvement in woodland and forest microclimate optimization and so on (S. Peng *et al.*, 2016).

for example, soil and water conservation capacity of artificial broad-leaved forest in Xiaoliang Station close to natural mixed forest (Peng *et al.*, 2003). Trees and other vegetation can be planted as part of efforts to restore sand encroached areas. In some situations, a combination of mechanical means and the planting of trees and other perennial vegetation can be used to halt or reduce movement by stabilizing the soil, reducing the wind-speed gradient and increasing water retention, which, in turn, allows more vegetation to establish (FAO, 2010).

The eco-benefit of restoration of degraded forest is Soil and water conservation capacity which improves environmental benefits, mainly in the aspects of controlling of soil erosion, soil quality improvement and forest microclimate optimization (Peng *et al.*, 2003). Ecological restoration is a powerful strategy for reversing biodiversity loss, increasing the provision of ecosystem services, and contributing to sustainable livelihoods. What makes restoration uniquely valuable is its inherent capacity to provide people with the opportunity not only to repair ecological damage, but also to improve the human condition (SER/IUCN, 2004).

2.7.4. Plants and our environment

It is impossible to talk about an environment without plants because of their importance to the balance of nature. Some of the role of plant for the environments is: air quality, water quality, cooling the surrounding air and drought control. see more elaboration below: -

Air quality: The quality of the air can be greatly influenced by plants. Plants are one of the natural carbon “sinks” (natural systems that absorb and store carbon dioxide from the atmosphere). Plants can also stop the movement of dust and other forms of particulates and as well absorb many other kinds of gaseous pollutants (GHASP, 1999).

Water quality: Plants are extremely important to the quality of the water we use. A diverse cover of plants aids in maintaining healthy watersheds, streams, and lakes by holding soil in place, controlling stream flows, and filtering sediments from water (Tanner, 2001).

Cooling the surrounding air: Trees and other vegetation reduce atmospheric temperatures thereby cooling the surrounding environment in four ways: They trap Carbon dioxide (the major component of greenhouse gases) from the atmosphere for their photosynthesis thereby reducing greenhouse effect; Trees use solar energy (sunlight) for photosynthesis, converting the energy into food (carbohydrate) and oxygen thereby reducing the effect of the sun on sunny days; Trees

provide shade, thereby cooling nearby surfaces; Trees use evapotranspiration to cool themselves and the surrounding air (Usman *et al.*, 2014). For example, a single large tree can transpire up to 100 gallons (400 l) of water a day, producing a cooling effect similar to that of five average air conditioners running for 20 hours (GHASP, 1999).

Drought control: The moisture released into the air by trees (during transpiration) stabilizes rainfall thereby decreasing the episodes of drought (Usman *et al.*, 2014).

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the Study Area

3.1.1. Geographical location

Adi Arkay Wereda is located in Semien Gonder Zone of Amhara Regional State. This Wereda has a total area of 1,685.16 km² and comprises 22 Kebeles, and 2 urban centers (Adi Arkay and Zarima). The capital town of the Wereda is Adi Arkay, which is located at a distance of about 412 kilometers from the regional capital Bahir Dar and 910 kilometers from Addis Ababa. It is bordered on the south by Jan Amora, on the southwest by Debarq, on the north by the Tigray Region, and on the east by Tselemt. This Wereda is situated on the northern slope of the Semien Mountain. Due to its inaccessibility and lack of most basic infrastructure, in 1999 the regional government classified Adi Arkay as one of the 47 drought prone and food insecure Wereda (UNDP-EUE, 1999). Out of the 22 Kebeles, six Kebeles marked by the red dot were selected for ethno botanical study (Figure 1).

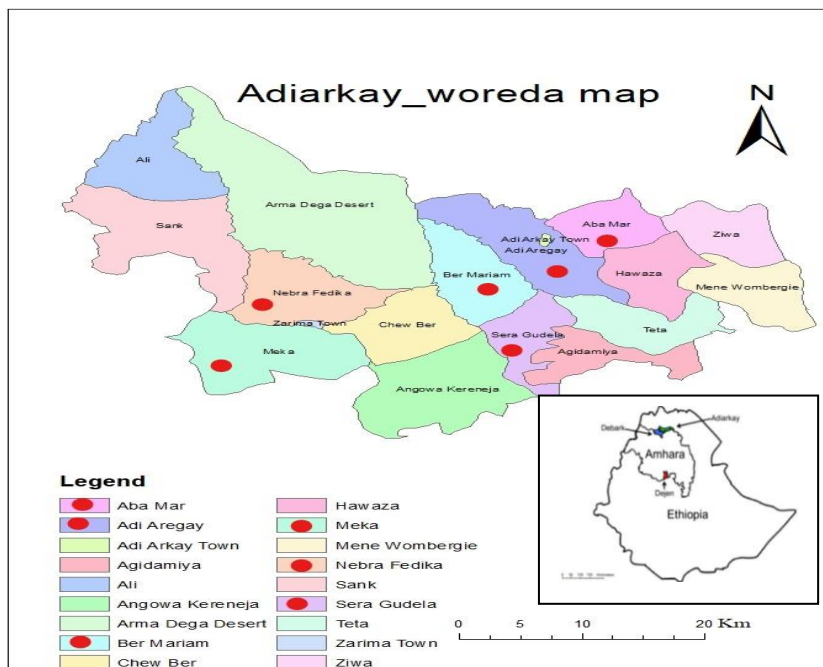


Figure 1. Map of Ethiopia showing the location of Adi Arkay Wereda within Amhara Region (AAWAO, 2020).

3.1.2. Climate

Climate data of the study area was obtained from Adi Arkay district meteorological station and showed that the highest mean annual temperature of the last four years (2016-2019) was 29.6°C recorded in April, whereas the lowest was 21.9 °C recorded in August. The rainfall in Adi Arkay is unimodal, that is, there is one rainy season. The highest mean annual rainfall of the district during the last four years (2016-2019) was 592.9 mm recorded in August, whereas in January and February there is no rainfall (Figure 2).

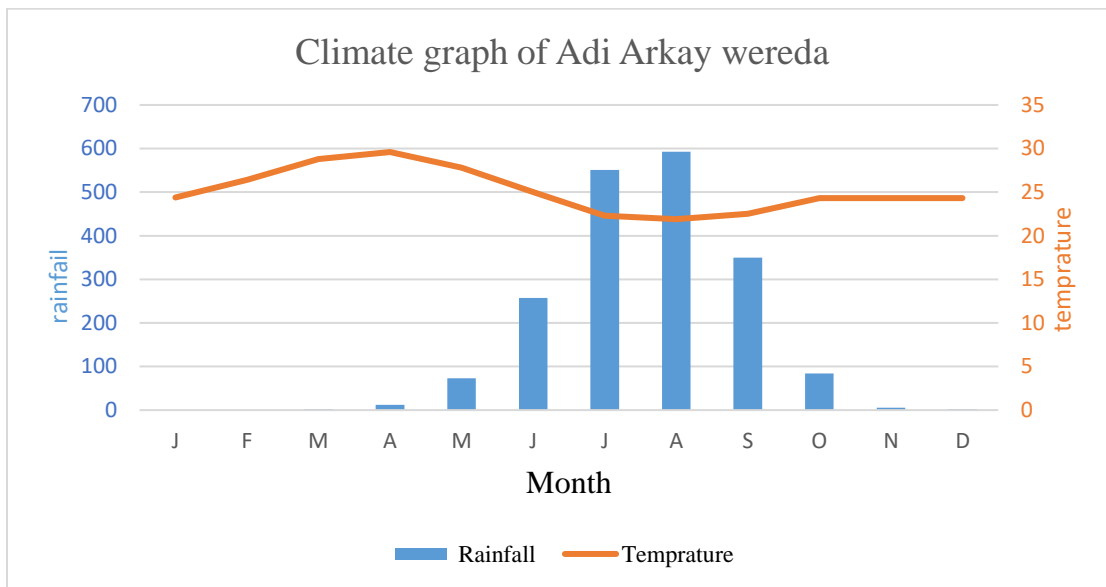


Figure 2. Climatic diagram showing mean annual temperature (°C) and rainfall (mm) of Adi Arkay Wereda from 2016-2019 (Source: Adi Arkay Wereda meteorological data, 2020).

3.1.3. People and healthcare status

3.1.3.1. Demographics

Based on the 2007 national census conducted by Central Statistical Agency of Ethiopia (CSA), Adi Arkay Wereda has a total population of 93,763. Out of this 45,856 were women and 47,907 were men. 10,391 are urban inhabitants. Among the urban inhabitants 4,784 were male and 5,607 were female. A total of 20,203 households were counted in this Wereda, resulting an average of 4.64 persons to a household. The majority of the inhabitant practiced Ethiopian orthodox Christianity with 89.5 % reporting that as their religion, while 10.5% of the population were Muslim. Two largest ethnic groups live in Adi Arkay, namely: Amhara (97.63%) and Tigray (2.1%).

3.1.3.2. Healthcare status of the people

In Adi Arkay Wereda, there are 4 health centers, 2 private clinics and 3 private drug stores. Due to lack of a health center in most rural Kebeles and being far from health services, the rural peoples are mostly affected by different diseases. Even if they are interested to go far distance for getting treatment in the health center the cost needed for modern drugs is high and they are unable to cover this. As a result, they prefer traditional medicine in low cost in their locality without going far distance. According to the report of Adi Arkay Wereda Health Office (AAWHO, 2020), the first ten major human diseases include: respiratory infections, digestion problem, amoeba and the rest are shown in Table 1.

Table 1. Top ten human diseases happened in the past two years (2018 & 2019) in Adi Arkay Wereda (AAWHO, 2020)

No	Diseases types	2018	2019	Total
1	Respiratory Infection	211	1382	1593
2	Dyspepsia (digestion problem)	282	1091	1373
3	Amoeba	333	976	1309
4	Bacterial intestinal infection	234	1003	1237
5	Urinary Tract Infection	157	654	811
6	Pneumonia	126	620	746
7	Giardiasis	86	440	526
8	Trachoma	108	358	466
9	Ascariasis	121	324	445
10	Malaria	85	348	433

3.1.4. Socio-economic situation

3.1.4.1. Crop production

A sample enumeration performed by the Central Statistical Agency (CSA) in 2001 interviewed 24,909 farmers in Adi Arkay Wereda, who held an average of 1.33 hectares of land. Of the 18.778 square kilometers of private land surveyed, 94% was under cultivation, 0.6% pasture, 3.5% was fallow, the remaining 1.9% was devoted to other use. Furthermore, 80.8% of the farmers practiced mixed farming, where both crops and livestock production are managed under the same farming unit, while 17% only grow crops. Of the land under cultivation, 75.4% was planted in cereals, 7% pulses, 11.1% oilseed, 0.2% perennial crops like Gesho (*Rhamnus prinoides*), and 6.3% all other crops (Table 2).

Table 2. The most commonly produced crop in Adi Arkay Wereda (source: AAWAO, 2020)

Crop category	Scientific name	Local Amharic name
Cereals	<i>Sorghum bicolor</i>	Mashila
	<i>Eleusine coracana</i>	Dagusa
	<i>Eragrostis tef</i>	Teff
	<i>Zea mays</i>	Bekolo
	<i>Triticum aestivum</i>	Sindie
Pulses	<i>Vicia faba</i>	Bakela
	<i>Cicer aestivum</i>	Shinbira
	<i>Phaseolus vulgaris</i>	Adenguare
	<i>Pisum sativum</i>	Ater
Oil crop	<i>Guizotia abyssinica</i>	Nug
	<i>Sesamum orientale</i>	Selit
	<i>Linum usitatissimum</i>	Telba
Fruit	<i>Carica papaya</i>	Papaya
	<i>Malus sylvestris</i>	Apple
	<i>Musa paradisiaca</i>	Muz
	<i>Persea americana</i>	Avocado
	<i>Mangifera indica</i>	Mango
	<i>Citrus sinensis</i>	Birtukan
	<i>Psidium guajava</i>	Zeyton
	<i>Citrus aurantifolia</i>	Lomi
Vegetable	<i>Lycopersicon esculentum</i>	Timatim
	<i>Brassica integrifolia</i>	Tikl gomen
	<i>Cucurbita pepo</i>	Duba
Spice	<i>Capsicum annuum</i>	Berbere
	<i>Coriandrum sativum</i>	Dinbilal
	<i>Ruta chalepensis</i>	Tenadam
	<i>Zingiber officinale</i>	Zingible
Stimulant	<i>Coffea arabica</i>	Buna
	<i>Rhamnus prinoides</i>	Gesho
	<i>Catha edulis</i>	Chat
Root crop	<i>Allium cepa</i>	Key shenukrt
	<i>Allium sativum</i>	Nech shenukrt
	<i>Beta vulgaris</i>	Keysir
	<i>Daucusa carota</i>	Carrot
	<i>Solanum tuberosum</i>	Dinch
Fiber crop	<i>Gossypum barbdense</i>	Tit

3.1.4.2. Animal husbandry

The majority of the livestock that are farmed in this district were goats, cow, donkey, hens, ox and others. Beekeeping is also another source of income generation and food to the family within the district. The major source of livestock feed is natural pastures, crop residue, straw, fodder and weed. However, low quality and quantity in food supply, lack modern knowledge about animal farming for product improvement and the prevalence of various kinds of livestock diseases reduces the products obtained from animals (milk, meat, egg, honey and other products). The leading ten livestock diseases that mostly occurred in Adi Arkay Wereda were mange, NCD, tryps and the rest are listed in Table 3. (Source: AAWVHO, 2020)

Table 3. Top ten diseases of livestock happened in Adi Arkay Wereda

No	Top 10 livestock disease in terms of case frequency
1	Mange –itching
2	NCD (Newcastle Diseases)- viral diseases of poultry
3	Tryps – sleeping sickness
4	Rabies- viral infection
5	LSD (lysosomal storage diseases)- lumpy skin diseases
6	Anthrax – bacterial infection
7	Ringworm
8	Blackleg- bacterial infection
9	PPR (pest des petites ruminants) – goat diseases
10	Ovine pasteurillosis – respiratory diseases

3.2. Materials

The materials used in the field study were:

Cutting tool - which is used to cut specimen from live plant, pruning branches and slicing fruits, and other thick plant parts are used.

Collecting bag– helps to collect a mass of plant specimen for later pressing. Jewelers tag will be tied on each of the specimen before putting in to the bag.

Field press- which prevent the damage or wilting of specimens. It consists of two wooden ends, cardboards, newspapers and straps.

Field notebook- to record sit notes, observation on the surrounding vegetation, soil type, land scape, local name of the plant and other pertinent detail.

Camera – to take photo and videos from the study site.

3.3. Methods

3.3.1. Selection of the study sites

Reconnaissance survey was done to study the area and familiarize with the plant species present in the study area. Basic information was collected from the traditional healers, leaders of kebele administration, and from the local people before conducting field study. This information gave a general impression for confirming suitable sampling of study sites for data collection based on the actual situation. Adi Arkay Wereda has a total of 22 kebeles. Out of these, 6 kebeles were selected purposefully for ethnobotanical data collection based on the temperature variation, vegetation distribution (cover) and availability of traditional medical practitioners. The sampled Kebeles were Aba Mar, Adi Argay, Ber Mariam, Meka, Nebra Fidka and Sera Gudela.

3.3.2. Sampling of informants

A total of 60 informants aged greater than 18 years was selected from the local people in 6 study sites. As shown in Table 4, most of the informants (70%) were males and the rest (30%) are females. The majority of informants (43.3%) were grouped under 35-51 age group and small number of informants were belongs to 18-34 years, which is about 25%. With respect to their marital status, most of informants (55%) were married. With regarding to their educational status, the highest number of informants (63%) were illiterate and the remaining informants were in the level from elementary to university graduate. Regarding with informant type 12 were key informants and selected by purposive sampling method using suggestion gained from

knowledgeable elders and from the local community. The remaining 48 informants were general and selected randomly using lottery method.

Table 4. The distribution of informants with respect to sex, age, marital status, educational background and informant type.

Socio-demographic variables		Number	Percent
Sex	Male	42	70
	Female	18	30
Age group (in years)	18-34	15	25
	35-51	26	43.3
	>51	19	31.7
Marital status	Married	33	55
	Unmarried	19	31.7
	Divorced	8	13.3
Educational level	Illiterate	38	63
	Elementary school	10	16.7
	Secondary school	7	11.7
	College/university graduate	5	8.3
Informant type	Key	12	20
	General	48	80
Total		60	100

3.3.3. Data sources

The ethnobotanical data were collected from both primary and secondary sources. The primary data were generated through interviews, group discussions, and field visits in the study area, while the secondary sources were various literature related to this study. Another relevant information was also gathered from different Wereda offices.

3.3.4. Ethnobotanical data collection

Ethnobotanical investigation was carried out to collect data through interviews, field visits and group discussions. All of the interviews were based on checklist of semi-structured questions (Appendix 1). The local name of the plants, their uses, status and conservation methods was recorded. Informant consensus was considered and both quantitative and qualitative data were collected.

3.3.4.1. Semi-structured interview

Questions were prepared that contain personal data of the respondents (name, address, age, sex and educational level), information on medicinal plants (local name, habit, parts of the plant used, condition of part used, preparation, administration and others necessary information); information on wild edible plants (local name, part used, mode of consumption, season of collection etc.), ecological role of plants and other useful information regarding threats and conservation practice of these useful plants (Figure 3).



Figure 3. Interview with informants

3.3.4.2. Guided field walk and direct observation

According to Cunningham (2001), observation is an appropriate method to gather data on more sensitive issue. Through guided field walk (Figure 4), data on plant use was collected based on the observation of human plant interaction. It was also an opportunity to detect land forms, soil type, major threats and the growth habit of different useful plants whether they are herbs, shrubs, trees, climbers. Field observations were performed with the help of local guides in the study area.

Questions were raised to the guide when necessary to get further clarification. Some of the informants, study sites and plant species were photographed during the field walk.



Figure 4. Field observation with local guider

3.3.4.3. Group discussion

Brief group discussions were made during ethnobotanical data collection according to Martin (1995). Discussions were conducted at each study site with informants (traditional healers, knowledgeable community members, and other participants) to understand the relevant issues about medicinal, wild food plants and other uses of plants. The place and time for discussion was arranged based on the interest of the participants. Sample group discussion is illustrated in Figure 5.



Figure 5. Focus group discussion with informants

3.3.5. Plant specimen collection and identification

Medicinal plants, wild edible plants and other associated plants were collected from wild and cultivated areas. Plant specimens were collected with the help of guided field walks and the plant specimens were pressed and dried for voucher. Identification of the plant specimens was done both in the field and using taxonomic keys, volume 8 of the flora of Ethiopia and Eriterea (2009).

3.3.6. Ethical consideration

Special ethical considerations were made from the beginning to the end of data collection based on the cultural view of the local communities in the study area. The data were collected after permission is obtained from individuals who were involved in the research. This was performed by showing them letter that support the research from Addis Ababa University. Informants specially healers were also informed that the objective of the research is for academic reasons but not for commercial purposes and information was recorded after obtaining oral informed consent from each informant.

3.3.7. Data analysis

3.3.7.1. Descriptive statistics

Descriptive statistical methods such as percentage and frequency were employed to analyze and summarize the data obtained from the interviews on reported medicinal and wild edible plants and their role for the ecosystems. The results were summarized in the form of figures and tables according to Martin (1995) and Cotton (1996).

3.3.7.2. Informant consensus

The relative importance of different plant species for the community were determined from the consensus in informant's response.

3.3.7.3. Informant consensus factor (ICF)

Health problems were categorized in to group and informant consensus factor (ICF) was calculated to identify the agreements of the informants on the reported cures for the group of ailments. The factor provides a range of **0** to **1**, and plants with high ICF value are considered as more pharmacologically active as compared to low ICF value (Canals *et al*,2005). The ICF were calculated by the formula: $ICF = \frac{n_{ur} - n_t}{n_{ur} - 1}$

Where, ICF is informant's consensus factor, n_{ur} is number of use citation(respondents) in each category and n_t is number of species used.

3.3.7.4. Preference ranking

In this study preference ranking were carried out to analyses the most preferred medicinal, wild food and ecologically useful plants according to personal preferences. Accordingly, eight key informants were asked to rank five medicinal plants which are used for treatment of stomachache in human. They also asked to rank five medicinal plants used for treating the problem of leeches in livestock. Similarly, ten key informants were selected for the preference ranking exercise of six wild food plants based on their sweet taste. The preference ranking of five ecologically useful plants on the basis of their capacity to adapt the environment also exercised by ten informants. The rank was given in an integral value with most preferred items being assigned the highest number (6) while the least preferred were assigned in smallest number (1) and in accordance of their order for the remaining ones. The numbers from all respondents were summed to give the overall rank (Martin, 1995).

3.3.7.5. Direct matrix ranking

Direct matrix ranking exercise was employed following Martin (1995) and Cotton (1996) in order to compare multipurpose use of medicinal and food plants based on information gathered from informants. Accordingly, seven key informants were selected to carry out direct matrix ranking of six most important multi-purpose medicinal plants and six most important multi-purpose wild food plants for six major uses. Each chosen key informants assigned to them using numerical scale with; 5=excellent, 4=very good, 3=good, 2=less used, 1=least used and 0= not used. The results of individual responses were added together to create a matrix that is representative to the community.

3.3.7.6. Paired comparison

It was applied to determine the most ecologically useful plants and the most threatening factors for the diversity of useful plant resource. Accordingly, seven key informants were selected and asked to choose the best ecologically useful plants from every pair of plants on the basis of their ability to hold more soil particles in their roots. Similarly, eight key informants were selected for choosing the most threatening factors of plant resource from every pair of threat factors. The total number of possible pairs was obtained by applying the formula $\frac{n(n-1)}{2}$, where n is the number of items being compared. Finally, the numbers of times each items are choosing were added from all respondents and giving the overall scores, which was ranked for the items. An item with the highest frequency of choices had the highest score and ranked first (Martin, 1995).

3.3.7.7. Jaccard's coefficient of similarity

Jaccard's Coefficient of Similarity (JCS) was carried out in order to see species similarity among different study sites. It was computed between study areas with other areas, which were studied by other authors in different parts of the country (Kent and Coker, 1992).

JCS was calculated as,
$$\text{JCS} = \frac{c}{(a+b+c)}$$

Where; a= Number of species found in study area A

b= Number of species found only in study area B

c= Number of common species found in study area A and B

CHAPTER FOUR

4. RESULTS

4.1. Indigenous Knowledge of Local People on Landscape, Soil Type and Vegetation Classification in the Study Area

According to their long lasting indigenous knowledge, the indigenous people in the study area classified the land forms, soil type and vegetations.

4.1.1. Land form classification by indigenous people

The local people in Debark divide land form into four main types:

- **Up and down** (Wotageba): Land not used for grazing land or agricultural activities.
- **Mountainous** (Terrarama): Mountain area characterized with higher altitude
- **Plain** (Medama): Level-land that serves especially for grazing but it also serves for cropping.
- **Valley** (Shelequama): landform that does not serves grazing and agricultural activities

4.1.2. Soil type classification by indigenous people

The local people classify soil based on soil characteristics such as color of the soil and fertility of the soil. The following three soil types have been identified by local people: -

- **Black soil** (Walka Afer): This soil type refers to black soil and with better fertility and production in contrast to other soil types
- **Red soil** (Key Afer): It is less fertile in comparison to the black soil. But, it can enable to grow crops of various types by applying fertilizer.
- **Silt soil** (Borenk): This type of soil is white soil which is not suitable for crop production.

4.1.3. Indigenous Vegetation Classification

The local people also have techniques of classifying vegetation into three main types: -

- **Forest** (Chaka): This type of vegetation is with densely populated plant species and composed of a range of larger trees.
- **Shrub** (Kutquato): Open woody and shrub land with patches of trees, bushes, shrubs and herbaceous species.

- **Grass land** (Yesar Meda): Refers to an area covered by grass and serves especially as grazing land.

4.2. Diversity of Useful Plants in the Study Area

In this study a total of 94 species belonging to 86 genera and 54 families were recorded that are useful for the local communities as medicinal and food; as well as for ecosystem. Of the total plant families; family Fabaceae had the highest number of plant species accounting for 8 (8.51 %) species followed by Solanaceae with 6 (6.38%) species; Moraceae contain 5 (5.31%) species; four families contain 4 (4.25%) species each; three of the families contain 3 (3.19%) species each; six of the families contain 2 (2.12%) species each and the rest 38 families contain one (1.06%) species each (Table 5 and Appendix 2 for more detail).

Table 5. Composition of useful plant resources for human and livestock healthcare, food and for the ecosystem with respect to their families, genera and species.

No.	Family	No. of genera	Percentage	No. of species	Percentage
1	Fabaceae	7	8.13	8	8.51
2	Solanaceae	6	6.97	6	6.35
3	Moraceae	1	1.16	5	5.31
4	Lamiaceae	4	4.65	4	4.25
5	Rosaceae	4	4.65	4	4.25
6	Rhamnaceae	3	3.48	4	4.25
7	Euphorbiaceae	3	3.48	4	4.25
8	Asteraceae	3	3.48	3	3.19
9	Rubiaceae	3	3.48	3	3.19
10	Polygonaceae	2	2.32	3	3.19
11	Apiaceae	2	2.32	2	2.12
12	Cucurbitaceae	2	2.32	2	2.12
13	Myrtaceae	2	2.32	2	2.12
14	Oleaceae	2	2.32	2	2.12
15	Ranunculaceae	2	2.32	2	2.12
16	Rutaceae	2	2.32	2	2.12
17	Acanthaceae	1	1.16	1	1.06
18	Alliaceae	1	1.16	1	1.06
19	Amaranthaceae	1	1.16	1	1.06
20	Anacardiaceae	1	1.16	1	1.06
21	Apocynaceae	1	1.16	1	1.06
22	Arecaceae	1	1.16	1	1.06
23	Asclepiadaceae	1	1.16	1	1.06
24	Bignonaceae	1	1.16	1	1.06

25	Boraginaceae	1	1.16	1	1.06
26	Brassicaceae	1	1.16	1	1.06
27	Cactaceae	1	1.16	1	1.06
28	Capparidaceae	1	1.16	1	1.06
29	Caryophyllaceae	1	1.16	1	1.06
30	Celostraceae	1	1.16	1	1.06
31	Chenopodiaceae	1	1.16	1	1.06
32	Combretaceae	1	1.16	1	1.06
33	Crassulaceae	1	1.16	1	1.06
34	Cyperaceae	1	1.16	1	1.06
35	Ebenaceae	1	1.16	1	1.06
36	Flacourtiaceae	1	1.16	1	1.06
37	Linaceae	1	1.16	1	1.06
38	Loganiaceae	1	1.16	1	1.06
39	Malvaceae	1	1.16	1	1.06
40	Meliaceae	1	1.16	1	1.06
41	Meliantaceae	1	1.16	1	1.06
42	Moringaceae	1	1.16	1	1.06
43	Myrsinaceae	1	1.16	1	1.06
44	Olacaceae	1	1.16	1	1.06
45	Phytolaccaceae	1	1.16	1	1.06
46	Podocarpaceae	1	1.16	1	1.06
47	Sapindaceae	1	1.16	1	1.06
48	Sapotaceae	1	1.16	1	1.06
49	Scrophulariaceae	1	1.16	1	1.06
50	Simaroubaceae	1	1.16	1	1.06
51	Tiliaceae	1	1.16	1	1.06
52	Urticaceae	1	1.16	1	1.06
53	Vitaceae	1	1.16	1	1.06
54	Zingiberaceae	1	1.16	1	1.06
	Total	86	100	94	100

4.2.1. Growth forms of useful plants in the study area

Among the total plant species recorded from the study area, trees were the dominant life form that contained 33 (35.10%) species followed by shrubs with 30 (31.91%) species (Figure 6 and Appendix 2 for more detail).

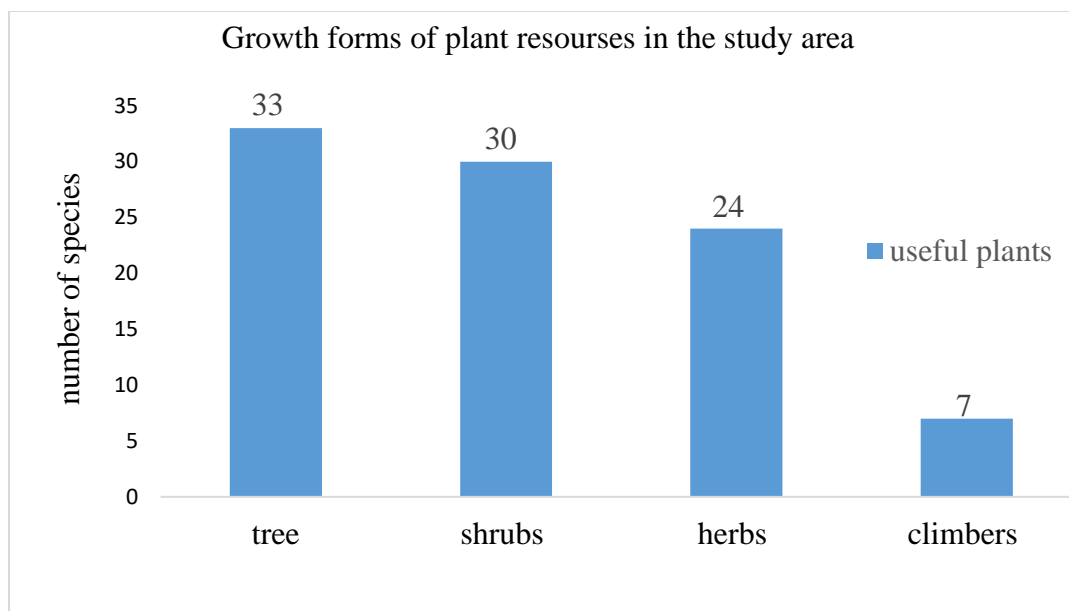


Figure 6: Growth form of useful plant resource in the study area

4.2.2. The current status of useful plants in the study area

Informants reported that most useful plants are declining from time to time due to human-made effects. Many trees and shrubs are used for construction, charcoal, fuelwood and for fence. The continued logging of these useful plants led to their decline. Accordingly, about 47 (50%) of the useful plants in the study area were rare as reported by informants; which means about half of the useful plants in the study area were distributed relatively in small number (Figure 7 and Appendix 2 for more detail).

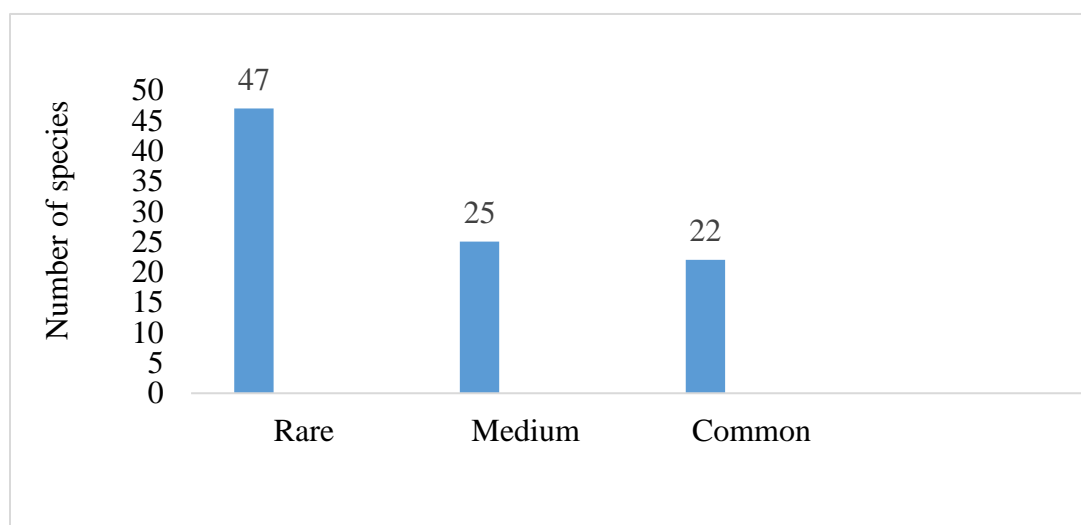


Figure 7. The current status of useful plants in Adi Arkay Wereda

4.3. Medicinal Plant Resources Used by the Local People

4.3.1. Diversity of medicinal plant species used to treat human and livestock ailments

Medicinal plants used to treat only human health problems were 46 species belonging to 29 families and 44 genera. Fabaceae were represented by the highest number of species containing 4 (8.69%) species followed by Lamiaceae, Rhamnaceae and Solanaceae containing 3 (6.52%) species each; eight of the families containing 2 (4.34%) species each and the remaining 17 families were containing one (2.17%) species each. Medicinal plants used to treat only livestock health problems recorded were 11 species belonging to 9 families and 11 genera. Fabaceae and Solanaceae were represented by 2 (18.2%) species each while the remaining 7 families containing one (9.1%) species each. Medicinal plants used to treat both human and livestock health problems recorded were 16 species belonging to 15 families and 16 genera. Euphorbiaceae were represented by the highest number of species containing 2 (12.5%) species while the remaining fourteen families containing one (6.25%) species each. In general, the total medicinal plant species recorded in the study area were 73 that belong to 69 genera and 44 families. Fabaceae and Solanaceae were represented by 6 (8.21%) species each followed by Euphorbiaceae and Rhamnaceae containing 4 (5.47%) species each; three of the families containing 3 (4.10%) species each; seven of the families containing 2 (2.73%) species each and the remaining 30 families containing one (1.36%) species each (Appendix 3).

4.3.2 Sources of medicinal plants

The majority of the medicinal plants were collected from the wild vegetation, accounting for 50 (68.49%) species. Thirteen (17.8%) species were cultivated and the remaining ten (13.69%) species are obtained both from the wild and cultivated areas (Table 6).

Table 6. Source of medicinal plant species in the study area

Source	Only human MPs		Only livestock MPs		Human and livestock MPs		Total MPs	
	Frequency	Percent	frequency	Percent	Frequency	Percent	Frequency	Percent
Wild	29	63.04	10	90.90	11	68.75	50	68.49
Cultivated	11	23.91	-	-	2	12.5	13	17.80
Both	6	13.04	1	9.09	3	18.75	10	13.69
Total	46	100	11	100	16	100	73	100

4.3.3. Season of collection of medicinal plants

As reported by healers, the leaves of medicinal plants were collected in wet season, then dried, powdered and stored to be used when needed. This is because some plants shed their leaves in dry season and it is difficult to get them at any time. They also reported that roots of smaller plants were collected in wet season since smaller plants dry completely in dry season and it is difficult to detect where the root is located. However, in wet season the plant grows and the shoot can be found where the root is located and then dig the ground and take the root. Likewise, in the same manner as that of the leaf, the root collected in wet season is dried and powdered to be stored for the purpose of using when needed. This is possible when parts are used in dry condition. This is the reason why most of the medicines are collected in wet season according to healers. Information gained from informants showed that parts of medicinal plant obtained from trees and shrubs such as root, bark, stem, and latex are collected when they are needed both in dry and wet season. Fruits and seeds are available when the leaf drops in dry season. Seeds are collected when accessible and stored for using it when needed, but fruits are less likely to be stored since they become spoiled as reflected by the healers and local community.

4.3.4. Growth forms of medicinal plants

Among the total 73 medicinal plant species reported in the study area herbs were the most common growth form of medicinal plants and stood first with 24(32.87%) species, followed by shrubs with 22 (30.13%) species (Figure 8).

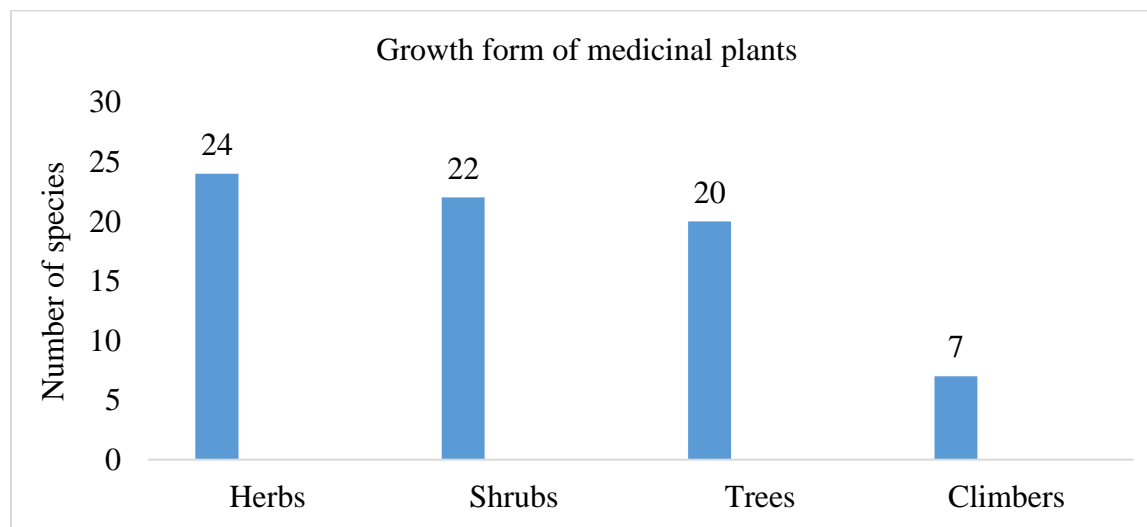


Figure 8. Growth form or habit of medicinal plants in the study area

4.3.5 Plant parts used for preparation of remedy

The finding of the study indicated that different parts of the plants were reported to be used as medicines for the treatment of various health problems. The most frequently utilized plant part in the preparation of remedies were leaves, which accounted for 55 (41.04 %) species followed by roots 26 (19.40%) and the rest are shown in Table 7.

Table 7. The parts of the plant used for remedy preparation in the study area.

Part used	Human medicinal plant species		Livestock medicinal plant species		Total medicinal plant specie	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Leaf	44	44.44	11	31.42	55	41.04
Root	16	16.16	10	28.57	26	19.4
Bark	10	10.10	5	14.28	15	11.19
Fruit	6	6.06	5	14.28	11	8.20
Seed	8	8.08	1	2.85	9	6.71
Latex	3	3.03	1	2.85	4	2.98
Bulb	4	4.04	-	-	4	2.98
Stem	4	4.04	-	-	4	2.98
Root & bark	1	1.01	1	2.85	2	1.49
Leaf and stem	1	1.01	-	-	1	0.74
Root & leaf	1	1.01	-	-	1	0.74
Tuber	1	1.01	-	-	1	0.74
Fruit and leaf	-	-	1	2.85	1	0.74
Total	99	100	35	100	134	100

4.3.6 Condition of the medicinal plant parts

The finding of the study showed that herbal remedies are prepared using fresh, dried and both dry and fresh condition. 89 (67.93%) of the total medicinal plant parts were reported to be used in fresh form while 29 (22.13%) were used in the form of dried plant material and 13(9.92%) were reported to be used both in fresh and dry condition (Figure 9).

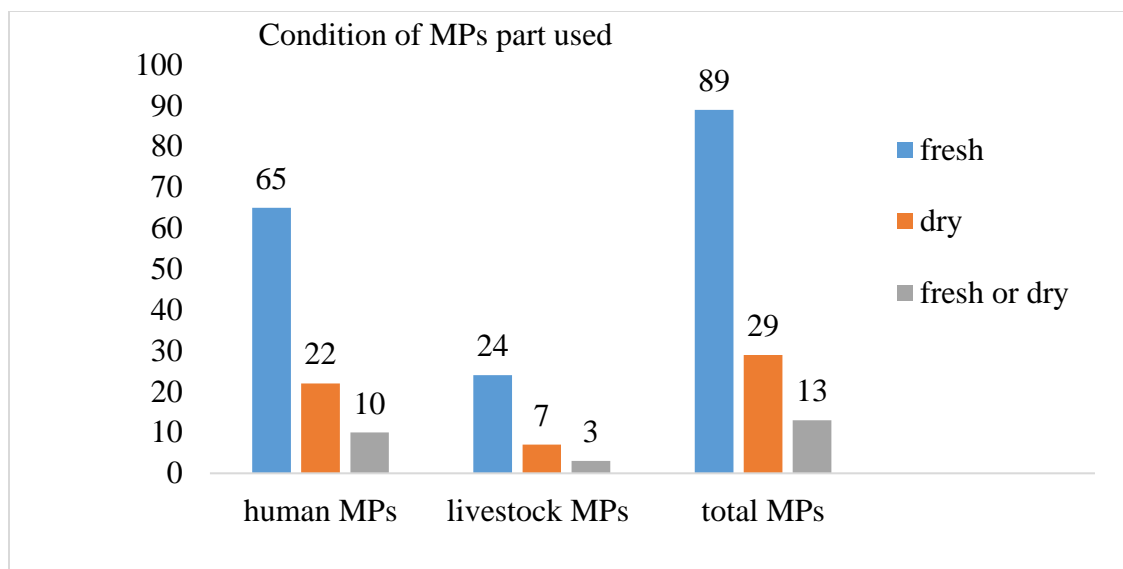


Figure 9. Condition of remedy preparation from plant parts

4.3.7. Methods of remedy preparation

The local people use different forms of remedy preparations to treat various human and livestock ailments. The most common technique of remedy preparation was squeezing, which accounted for 26(17.33%) of the preparations followed by grinding contributing to about 19(12.66%) preparations, crushing 18(12%) preparations, and the rest are shown in Table 8.

Table 8. Methods of preparation of medicinal plants.

Mode of preparation	HMPs		LMPs		Total MPs	
	Frequency	percent	Frequency	percent	Frequency	percent
Squeezing	17	14.91	9	25	26	17.3
Grinding after drying	16	14.03	3	8.33	19	12.66
Crushing the fresh parts	12	10.52	6	16.6	18	12
Boiling with water	16	14.03	1	2.77	17	11.33
Smoking	10	8.77	5	13.8	15	10
Extract the latex or juice	5	4.38	6	16.6	11	7.33
Chewing	11	9.64	-	-	11	7.33
Immersing	8	7.01	3	8.33	11	7.33
Heating	3	2.63	-	-	3	2
Cutting parts	2	1.75	-	-	2	1.33
Other methods	14	12.28	3	8.33	17	11.33
Total	114	100	36	100	150	100

4.3.8. Applications of remedies

The prepared remedies were applied in a number of methods. The most common method of remedy application reported by informants of the study area was drinking which was mentioned in 49 (35%) cases of the prepared remedy followed by creaming and fumigating 15(10.71%) each, sniffing and tied 10 (7.14%) each and the rest are shown in Figure 10. Generally, internal ailments were commonly treated by drinking herbal preparations; tooth infections were treated by holding the remedial plant part by the teeth; skin infections such as ringworm were treated by creaming herbal preparations on an infected skin. See all the rest application methods of the prepared herbal medicines for treating various other diseases in the study area in Appendix 4.

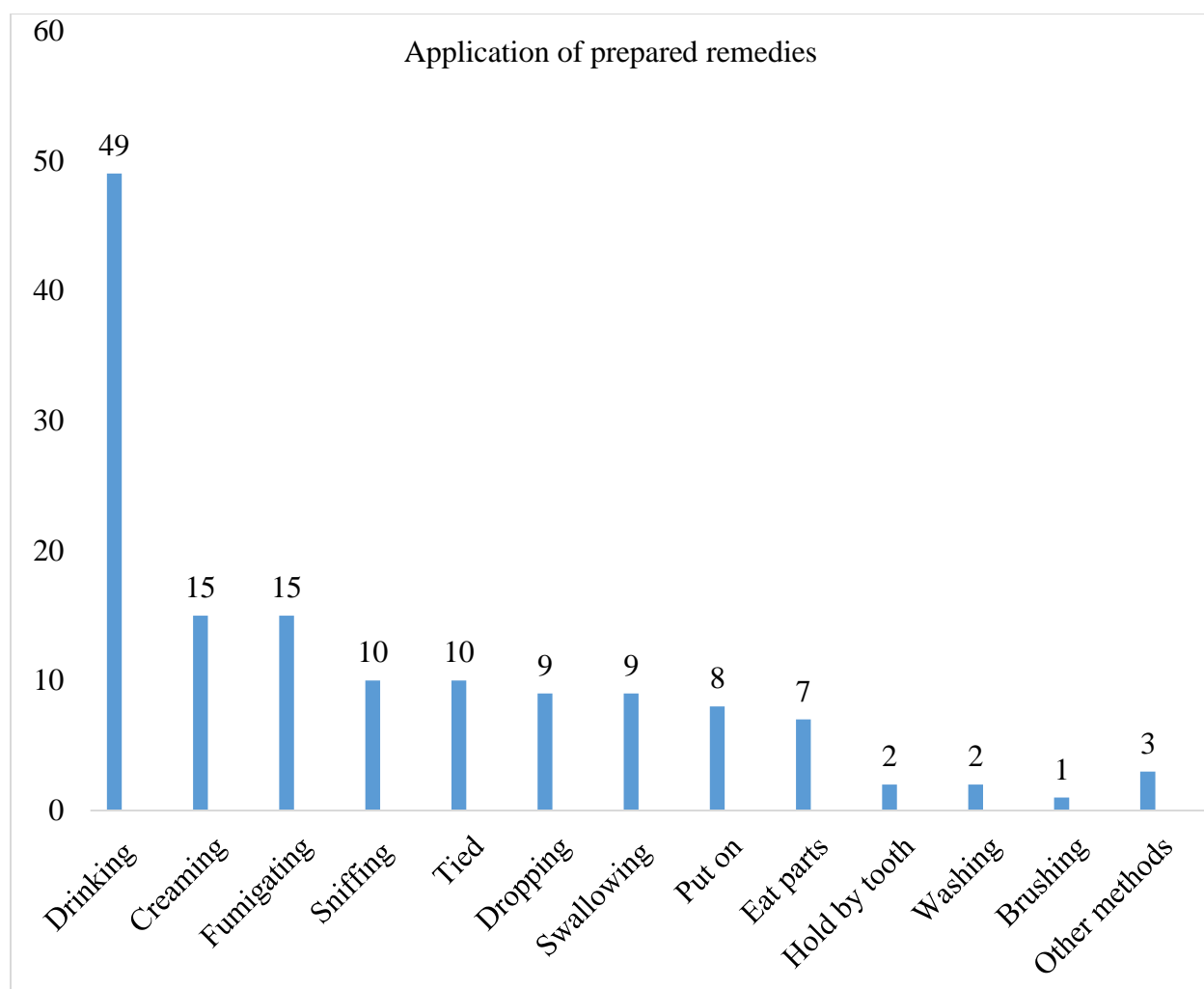


Figure 10. Mode of application of the prepared medicinal plants in the study area.

4.3.9. Routes of remedy administration

The finding of the research in the study area shows that there were different routes of remedy administrations. The majority of remedies 57 (48.71%) prepared for treating various human and livestock ailment were given orally followed by dermal 35 (29.91%) and nasal 9 (7.69%) and the rest and combinations are given in Table 9. Some of the application modes had spiritual values in the area. For example, the healers explained that the cross prepared from the stem of *Boscia angustifolia* (kermed) is tied on the neck of the patient to repel evil spirit away.

Table 9. The different routes of remedy administration

Route of administration	Human MPs		Livestock MPs		Total MPs	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Oral	46	52.87	11	36.66	57	48.71
Dermal	24	27.58	11	36.66	35	29.91
Nasal	6	6.89	3	10	9	7.69
Ocular (eye)	2	2.29	3	10	5	4.27
Oral and nasal	3	3.44	-	-	3	2.56
Oral & dermal	1	1.14	1	3.3	2	1.7
Tooth surface	2	2.29	-	-	2	1.7
Ear	2	2.29	-	-	2	1.7
Neck	1	1.14	-	-	1	0.85
Tail	-	-	1	3.3	1	0.85
Total	87	100	30	100	117	100

4.3.10. Dosage used

The local healers used various units of measurement such as finger lines, spoon, cup, handful (woket), glass and number (for leaf and fruit). The amount (dose) of the remedy depends on diseases type and severity (patients with more severe illness were given small amount but many times at regular interval), age (Children are given less than adults) and during pregnancy (mostly small amount, in some case not permitted). However, it was observed that there is a difficulty in determining the accurate dose of herbal preparations, as measurements are done by approximation. This may have an effect on the patient (high dose may kill the patient and low dose may not help the patient recover from the illness).

4.4. Health Problems and Medicinal Plants in the Study Area

As the information gained from informants, there are a total of 53 ailments were recorded. Among the 53 ailments reported in the study area 47 of them are human ailments, 14 are livestock ailments

and 8 ailments are common to human and livestock. Among the total 53 ailments reported by the informants, stomachache and wound are treated by higher number of plant species, 10 plant species are used for the treatment of each ailment followed by eye diseases treated by 8 plant species; cough and fibril illness treated by 6 plant species each and the rest are listed in Appendix 5.

Human health problem and the number of medicinal plant species used

As I have mentioned earlier there are 47 human ailments reported by informants. Of these 47 human ailments, stomachache and wound are treated by a relatively high number of plant species, 7 plant species are used for the treatment of each ailment followed by cough treated by 6 plant species; body swelling, evil eye, fibril illness and hemorrhoid were treated by four medicinal plants; common cold, dandruff, eye diseases, hepatitis, malaria, tooth diseases and gastritis were treated by 3 medicinal plant species and the rest are listed in Appendix 6.

Livestock health problem and the number of medicinal plant species used

Of the total 14 reported livestock ailment eye diseases and leech are treated by a relatively high number of plant species, 5 plant species are involved for the treatment of each ailment followed by wound treated by 4 plant species; fibril illness, retained placenta and stomach ache were treated by 3 medicinal plant species; hen disease, dislocating bone, plague and rabies were treated by 2 medicinal plants and the rest are listed in Appendix 7.

4.5. Medicinal Plant Species and the Number of Ailments Treated in Each MPs

A total of 73 MPs used for human and livestock ailment treatment was reported by the informants. The finding showed that the number of ailments treated by each plant species varies from plant to plant. Accordingly, the local people use *Croton macrostachyus* to treat highest number of ailments (7, 13.2%) followed by *Citrus aurantifolia* (6, 11.32%) ailments; *Rubia corareifolia* and *Phytolacca dodecandra* (5, 9.43%) ailments each; the rest are listed in Appendix 8.

Human medicinal plant species and the number of ailments treated in each MPs

Peoples of the study area depends on 62 Medicinal plants to treat human ailments. Of the 62 medicinal plant used to treat human health problem; *Croton macrostachyus* was found to treat the highest number of health problems (6, 12.76%) followed by *Rubia corareifolia* (5, 10.63%) ailments; *Allium sativum* (4, 8.51%) ailments and the rest are listed in Appendix 8.

Livestock medicinal plant species and the number of ailments treated in each MPs

The local people of the study area uses 27 medicinal plants to treat livestock ailments. Of the reported livestock medicinal plant *Citrus aurantifolia* and *Kosteletzka begonifolia* are used to treat the highest number of ailments (3, 21.42%) followed by *Phytolacca dodecandra* and *Nicotina tabacum* treats (2, 14.28%) ailment each; ant the rest are listed in Appendix 8.

4.6. Ranking of Most Important Medicinal Plants

4.6.1. Informant consensus

Not all the 73 reported medicinal plants in the study area are known by the community equally. Some medicinal plants were well known than others. Medicinal plants that were frequently cited (more popular) by informants are important for treatment of certain diseases. The finding of this study indicates that *Kosteletzka begonifolia* is the most cited medicinal plant species and have high informant consensus, which is cited by 36 informants, followed by *Verbascum sinaiticum* with 34 use citations, *Moringa stenopetala* with 34 use citations (Table 10).

Table 10. List of medicinal plants with the relatively higher informant consensus values

No.	Scientific name	Local name	No. of informants (use citation)	Percentage
1	<i>Kosteletzka begonifolia</i>	Yemegerem	36	60
2	<i>Verbascum sinaiticum</i>	Tirna (yemichu)	34	56.66
3	<i>Moringa stenopetala</i>	Shiferaw	34	56.66
4	<i>Zehneria scabra</i>	Haregres	26	43.33
5	<i>Ziziphus spina-christi</i>	Gaba	26	43.33
6	<i>Anogeissus leiocarpa</i>	Kirkira	21	35
7	<i>Calotropis procera</i>	Tobia	21	35
8	<i>Melia azedarach</i>	Nim	20	33.33
9	<i>Ocimum laminifolium</i>	Damakessie	18	30
10	<i>Rubia corareifolia</i>	Minchrur	17	28.33
11	<i>Phytolacca dodecandra</i>	Endod	15	25
12	<i>Nicotina tabacum</i>	Timbaho	14	23.33
13	<i>Croton macrostachyus</i>	Misana	14	23.33
14	<i>Securidaca longepedunculata</i>	Temenhay	14	23.33
15	<i>Citrus aurantifolia</i>	Lomi	14	23.33
16	<i>Maesa lanceolate</i>	Shuaria	14	23.33
17	<i>Ziziphus abyssinica</i>	Abetre	12	20
18	<i>Datura stramonium</i>	Astenagir	11	18.33
19	<i>Bersama abyssinica</i>	Azimir	11	18.33
20	<i>Brucea antidysenterica</i>	Waginose	11	18.33

4.6.2. Informant consensus factor (ICF)

ICF was measured to study the total usage of plant species. Plants with high ICF value can be considered as more important for the treatment of the diseases than plants with low ICF values. High ICF value were obtained in the maximum number of respondents (use citation) or when few plants can treat a specific disease (Table 11).

Table 11. Informant consensus factor (ICF)

Diseases category	n _r =No. of species used	n _{ur} =total No. of use citation(respondent)	ICF
Swelling (megerem and kurba), boil, jero degif)	6	75	0.932
Fibril illness, shivering, yebird beshita	7	72	0.915
Hypertension, headache and nasal bleed	3	21	0.90
Hemorrhoid	4	21	0.85
Wound, fire burn, itch, ringworm, dandruff	15	86	0.835
Rabies and hepatitis	4	19	0.83
Leech, plague, hen diseases, hen external parasite	8	40	0.82
Stomach ache and gastritis	13	52	0.76
Evil eye, evil spirit and psychosis	4	11	0.7
Malaria, yellow fever	4	11	0.7
Retained placenta, bone dislocating and skin cut	5	13	0.66
STD(jigil),dysuria, rheumatism	2	4	0.66
Diarrhea, ear parasite, ascariasis, tapeworm and other internal parasite	5	11	0.6
Scorpion bite, snake bite, spider poison, abdominal morbidity and toxin consuming	6	13	0.583
Eye, ear, tooth diseases	11	23	0.545
Cough, common cold, tonsil and uvula descending	12	20	0.421
Fleas and repealing flies	3	4	0.33

Categories of diseases that have high informant consensus factor (ICF) value in the study area were:

Swelling (megerem, kurba, boil, jero degif): This group had the highest ICF value (0.932) with 6 species reported by 75 use citations. Plant species used in the treatment of such diseases included *Phytolacca dodecandra*, *Kosteletzka begonifolia*, *Kalanchoe petitiiana*, *Justicia schimperiana*, *Cyperus dichroostathyus*, *Brucea antidysenterica*. Among those medicinal plants *Kosteletzka begonifolia* has higher informant consensus, about 36 (60%) in the study area (Table 10).

Fibril illness, shivering, yebird beshita: This group came up with the second highest ICF value (0.915) with 7 species reported by 72 use citations. Plant species used in the treatment of such diseases included *Zehneria scabra*, *Verbascum sinaiticum*, *Silene macrosolen*, *Securidaca longepedunculata*, *Ocimum lamiifolium*, *Echinops kebericho* and *Citrus aurantifolia*. Among these medicinal plant, *Verbascum sinaiticum* had higher informant consensus, about 34(56.66%) in the study area (Table 10).

Hypertension, headache and nasal bleeding: This group were the third highest ICF value (0.90) with 3 species reported by 21 use citations. Plant species used in the treatment of such diseases included *Rubia corareifolia*, *Ocimum lamiifolium* and *Moringa stenopetala*. Of these, *Moringa stenopetala* had higher informant consensus, about 34(56.66%) in the study area (Table 10).

4.6.3. Preference ranking

When the same health disorder is treated by different medicinal plants, people show preference of one over the other. Table 12 and 13 showed tha the preference ranking of medicinal plants against stomachache in human and leech problem in livestock respectively.

Preference ranking of five medicinal plants that were reported for treating stomachache in human beings by eight key informants on the basis its effectiveness indicated that *Zingiber officinale* ranked first and preferred more to treat the ailment, followed by *Anogeissus leiocarpa*, *Nigella sativa*, *Foeniculum vulgare* and *Trigonella foenum-graecum* (Table 12).

Table 12. Preference ranking of five medicinal plants used to treat stomachache in human beings in the study area (5=most preferred, 1= least preferred)

Plant species	Respondents (R1-R8)								Total	Rank
	R1	R2	R3	R4	R5	R6	R7	R8		
<i>Anogeissus leiocarpa</i>	4	4	5	4	4	5	3	5	34	2 nd
<i>Foeniculum vulgare</i>	3	2	2	1	3	1	2	1	14	4 th
<i>Nigella sativa</i>	2	3	3	3	2	4	4	3	24	3 rd
<i>Trigonella foenum-graecum</i>	1	1	1	2	1	2	1	2	11	5 th
<i>Zingiber officinale</i>	5	5	4	5	5	3	5	4	36	1 st

The simple preference ranking of five medicinal plants against leech in livestock that were reported by eight informants on the basis of their effective treatments indicate that *Maesa lanceolata*, ranked first followed by *Millettia ferruginea*, *Nicotina tabacum*, *Physalis peruviana* and *Citrus aurantifolia* (Table 13).

Table 13. Preference ranking of five medicinal plants against the problem of leeches in livestock in the study area (5=most preferred, 1= least preferred).

Plant species	Respondents (R1-R8)									Rank
	R1	R2	R3	R4	R5	R6	R7	R8	total	
<i>Citrus aurantifolia</i>	1	2	1	1	1	2	2	1	11	5 th
<i>Maesa lanceolata</i>	5	5	5	5	5	5	5	5	40	1 st
<i>Millettia ferruginea</i>	4	4	4	3	2	4	4	3	28	2 nd
<i>Nicotina tabacum</i>	3	3	2	2	3	3	3	4	23	3 rd
<i>Physalis peruviana</i>	2	1	3	4	4	1	1	2	18	4 th

4.6.4. Direct matrix ranking

Direct matrix ranking was performed to assess the medicinal plants and their multi-purpose values of each plant species. The results of the direct matrix ranking indicated that *Anogeissus leiocarpa* stood first in being the most multipurpose medicinal plant followed by *Olea europaea*, *Tamarindus indica*, *Ziziphus abyssinica*, *Stereospermum kunthianum* and *Croton macrostachyus* (Table 14).

Table 14. Results of direct matrix ranking by seven respondents for six medicinal plant species and six major uses in the study area. The values that each informant gave for each purpose were added and the sum was placed in the Table (5 = Excellent, 4 = Very good, 3 = Good, 2 = Less, 1 = least and 0= No use)

Multi purpose medicinal plant species in the study area	Main uses of the plants							Total	Rank
	Medicine	Food	Fence	Firewood	Construction	Charcoal			
<i>Anogeissus leiocarpa</i>	27	0	34	35	35	35	166	1 st	
<i>Croton macrostachyus</i>	35	0	23	28	18	13	117	6 th	
<i>Olea europaea</i>	32	0	23	35	30	35	155	2 nd	
<i>Stereospermum kunthianum</i>	35	0	25	23	20	22	125	5 th	
<i>Tamarindus indica</i>	35	35	20	14	15	22	141	3 rd	
<i>Ziziphus abyssinica</i>	35	24	35	26	0	20	140	4 th	

4.7. Ethnobotany of Wild Edible Plants

4.7.1. Diversity of wild edible plant resources

A total of 30 wild edible plants were recorded in the study area and these plants were found distributed in 20 families and 24 genera. Among these 20 families, Moraceae had the highest proportion of edible plants, which were represented by 5 (16.66%) species followed by Rosaceae represented by 3 (10%) species; Polygonaceae, Fabaceae, Rhamnaceae and Rubiaceae were represented by 2 (6.66%) species each; and the remaining 14 families were represented by one (3.33%) species each (Table 15).

Table 15. List of the wild edible plant families and the corresponding number of genera and species in the study area

No.	Families	No. of genera	Percentage	No. of species	Percentage
1	Moraceae	1	4.16	5	16.66
2	Rosaceae	3	12.5	3	10
4	Fabaceae	2	8.33	2	6.66
3	Polygonaceae	1	4.16	2	6.66
5	Rhamnaceae	1	4.16	2	6.66
6	Rubiaceae	2	8.33	2	6.66
7	Anacardiaceae	1	4.16	1	3.33
8	Apocynaceae	1	4.16	1	3.33
9	Arecaceae	1	4.16	1	3.33
10	Boraginaceae	1	4.16	1	3.33
11	Cactaceae	1	4.16	1	3.33
12	Ebenaceae	1	4.16	1	3.33
15	Flacourtiaceae	1	4.16	1	3.33
16	Lamiaceae	1	4.16	1	3.33
17	Loganiaceae	1	4.16	1	3.33
13	Myrtaceae	1	4.16	1	3.33
14	Olacaceae	1	4.16	1	3.33
18	Sapotaceae	1	4.16	1	3.33
19	Tiliaceae	1	4.16	1	3.33
20	Urticaceae	1	4.16	1	3.33
Total		24	100	30	100

4.7.2. Growth forms of wild edible plants

As reported by informants, there are three growth forms (tree, shrub and herb) of wild edible plants in the study area. Among the reported growth forms of wild edible plants, trees were the highest

growth form with 17 (57%) species followed by shrubs with 10 (33%) species (Figure 11).

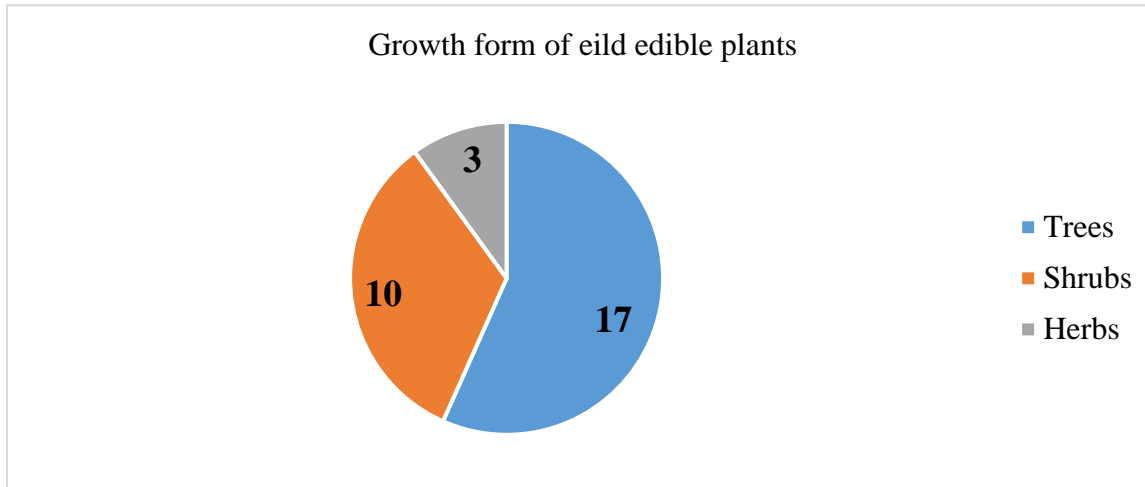


Figure 11. Growth forms of wild edible plants in Adi Arkay Wereda

4.7.3. Plant parts used as food

The finding of the study showed that different parts of the plant such as fruits, leaves, stems, roots, flowers and gums were used as a source food. Among these six plant parts fruits were found to be the most widely used wild edible plant part in the study area, which accounted for 25 (83.33%) species while the rest plant parts such as leaves, stems, roots, flowers and gums accounted for 1 (3.33%) species for each parts. See more on Appendix 9.

4.7.4. Mode of consumption of WEPs

As the finding of the study shows wild edible plants were consumed in raw form (when it gets ripen in the plant) or after it gets processed in home. The majority of the WEPs about 27 (90%) species were reported to be consumed raw and the remaining 10% were consumed after processing (Appendix 9).

4.7.5. Season of collection (harvesting time) of WEPs

The findings of the study showed that wild edible plants are harvested and consumed in different seasons or months of the year. According to the respondents the highest number of WEPs were harvested during March, which accounts for 14 (46.66%) species harvested; while the least number of species is harvested during June, July and August with 2 (6.66%) species harvested within each month (Figure 12).

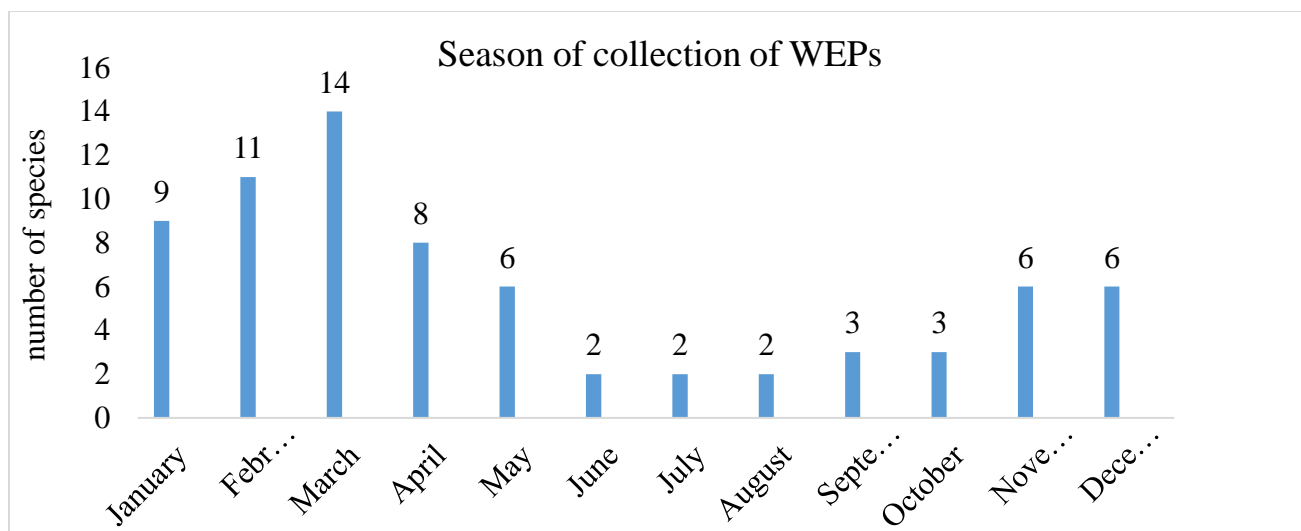


Figure 12. Harvesting month of wild edible plants in Adi Arkay Wereda

4.7.6. Ranking of most important wild edible plants

4.7.6.1. Informant consensus

The relative importance of different plant species for the community is determined from the consensus in informant's response. Plants with high informant consensus (plants that are more popular than the other) are considered to have a greater importance (Table 16).

Table 16. List of the top fifteen wild edible plants with high informant's consensus (popularity) in the study area.

List of wild edible plant species			Total No of citation (informants)	Percentage (%)
No.	Scientific name	Local name		
1	<i>Diospyros mespiliformis</i>	Sekin	47	78.33
2	<i>Zizyphus spina-christi</i>	Gaba	47	78.33
3	<i>Carissa spinarum</i>	Agam	45	75
4	<i>Cordia africana</i>	Wanza	45	75
5	<i>Ficus sur</i>	Shola	34	56.66
6	<i>Ficus vasta</i>	Warka	28	46.66
7	<i>Vangueria madagascariensis</i>	Guramile	25	41.66
8	<i>Tamarindus indica</i>	Humer	21	35
9	<i>Syzygium guineense</i>	Dokma	19	31.66
10	<i>Ximenia americana</i>	Inkoy	19	31.66
11	<i>Strycnos innocua</i>	Tinkohaye	18	30
12	<i>Mimusops kummel</i>	Kummel	17	28.33
13	<i>Rhus vulgaris</i>	Kamuna	15	25
14	<i>Ziziphus abyssinica</i>	Abetre	13	21.66
15	<i>Dovyalis abyssinica</i>	Koshim	13	21.66

4.7.6.2. Preference ranking

The preference ranking of the most preferred wild edible plants on the basis of its sweet taste was performed and shows that *Diospyros mespiliformis* is the most preferred wild plant species and ranked first followed by *Ximenia americana*, *Carissa spinarum*, *Zizyphus spina-christi*, *Cordia africana* and *Vangueria madagascariensis* (Table 17).

Table 17. Preference ranking of six wild edible plants on the basis of its sweet taste in Adi Arkay Wereda (6=most preferred, 1= least preferred)

Plant species	Respondent (R1-R10)										Total	Rank
	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10		
<i>Carissa spinarum.</i>	1	1	2	5	5	5	4	5	4	4	36	3 rd
<i>Cordia africana</i>	3	2	4	1	1	1	3	3	6	1	25	5 th
<i>Diospyros mespiliformis</i>	5	5	5	4	6	6	6	6	3	6	52	1 st
<i>Vangueria madagascariensis</i>	2	3	3	2	3	3	2	2	2	2	24	6 th
<i>Ximenia americana</i>	4	6	6	6	2	4	5	1	5	3	42	2 nd
<i>Zizyphus spina-christi</i>	6	4	1	3	4	2	1	4	1	5	31	4 th

4.7.6.3. Direct matrix ranking

Direct matrix ranking was applied to analyze the multipurpose wild edible plants. The direct matrix ranking of six most popular multi-purpose wild food plants showed that *Zizyphus spina-christi* was ranked first, followed by *Cordia africana*, *Tamarindus indica*, *Syzygium guineense*, *Ximenia americana* and *Diospyros mespiliformis* (Table 18).

Table 18. Results of direct matrix ranking on six wild food plants and six purposes based on 7 key informants.

Plant species	Main use of the plants							Total	Rank
	Edibility	Medicinal	Fencing	Firewood	Construction	Charcoal			
<i>Diospyros mespiliformis</i>	35	0	15	22	35	14	121	6 th	
<i>Zizyphus spina-christi</i>	35	30	35	29	15	14	158	1 st	
<i>Cordia africana</i>	31	17	23	25	29	24	149	2 nd	
<i>Syzygium guineense</i>	28	0	22	33	30	20	133	4 th	
<i>Tamarindus indica</i>	35	35	20	14	15	22	141	3 rd	
<i>Ximenia americana</i>	35	0	35	27	0	29	126	5 th	

4.8. Nutraceutical Wild Edible Plant Species

Among the wild food plants recorded in this study, 12 (40%) species serve the local community both as sources of food and traditional medicine. A total of 11 human and 5 livestock ailments were identified to be treated by wild edible plants. The most commonly reported ailments to be treated by nutraceutical plants were eye diseases (Table 19).

Table 19. Nutraceutical wild edible plants used to treat human and livestock ailments

No.	Nutraceutical wild edible plants		Uses	Ailment treated
	Scientific name	Local name		
1	<i>Acacia abyssinica</i>	Girar	Human	Tooth diseases
2	<i>Carissa spinarum</i>	Agam	Livestock	Eye diseases
3	<i>Cordia africana</i>	Wanza	Human	Gastritis
			Livestock	Retained placenta
4	<i>Ficus sur</i>	Shola	Human	Scorpion bite
5	<i>Ficus vallis-choudae</i>	Bambuledie	Human	Hepatitis
6	<i>Grewia ferruginea</i>	Lenkuata	Human	Dandruff
			Both	Retained placenta
			Livestock	Stomachache
7	<i>Rosa abyssinica</i>	Kega	Livestock	Stomachache
8	<i>Rumex abyssinicus</i>	Mekmeko	Human	Eye diseases
9	<i>Rumex nervosus</i>	Embacho	Livestock	Eye diseases
10	<i>Tamarindus indica</i>	Humer	Human	Cough, intestinal parasite, diarrhea
11	<i>Ziziphus abyssinica</i>	Abetre	Both	Wound
12	<i>Ziziphus spina-christi</i>	Gaba	Human	Dandruff

4.9. Marketability of Medicinal and Wild Edible Plants in the Study Area

4.9.1. Marketed medicinal plants

The respondents explained that most traditional healers sell traditional medicinal plants at their homes rather than in an open market. Survey made in the local markets showed that medicinal plants are not widely traded for medicinal purposes, but mostly for other different uses such as spices, food, smoke, etc. (Table 20). However, among the reported medicinal plants only *Rubia corareifolia* (minchirur) were sold in the market place for their medicinal purpose (figure 13E).

Table 20. Medicinal plants sold in an open market for different purpose

Scientific name	Local name	Purpose of selling in the market	Medicinal use in the study area
<i>Allium sativum</i>	Nech shinkurt	Spice, Food	Cough, common cold, malaria and abdominal morbidity
<i>Capsicum annum</i>	Mitmita	Food	Malaria
<i>Citrus aurantifolia</i>	Lomi	Food	Wound, cough, yebird beshita, toxin consuming, leech and hen diseases
<i>Coriandrum sativum</i>	Dinbilal	Spice	Cough
<i>Linum usitatissimum</i>	Teliba	Food	Retained placenta
<i>Myrtus communis</i>	Ades	Smoke	Dandruff
<i>Nigella sativa</i>	Tikur azmud	Food	Stomach ache
<i>Otostegia integrifolia</i>	Tinjut	Smoke	Stomachache and fleas
<i>Physalis peruviana</i>	Komydero	Food	Leech
<i>Rhamnus prinoides</i>	Gesho	Beverage	Uvular descending
<i>Rubia cordifolia</i>	Minchirur	Medicinal	Headache, eye diseases. stomachache, nasal bleed and ear parasite
<i>Rumex abyssinicus</i>	Mekmeko	Spice	Eye diseases
<i>Ruta chalepensis</i>	Tenadam	Spice	Evil eye and cough
<i>Securidaca longepedunculata</i>	Temenhay	Smoke	Fibril illness, rabies and evil-eye
<i>Tamarindus indica</i>	Humer	Food	Cough, internal parasite and diarrhea
<i>Trigonella foenum-graecum</i>	Abish	Food, spice	Stomach ache
<i>Vicia faba</i>	Bakela	Food	Boil
<i>Zingiber officinale</i>	Zingible	Spice	Stomach ache
<i>Ziziphus spina-christi</i>	Gaba	Food	Dandruff



Figure 13. Some marketed medicinal plants for different purposes. *Securidaca longepedunculata* (A), *Rumex abyssinicus* (B), *Myrtus communis* (C), *Ruta chalepensis* (D), *Rubia corareifolia* (E)

4.9.2. Marketed wild food plants

Market surveys were conducted to document the wild food plants sold in local markets. Many of the wild edible plants were reported to be consumed in the fields during cattle keeping and travelling in raw condition. There were two wild edible plant (*Zizyphus spina-christi* and *Tamarindus indica*) that are frequently sold in the market among the reported wild food plant species. However, other WEPs such *Carissa spinarum* (agam), *Diospyros mespiliformis* (serkin) and *Cordia africana* (wanza) were also sold in the market place.



A. B.
 Figure 14. Most frequently sold wild edible plants A: *Tamarindus indica* (humer) and B: *Ziziphus spina-christi* (gaba)

4.10. Other Uses of Medicinal and Wild Edible Plants

Some plants were reported to have uses other than their medicinal and food values. Different parts of the reported medicinal and wild edible plants are also used for house construction, bee forage, firewood, toothbrush, charcoal, washing clothed, animal feed and for fence. Plants that are used for purposes other than wild food and medicine are given in Appendix 10.

4.11. Traditional Knowledge and Knowledge Transfer

4.11.1. Knowledge of TMPs and WEPs with respect to gender, age, educational level and informant type in the study area

The knowledge of informants with respect to sex shows that males are more knowledgeable than female. On average males know 5.16 medicinal and 7.09 wild edible plants while females know 4.05 medicinal and 5.38 wild edible plants. The findings on the knowledge of different age groups shows that, the majority of knowledgeable people about traditional medicine were found in the

ages above 51 years old, but the knowledgeable group concerning WEPs were (18-34) age group. On average one individual who belongs to the above 51 age group knows 6 medicinal and 6.05 edible plants, which is more than the first and second age groups in terms of traditional medicine, however, their knowledge on WEPs is lower than the first and the second group. This indicates that, they are more knowledgeable on traditional medicine than wild edible plants. Informants that belong to the 18-34 age group knew only about 3.8 medicinal plants but about 7.13 wild edible plants on average, which makes them the least knowledgeable on MPs than the second and the third age group, but they are more knowledgeable on WEPs than the second and the third age group. The findings of the study on the knowledge of informants about medicinal and edible plants regarding their educational level shows that illiterate people (mostly farmers) are more knowledgeable. On average one person knows 5.81 medicinal and 7.47 WEPs. With respect to informant type key informants are more knowledgeable than general informants. On average a key informant knows 7.75 medicinal and 7.25 edible plants (Table 21).

Table 21. The level of traditional knowledge about medicinal and wild edible plants with respect to sex, age, education level and informant type.

Socio demographic variable of the informants		Number of Informants	Knowledge about MPs		Knowledge about WEPs	
			frequency of MPs	Average	Frequency of WEPs	Average
Sex	Male	42	217	5.16	298	7.09
	Female	18	73	4.05	97	5.38
Age group	18-34	15	57	3.8	107	7.13
	35-51	26	119	4.57	173	6.65
	>51	19	114	6	115	6.05
Educational level	Illiterate	38	221	5.81	284	7.47
	Primary school	10	27	2.7	49	4.9
	Secondary school	7	25	3.57	38	5.42
	University/college graduate	5	17	3.4	24	4.8
Informant type	General	48	197	4.10	308	6.41
	Key	12	93	7.75	87	7.25

4.11.2. Transferring knowledge of TMPs and WEPs

The findings of the study showed that the highest number of MPs knowledge were obtained from elders (above 51 years old) while the youth are least knowledgeable. I have asked some informants that belong to the 18-30 age group, why they are not knowledgeable on traditional medicine? The

response was due to the secrecy of knowledge of traditional medicine by the knowledgeable person. I have also asked the informants why the knowledgeable persons make their knowledge secret? And the response was that the knowledgeable person (specially healers) needed to sell the medicines and use the income gained from selling traditional medicine as a means of their livelihood. However, if somebody knows medicinal plants and start to prepare by himself for treating when encountered by diseases or for selling them; the customers of the healers reduce and hence the income of local healers may reduce. What makes surprise, healers prepare medicine for the patients in secure place and they make the part of the plant very fine (too small) to prevent the patient from knowing the plant. Even if the healers want to share the knowledge, they share it only to one of the family members (usually son). This is one reason the knowledge to decline from time to time.

4.12. The Diversity of Plant Resources and their Role in Ecosystem Conservation

4.12.1. The diversity of ecologically useful plant resources in the study area

In this study a total of 48 species belonging to 27 families and 42 genera were recorded that are useful for the ecosystem. Of the total plant families; family Fabaceae had the highest number of plant species, which accounted for 8 (16.66%) species followed by Moraceae containing 5 (10.41%) species, Rhamnaceae and Rosaceae containing 4 (8.33%) species each, Oleaceae containing 3 (6.25%) species, Myrtaceae and Rubiaceae contain 2 (4.16%) species each and the rest 20 families contain 1 (2.08%) species each (Table 22).

Table 22. Composition of useful plants for the ecosystem with respect to their number of Families, genera and species

No.	Family	No. of genera	Percentage	No. of species	Percentage
1	Fabaceae	7	16.66	8	16.66
2	Moraceae	1	2.38	5	10.41
3	Rhamnaceae	3	7.14	4	8.33
4	Rosaceae	4	9.52	4	8.33
5	Oleaceae	3	7.14	3	6.25
6	Myrtaceae	2	4.76	2	4.16
7	Rubiaceae	2	4.76	2	4.16
8	Acanthaceae	1	2.38	1	2.08
9	Anacardiaceae	1	2.38	1	2.08
10	Apocynaceae	1	2.38	1	2.08
11	Bignoniaceae	1	2.38	1	2.08

12	Boraginaceae	1	2.38	1	2.08
13	Celostracea	1	2.38	1	2.08
14	Combretaceae	1	2.38	1	2.08
15	Ebenaceae	1	2.38	1	2.08
16	Euphorbiacea	1	2.38	1	2.08
17	Flacourtiaceae	1	2.38	1	2.08
18	Lamiaceae	1	2.38	1	2.08
19	Loganiaceae	1	2.38	1	2.08
20	Meliaceae	1	2.38	1	2.08
21	Meliantaceae	1	2.38	1	2.08
22	Moringaceae	1	2.38	1	2.08
23	Podocarpaceae	1	2.38	1	2.08
24	Polygonaceae	1	2.38	1	2.08
25	Sapindaceae	1	2.38	1	2.08
26	Sapotaceae	1	2.38	1	2.08
27	Tiliaceae	1	2.38	1	2.08
	Total	42	100	48	1000

4.12.2. The role of plants for the ecosystem in the study area

Plants with large and deep root system such as *Ficus thonningi* (chibeha), *Ficus vallis-choudae* (bambuledie), *Ficus vasta* (warka), *Piliostigma thonningi* (dabja), *Ficus sur*, this is the name of another plant (shola), *Ficus sycomorus* (bamba), *Anogeissus leiocarpa* (kirkira), *Diospyros mespiliformis* (serkin), *Cordia africana* (wanza), *Zizyphus spina-christi* (gaba), *Acacia abyssinica* (girar), *Tamarindus indica* (humer), *Croton macrostachyus* (misana), *Strycnos innocua* (tinkohayo), *Syzygium guineense* (dokma), *Acacia mearnsii* (yetemenja zaf) are important in collecting the soil in to its root rather than moving away with flood. Plants are also important for the restoration of degraded ecosystems by preventing further degradation by reducing the movement of the soil with heavy runoff. If the soil is protected from further erosion, it supports the growth of other plants and helps the area to recover. Plants with large root, fast growth rate and those that have a capacity to adapt the environment are important in the rapid restoration of degraded areas. As it is shown in Figure 15A an area destructed before, after getting protection it begins recovering. The predominant plant involved in this restoration role was *Anogeissus leiocarpa*. Plants are too important for the ecosystem in soil fertility. When the different parts of the plants such as leaves, flowers, and fruits drop to the ground mineral elements that were incorporated in the different parts of the plants are released in to the soil as a result of

decomposition, which increases the fertility of the soil (Table 23). Plant species that are suitable for the ecosystems are listed in Appendix 11.

Table 23. Some of the plant species and their parts involved in soil fertility

Plant species with scientific name (local Amharic name)	Part involved in soil fertility		
	Leaf	Flower	Fruit
<i>Anogeissus leiocarpa</i> (kirkira)	✓	✓	
<i>Carissa spinarum</i> (agam)	✓	✓	✓
<i>Cordia africana</i> (wanza)	✓	✓	✓
<i>Croton macrostachyus</i> (misana)	✓	✓	
<i>Diospyros mespiliformis</i> (serkin)	✓		✓
<i>Ficus sur</i> (shola)	✓		✓
<i>Ficus sycomorus</i> (bamba)	✓		✓
<i>Ficus thonningi</i> (chibeha)	✓		
<i>Ficus vallis-choudae</i> , (bambuledie)	✓		✓
<i>Ficus vasta</i> (warka)	✓		✓
<i>Gardenia turnifolia</i> (gambilo)	✓	✓	✓
<i>Jasminum abyssinicum</i> (tenbelel)	✓	✓	
<i>Melia azedarach</i> (nim)	✓		
<i>Stereospermum kunthianum</i> (zana)	✓	✓	
<i>Syzygium guineense</i> (dokma)	✓	✓	✓
<i>Tamarindus indica</i> (humer)	✓		✓
<i>Vernonia amygdalina</i> (girawa)	✓	✓	

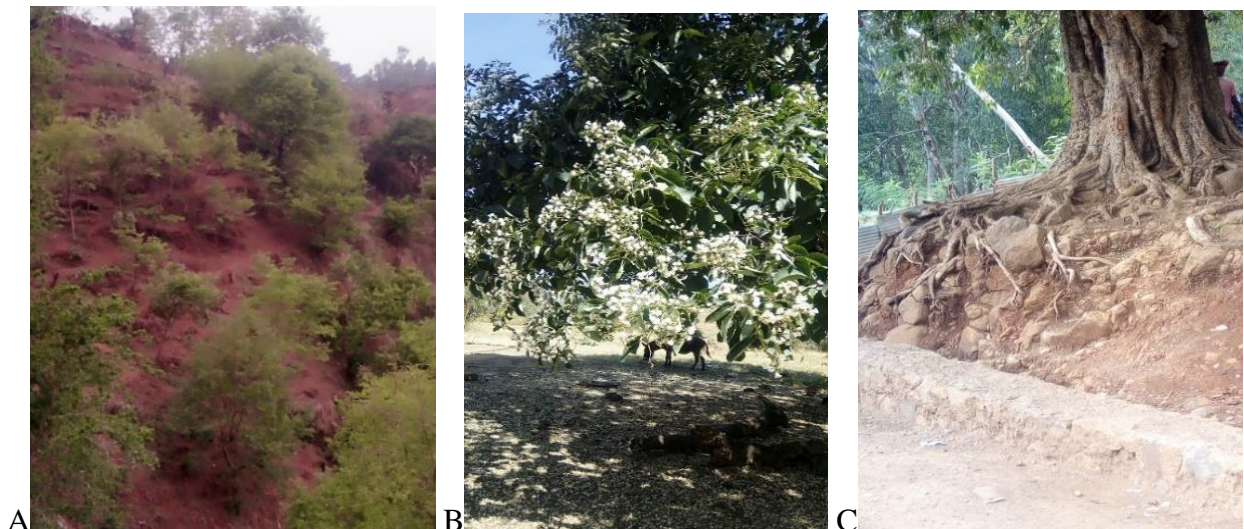


Figure 15. The involvement of different plant species for ecosystem conservation. *Anogeissus leiocarpa* with other plants in ecosystem restoration work (A), the role of *Cordia africana* in soil fertility by dropping its flowers on the ground (B), the root of *Ficus thonningi* anchoring the plant and holding soil particles together (C)

4.12.3. Ranking of most important plants for the ecosystem

4.12.3.1. Preference ranking

Preference ranking was carried out on the five ecologically important plant species on the basis of their environmental adaptability as indicated by informants. The preference ranking of ecologically important plants showed that *Anogeissus leiocarpa* stood first followed by *Cordia africana*, *Ficus sur*, *Diospyros mespiliformis*, and *Zizyphus spina-christi* (Table 24).

Table 24. Preference ranking of five ecologically important plants on the basis of their environmental adaptability in the study area (5=most preferred, 1= least preferred)

Plant species	Respondent (R1-R10)											Total	Rank
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10			
<i>Anogeissus leiocarpa</i>	5	5	5	5	5	5	5	5	5	5	50	1 st	
<i>Cordia africana</i>	4	4	4	3	3	1	2	4	4	3	32	2 nd	
<i>Diospyros mespiliformis</i>	1	3	1	4	4	3	1	1	3	2	23	4 th	
<i>Ficus sur</i>	2	1	2	1	2	4	4	3	1	4	24	3 rd	
<i>Zizyphus spina-christi</i>	3	2	3	2	1	2	3	2	2	1	21	5 th	

4.12.3.2. Paired comparison

For ecologically useful plants that were identified by the informants to be used for controlling erosion by collecting soil particles through their large roots, a paired comparison was made among five ecologically useful plants in the study area. Seven informants participated in this activity. Accordingly, *Ficus vasta* stood first followed by *Ficus thonningi*, *Anogeissus leiocarpa*, *Ficus sur* and *Syzygium guineense* (Table 25)

Table 25. Paired comparison of the five ecologically important plants on the basis of their capacity to hold more soil particles in their large root system.

Ecological useful plants	Respondent (R1-R17)								Total	Rank
	R1	R2	R3	R4	R5	R6	R7			
<i>Anogeissus leiocarpa</i>	0	3	3	0	2	0	3	11	3 rd	
<i>Ficus sur</i>	2	0	1	3	1	3	0	10	4 th	
<i>Ficus thonningi</i>	3	2	2	1	3	2	2	15	2 nd	
<i>Ficus vasta</i>	4	4	4	4	4	4	4	28	1 st	
<i>Syzygium guineense</i>	1	1	0	2	0	1	1	6	5 th	

4.13. Threats and Conservation of Useful Plants and the Ecosystems

4.13.1. Threats of useful plants and the ecosystems in the study area

In this study, several factors such as humans, other animals and natural factors were found to contribute to the threats that affect survival of medicinal and wild edible plants as well as the plants that protect the ecosystem from destruction. The informants reported that human-made factors are more than others.

Deforestation

Forests that contain useful plants are being deforested in the study area for different purposes. Some of the reason why people are cutting down plants were: first; for the expansion of agricultural land to cultivate crop plant (figure 16A). Second; to obtain wood for house construction, charcoal production, fuelwood (since there is no electric power in the rural part of the study area people cut plants for the purpose of using them as a fuelwood, Figure 16 B and C) and for fence (in most case plants that are spiny were preferable for fencing). Area becomes vulnerable to erosion if there were no vegetation cover.



Figure 16. Major threats of plant diversity in the study area showing expansion of agricultural land for crop production (A) and fuelwood collection (B and C)

Burning of natural forest

Farmers cut plants and burn it when they get dry to cultivate crop plants for their livelihood. Once the fire started it causes great damage to the rest of the vegetation. Since the condition of the environment is hot, it facilitates the spreading of the fire to the rest of the plants.

Over exploitation especially for medicinal purpose

The findings of the study show that root is the second mostly utilized part for remedy preparation, and cutting the root is the major threat for the reduction of medicinal plants. Therefore, over exploitation is one of the reasons in addition to agricultural land expansion, house construction, fencing, fuelwood collection and charcoal production.

Animals

Due to an increase in grazing animals and shortage of grazing land, animals feed on the same ground over and over again, this phenomenon eradicate useful plants in that area. Animals also eat (nip off) the growing point of the tip of young tree and preventing them from growing. when animals feed on the same ground over and over again and the land exposed to erosion as their continuous trampling break up and loosen the surface of the ground.

Severe runoff

Severe flooding causes an area to become destructed, which causes the plant to lose its habitat. Erosion (Figure 17A) was the common phenomenon in the study area and causes land sliding (Figure 17B).

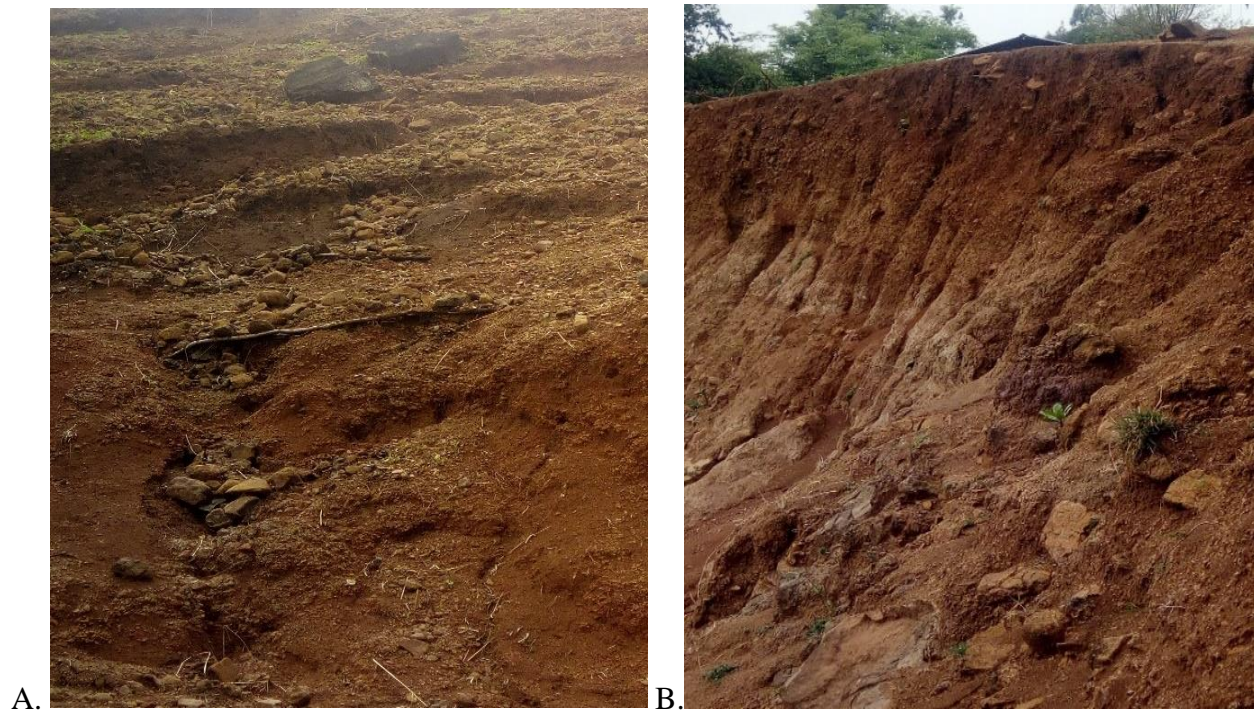


Figure 17. Eroded land (A) and land sliding due to severe erosion (B)

Diseases

Diseases are other threats of plant resource in the study area. As shown in Figure 18, *Melia azedarach* (nim) was attacked by diseases. The disease had also spread to other plants that are found around it such as *Cordia africana* (wanza) and *Vernonia amygdalina* (grawa). At the beginning, the plant was very greasy and then turned in to mold like and finally the plant to dried up.



Figure 18. An infected *Melia azedarach* tree

Paired comparison of threat factors of useful plants in the study area

Paired comparison was applied to analyze the threat of useful plant species in the study area. Paired comparison for five threatening factors showed that agricultural expansion was the most threatening factor of useful plant followed by firewood collection, charcoal production and house construction and fencing (Table 26).

Table 26. Paired comparison results of eight respondents on five factors perceived as threats to useful plants (values: 1=least destructive, 4=most destructive)

Threatening factor	Respondents (R1-R8)								Total	Rank
	R1	R 2	R3	R4	R5	R6	R7	R8		
Agricultural expansion	4	4	4	4	4	4	4	4	32	1 st
House construction	1	2	2	1	1	2	1	2	12	4 th
Fencing	0	1	0	1	0	1	0	1	4	5 th
Firewood collection	3	2	2	2	2	2	3	1	17	2 nd
Charcoal production	2	1	2	1	3	1	2	2	14	3 rd

4.13.2. Conservation methods of useful plants and the ecosystems in the study area

To safeguard ethno botanically useful plants and the ecosystem, different conservation methods have been performed in the study area. Some of the conservation methods are:

Terracing

Terracing is important in preventing severe runoff and involved in the formation of sediments on the wall of the terrace. In the study area the government encouraged the community in making terraces in degraded or degrading areas in participatory programmes through productive safety net programmes, since Adi Arkay is one of the food insecure district in Amhara Regional State. Terracing is done in an area that has been degraded or degrading to restore the area or for the purpose of protecting further degradation and this is followed by tree planting (Figure 19).

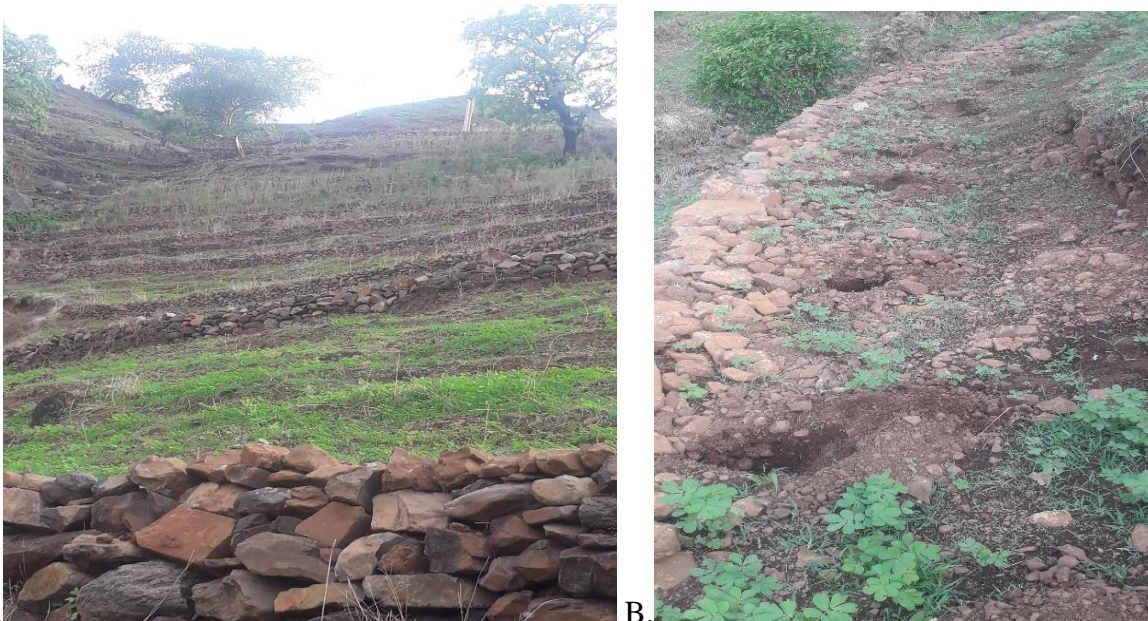


Figure 19. Terracing for the purpose of ecosystem conservation (A) and preparation of holes for planting trees (B)

Protecting the natural vegetation

Protecting of plants from human and other animals that have negative effects on the vegetation is crucial in the sustainability of useful plant resources and the stability of an ecosystem and in preventing the degradation of the area particularly for the conservation of useful plants in their natural habitats rather than in home gardens. For instance, Myteklit forest is one of the protected natural vegetation in Adi Arkay Wereda near the town, Adi Arkay (Figure 20). The vegetation cover of the forest is found in contiguous form covering an area. In this forest, plants with different

growth form (trees, shrubs, herbs and climbers) were found. In total, 39 useful plants were recorded in Myteklit forest. Of the total recorded useful plants in the forest, 12 of them are edible plants, 17 of them are medicinal plants and 10 of them are nutraceutical plants, which indicates that the forest is rich in useful plants (Table 27). The forest in Medihaniyalem church is another protected site in the study area. According to the responses of informants the area was devegetated before. However, after the church has been constructed the area got protection and became a forest now.

Table 27. Useful plant species recorded in Myteklit forest, Adi Arkay Wereda

Scientific name	Family name	Local name	Habit	Ethnobotanical use
<i>Acacia abyssinica</i> .	Fabaceae	Girar	Tree	Medicinal and food
<i>Anogeissus leiocarpa</i>	Combretaceae	Kirkira	Tree	Medicinal
<i>Becium grandiflorum</i>	Lamiaceae	Metete	Shrub	Food
<i>Bersama abyssinica</i>	Meliantaceae	Azamir	Shrub	Medicinal
<i>Brucea antidysenterica</i>	Simaroubaceae	Waginos	Shrub	Medicinal
<i>Calotropis procera</i>	Asclepiadaceae	Tobia	Shrub	Medicinal
<i>Calpurnia aurea</i>	Fabaceae	Zigita	Shrub	Medicinal
<i>Carissa spinarum</i>	Apocynaceae	Agam	Shrub	Medicinal and food
<i>Cavatica gracilis</i>	Vitaceae	Aserkush	Climber	Medicinal
<i>Clematis simensis</i>	Ranunculaceae	Azo-hareg	Climber	Medicinal
<i>Cordia africana</i>	Boraginaceae	Wanza	Tree	Medicinal and food
<i>Croton macrostachyus</i>	Euphorbiaceae	Misana	Tree	Medicinal
<i>Diospyros mespiliformis</i>	Ebenaceae	Serkin	Tree	Food
<i>Ficus sur</i>	Moraceae	Shola	Tree	Medicinal and food
<i>Ficus sycomorus</i>	Moraceae	Bamba	Tree	Food
<i>Ficus thonningi</i>	Moraceae	Chibeha	Tree	Food
<i>Ficus vallis-choudae</i>	Moraceae	Banbulede	Tree	Medicinal and food
<i>Ficus vasta</i>	Moraceae	Warka	Tree	Food
<i>Grewia ferruginea</i>	Tiliaceae	Lenkuata	Tree	Medicinal and food
<i>Helinus mystacinus</i>	Rhamnaceae	Esat abrid	Climber	Medicinal
<i>Jasminum abyssinicum</i>	Oleaceae	Tembelele	Shrub	Medicinal
<i>Justicia schimperiana</i>	Acanthaceae	Simiza	Shrub	Medicinal
<i>Maytenus arbutifolia</i>	Celostraceae	Atat	Shrub	Medicinal
<i>Mimusops kummel</i>	Sapotaceae	Kummel	Tree	Food
<i>Ocimum laminifolium</i>	Lamiaceae	Damakesie	Shrub	Medicinal
<i>Phoenix reclinata</i>	Arecaceae	Selien	Tree	Food
<i>Rhus vulgaris</i>	Anacardiaceae	Kamuna	Shrub	Food
<i>Rumex abyssinicus</i>	Polygonaceae	Mekmeko	Herb	Medicinal and food
<i>Rumex nervosus</i>	Polygonaceae	Embacho	Herb	Medicinal and food
<i>Solanum dasyphyllum</i>	Solanaceae	Emboy	Shrub	Medicinal
<i>Stereospermum kunthianum</i>	Bignoniaceae	Zana	Tree	Medicinal
<i>Strychnos innocua</i>	Loganiaceae	Tinkohaye	Tree	Food
<i>Syzygium guineense</i>	Myrtaceae	Dokima	Tree	Food

<i>Vangueria madagascariensis</i>	Rubiaceae	Guramile	Shrub	Food
<i>Vernonia amygdalina</i>	Astraceae	Girawa	Shrub	Medicinal
<i>Ximenia americana</i>	Olacaceae	Inkoye	Tree	Food
<i>Zehneria scabra</i>	Cucurbitaceae	Haregesa	Climber	Medicinal
<i>Ziziphus abyssinica</i>	Rhamnaceae	Abetrie	Tree	Medicinal and food
<i>Ziziphus spina-christi</i>	Rhamnaceae	Gaba	Shrub	Medicinal and food



Figure 20. Protected natural vegetation of Myteklit forest in the study area

Plantation

Planting of trees in an area which had lost its vegetation cover helps to prevent the area from degradation. Since areas with no vegetation cover are highly exposed to severe erosion, plants help to reduce surface runoff by holding the soil with their roots. In the study area plantation programmes were performed during June by mass mobilization of the community. The community gives more attention to plants growing around their home starting from the time of planting. I observed that most of the people plant trees carelessly when it is performed far away from their homes. Contrary to this the people plant trees around their homes in the proper area, they make fence to protect them against animals, they also watered them to prevent from drying. Plant species that are planted in the study area are listed in Table 28.

Table 28. Plants that were planted in the study area

Plant species with (scientific name, local name)	Site of plantation	
	Around home	Few distance Far from home
<i>Justicia schimperiana</i> (simiza)	✓	
<i>Podocarpus gracilior</i> (zigba)		✓
<i>Melia azedarach</i> (nim)	✓	
<i>Acacia mearnsii</i> (ytemenja zaf)		✓
<i>Olea europaea</i> (weira)		✓
<i>Cordia africana</i> (wanza)		✓
<i>Phytolacca dodecandra</i> (endod)	✓	
<i>Diospyros mespiliformis</i> (serkin)		✓
<i>Anogeissus leiocarpa</i> (kirkira)		✓
<i>Moringa stenopetala</i> (shiferaw)	✓	
<i>Ficus thonningi</i> (chibeha)		✓
<i>Zehneria scabra</i> (haregresa)	✓	
<i>Euphorbia tirucalli</i> (kinchib)	✓	
<i>Croton macrostachyu</i> (Misana)		✓
<i>Ficus sur</i> (shola)		✓

Some people conserve medicinal plants by cultivating them in home gardens for different purposes. Plants like *Rhamnus prinoides* (gesho), *Citrus aurantifolia* (lomi), *Allium sativum* (nech shinkurt), *Ruta chalepensis* (tenadam), *Trigonella foenum-graecum* (abish), *Coriandrum sativum* (dinbilal) and *Cucurbita pepo* (duba) were cultivated by some of the community members mainly for food, spice and income. Some other plants are also planted around their homes for the purpose of fencing the home (*Justicia schimperiana* (simiza), *Euphorbia tirucalli* (kinchib) and *Zehneria scabra* (haregresa); *Melia azedarach* (nim, for shade) and *Phytolacca dodecandra* (endod, for washing clothes). Due to their diverse uses and lower shade effect on crops, some useful plants (e.g. *Tamarindus indica*, humer) were left to grow in farmlands.

CHAPTER FIVE

5. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1. Discussion

5.1.1. Classification of land scape, soil type and vegetation by the local peoples

Local people living in the study area have a long lasting experience of relationship and interaction with each other and with the natural resources that exist around them. They have well organized indigenous knowledge systems to classify vegetation, landscape and soil type. The local people classify the vegetation of the study area according to their growth form as large tree, shrub and grass. They also classify the soil type according to color and fertility as black, red and silt soil. Among these categories of soil, black soil is black in its color and more fertile while silt soil is white soil, which is white in color and less in fertility and is poor for cultivation of crops. The landscape is classified as up and down, mountain, plain and valley. This finding was also indicated in studies conducted elsewhere in Ethiopia by Eskedar Abebe (2011), Getu Alemayehu *et al.* (2015) and Asmera Amde (2017). This knowledge of local people confirms that people of the study area not only know useful plants (specifically medicinal) but have deep knowledge of their surroundings (Moa Megersa, 2010).

5.1.2. Medicinal plants used by peoples of the study area

The 73 medicinal plants that were used to treat human and livestock ailments by the local people and reported by the respondents indicate the depth of the indigenous knowledge of the local people on medicinal plants and also shows that the local people use many medicinal plant species as a means of healthcare for their own and for their animals. This interest in medicinal plants in Ethiopia is related to acceptability, accessibility and biomedical benefits (Dawit Abebe, 2001).

Among the 44 families, families Fabaceae and Solanaceae had the highest number of species, which accounts for 6 (8.21%) species each followed by Euphorbiaceae and Rhamnaceae containing 4 (5.47%) species each. Similar studies conducted elsewhere in the country by Mirutse Gidey *et al.* (2007), Ermias Lulekal *et al.* (2008), Moa Megersa (2010) and Sintayehu Tamene (2011), as well as from other parts of the world by Hassan-Abdellah *et al.* (2013) and Samar *et al.* (2013), reported that Fabaceae is represented by the highest number of medicinal plant species. Whereas, other researchers reported that Asteraceae is the leading family with highest number of

medicinal plant species (Getnet Chekole, 2011; Nigussie Amsalu *et al.*, 2015; Asmera Amde, 2017 and Seble Wolde-Yohannis *et al.*, 2018). These observations are related to the fact that these two families are widely distributed and have the highest number of species in the flora of Ethiopia being first or second in family analyses.

The findings of the study showed that 62 (84.93%) of medicinal plant species in the study area were used against 47 human ailments and 27 (36.98%) against 14 livestock diseases. This shows that more number of human diseases and medicinal plants were reported as compared to those used for livestock disease treatment. This may be due to giving less attention for animal health as compared to human health or loss of ethnoveterinary knowledge as the knowledge is transferred secretly and orally. A similar finding was reported by Getnet Chekole (2011); Nigussie Amsalu *et al.* (2015); Getu Alemayehu (2017) and Seble Wolde-Yohannis *et al.* (2018), who were also reported that more number of medicinal plants were used to treat human ailments than livestock ailments.

Most of the medicinal plant species reported in the study area were also used in other parts of the country. For instance, of the total 73 medicinal plants collected in Adi Arkay Wereda 34 of them were reported by Seyoum Getaneh and Zerihun Girma (2009) in Debre Libanos Wereda; 39 of them by Nigussie Amsalu *et al.* (2015) in Gozamen Wereda; 49 of them were reported by Asmera Amade (2017) in Debark Wereda and 29 of them by Bogale Haile (2018) in Wadla Wereda (Table 29). This shows that peoples across different parts of the country have a tendency to utilize the same medicinal plants due to local experience and exchange of information.

5.1.3. Habit and source of medicinal plants

Among the medicinal plants reported in the study area 24(32.87%) species were herbs, followed by shrubs with 22 (30.13%) species. The dominance of herbs is an indication of their better abundance in nearby areas than trees and shrubs (Mirutse Giday *et al.*, 2007). This finding is consistent with the finding of Moa Megersa (2010); Getu Alemayehu (2017) and Seble Wolde-Yohannis *et al.* (2018). They also found that the most frequent habits of medicinal plants were herbs. In contrast, other findings elsewhere in Ethiopia by Ermias Lulekal *et al.* (2008); Getnet Chekole (2011), and Sintayehu Tamene (2011), as well as from other part of the world by Hassan-Abdellah *et al.* (2013) revealed that shrubs were the most used growth forms of medicinal plants. Other study in Sudan by Musa (2011) showed that trees accounted for the highest proportion of

medicinal plants (88.9%). These findings do not agree with the results of the current study and this may be related to the plant composition of the areas in which the studies were made and may be cultural effects.

Regarding the source, majority of the medicinal plant species (50, 68.49%) were collected from their natural habitats in the wild than those cultivated in the home garden or farm land. This indicates that traditional healers and local communities depend on the wild sources rather than home garden to obtain most of the medicinal plants. It also indicates that medicinal plants in the natural forest are being overexploited by traditional healers for the purpose of medicine. Zemedu Asfaw (1997) found that plant species cultivated in Ethiopian home gardens for the purpose of medicine are about 6% of the species cultivated in home gardens. This figure indicates that a large number of medicinal plant species that are used by the herbalists are collected from the natural vegetation and the activity of cultivating medicinal plants in the home garden is very poor. This may be due to the scarcity of water to cultivate them in the home garden. Studies conducted earlier by Moa Megersa (2010), Sintayehu Tamene (2011), Mesay Wolde-Mariam *et al.* (2015), and Nigussie Amsalu *et al.* (2015), Getu Alemayehu (2017), Bogale Haile (2018) and Seble Wolde-Yohannis *et al.* (2018) found that most of the medicinal plants were collected from natural vegetation in the wild. These findings are in agreement with the current study. The current study is also in line with other medicinal plant studies conducted in Djibouti by Hassan-Abdellah *et al.* (2013), who reported that 96% of the medicinal plants were sourced from non-cultivated areas. In contrast to the current study, Gidey Yirga (2010) reported that most (64%) of the traditional medicinal plants were found in cultivation. Regarding the time of collection, informants responded that it is preferred to collect medicinal plants in the morning hours before sunrise. This may be due to the desire by healer to keep secrecy of the plant from others.

5.1.4. Parts used, condition of parts, methods of preparation, application and route of remedy administration

There were different parts of plants used as a medicine for various kinds of human and livestock ailments. Among these different parts of plants, leaves were the most commonly used parts, which accounts for 41.04 % followed by root (19.40%). The ease of accessibility to leaves explains their frequent inclusion in most of the preparations (Singh and Lal, 2008). It may also be due to their efficacy as a result of their role as a site of chemical reactions and in acting as a reservoir for

metabolism like photosynthesis (Balick and Cox, 1996). It may also be harvesting of leaf does not cause great damage on the mother plants as compared to roots, stems and barks. This finding is in line with the finding of Gidey Yirga (2010), Moa Megersa (2010), Getnet Chekole (2011) and Sintayehu Tamene (2011). In contrast with the current finding, the findings of Mirutse Giday *et al.* (2007) and Mesay Wolde-Mariam *et al.* (2015) indicated that the local people prepare their remedy mostly from roots. The current finding is also in contrast with studies conducted in Sudan by Musa (2011), who reported that stem bark contributes about 37% of part used, followed by roots and leaves (20%), fruits (17%), gum as (4%) and seeds 2%.

Local communities in the study area make use of several methods of preparation for the harvested medicinal plants. The most common methods of remedy preparations were squeezing, which accounts for 26 (17.33%) preparations followed by grinding accounting for 19 (12.66%) preparations. This finding is in agreement with the work of Eskedar Abebe (2011). The dominant use of squeezing for remedy preparation could be due to its effectiveness. In contrast to the present study, crushed plant material is the common method of remedy preparation (Gidey Yirga (2010), Moa Megersa (2010), Getnet Chekole (2011) and Asmera Amde (2017). Other studies elsewhere in the country by Sintayehu Tamene (2011) reported that the principal method of remedy preparation was chewing. The results of this study is in disagreement with the current study.

The results of the study about the condition of plant parts showed that fresh, dried and both fresh and dried forms of medicinal plant were used for the preparation of remedies. The majority of herbal medicine preparations use fresh materials about 89 (67.93%). It could be due to the fact that using fresh forms is the most effective for treatment of remedies than the dried form because when the plant material gets dried the active ingredient get lost. Studies conducted earlier by Seyoum Getahun and Zerihun Girma (2009), Gidey Yirga (2010), Eskedar Abebe (2011), Getnet Chekole (2011), Nigussie Amsalu *et al.* (2015), Getu Alemayehu (2017) found that fresh plant materials were widely used for herbal medicine preparation. These findings are in agreement with the current study.

The finding of the current study shows that; oral administration was the dominant route with 57 (48.71%) followed by dermal 35 (29.91%) administration. This finding is similar with the work of Mirutse gidey *et al.* (2007), Ermias Lulekal *et al.* (2008) and Sintayehu Tamene (2011), who reported that oral administration was the highest route of remedy administration. In similar manner

with the current study, other study conducted elsewhere in the world by Hassan-Abdellah *et al.* (2013) found that the main administration routes were oral. In contrast to the current study, Gidey Yirga (2010) reported that dermal was the main route of remedy administration for about 48%. Both oral and dermal routes permit rapid physiological reaction of the prepared medicines with the pathogens and increase their curative power (Fisseha Mesfin *et al.*, 2009). The prepared traditional medicines were applied in a number of methods, among which drinking accounted for 49 (35%) of the prepared remedies followed by creaming and fumigating 15 (10.71%). This finding is in agreement with the findings of Eskedar Abebe (2011) and Asmera Amde (2017), who reported that most of the prepared traditional medicines were applied by drinking.

5.1.5. Jaccard`s coefficient of similarity (JCS) of medicinal plants with other area.

The results of the comparison using Jaccard coefficient of similarity of medicinal plants in Adi Arkay Wereda with other areas of the country indicated that the highest degree of similarity was observed with the study conducted by Bogale Haile (2018) in Wadla Wereda with 26.36% similarity and the least similarity was linked with the study conducted by Seyoum Getaneh and Zerihun Girma (2009) in Debre Libanos Wereda with 20.48% similarity (Table 29).

Table 29. The JCS of medicinal plants in Adi Arkay Wereda with other Weredas.

Sample are	A	B	C	JSC (%)	Source
Adi Arkay Wereda	73	-	-	-	
Debre Libanos Wereda	83	49	34	20.48	Seyoum Getaneh and Zerihun Girma (2009)
Gozamen Wereda	93	54	39	20.96	Nigussie Amsalu <i>et al.</i> (2015)
Debark Wereda	93	44	49	26.34	Asmera Amade (2017)
Wadla Wereda	55	26	29	26.36	Bogale Haile (2018)

5.1.6. Wild edible plants

The study area had rich in 30 wild edible plant species that serve the local communities as food sources. These plant species belong to 24 genera and 20 families. Families Moraceae and Rosaceae had the highest number of wild edible plant species accounting for five and three species respectively. Other studies conducted elsewhere in the country by Berhane Kidane *et al.* (2014), Mekuanent Tebkew (2015) and Adbaru Degualem (2018) revealed that the highest contribution of Moraceae to the wild edible plants. The results of this study is consistent with the current study. In contrast to the current study Ermias Lulekal *et al.* (2011), Getu Alemayehu *et al.* (2015) and

Getu Alemayehu (2017) showed that Fabaceae were found to be represented by the highest number of edible species.

According to FAO (2010), more than 35% of Ethiopian people are food insecure. Therefore, the wild food species were edible at the times of food shortage so as to prevent starvation as well as in normal times (Getachew Addis *et al.*, 2005 and Ermias Lulekal *et al.*, 2011). The role of wild food plants mainly during unsustainable condition were also explained by Zemedede Asfaw (1997).

Most of the wild edible plant species reported in this study area are also known to be consumed in other parts of the country. For instance, of the total 30 edible plants recorded in Adi Arkay Wereda seven of them were reported by Baressa Anbesa (2014) in Bule Hora Wereda; sixteen of them by Mekuanent Tebkew (2015) in Chilga Wereda; fourteen of them by Misganaw Meragiaw (2015) in Delanta Wereda and seventeen of them were reported by Adbaru Degualem (2018) in Guangua and Banja Wereda (Table 30). This shows that people across different parts of the country have a tendency to utilize the same wild plants as a food.

5.1.7. Habit, part used, mode of consumption, collection season of wild edible plants

Among the reported WEPs in the study area, trees were the highest growth form with 17 (57%) followed by shrubs with 10 (33%) species. This finding is in line with the work of Mekuanent Tebkew (2015), who reported that trees were the dominant growth forms of edible plants. But, the current finding is inconsistent with the findings of Ermias Lulekal *et al.* (2011), Baressa Anbesa (2014), Getu Alemayehu *et al.* (2015) and Adbaru Degualem (2018), they found that shrubs accounted for the highest habit of wild edible plants. Study conducted in Delanta district by Misganaw Meragiaw *et al.* (2015) indicated that herbs represented the dominant growth form (61.2%). This study is in disagreement with the present study.

Among the different parts of WEP used as food for the local community, fruits were the widely used, which accounted for 25 (83.33%) species. This could be due to its edibility without any processing in the wild, and also it could be its sweet taste as compared to other parts. This finding is in line with the work of Tigist Wondimu *et al.* (2006), Ermias Lulekal *et al.* (2011), Getnet Chekole (2011), Baressa Anbesa (2014), Mekuanent Tebkew (2015), they found that fruits accounted for the highest percentage of wild edible plants. But the current finding is contrasted with the findings of Tilahun Teklehaymanot and Mirutse Giday (2010) who studied in southern

Ethiopia and indicated wild edible plants used as vegetables by harvesting their leaves, young twigs, upper parts (leaf and stem).

Regarding the mode of consumption, the majority of the plants (27, 90%) species were eaten raw when they get ripen. This finding is consistent with the finding of Tigist Wondimu *et al.* (2006), who reported that 5% of the non-cultivated food plants are served after cooking, all the rest (95%) are eaten raw without any processing. The finding of Mekuanent Tebkew (2015) also shows that 79% were consumed fresh and uncooked, while 21% were eaten after cooking.

Concerning the harvesting time of wild edible plants, the finding of the study shows that wild edible plants were harvested and consumed in different season or months of the year. According to the respondents the highest number of WEPs were harvested during March, which accounts for 14 (46.66%) species. This finding is consistent with the work of Mekuanent Tebkew (2015), who reported that proportionally higher numbers of plants were harvested in March and June (12 species in each month).

5.1.8. Jaccard`s coefficient of similarity (JCS) of wild edible plants with other area.

The results of the comparison using Jaccard coefficient of similarity of wild edible plants in Adi Arkay Wereda with other areas of the country indicated that the highest degree of similarity was observed with the study conducted by Adbaru Degualem (2018) in Guangua and Banja Wereda with 25.75% similarity and the least similarity was linked with the study conducted by Baressa anbesa (2014) in Bule Hora Wereda with 12.06% similarity (Table 30).

Table 30. The JCS of wild edible plants in Adi Arkay Wereda with other Weredas.

Sample area	A	B	C	JCS (%)	Source
Adi Arkay Wereda	30	-	-	-	
Bule Hora Wereda	29	22	7	12.06	Baressa anbesa (2014)
Chilga Wereda	33	17	16	24.24	Mekuanent Tebkew(2015)
Delanta Wereda	49	35	14	14.28	Misganaw Mergiw <i>et al.</i> (2015)
Guangua and Banja Wereda	33	16	17	25.75	Adbaru Degualem (2018)

5.1.9 Marketability of medicinal plants and wild edible plants in the study area

The finding of the study showed that some of the medicinal plants were sold in an open market for the purpose of food, spice and smoke. This finding agrees with the work of Eskedar Abebe (2011)

and Getu Alemayehu (2017). Only one medicinal plant (*Rubia cordifolia*, minchirur) was reported to be sold in an open market for the purpose of its medicinal value.

Regarding marketability of wild edible plants, there were two WEPs (*Ziziphus spina-christi* (gaba) and *Tamarindus indica* (humer)) that are frequently sold in an open market. This implies that there is a limitation of selling WEPs in the market place. It could be due to the fact that the communities believed WEPs are food for children and birds. However, *Ximenia americana* (inkoy) was sold during earlier years, but now it is not available in the market. This is related to the reduced accessibility because of deforestation that is taking place from time to time. This finding is similar with the work of Getnet Chekole (2011), who reported that the marketability of WEPs were reduced due to its accessibility. The local people give less emphasis to wild edible plants, as a result they are highly over-harvested for different purposes such as for fuelwood, construction, charcoal, fence, animal feed and for other purpose, which leads to the reduction of WEPs and their habitats and ecosystem destructed.

5.1.10. Nutraceutical plant species

Out of the total 30 wild food plants reported in the study area, 12 of them were used as a traditional medicine. Food plants that have scientifically proven health benefits for both disease treatment and prevention are nutraceutical plants (Dillard and German, 2000). But, species involved in more than one use values may lead to threats and special attention could be given to them (Getnet Chekole, 2011).

5.1.11. Indigenous knowledge about useful plants in the study area

5.1.11.1. Indigenous knowledge about medicinal plant

Result obtained from informants in relation to their age showed that elders were more knowledgeable. This might be due to the fact that elderly informants have long lasting direct and regular contact with the natural plant resources. This helped them to be more knowledgeable than the younger and medium aged informants. Other studies conducted elsewhere in Ethiopia by Moa Megersa (2010) as well as from other parts of the world by Samar *et al.* (2013) showed that information on the medicinal use of plant is mostly confined to elder people.

Males are seen to be more knowledgeable than females. This could be due to cultural influence on females requiring them to invest most of their time by doing a number of things in their home while males usually go outside their home in the field area and gather what is available there.

Similar results were reported by Moa Megersa (2010), who reported that out of the collected medicinal plants (126), males could mention all of the medicinal plants whereas females explained the use of 40 medicinal plants only. The same author also reported that females' medicinal plant knowledge is limited to plants which are found in home garden.

Illiterates also were the knowledgeable informants about medicinal plant than literates. This may be due to literates usually passing their time by going to school than in the field or in forest. This finding is in line with the work of Moa Megersa (2010) and Sintayehu Tamene (2011), who reported that non-educated informants handled much knowledge of traditional medicine; whereas educated informants had low knowledge of traditional medicine, which is an indication of impact of modern education on traditional medicine. Unlike the current finding, Nigussie Amsalu *et al.* (2015) reported that most of them were literate (modern and church education). Derogatory attitudes (such as Debtera, Tenquay, sir mash and kitelbetash) towards the traditional medicine practitioners had forced them to keep their knowledge and practices in secret manner. Moreover, it is an income generation activity for the healers (Gidey Yirga, 2010). The other aspect of problem in knowledge transfer is cultural belief. Some healers believe that when other people know or call the name of the medicinal plant it will lose its capacity to cure the ailment. This finding is in line with the results reported by Moa Megersa (2010). Since the treatment effect is not from the name of the plant but rather from its chemical composition, this belief has no known scientific support.

5.1.11.2. Indigenous knowledge about wild edible plant

Results obtained from informants in relation to their age, much of the knowledge of WEPs in the study area was obtained from informants of younger ages (18-34) when compared with the other age groups. This might be due to youngsters usually keep cattle in the field and get the chance of interacting with the wild plants. This finding is in line with the results reported by Tigist Wondimu *et al.* (2006) and Adbaru Degualem (2018), who reported that more ethnobotanical data about the wild food plants were obtained from male youngsters. In contrast with the current study, Getu Alemayehu *et al.* (2015) showed that much of the knowledge of wild edible plants in the study area was obtained from elderly informants, when compared with the younger people.

In relation with sex, males are more knowledgeable. This may be due to the fact that males perform their day-to-day activities mainly in the field while females are less involved in field work. This finding is consistent with the work of Adbaru Degualem (2018). In relation to educational level,

illiterates were more knowledgeable than literates. It could be due to illiterates having more chance to visit the field as their livelihood depends on the field either by growing crops or by animal farming in the forest while literates pass their time by visiting schools.

5.1.12. The role of plants for the ecosystem

A total of 48 species of plants belonging to 27 families were recorded for their usefulness for the ecosystem. Of the total plant families; family Fabaceae had the highest number of plant species (16.66%). Plant species belonging to family Fabaceae are critical in fixing nitrogen and hence increases the fertility of the soil. Other studies showed that soil fertility is managed through the integration of leguminous plant species (CIRAD-CTFT, 1989) in the farming system. The findings of the study also show that plants play a major role in conserving soil erosion by holding the soil particles with the roots. Other studies show that plants play key roles in regulating water flows and minimizing the damage caused by floods; undisturbed forests are generally regarded as the most efficient land-cover type for maintaining the hydrological balance (FAO, 2011). Soil loss due to erosion reduces soil depth (Omita *et al.*, 1999), consequently, decreasing the amount of soil moisture content and rooting depth. When plant root is not deep, the plant may fall during heavy flood and wind. To prevent this from happening the amount of soil has to be increased. This is done by protecting the area from further degradation and by restoring the eroded one. Plantation is important for both soil depth and fertility as the different parts of the plant fall and gets decomposed by the action of microorganisms. Similarly, tree plantations have been shown to improve soil conditions of degraded sites by Islam and Weil (2000); and Carnus *et al.* (2003).

Plants are also involved in the restoration of degraded habitat. Ecological restoration is viewed as the preservation of the original habitats or as a means of preventing the continual loss of biodiversity (Young, 2000; Muutka and Laasonen, 2002). There are many approaches to land and vegetation restoration (Brown and Lugo, 1994), each of which depending on the severity of damage to the land resource (Lugo, 1997). Lamb and Tomlinson (1994) believes that the first objective of degraded land rehabilitation should be the prevention of further degradation, but also to catalyze native forest restoration after prolonged anthropogenic disturbances. Studies made in the south central highlands of Ethiopia showed that within 15–17 years of establishment on abandoned farmland, plantations assisted the restoration of 78% of native woody flora recorded from under an adjacent natural forest (Mulugeta Lemenih *et al.*, 2004). Therefore, plantation

forests could be employed as viable restoration management tools for rapid recovery of degraded landscapes as well as threatened biodiversity resources.

5.1.13. Threats and conservation of useful plants as well as the ecosystems

5.1.13.1. Threats of useful plants and the ecosystems

Many threats causing endangerment to plant diversity in the study area as well as the ecosystem degradation were reported. Some of the factors that cause the reduction of useful plants and the degradation of ecosystems were deforestation for different purpose (agricultural land expansion, firewood collection, charcoal production, overexploitation in case of MPs, house construction, fencing), presence of grazing animals, and severe erosion. Habitat loss/degradation of plants due to agricultural land expansion is probably the major threat to the plant diversity of the study area. It could be due to the scarcity of land associated with population growth, people tend to clear the forests and establish crops. This finding is consistent with the results reported by Mulugeta Lemenih and Demel Teketay (2004), Sintayehu Tamene (2011), Misganaw Meragiaw *et al.* (2015), Seble Wolde-Yohannis *et al.* (2018), who reported that the most threatening factor for the loss of plant species is agricultural land expansion in relation to population growth. Therefore, sustainable agricultural systems should be promoted to prevent further reduction of plant diversity. In contrast with the current study, Gidey Yirga (2010) and Bogale Haile (2018) reported that scarcity of rain (drought) were the leading factor that threatens plant resources in general (specifically medicinal plants). The finding of Adbaru Degualem (2018) reveals that fuelwood collection was the leading factors of threats of plant diversity, specifically WEPs. The most serious proximate threats of plant diversity are habitat loss or degradation and over-harvesting (Hamilton, 2004). As the findings of the study show that the local community use the useful plants as fuelwood, construction material, charcoal and fencing than as food or medicine, this leads to the loss of most of the plants in the study area.

Even if the influence of human on plant resources and ecosystems is more than other species, animals also cause problems. when animals feed on the same ground over and over again and the land is exposed to erosion as their continuous trampling break up and loosen the surface of the ground. According to Teng *et al.* (2006) intensive grazing may change soil physical structure and chemical properties by trampling.

Soil erosion is also a common phenomenon in the study area, which leads to ecosystem degradation. In similar manner with the current study, FAO (1986) and Kebrom Tekle (1999) found that land degradation due to soil erosion is one of the most visible phenomena on deforested sites in Ethiopia.

5.1.13.2. Conservation of useful plants as well as the ecosystem in the study area

Sustainable utilization and conservation of plant biodiversity are essential for the continuation of ecosystem functioning (Srivastava and Vellend, 2005). To reduce the threatening factors of plant diversity in the study area, there were forest conservation measures taken. For example; Myteklit forests are being protected by the government for the purpose of protecting the plants available in the forest (in turn the medicinal and edible plants get protection) and also for the purpose of ecosystem conservation. Similar results were reported by Getnet Chekole (2011), who reported that natural forests are being protected by the local people in collaboration with the government. Some medicinal plants are also observed in home gardens and farm lands in addition to the natural habitats. The conservation and management of medicinal plants by the local community in the home gardens as well as in farm lands is not for medicinal purpose rather to sustain their livelihoods.

5.2. Conclusion

This ethnobotanical study conducted in Adi Arkay Wereda, North Gonder Zone, Amhara Regional State documented and analyzed useful plant species and their use values (medicinal and food) for the community as well as for the ecosystem. The study indicated that the area has rich useful plant composition. A total of 94 useful Plant species were recorded. Among the recorded plants, 73 were noted to treat various human and livestock ailments, 30 were noted to serve the community in food and 48 species provide ecological role. The study also reveals that a single plant species may provide food and medicine for the community, intern protect the soil from erosion. The source of those useful plants were greater in their natural habitat than in the home gardens or in farm land so natural vegetation is important as a medicinal and food source for the local community and benefit the ecology by protecting the land from erosion. Modern healthcare services in the study area are not adequate, and most people have limited economic means to buy modern medicine. Thus, traditional medicine remains the most popular medicine in solving health problems of the local community.

A total of 73 medicinal plants were recorded in the study area that are used to treat human and livestock ailments. 62 medicinal plants are used to treat 47 human ailment and 27 medicinal plants to treat 14 livestock ailment. This means more number of human diseases and medicinal plants were reported compared with livestock diseases and ethnoveterinary medicinal plants. Swelling (Megerem) and fibril illness are found to be the major diseases of both human and livestock. Regarding the family level species richness, Fabaceae and Solanaceae had the highest number of species, which accounted for 6 (8.21%) species each followed by Euphorbiaceae and Rhamnaceae containing (4, 5.47%)species each. Herbs were found to be the dominant growth forms of medicinal plants followed by shrubs. The most frequently used plant parts were leaves followed by roots. The major modes of remedy preparation were squeezing (26, 17.33%) preparations followed by grinding about 19(12.66%). The finding in terms of the conditions of plant parts used showed that fresh plant materials were the most common form for preparation of remedies. Oral administration was the dominant route of remedy administration followed by dermal. The measurements used to determine the dosages were not standardized. The most common measurements were spoon, cup, glass, finger length, hand full and others, but they are not accurate enough to determine the proper dose of the remedy that cures the diseases. The majority of the healers keep their medicinal plant knowledge secret because it is the means of their livelihood and

cultural beliefs associated with traditional medicines and further transfer of knowledge could only take place within family members.

A total of 30 wild edible plants were recorded in the study area and these plants were distributed in 20 families and 24 genera. Of all the families, family Moraceae had the highest number of species, which accounted for 5 species (16.66%), followed by Rosaceae represented by 3 species (10%). The result of growth forms indicated that trees had the highest proportion of the edible plants followed by shrubs. Fruit is found to be the most edible plant part and mostly taken as raw. Most of the wild edible plants were harvested during March. Out of the 30 total wild edible plants, 12 (40%) were nutraceutical wild plants that are used to treat a total of 11 human and 5 livestock ailments.

Most of the medicinal plants are not widely traded for medicinal purposes, but mostly for other different uses for food, spice, smoke or other purpose. Regarding wild edible plants, there were two wild edible plant whose fruits were marketed frequently in the open market place.

Plant species provide ecological role besides food and medicinal role for the community. Forty-eight plant species were identified by informants for being ecologically important in the way that they provide supporting service for the ecosystem like erosion control, nutrient cycling and restoration of an area that has been degraded.

Deforestation has resulted in loss of the natural vegetation. These in turn become factors for loss of useful plants and factor for ecosystem destruction. The possible solutions for preventing the reduction of plant resources were protecting them from further exploitation and their habitat (ecosystem) from degrading. Plantation and conservation measure is therefore important for the restoration of the degraded ecology and for recovery of the biodiversity resources of the area.

5.3. Recommendations

Based on the findings of the study, the following recommendations can be forwarded:

- ❖ Most of the medicinal plants were obtained from the wild and appear to be rare due to different threatening factors. Therefore, conservation of such medicinal plants by cultivating in home gardens is needed before they become locally extinct;
- ❖ The community in the study area gave more attention for cultivated plants than plants in the wild. It is also important to give attention for plants found in the wild for getting better choice of service from plant in wild.
- ❖ In the study area traditional medical knowledge is passed orally down in family member, it is important to document medicinal plant knowledge to keep the traditional medical knowledge left in the community without any loss or reduction.
- ❖ Some plant species in the study area are important for the community both as food, and medicine and serve the community in many ways. Plants with multiple purposes are more vulnerable to destruction. Therefore, creating awareness about the benefit these plants provide is important for the conservation of these multi-purpose plants.

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APPENDICES

Appendix 1. Checklist of semi-structured interview questions for collecting ethnobotanical data. Dear respondent the objective of this interview is to collect information about plant species that are suitable for human use and the ecosystems. It is for academic reasons but not for commercial purposes. Therefore, your genuine response is very important for the accomplishment of the study. I thank you in advance for your cooperation.

I. General information

1. Date.....
2. Interview site (name of kebele)
3. Name of interviewer.....
4. Name of respondent (optional)
 - 4.1.sex.....
 - 4.2.age.....
 - 4.3.Marital status.....
 - 4.4.Educational background (what is the last grade you attended)?

II. Information related to the ecosystem role of plants

1. List the traditional way of classifying vegetation, soil type and land scape in your locality?
2. What are the major plant community type existing in your area that are suitable in conserving the ecosystem? In what way they provide conservation role?
 - a) Improve soil fertility
 - b) Facilitate restoration
 - c) Flood regulation (erosion control)
 - d) Enhance biodiversity
3. What plant species are more preferable for ecosystem conservation?
4. Is there plantation program for the purpose of ecosystem conservation in your locality? If yes, what plant species are planted and which of them are better adapted to the environment?
5. What is the habit (tree, shrubs, herbs, climbers) and current status (rare, medium, common) of the plants?
6. Do you know any use of plants for the community besides their ecological role? If yes, what are those useful plants and their purpose they provide for the community?

III. Information related to the medicinal use of plants

1. Do you use plants for medicines?
2. If your answer is yes for question number 1;
 - 2.1 what medicinal plants are used to treat human diseases and which medicinal plant species is most preferred for the treatment of human ailments in your locality?
 - 2.2 What medicinal plants are used to treat livestock diseases and which medicinal plant species is most preferred for the treatment of livestock ailments in your locality?
 - 2.3 What medicinal plants are common for human and livestock diseases treatment?
3. What is the habit of the medicinal plants (tree, shrubs, herbs, climbers)?
4. Where do the medicinal plants collected (wild or cultivated)?
5. What part/parts of the medicinal plant(s) is/are used?

Flower <input type="checkbox"/>	Leaf <input type="checkbox"/>
Latex <input type="checkbox"/>	Sap <input type="checkbox"/>
Fruit <input type="checkbox"/>	Bark <input type="checkbox"/>
Seed <input type="checkbox"/>	Stem <input type="checkbox"/>
Root <input type="checkbox"/>	Specify other parts <input type="checkbox"/>
6. How is the condition of plant parts used for treatment? (dry, fresh, dry and fresh)
7. What is the method of preparation of medicinal plants?
8. How are the prepared remedies used by the patient (s)?

Drinking <input type="checkbox"/>	Eating <input type="checkbox"/>
Dropping <input type="checkbox"/>	Creaming <input type="checkbox"/>
Brushing <input type="checkbox"/>	Specify others <input type="checkbox"/>
9. How are the prepared remedies taken by the patients? (oral, dermal, tooth surface, ocular, ear, specify others route of remedy administration)
10. Which Seasons are preferred for collection of medicinal plants in your area?

Wet season <input type="checkbox"/>
Dry season <input type="checkbox"/>
All-the-year round <input type="checkbox"/>
11. What are the common diseases of human in your area?

12. What are the common diseases of animal in your area?
13. How is the knowledge of medicinal plants transferred in the study area?
14. Is/Are the medicinal plant(s) marketable?
15. If your answer is yes for question number 16, Which plant species are more common on a market?

IV. Question related to the wild edible plants

1. Are there wild edible plants in your area?
2. If your answer is yes for question number 1, list the name of those wild edible plants?
3. What is the growth form and the current status of these edible plants?
4. What part do wild edible plants play in household food security? (

Flower <input type="checkbox"/>	fruit <input type="checkbox"/>
Stem <input type="checkbox"/>	gum <input type="checkbox"/>
Leaf <input type="checkbox"/>	specify others <input type="checkbox"/>
5. How is the mode of consumption?

Raw <input type="checkbox"/>	processed <input type="checkbox"/>
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6. How is the preference of wild edible plants over the others and what is the most preferred wild edible plants?
7. Is/Are the wild edible plant(s) marketable?
8. If your answer is yes for question number 7, which plant species are more common on a market?
9. In which months large number of wild edible plants are harvesting in your area?
10. How is the knowledge of wild edible plants transferred in the study area?
11. what medicinal or edible plants have any other purpose in the area? (furniture, timber (wood for building), firewood, charcoal, fence, bee forage for honey production, spice and other uses)?
12. Are there treats to useful plants as well as for the ecosystems? If so what are the major problems associated with them in the area? (over exploitation for medicinal purpose, Food, Firewood collection, Charcoal making, Fence, Construction, Furniture, and specify others)
13. Are there conservation methods of useful plants and the ecosystem in your area? If so mention the management practices by the indigenous people?
14. How abundant these useful plants as compared to the past? Is it increasing or decreasing? What factor is responsible for the increasement or decreasement?

Appendix 2: List of useful plant species with their scientific, family, local names, Growth form, Source and Status in the study area

No	Scientific name	Family	Local name in Amharic	Habit	Source	Status
1	<i>Acacia abyssinica</i> Hochst. ex Benth.	Fabaceae	Girar	Tree	Wild	Medium
2	<i>Acacia mearnsii</i> Willd	Fabaceae	Yetemenjaf	Tree	Wild	Medium
3	<i>Allium sativum</i> L.	Alliaceae	Nechi sinkurt	Herb	Cultivated	Medium
4	<i>Anogeissus leiocarpa</i> Guill. and Perr.	Combretaceae	Kirkira	Tree	Wild	Common
5	<i>Artemisia abyssinicus</i> Sch. Bip. ex Engl.	Asteraceae	Chikugn	Herb	Wild	Rare
6	<i>Becium grandiflorum</i> (Lam.) Pic. Serm.	Lamiaceae	Metete	Shrub	Wild	Medium
7	<i>Bersama abyssinica</i> Fresen.	Melanthaceae	Azimir	Shrub	wild	Common
8	<i>Boscia angustifolia</i> A. Rich	Capparidaceae	Kermed	Tree	Wild	Rare
9	<i>Brucea antidysenterica</i> I. F. Mill	Simaroubaceae	Waginos	Shrub	Wild	Rare
10	<i>Calotropis procera</i> (Ait.) Ait.f.	Asclepiadaceae	Tobia	Shrub	Wild	Rare
11	<i>Calpurnia aurea</i> (Ait.) Benth.	Fabaceae	Zigita	Shrub	Wild	Rare
12	<i>Capsicum annum</i> L.	Solanaceae	Mitimita	Herb	Cultivated	Common
13	<i>Carissa spinarum</i> L.	Apocynaceae	Agam	Shrub	Wild	Common
14	<i>Cavratia gracilis</i> (Guill. & Perr.) Suesseng	Vitaceae	Aserkush	Climber	Wild	Common
15	<i>Chenopodium murale</i> L.	Chenopodiaceae	Amedmado	Herb	Wild	Rare
16	<i>Citrus aurantifolia</i> (L.) Burn. f.	Rutaceae	Lomi	Shrub	cultivated	Medium
17	<i>Clematis simensis</i> Fresen.	Ranunculaceae	Azo-hareg	Climber	wild	Rare
18	<i>Cordia africana</i> Lam.	Boraginaceae	Wanza	Tree	wild	Common
19	<i>Coriandrum sativum</i> L.	Apiaceae	Dinbilal	Herb	Cultivated	Rare
20	<i>Croton macrostachyus</i> Delile	Euphorbiaceae	Misana	Tree	Wild	Medium
21	<i>Cucurbita pepo</i> L.	Cucurbitaceae	Duba	Climber	Cultivated	Common
22	<i>Cyathula polycephala</i> Baker	Amaranthaceae	Chigogot	Herb	Wild	Common

23	<i>Cyperus dichroostathus</i> A.Rich.	Cyperaceae	Giramita	Herb	Wild	Medium
24	<i>Datura stramonium</i> L.	Solanaceae	Astenagir	Herb	Wild	Rare
25	<i>Diospyros mespiliformis</i> Hochst. ex A. DC	Ebenaceae	Serkin (aye)	Tree	Wild	Common
26	<i>Dodonaea angustifolia</i> L.f.	Sapindaceae	Kitkita	Tree	Wild	Rare
27	<i>Dovyalis abyssinica</i> (A. Rich.) Warb.	Flacourtiaceae	Koshim	Shrub	Wild	Rare
28	<i>Echinops kebericho</i> Mesfin	Asteraceae	Kebercho	Herb	Wild	Rare
29	<i>Euphorbia abyssinica</i> Gmel.	Euphorbiaceae	Kulkual	Shrub	Both	Rare
30	<i>Euphorbia tirucalli</i> L.	Euphorbiaceae	Kinchib	Shrub	Both	Common
31	<i>Ficus sur</i> Forssk.	Moraceae	Shola	Tree	Wild	Common
32	<i>Ficus sycomorus</i> L.	Moraceae	Bamba	Tree	Wild	Medium
33	<i>Ficus thonningi</i> Blume	Moraceae	Chibeha	Tree	Wild	Common
34	<i>Ficus vallis-choudae</i> Delile	Moraceae	Banbulede	Tree	Wild	Medium
35	<i>Ficus vasta</i> Forssk.	Moraceae	Warka	Tree	Wild	Common
36	<i>Foeniculum vulgare</i> Miller	Apiaceae	Ensilal	Herb	Wild	Rare
37	<i>Gardenia turnifolia</i> Schumach. & Thonn.	Rubiaceae	Gambilo	Shrub	Wild	Rare
38	<i>Grewia ferruginea</i> Hochst. ex A. Rich.	Tiliaceae	Lenkuata	Tree	Wild	Rare
39	<i>Hagenia abyssinica</i> (Brace) J. F. Gmel.	Rosaceae	Koso	Tree	Wild	Rare
40	<i>Helinus mystacinus</i> (Ait.) E. Mey. ex Steud.	Rhamnaceae	Esat abrid	Climber	Wild	Medium
41	<i>Jasminum abyssinicum</i> Hochst. ex DC.	Oleaceae	Tembelel	Shrub	Wild	Rare
42	<i>Justicia schimperiana</i> (Hochst. ex Nees) T.Anders.	Acanthaceae	Simiza	Shrub	both	Medium
43	<i>Kalanchoe petitiiana</i> L.	Crassulaceae	Endawula	Tree	wild	Rare
44	<i>Kosteletzka begonifolia</i> Ulbr.	Malvaceae	Yemegere m	Herb	Wild	Rare
45	<i>Lepidium sativum</i> L.	Brassicaceae	Feto	Herb	Cultivated	Rare
46	<i>Linum usitatissimum</i> L.	Linaceae	Telba	Herb	Cultivated	Medium
47	<i>Maesa lanceolata</i> Forssk.	Myrsinaceae	Shuariya	Tree	Wild	Medium

48	<i>Maytenus arbutifolia</i> (A. Rich.) Wilczek	Celostraceae	Atat	Shrub	Wild	Common
49	<i>Melia azedarach</i> L.	Meliaceae	Nim	Tree	both	Common
50	<i>Millettia ferruginea</i> (Hochst.) Bak.	Fabaceae	Birbira	Tree	Wild	Rare
51	<i>Mimusops kummel</i> A.DC.	Sapotaceae	Kummel	Tree	Wild	Medium
52	<i>Moringa stenopetala</i> (Baker f.) Cufod.	Moringaceae	Shiferaw	Tree	Both	Common
53	<i>Myrtus communis</i> L.	Myrtaceae	Adese	Shrub	Wild	Rare
54	<i>Nicotina tabacum</i> L.	Solanaceae	Timbaho	Shrub	Wild	Rare
55	<i>Nigella sativa</i> L.	Ranunculaceae	Tikur azmud	Herb	cultivated	Rare
56	<i>Ocimum laminafolium</i> Koth	Lamiaceae	Damakesie	Shrub	Both	Rare
57	<i>Olea europaea subsp.cuspidata</i> L.	Oleaceae	Woirra	Tree	Wild	Rare
58	<i>Opuntia ficus-indica</i> (L.) Miller	Cactaceae	Kulkual (beles)	Shrub	Wild	Rare
59	<i>Otostegia integrifolia</i> Benth.	Lamiaceae	Tinjut	Shrub	Wild	Rare
60	<i>Phoenix reclinata</i> Jacq.	Arecaceae	Selien	Tree	Wild	Medium
61	<i>Physalis peruviana</i> L.	Solanaceae	Komeydero	Herb	Both	Common
62	<i>Phytolacca dodecandra</i> L. Herit.	Phytolaccaceae	Endod	Climber	Both	Rare
63	<i>Piliostigma thonningii</i> (Schumach)	Fabaceae	Dabija	Tree	Wild	Medium
64	<i>Podocarpus falcatus</i> (Thunb) Mirb.	Podocarpaceae	Zigba	Tree	Wild	Rare
65	<i>Prunus persica</i> (L.) Batsch	Rosaceae	Kok	Tree	Wild	Rare
66	<i>Rhamnus Prinoides</i> L'Herit	Rhamnaceae	Gesho	Shrub	Cultivated	Common
67	<i>Rhus vulgaris</i> Meikle	Anacardiaceae	Kamuna	Shrub	Wild	Medium
68	<i>Ricinus communis</i> L.	Euphorbiaceae	Bulka (gulo)	Shrub	Both	Common
69	<i>Rosa abyssinica</i> Lindley	Rosaceae	Kega	Shrub	wild	Rare
70	<i>Rubia cordifolia</i> L.	Rubiaceae	Mincirur	Climber	Wild	Rare
71	<i>Rubus apetalus</i> poir	Rosaceae	Enjory	Shrub	Wild	Rare
72	<i>Rumex abyssinicus</i> Jacq.	Polygonaceae	Mekmoko	Herb	Wild	Rare
73	<i>Rumex nervosus</i> Vahl	Polygonaceae	Embacho	Herb	Wild	Medium
74	<i>Ruta chalepensis</i> L.	Rutaceae	Tenadam	Herb	Cultivated	Rare

75	<i>Securidaca longepedunculata</i> Fresen	Polygonaceae	Temenhay	Tree	Wild	Rare
76	<i>Silene macrosolen</i> A. Rich.	Caryophyllaceae	Wegert	Herb	Wild	Rare
77	<i>Solanum incanum</i> L.	Solanaceae	Emboy	Shrub	Wild	Rare
78	<i>Stereospermum kunthianum</i> Cham.	Bignonaceae	Zana	Tree	Wild	Medium
79	<i>Strychnos innocua</i> Delile	Loganiaceae	Tinkohaye	Tree	Wild	Common
80	<i>Syzygium guineense</i> (Willd.) DC.	Myrtaceae	Dokima	Tree	Wild	Rare
81	<i>Tamarindus indica</i> L.	Fabaceae	Humer	Tree	Wild	Rare
82	<i>Thymus schimperi</i> Ronnifer	Lamiaceae	Tosign	Herb	Wild	Rare
83	<i>Trigonella foenum-graecum</i> J. M. Suttie	Fabaceae	Abish	Herb	Cultivated	Rare
84	<i>Urtica simensis</i> Steudel	Urticaceae	Sama	Herb	Wild	Medium
85	<i>Vangueria madagascariensis</i> J.F. Gmel.	Rubiaceae	Guramile	Shrub	Wild	Medium
86	<i>Verbascum sinaiticum</i> Benth.	Scrophulariaceae	Tirnaha	Herb	Wild	Rare
87	<i>Vernonia amygdalina</i> Delile	Astraceae	Girawa	Shrub	Wild	Medium
88	<i>Vicia faba</i> L.	Fabaceae	Bakela	Herb	Cultivated	Medium
89	<i>Withtania somnifera</i> (L.) Dunal in DC.	Solanaceae	Gizewa	Shrub	Wild	Rare
90	<i>Ximenia americana</i> L.	Olacaceae	Inkoye	Tree	Wild	rare
91	<i>Zehneria scabra</i> (Linn. f.) Sond.	Cucurbitaceae	Haregresa	Climber	Both	Common
92	<i>Zingiber officinale</i> Roscoe	Zingiberaceae	Zinjible	Herb	Cultivated	Medium
93	<i>Ziziphus abyssinica</i> Hoschst.	Rhamnaceae	Abetrie	Tree	Wild	Medium
94	<i>Ziziphus spina-christi</i> (L.) Desf.	Rhamnaceae	Gaba	Shrub	Wild	Common

Appendix 3. List of the medicinal plant families and their corresponding number of genera and species in the study area

Families	Only human MPs		Only livestock MPs		Both Human and livestock MPs		Total medicinal plants	
	No. of genera with %	No. of species with %	No. of genera with %	No. of species with %	No. of genera with %	No. of species with %	No. of genera with %	No. of species with %
Fabaceae	4, 9.09%	4, 8.69%	2, 18.2%	2, 18.2%	-	-	6, 8.69%	6, 8.21%
Solanaceae	3, 6.81%	3, 6.52%	2, 18.2%	2, 18.2%	1, 6.25%	1, 6.25%	6, 8.69%	6, 8.21%
Euphorbiaceae	1, 2.27%	2, 4.34%	-	-	2, 12.5%	2, 12.5%	3, 4.34%	4, 5.47%
Rhamnaceae	3, 6.81%	3, 6.52%	-	-	1, 6.25%	1, 6.25%	3, 4.34%	4, 5.47%
Asteraceae	2, 4.54%	2, 4.34%	1, 9.1%	1, 9.1%	-	-	3, 4.34%	3, 4.1%
Lamiaceae	3, 6.81%	3, 6.52%	-	-	-	-	3, 4.34%	3, 4.1%
Polygonaceae	2, 4.54%	2, 4.34%	1, 9.1%	1, 9.1%	-	-	2, 2.89%	3, 4.1%
Apiaceae	2, 4.54%	2, 4.34%	-	-	-	-	2, 2.89%	2, 2.73%
Cucurbitaceae	2, 4.54%	2, 4.34%	-	-	-	-	2, 2.89%	2, 2.73%
Moraceae	1, 2.27%	2, 4.34%	-	-	-	-	1, 1.44%	2, 2.73%
Oleaceae	2, 4.54%	2, 4.34%	-	-	-	-	2, 2.89%	2, 2.73%
Ranunculaceae	2, 4.54%	2, 4.34%	-	-	-	-	2, 2.89%	2, 2.73%
Rosaceae	1, 2.27%	1, 2.17%	1, 9.1%	1, 9.1%	-	-	2, 2.89%	2, 2.73%
Rutaceae	1, 2.27%	1, 2.17%	-	-	1, 6.25%	1, 6.25%	2, 2.89%	2, 2.73%
Acanthaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Alliaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Amaranthaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Apocynaceae	-	-	1, 9.1%	1, 9.1%	-	-	1, 1.44%	1, 1.36%

Asclepiadaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Bignonaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Boraginaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Brassicaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Capparidaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Caryophyllaceae	-	-	1, 9.1%	1, 9.1%	-	-	1, 1.44%	1, 1.36%
Celostracea	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Chenopodiaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Combretaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Crassulaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Cyperaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Linaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Malvaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Meliaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Melanthaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Moringaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Myrsinaceae	-	-	1, 9.1%	1, 9.1%	-	-	1, 1.44%	1, 1.36%
Myrtaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Phytolaccaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Rubiaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Sapindaceae	-	-	1, 9.1%	1, 9.1%	-	-	1, 1.44%	1, 1.36%
Scrophulariaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Simaroubaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%

Tiliaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Vitaceae	-	-	-	-	1, 6.25%	1, 6.25%	1, 1.44%	1, 1.36%
Zingiberaceae	1, 2.27%	1, 2.17%	-	-	-	-	1, 1.44%	1, 1.36%
Total	44	46	11	11	16	16	69	73

Appendix 4. List of medicinal plants used to treat human(Hu) and livestock(Li) ailments with its scientific, family, local names, parts used, condition of parts, uses, diseases treated, methods of preparations, application and routes of administration in the study area.

key: Habit(H): Tree(T), Shrub(S), Herbs(H), Climbers(C); Part Used (PU): Leaf(Le), Seed(Se), Tuber(T), Stem(St), Root(R), Fruit(F), Latex(La), Bulb(Bu), Bark(Ba), Root & Leaf(RL), Root & Bark(RB), Leaf and Stem(LS), Fruit and Leaf(FL); Condition of Parts(CP): Dry(D), Fresh(F), Dry or Fresh(DF); Use(U): Human(Hu), Livestock(Li); Diseases Treated(DT); Method of Preparation and Application(MPA); Route of Administration(RA): Oral(Or), Ear(E), Ocular(Oc), Dermal(D), Tail(T), Nasal(N), Oral & Nasal(ON), Oral & Dermal (OD), Neck(Ne), Tooth Surface(TS)

Scientific name	family	Local name	H	Us e	DT	PU	CP	MPA	RA
<i>Acacia abyssinica</i>	Fabaceae	Girar	T	Hu	Tooth diseases	Le	F	Chewing	Or
<i>Allium sativum</i>	Alliaceae	Nechi sinkurt	H	Hu	cough	Bu	F	boil with water then drink	Or
					Common cold	Bu	F	sniff the fresh bulb	Na
					Malaria	Bu	F	Eat the bulb	Or
					Abdominal morbidity	Bu	F	boil with the leaf of <i>Citrus limon</i> , when it gets cool mix with honey , then drink after three days	Or
<i>Anogeissus leiocarpa</i>	Combretaceae	Kirkira	T	Hu	stomachache	Ba	F	Chewing and swallow the liquid	Or
				Hu	Malaria	Ba	F	boiling with water, then drink	Or
				Hu	Uvula descending	Ba	F	Chewing and swallow the fluid	Or

				Li	Eye diseases (cataract)	Le	F	squeeze and then drop the liquid to their eye	Oc
<i>Artemisia abyssinicus</i>	Asteraceae	Chikugh	H	Hu	Common cold	Le	F	Sniff the leaf	Na
<i>Bersama abyssinica</i>	Melanthaceae	Azamir	S	Hu	Ascariasis	Le	F	squeeze and mix with water then drink	Or
<i>Boscia angustifolia</i>	Capparidaceae	Kermed	T	Hu	Evil eye	R	D	Grind the root then inhale or sniff	Na
					evil spirit	St	D	Cut the stem part then tie in the neck	Ne
<i>Brucea antidysenterica</i>	Simaroubaceae	Waginos	S	Hu	Swelling	Le	F	squeeze the leaf, then drink with water	Or
<i>Calotropis procera</i>	Asclepiadaceae	Tobia	S	Hu	Itch	R	D	Dry and grind, then creamed with butter	D
				Hu	Hemorrhoid	La	F	Extract the latex then creamed the fluid	D
				Li	Wound	La	F	Extract the latex, mix with <i>Euphorbia tirucalli</i> and <i>Euphorbia abyssinica</i> latex then creamed after 3 days	D
<i>Calpurnia aurea</i>	Fabaceae	Zigita	S	Li	Ectoparasite of hen	Le	D	Burn and Fumigate the smoke	D
<i>Capsicum annum</i>	Solanaceae	Mitimita	H	Hu	Malaria	F	F	Eat the fruit	Or
<i>Carissa spinarum</i>	Apocynaceae	Agam	S	Li	Eye diseases	Le	F	squeeze the leaf then drop to their eye	Oc
				Hu	Evil spirit (metet)	R	D	Smoke and fumigate	D
<i>Cavratia gracilis</i>	Vitaceae	Aserkush	C	Both	Wound	R	D	Dry and grind the root, then applied (put on) the powder topically	D
<i>Chenopodium murale</i>	Chenopodiaceae	Amedmado	H	Hu	Wound	Le	F	squeeze then creamed	D
<i>Citrus aurantifolia</i>	Rutaceae	Lomi	S	Hu	Wound	F	F	Extract the juice, drop the lemon juice on the wound site	D
				Hu	Cough	Le	F	Boil the leaf with <i>Allium sativum</i> and then drink by filtering	Or

				Hu	yebird beshita	Le	D	Burn with fire then fumigate the smoke	D
				Li	Toxin consuming	F	F	Extract the juice, mix with egg albumin and then give them through their mouth	Or
				Li	Leech	F	F	Extract the juice then insert their nasal passage	Na
				Li	Hen diseases	F	F	Extract the juice, mix with water then allow them to drink	Or
<i>Clematis simensis</i>	Ranunculaceae	Azohareg	C	Hu	Hemorrhoid	Le	F	squeezed the leaf then creamed topically	D
<i>Cordia Africana</i>	Boraginaceae	Wanza	T	Hu	Gastritis	F	F	Eating the fruit	Or
					Scorpion bite	R	F	Chewing the root	Or
					Tape worm	F	F	Swallow the fruit	Or
			Li	Retained placenta	Ba	F	Tied to their tails	T	
<i>Coriandrum sativum</i>	Apiaceae	Dinbilal	H	Hu	Cough	Se	D	Boil the seed with butter and water then drink	Or
<i>Croton macrostachyus</i>	Euphorbiaceae	Misana	T	Hu	Hepatitis	Le	F	Boil the leaf then drink or cock the leaf as stew then eat	Or
				Hu	Ringworm	Le	F	Brushing	D
				Hu	Wound (lufe)	LS	F	crush and then cream with butter	D
				Hu	Dysuria (shint mat)	R	F	Crushing and mix with tella , then drink	Or
				Hu	STDs =jgil	Ba	f	crush the bark with the leaf of <i>phytolaca dodecandra</i> , mix with water then drink	Or
				Hu	Yellow fever	Ba	F	Crush then drink with tella	Or
				Li	Rabies	Ba	F	Crush the bark with the root of <i>phytolaca dodecandra</i> and then allow them to drink	Or

<i>Cucurbita pepo</i>	Cucurbitaceae	Duba	C	Hu	Tape worm	Se	D	Eat the seed in empty stomach at the morning	Or
<i>Cyathula polycephala</i>	Amaranthaceae	Chigogot	H	Hu	Eye diseases	Le	F	Crushed and add with water , then drop the suspension	Oc
<i>Cyperus dichroostathus</i>	Cyperaceae	Giramita	H	Hu	Jero degif	St	FD	Tied on the swollen part	D
<i>Datura stramonium</i>	Solanaceae	Astenagir	H	Hu	Tooth diseases	Se	D	Put the dry seed on to fire then fumigate the smoke or catch hold the seed by tooth	TS
					wound (on head)	Le	F	squeeze the leaf and creamed it	D
<i>Dodonaea angustifolia</i>	Sapindaceae	Kitkita	T	Li	Bone dislocating	Ba	F	Tied the bone round	D
<i>Echinops kebericho</i>	Asteraceae	Kebercho	H	Li	Fibril illness	R	D	Burn and fumigate with the smoke	D
					Shivering	R	D	Burn and fumigate the smoke	D
<i>Euphorbia abyssinica</i>	Euphorbiaceae	Kulkual	S	Hu	wound (Chinkur)	La	F	Extract the latex, then creamed	D
<i>Euphorbia tirucalli</i>	Euphorbiaceae	Kinchib	S	Hu	Hemorrhoid	La	F	Extract the latex, then creamed	D
<i>Ficus sur</i>	Moraceae	Shola	T	Hu	Scorpion bite	Ba	F	Chewing and swallow the liquid	Or
<i>Ficus vallis-choudae</i>	Moraceae	Banbulede	T	Hu	Hepatitis	Le	F	squeeze the leaf ,then drink with honey or with buttermilk	Or
<i>Foeniculum vulgare</i>	Apiaceae	Ensilal	H	Hu	Stomach ache	Le	F	Boil the leaf with tea or coffee then drink	Or
<i>Grewia ferruginea</i>	Tiliaceae	Lenkuata	T	Bo	Retained placenta	Ba	F	immersed in water then allow them to drink	Or
				th	Stomachache	Le	F	Crush, mix with salt then allow them to drink	Or
				Li	Dandruff	Ba	F	Wash the head by its soft bark	D
<i>Hagenia abyssinica</i>	Rosaceae	Koso	T	Hu	Tapeworm	Le	F	squeeze then drink the fluid with honey	Or
<i>Helinus mystacinus</i>	Rhamnaceae	Esat abrid	C	Hu	Fire burn	Le	F	Crush and mix with honey then tied	D

<i>Jasminum abyssinicum</i>	Oleaceae	Tembele l	S	Hu	Tooth diseases	Le	F	Catch hold the leaf by tooth	TS
					Snake bite	Le	F	squeeze then drink the fluid	Or
					Fleas	Le	F	Burn with straw the fumigate the home	-
<i>Justicia schimperiana</i>	Acanthaceae	Simiza	S	Hu	Boil	Le	F	heat the leaf in fire then put on the boil	D
					Rheumatism	Le	F	squeezed then cream with water around the pain	D
<i>Kalanchoe petitiiana</i>	Crassulaceae	Endawula	T	Hu	Swelling	Le	F	Fresh leaf is heated on the fire then put on the swollen part	D
<i>Kosteletzka begonifolia</i>	Malvaceae	Yemegerem	H	Li	Itch	Le	FD	squeeze the leaf then creamed the fluid on the itch	D
				Both	Swelling (megere m)	R	FD	Crushing and mix with water, then drink after a certain moment	Or
				Li	Eye diseases	R	F	squeeze and then drop the liquid to their eye	Oc
<i>Lepidium sativum</i>	Brassicaceae	Feto	H	Hu	Hemorrhoid (wart)	St	D	Burn the stem then put the flame onto the wart	D
<i>Linum usitatissimum</i>	Linaceae	Telba	H	Both	Retained placenta	Se	D	Boil, after it gets cool drink	Or
<i>Maesa lanceolate</i>	Myrsinaceae	Shuariya	T	Li	leech	Le	F	Crushed and add in water body , where they drink	-
<i>Maytenus arbutifolia</i>	Celostraceae	Atat	S	Hu	Wound	Le	F	Cut the leaf and placed flat stone on it when it gets dry the wound become cure	-
<i>Melia azedarach</i>	Meliaceae	Nim	T	Hu	Tonsillitis	Le	F	Chewing then swallow the liquid	Or
				Li	Hen disease	Le	F	squeezed then allow them to drink by mixing with water	Or
<i>Millettia ferruginea</i>	Fabaceae	birbira	T	Li	Leech	Le	F	Crushed and add in to water body, where they drink	-
<i>Moringa stenopetala</i>	Moringaceae	Shiferaw	T	Hu	Hypertension	Le	FD	Dry, grind and drink with tea Or boil the	Or

								fresh leaf with tea then drink	
					Headache	Le	FD	Dry, grind and drink with tea Or boil the fresh leaf with tea then drink	Or
					Gastritis	Le	F	Cook the leaf like stew then eat	Or
<i>Myrtus communis</i>	Myrtaceae	Adese	S	Hu	Dandruff	Le	D	The leaf is grind or powdered, mixed with butter and creamed	D
<i>Nicotina tabacum</i>	Solanaceae	Timbaho	S	Li	Leech	Le	F	squeezing the leaf the given to their nasal passage or allow them to drink	ON
					Plague (tifna)	Le	D	Dry and grind the leaf then give through their nasal passage by mixing with milk	Na
<i>Nigella sativa</i>	Ranunculaceae	Tikur azmud	H	Hu	Stomach ache	Se	D	Grind and eat with bread	Or
<i>Ocimum laminafolium</i>	Lamiaceae	Damakesie	S	Hu	Common cold	Le	FD	squeeze the leaf and drink by mix with tea or fumigate the steam by boiling the leaf	OD
					fibril illness	Le	FD	squeeze the leaf and drink by mix with tea or fumigate the steam by boiling the leaf	ON
					Hypertension	Le	F	Boil with tea then drink	Or
<i>Olea europaea subsp.cuspidata</i>	Oleaceae	Woirra	T	Hu	Gastritis	St	F	take liquid produced from stem with water	Or
					Repeal flies away	Le	D	Smoke and fumigate the house	-
<i>Otostegia integrifolia</i>	Lamiaceae	Tinjut	S	Hu	Stomachache	Le	F	squeezing then drink in small amount	Or
					Fleas	Le	D	Smoke and fumigate the home	-
<i>Physalis peruviana</i>	Solanaceae	Komeydeero	H	Li	Leech	F	F	Extract the fruit juice then insert the fruit juice through nose	No

<i>Phytolacca dodecandra</i>	Phytolaccaceae	Endod	C	Hu	Hepatitis	Le	F	squeezing the leaf , then drink	Or
				Hu	swelling (yeshewa kurba)	Le	F	Heat the leaf in fire and then put on the swelling	D
				Li	Stomach ache	R	F	Crush and mix with water, then allow them to drink	Or
					Rabies	R	F	immersed in water then allow them to drink	Or
				Li	Wound	FL	F	Crush ,and then creamed	D
<i>Rhamnus Prinoides</i>	Rhamnaceae	Gesho	S	Hu	Uvular descending	Le	F	squeeze then drink small amount	Or
<i>Ricinus communis</i>	Euphorbiaceae	Bulka (gulo)	S	Hu	Ear diseases	Le	F	Squeeze and then dropping in to the ear	E
				Li	eye diseases (cataract)	Le	F	Heat the leaf in fire then squeeze the fluid and then drop to their eye	Oc
<i>Rosa abyssinica</i>	Rosaceae	Kega	S	Li	Stomach ache	R	F	immersed in water then allow them to drink	Or
<i>Rubia cordifolia</i>	Rubiaceae	Mincirur	C	Hu	Headache (migraine)	R	D	Grind the root and drink with tea	Or
					Eye diseases	R	D	Grind the root and drink with tea	Or
					Stomach ache	R	D	Grind the root and drink with tea	Or
					Nasal bleed	R	D	Grind the root then, insert through nasal passage with butter	N
					Ear parasite	R	D	After drying grind then mix the powder with butter and placed sun. when it gets absorbed squeeze and insert in to ear or nasal passage	E , N

<i>Rumex abyssinicus</i>	Polygonaceae	Mekmo ko	H	Hu	Eye diseases	R	D	Dry and grind , then drink with tea	Or
<i>Rumex nervosus</i>	Polygonaceae	Embacho	H	Li	Eye diseases	Le	F	squeeze the leaf then drop the liquid to their eye	Oc
<i>Ruta chalepensis</i>	Rutaceae	Tenadam	H	Hu	Evil eye	Le	F	Crush and sniff it	Na
					Cough	Se	F	boil with water then drink	Or
<i>Securidaca longepedunculata</i>	Polygonaceae	Temenhay	T	Hu	Fibril illness	R	D	Burn and fumigate the smoke	D
					Rabies	R	F	The root is crushed then mixed with water and drink	Or
					Evil eye	R	D	Dry, grind ,mix with root and bark of <i>Croton macrostachyus</i> then insert the powder nasally or fumigate the smoke	Na
<i>Silene macrosolen</i>	Caryophyllaceae	Wegert	H	Li	Fibril illness	R	D	Burn with fire then fumigate the smoke	D
<i>Solanum incanum</i>	Solanaceae	Emboy	S	Hu	Scorpion bite	R	F	Chewing and swallow the liquid	Or
					Li	Plague (tifna)	F	F	Extract the juice , mix with milk then insert through their nasal passage
<i>Stereospermum kunthianum</i>	Bignoniaceae	Zana	T	Hu	Skin cut	Ba	F	Tied the bark around the damaged part	D
					Both	Bone dislocating	Ba	F	Tied the bark around the bone
<i>Tamarindus indica</i>	Fabaceae	Humer	T	Hu	Cough	F	F	Immerse then Suck (eat) the fruit	Or
					Internal parasite	F	F	immerse the fruit in water then drink when it gets dissolved	Or
					Diarrhea	F	F	Eat	Or
<i>Thymus schimperi</i>	Lamiaceae	Tosign	H	Hu	Cough	Le	D	grind and drink with water during coughing	Or
<i>Trigonella foenum-graecum</i>	Fabaceae	Abish	H	Hu	Stomach ache	Se	D	Boil with water then drink	Or
<i>Verbascum sinaiticum</i>	Scrophulariaceae	Tirnaha	H	Both	Fibril illness	R	FD	immersed in water, then drink 1 cup of the filtered liquid or dry	OD

								the root and the fumigate the smoke at night ,wash at the morning	
<i>Vernonia amygdalina</i>	Astraceae	Girawa	S	Hu	Spider poison	Le	F	squeeze, then creamed	D
<i>Vicia faba</i>	Fabaceae	Bakela	H	Hu	Boil	Se	D	Chewed the seed and tied on to the boil	D
<i>Withtania somnifera</i>	Solanaceae	Gizewa	S	Hu	Psychosis	Le	F	immerse in water then wash the body	D
					Evil eye	RL	FD	Crushed and drunk with water or fumigate the fume (smoke)	OD
<i>Zehneria scabra</i>	Cucurbitaceae	Haregre sa	C	Hu	Fibril illness	Le	FD	Boil with water and then fumigate the steam and drink 1 glass of fluid	OD
					common cold	Le	FD	Boil with water and then fumigate the steam	N
<i>Zingiber officinale</i>	Zingiberaceae	Zinjible	H	Hu	Stomach ache	T	F	Chewing and swallow the liquid	Or
<i>Ziziphus abyssinica</i>	Rhamnaceae	Abetrie	T	Both	Wound	RB	D	Dry and grind then applied(put on) the powder on the wound	D
<i>Ziziphus spinachristi</i>	Rhamnaceae	Gaba	S	Hu	Dandruff	Le	F	squeeze and creamed the fluid	D

Appendix 5. Total ailments in the study area reported by informants with the number of medicinal plants used to treat each ailment. There are 73 medicinal plants used to treat 53 different ailments of human and livestock. The percentage of species involved in the treatment were calculated out of the total 73 medicinal plants.

No.	Type of ailments	Local name of the ailments	Plant species used	Percent
1	Stomach ache	Yehod kurtet	10	13.69
2	Wound	Kusl	10	13.69
3	Eye diseases	Ye ayn himem	8	10.95
4	cough	Sal	6	8.21
5	Fibril illness	Mich	6	8.21
6	Leech	Alekt	5	6.84
7	Common cold	Gunfan	4	5.47
8	Evil eye	Buda	4	5.47
9	Hemorrhoid (wart)	Kintarot	4	5.47

10	Swelling	Ebtet	4	5.47
11	Dandruff	Forefor	3	4.10
12	Gastritis	Cheguara himem	3	4.10
13	Hepatitis	Yeshewa wef	3	4.10
14	Malaria	Weba	3	4.10
15	Rabies	Yebid wusha	3	4.10
16	Retained placenta	Yengde lij mezegyet	3	4.10
17	Scorpion bite	Yegint niksha	3	4.10
18	Tape worm	Kosso	3	4.10
19	Tooth diseases	Yetirs himem	3	4.10
20	Boil	Bugnji	2	2.79
21	Bone dislocating	Yatint sibrat	2	2.79
22	Evil spirit	Aganit (metet)	2	2.79
23	Fleas	Kuncha	2	2.79
24	Headache	Eras mitat	2	2.79
25	Hen disease	Yedero beshita	2	2.79
26	Hypertension	Yedem gifit	2	2.79
27	Itch	Ekek	2	2.79
28	Plague	Tifna	2	2.79
29	Uvula descending	Yankar mewred	2	2.79
30	Abdominal morbidity	Yehod likfit	1	1.36
31	Ascariasis	Wesfat	1	1.36
32	Diarrhea	Tekmat	1	1.36
33	Dysuria	Shintmat	1	1.36
34	Ear diseases	Yejero himem	1	1.36
35	Ear parasite	Kunkun	1	1.36
36	Ectoparasite of hen	Yedero bekete	1	1.36
37	Fire burn	Esat mebelat	1	1.36
38	Internal parasite	Yewst tigegna	1	1.36
39	Jero degif	Jero degif	1	1.36
40	Nasal bleed	Nesir	1	1.36
41	Psychosis	Yamiro chigr	1	1.36
42	Repeal flies away	Zinboch endaykerbu	1	1.36
44	Rheumatism	Kurtimat	1	1.36
44	Ringworm	Kuakucha	1	1.36
45	Shivering	Manketket	1	1.36
46	Skin cut	Yekoda megodat	1	1.36
47	Snake bite	Yebab niksha	1	1.36
48	Spider poison	Yeshererit likft	1	1.36
49	STDs	Jigil	1	1.36
50	Tonsillitis	Tonsil	1	1.36
51	Toxin consuming	Merz lebela	1	1.36
52	yebird beshita	yebird beshita	1	1.36
53	Yellow fever	Bicha weba	1	1.36

Appendix 6. Human ailments and the number of plant species used to treat the ailments. There are 62 medicinal plants used to treat 47 different human diseases and the percentage of species involved in the treatment were calculated out of the 62 human medicinal plants

No.	Ailment type	Amharic name	No. of species used	Percentage
1	Stomach ache	Yehod kurtet	7	11.29
2	wound	Kusil	7	11.29
3	Cough	Sal	6	9.67
4	Swelling	Ebtet	4	6.45
5	Evil eye	Buda	4	6.45
6	fibril illness	Mich	4	6.45
7	Hemorrhoid	Kintarot	4	6.45
8	Common cold	Gunfan	3	4.83
9	Dandruff	Forefor	3	4.83
10	Eye diseases	Yeayn himem	3	4.83
11	Gastritis	Cheguara bignet	3	4.83
12	Hepatitis	Yeshewa wef	3	4.83
13	Malaria	Weba	3	4.83
14	Tooth diseases	Yetirs himem	3	4.83
15	Boil	Bugnji	2	3.22
16	Fleas	Kuncha	2	3.22
17	headache	Eras mitat	2	3.22
18	Itch	Ekek	2	3.22
19	Retained placenta	Yengdie lij mezegyet	2	3.22
20	Scorpion bite	Yegint niksats	2	3.22
21	Tapeworm	Kosso	2	3.22
22	Uvula descending	Yentil mewred	2	3.22
23	Abdominal morbidity	yehod likift	1	1.62
24	Ascariasis	Wesfat	1	1.62
25	Diarrhea	Tekmat	1	1.62
26	Bone dislocating	Atint sibrat	1	1.62
27	Dysuria	Shintmat	1	1.62
28	Ear diseases	Yejero himem	1	1.62
29	Ear parasite	Kunkun	1	1.62
30	Evil sprite	Aganit	1	1.62
31	Fire burn	Esat lebelaw	1	1.62
32	Hypertension	Dem gifit	1	1.62
33	Internal parasite	Yewst tigestna	1	1.62
34	Jero degif	jero degif	1	1.62
35	nasal bleed	Nesir	1	1.62
36	Psychosis	Yamiro himem	1	1.62
37	Rabies	Yebid wusha	1	1.62
38	Repeal flies	Zinb endaykerb	1	1.62
39	Rheumatism	Kurtimat	1	1.62

40	Ringworm	Kuakucha	1	1.62
41	Skin cut	Yekoda gudad(medmat)	1	1.62
42	Snake bite	Yebab niksas	1	1.62
43	Spider poison	Shererit	1	1.62
44	STDs	Jigil	1	1.62
45	Tonsillitis	Ye anka bignet	1	1.62
46	Yebird beshita	Bird lemetaw	1	1.62
47	Yellow fever	Bicha weba	1	1.62

Appendix 7. Livestock ailments and the number of plant species used to treat the ailment. There were 27 MPs that are used to treat 14 livestock ailments.

No	Ailment type	Amharic name	No. of species used	Percentage
1	Eye diseases	Yayin himem	5	18.51
2	Leech	Alekit	5	18.51
3	wound	Kusil	4	14.81
4	fibril illness	Mich	3	11.11
5	Retained placenta	Engide lij mezegyet	3	11.11
6	Stomach ache	Yehod kurtet	3	11.11
7	Hen disease	Yedero beshita	2	7.4
8	Dislocating bone	Yatint sibrat	2	7.4
9	Plague	Tifna	2	7.4
10	Rabies	Yebid wusha	2	7.4
11	Hen ectoparasite	Yedero bekete	1	3.7
12	Shivering	Maniketiket	1	3.7
13	Swelling	Ebitet	1	3.7
14	consume toxin	Merz lebela	1	3.7

Appendix 8. MPs and the number of human and livestock ailments treated by each of th MPs. Hint: the percentage of the ailment treated were calculated in human out of 47 diseases, in livestock out of 14 diseases and in general out of the total 53 diseases.

No.	Medicinal plant species with scientific name	Local name of medicinal plants	Treated human ailment		Treated livestock ailment		Total ailment treated	
			Freque ncy	Percent	freque ncy	Percent	Frequ ency	Percent
1	<i>Croton macrostachyus</i>	Misana	6	12.76	1	7.14	7	13.2
2	<i>Citrus aurantifolia</i>	Lomi	3	6.38	3	21.42	6	11.32
3	<i>Phytolacca dodecandra</i>	Endod	3	6.38	2	14.28	5	9.43
4	<i>Rubia corareifolia</i>	Minchirur	5	10.63	-	-	5	9.43
5	<i>Allium sativum</i>	Nechi shinkurt	4	8.51	-	-	4	7.54

6	<i>Anogeissus leiocarpa</i>	Kirkira	3	6.38	1	7.14	4	7.54
7	<i>Cordia africana</i>	Wanza	3	6.38	1	7.14	4	7.54
8	<i>Calotropis procera</i>	Tobiya	2	4.25	1	7.14	3	5.66
9	<i>Grewia ferruginea</i>	Lenquata	2	4.25	2	14.28	3	5.66
10	<i>Jasminum abyssinicum</i>	Tembelel	3	6.38	-	-	3	5.66
11	<i>Kosteletzka begonifolia</i>	yemegerem	1	2.12	3	21.42	3	5.66
12	<i>Moringa stenopetala</i>	Shiferaw	3	6.38	-	-	3	5.66
13	<i>Ocimum laminafolium</i>	Damakessie	3	6.38	-	-	3	5.66
14	<i>Securidaca longepedunculata</i>	Temenhay	3	6.38	-	-	3	5.66
15	<i>Tamarindus indica</i>	Humer	3	6.38	-	-	3	5.66
16	<i>Boscia angustifolia</i>	Kermed	2	4.25	-	-	2	3.77
17	<i>Carissa spinarum</i>	Agam	1	2.12	1	7.14	2	3.77
18	<i>Datura stramonium</i>	Astenagir	2	4.25	-	-	2	3.77
19	<i>Echinops kebericho</i>	Kebercho	-	-	2	14.28	2	3.77
20	<i>Justicia schimperiana</i>	Simiza	2	4.25	-	-	2	3.77
21	<i>Melia azedarach</i>	Nim	1	2.12	1	7.14	2	3.77
22	<i>Nicotina tabacum</i>	Timbaho	-	-	2	14.28	2	3.77
23	<i>Olea europaea subsp .cuspidata</i>	Weira	2	4.25	-	-	2	3.77
24	<i>Ricinus communis</i>	Bulka	1	2.12	1	7.14	2	3.77
25	<i>Ruta chalepensis</i>	Tenadam	2	4.25	-	-	2	3.77
26	<i>Solanum incanum</i>	Emboy	1	2.12	1	7.14	2	3.77
27	<i>Stereospermum kunthianum</i>	Zana	2	4.25	1	7.14	2	3.77
28	<i>Withtania somnifera</i>	Gizewa	2	4.25	-	-	2	3.77
29	<i>Zehneria scabra</i>	Haregres	2	4.25	-	-	2	3.77
30	<i>Acacia abyssinica</i>	Girar	1	2.12	-	-	1	1.88
31	<i>Artemisia abyssinicus</i>	Chiqugn	1	2.12	-	-	1	1.88
32	<i>Bersama abyssinica</i>	Azamir	1	2.12	-	-	1	1.88
33	<i>Brucea antidysenterica</i>	Waginos	1	2.12	-	-	1	1.88
34	<i>Calpurnia aurea</i>	Zigita	-	-	1	7.14	1	1.88

35	<i>Capsicum annum</i>	Mitmita	1	2.12	-	-	1	1.88
36	<i>Cavratia gracilis</i>	Aserkush	1	2.12	1	7.14	1	1.18
37	<i>Chenopodium murale</i>	Amedmado	1	2.12	-	-	1	1.88
38	<i>Clematis simensis</i>	Azo-hareg	1	2.12	-	-	1	1.88
39	<i>Coriandrum sativum</i>	Dinbilal	1	2.12	-	-	1	1.88
40	<i>Cucurbita pepo</i>	Duba	1	2.12	-	-	1	1.88
41	<i>Cyathula polycephala</i>	Chigogot	1	2.12	-	-	1	1.88
42	<i>Cyperus dichroostathus</i>	Giramita	1	2.12	-	-	1	1.88
44	<i>Dodonaea angustifolia</i>	Kitkita	-	-	1	7.14	1	1.88
44	<i>Euphorbia abyssinica</i>	Kulkual	1	2.12	-	-	1	1.88
45	<i>Euphorbia tirucalli</i>	Kinchib	1	2.12	-	-	1	1.88
46	<i>Ficus sur</i>	Shola	1	2.12	-	-	1	1.88
47	<i>Ficus vallis-choudae</i>	Bambuledie	1	2.12	-	-	1	1.88
48	<i>Foeniculum vulgare</i>	Ensilal	1	2.12	-	-	1	1.88
49	<i>Hagenia abyssinica</i>	Koso	1	2.12	-	-	1	1.88
50	<i>Helinus mystacinus</i>	Esat-abrid	1	2.12	-	-	1	1.88
51	<i>Kalanchoe petitiiana</i>	Endawula	1	2.12	-	-	1	1.88
52	<i>Lepidium sativum</i>	Feto	1	2.12	-	-	1	1.88
53	<i>Linum usitatissimum</i>	Telba	1	2.12	1	7.14	1	1.88
54	<i>Maesa lanceolate</i>	Shuarua	-	-	1	7.14	1	1.88
55	<i>Maytenus arbutifolia</i>	Atat	1	2.12	-	-	1	1.88
56	<i>Millettia ferruginea</i>	Birbira	-	-	1	7.14	1	1.88
57	<i>Myrtus communis</i>	Ades	1	2.12	-	-	1	1.88
58	<i>Nigella sativa</i>	Tikur azmud	1	2.12	-	-	1	1.88
59	<i>Otostegia integrifolia</i>	Tinjut	2	4.25	-	-	2	3.77
60	<i>Physalis peruviana</i>	Komydero	-	-	1	7.14	1	1.88
61	<i>Rhamnus Prinoidea</i>	Gesho	1	2.12	-	-	1	1.88

62	<i>Rosa abyssinica</i>	Kega	-	-	1	7.14	1	1.88
63	<i>Rumex abyssinicus</i>	Mekmeko	1	2.12	-	-	1	1.88
64	<i>Rumex nervosus</i>	Embacho	-	-	1	7.14	1	1.88
65	<i>Silene macrosolen</i>	Wegert	-	-	1	7.14	1	1.88
66	<i>Thymus schimperi</i>	Tosign	1	2.12	-	-	1	1.88
67	<i>Trigonella foenum-graecum</i>	Abish	1	2.12	-	-	1	1.88
68	<i>Verbascum sinaiticum</i>	Tirnaha	1	2.12	1	7.14	1	1.18
69	<i>Vernonia amygdalina</i>	Girawa	1	2.12	-	-	1	1.88
70	<i>Vicia faba</i>	Bakela	1	2.12	-	-	1	1.88
71	<i>Zingiber officinale</i>	Zinjible	1	2.12	-	-	1	1.88
72	<i>Ziziphus abyssinica</i>	Abetre	1	2.12	1	7.14	1	1.88
73	<i>Ziziphus spina-christi</i>	Gaba	1	2.12	-	-	1	1.88

Appendix 9. List of wild food plants with its scientific, family, local names, habit, part used, mode of consumption and harvesting month in the study area.

Scientific name	Family	Local Name	Habit	Part used	Mode of consumption	Harvesting month
<i>Acacia abyssinica</i>	Fabaceae	Girar	Tree	Gum	Raw, Chewing	November, December, January
<i>Becium grandiflorum</i>	Lamiaceae	Metete	Shrub	Flower	Raw, Sucking	September, October
<i>Carissa spinarum</i>	Apocynaceae	Agam	Shrub	Fruit	Raw eaten	July, august
<i>Cordia africana</i>	Boraginaceae	Wanza	Tree	Fruit	Raw eaten	January, February, march
<i>Diospyros mespiliformis</i>	Ebenaceae	Serkin (aye)	Tree	Fruit	Raw eaten	December, January
<i>Dovyalis abyssinica</i>	Flacourtiaceae	Koshim	Shrub	Fruit	Raw eaten	April, May
<i>Ficus sur</i>	Moraceae	Shola	Tree	Fruit	Raw eaten	February, March
<i>Ficus sycomorus</i>	Moraceae	Bamba	Tree	Fruit	Raw eaten	February, March
<i>Ficus thonningi</i>	Moraceae	Chibeha	Tree	Fruit	Raw eaten	February, March
<i>Ficus vallis-choudae</i>	Moraceae	Bambuledie	Tree	Fruit	Raw eaten	February, march

<i>Ficus vasta</i>	Moraceae	Warka	Tree	Fruit	Raw eaten	January, February
<i>Gardenia turnifolia</i>	Rubiaceae	Gambilo	Shrub	Fruit	Raw eaten	January, February, March
<i>Grewia ferruginea</i>	Tiliaceae	Lenkwata	Tree	Fruit	Raw eaten	November, December
<i>Mimusops kummel</i>	Sapotaceae	Kummel (ishe)	Tree	Fruit	Raw eaten	January, February, April
<i>Opuntia ficus-indica</i>	Cactaceae	Kulkual (beles)	Shrub	Fruit	Raw eaten	March
<i>Phoenix reclinata</i>	Arecaceae	Selien	Tree	Fruit	Raw eaten	March, April, May
<i>Prunus persica</i>	Rosaceae	Kok	Tree	Fruit	Raw eaten	March, April
<i>Rhus vulgaris</i>	Anacardiaceae	Kamuna	Shrub	Fruit	Raw eaten	September, October, November
<i>Rosa abyssinica</i>	Rosaceae	Kega	Shrub	Fruit	Raw eaten	April, May
<i>Rubus apetalus</i>	Rosaceae	Enjory	Shrub	Fruit	Raw eaten	January, February
<i>Rumex abyssinicus</i>	Polygonaceae	Mekmeko	Herb	Root	Dry, crush then boil with tea	November, December
<i>Rumex nervosus</i>	Polygonaceae	Embacho	Herb	Young stem	Roasted, piled, and then eaten	September, October
<i>Strychnos innocua</i>	Loganiaceae	Tinkohaye	Tree	Fruit	Raw eaten	May, June
<i>Syzygium guineense</i>	Myrtaceae	Dokima	Tree	Fruit	Raw eaten	February, March, April
<i>Tamarindus indica</i>	Fabaceae	Humer	Tree	Fruit	Raw, dissolve & drink	March, April, May
<i>Urtica simensis</i>	Urticaceae	Sama	Herb	Leaf	Cooked as stew	July, August
<i>Vangueria madagascariensis</i>	Rubiaceae	Guramile	Shrub	Fruit	Raw eat	November, December, January
<i>Ximenia americana</i>	Olcaceae	Inkoye	Tree	Fruit	Raw eaten	April, May, June
<i>Ziziphus abyssinica</i>	Rhamnaceae	Abetere	Tree	Fruit	Raw eaten	November, December
<i>Ziziphus spina-christi</i>	Rhamnaceae	Gaba	Shrub	Fruit	Raw eaten	January, February, March, April

Appendix 10. Multipurpose medicinal and wild edible plants with its family, habit and uses in the study area.

Scientific name	Family	Local name	Habit	Uses
<i>Cordia africana</i>	Boraginaceae	Wanza	Tree	Food, medicine, Furniture, farm material, fuelwood, charcoal, house construction, bee forage
<i>Olea europaea subsp.cuspidata</i>	Oleaceae	Woirra	Tree	Medicine, Smoke, tooth brushing, farming tool, fuelwood, charcoal, house construction, fence
<i>Ziziphus spina-christi</i>	Rhamnaceae	Gaba	Shrub	Food, medicine, fence , fuelwood, charcoal, farm material
<i>Grewia ferruginea</i>	Tiliaceae	Lenkuata	Tree	Medicine , food, making basket, washing hair, hive making, fence
<i>Diospyros mespiliformis</i>	Ebenaceae	Serkin (aye)	Tree	Food, tooth brushing, house construction, charcoal, fence, fuelwood
<i>Anogeissus leiocarpa</i>	Combretaceae	Kirkira	Tree	Medicine, charcoal, house construction, fuelwood, fence, animal feed, farm material, bee forage
<i>Ziziphus abyssinica</i>	Rhamnaceae	Abetrie	Tree	Medicine, food, fence, fuelwood
<i>Mimusops kummel</i>	Sapotaceae	Kummel (ishe)	Tree	Food, house construction, fuelwood
<i>Syzygium guineense</i>	Myrtaceae	Dokima (liham)	Tree	Food, house construction, fuelwood, charcoal, fence, bee forage
<i>Rhus vulgaris</i>	Anacardiaceae	Kamuna	Shrub	Food, charcoal, fence, farming material, house construction, fuelwood, bee forage
<i>Croton macrostachyus</i>	Euphorbiaceae	Misana	Tree	Medicine, fuelwood, fence, house construction
<i>Carissa spinarum</i>	Apocynaceae	Agam	Shrub	Food, medicine, fence, fuelwood
<i>Acacia abyssinica</i>	Fabaceae	Girar	Tree	Medicine, food, fence, charcoal, fuelwood
<i>Ficus thonningi</i>	Moraceae	Chibeha	Tree	Food, fuelwood, charcoal, house construction, animal feed
<i>Ficus sur</i>	Moraceae	Shola	Tree	Food, medicine, charcoal, fuelwood,
<i>Ficus vasta</i>	Moraceae	Warka	Tree	Food, charcoal, house construction, paste , firewood, animal food
<i>Maytenus arbutifolia</i>	Celostracea	Atat	Shrub	Medicine, fence, goat feed, fuelwood,
<i>Euphorbia tirucalli</i>	Euphorbiaceae	Kinchib	Shrub	Medicine, fence, for paste
<i>Ficus vallis-choudae</i>	Moraceae	Banbulede	Tree	Food, medicine, fuelwood, charcoal, fence, house construction

<i>Securidaca longepedunculata</i>	Polygonaceae	Temenhay	Tree	Medicine, smoke, washing cloth
<i>Jasminum abyssinicum</i>	Oleaceae	Tembelelel	Shrub	Medicine , goat feed, bee forage
<i>Millettia ferruginea</i>	Fabaceae	birbira	Tree	Medicine, fishing, fuelwood
<i>Prunus persica</i>	Rosaceae	Kok	Tree	Food, charcoal, fuelwood
<i>Stereospermum kunthianum</i>	Bignoniaceae	Zana	Tree	Medicine, firewood, house construction, fence, animal food , bee forage
<i>Ximenia americana</i>	Oleaceae	Inkoye	Tree	Food, fence, firewood
<i>Vernonia amygdalina</i>	Astraceae	Girawa	Shrub	Medicine, firewood, fence, bee forage
<i>Bersama abyssinica</i>	Melianthaceae	Azamir	Shrub	Medicine, fence, firewood

Appendix 11. Suitable plant species for the ecosystems with its family, local name, habit and their status. All the plants listed are really important for the ecosystem in the way that they prevent erosion of soil by runoff, they increase soil fertility by fixing nitrogen in some species or by fixing their different parts in other species; and also they provide restoration role for the ecosystem by collecting soil particles and preventing further degradation, increase biodiversity.

Plant species	Family	Local name	Habit
<i>Acacia abyssinica</i>	Fabaceae	Girar	Tree
<i>Acacia mearnsii</i>	Fabaceae	Yetemenja zaf	Tree
<i>Anogeissus leiocarpa</i>	Combretaceae	Kirkira	Tree
<i>Becium grandiflorum</i>	Lamiaceae	Metete	Shrubs
<i>Bersama abyssinica</i>	Melianthaceae	Azamir	Tree
<i>Calpurnia aurea</i>	Fabaceae	Zigita	Shrub
<i>Carissa spinarum</i>	Apocynaceae	Agam	Shrub
<i>Cordia africana</i>	Boraginaceae	Wanza	Tree
<i>Croton macrostachyus</i>	Euphorbiaceae	Misana	Tree
<i>Diospyros mespiliformis</i>	Ebenaceae	Serkin	Tree
<i>Dodonaea angustifolia</i>	Sapindaceae	Kitkita	Tree
<i>Dovyalis abyssinica</i>	Flacourtiaceae	Koshim	Shrub
<i>Ficus sur</i>	Moraceae	Shola	Tree
<i>Ficus sycomorus</i>	Moraceae	Bamba	Tree
<i>Ficus thonningi</i>	Moraceae	Chibeha	Tree
<i>Ficus vallis-choudae</i>	Moraceae	Bambuledie	Tree
<i>Ficus vasta</i>	Moraceae	Warka	Tree
<i>Gardenia turnifolia</i>	Rubiaceae	Gambilo	Shrub

<i>Grewia ferruginea</i>	Tiliaceae	Lenkuata	Tree
<i>Hagenia abyssinica</i>	Rosaceae	Koso	Tree
<i>Jasminum abyssinicum</i>	Oleaceae	Tembelel	Tree
<i>Justicia schimperiana</i>	Acanthaceae	Simiza	Shrub
<i>Maytenus arbutifolia</i>	Celostraceae	Atat	Shrub
<i>Melia azedarach</i>	Meliaceae	Nim	Tree
<i>Millettia ferruginea</i>	Fabaceae	Birbira	Tree
<i>Mimusops kummel</i>	Sapotaceae	Kummel (ishe)	Tree
<i>Moringa stenopetala</i>	Moringaceae	Shiferaw	Tree
<i>Myrtus communis</i>	Myrtaceae	Adese	Shrub
<i>Olea europaea subsp.cuspidata</i>	Oleaceae	Woirra	Tree
<i>Piliostigma thonningi</i>	Fabaceae	Dabija	Tree
<i>Podocarpus falcatus</i>	Podocarpaceae	Zigba	Tree
<i>Prunus persica</i>	Rosaceae	Kok	Tree
<i>Rhamnus prinoides</i>	Rhamnaceae	Gesho	Shrub
<i>Rhus vulgaris</i>	Anacardiaceae	Kamuna	Shrub
<i>Rosa abyssinica</i>	Rosaceae	Kega	Shrub
<i>Rubus apetalus</i>	Rosaceae	Enjory	Shrub
<i>Securidaca longepedunculata</i>	Polygonaceae	Temenhay	Tree
<i>Stereospermum kunthianum</i>	Bignoniaceae	Zana	Tree
<i>Strycnos innocua</i>	Loganiaceae	Tinkohayo	Tree
<i>Syzygium guineense</i>	Myrtaceae	Dokima	Tree
<i>Tamarindus indica</i>	Fabaceae	humer	Tree
<i>Trigonella foenum- graecum</i>	Fabaceae	Abish	Herb
<i>Vangueria madagascariensis</i>	Rubiaceae	Guramile	Shrub
<i>Vernonia amygdalina</i>	Astraceae	Girawa	Shrub
<i>Vicia faba</i>	Fabaceae	Bakela	Herb
<i>Ximania americana</i>	Olacaceae	Inkoye	Tree
<i>Ziziphus abyssinica</i>	Rhamnaceae	Abetere	Tree
<i>Zizyphus spina-christi</i>	Rhamnaceae	Gaba	Shrub

Declaration

I, the under signed declare that this thesis is my original work and all sources of materials used to this thesis have been duly acknowledged.

Name	Signature	Date
Yibelital Moges	_____	_____

Date of submitted _____

This thesis has been submitted for examination with my approval as research advisor

Name	Signature	Date
Zemedet Asfaw (Prof.)	_____	<u>August 22, 2020</u>

Date of approval _____