ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

DEPARTMENT OF PLANT BIOLOGY AND BIODIVERSITY MANAGEMENT

FLORISTIC COMPOSITION OF FOREST PATCHES, ETHNOBOTANICAL AND NUTRACEUTICAL STUDIES IN SORO DISTRICT, CENTRAL ETHIOPIA

A Dissertation Submitted to the Department of Plant Biology and Biodiversity Management Presented in Fulfillment of the Requirements for the Degree of Doctor of Philosophy (PhD) in Plant Biology and Biodiversity Management.

By: Mulatu Hankiso Gaguro

Supervisors: Dr. Bikila Warkineh

Prof. Zemede Asfaw

Dr. Paulos Getachew

Dr. Asfaw Debella

June 2024

Addis Ababa, Ethiopia

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Declaration

The researcher declares in an author statement that this dissertation is original to the investigator and hasn't been submitted or presented to any other universities, colleges, or institutes for credit towards a degree or for any other purpose. All sources of the materials used have been duly acknowledged.

Dedication

This dissertation is dedicated to the people of Soro District, who maintained the plant resources in their surroundings along with the rich indigenous and local knowledge particularly on plants used in traditional herbal medicine for treating human and livestock ailments, wild edibles, and the associated traditional practices for future generations despite the tremendous environmental, economicturall, social and cultural changes that took place for years.

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Abbreviations/Acronyms

AAU-Addis Ababa University

AKs- Administrative kebeles

ANOVA- Analysis of variance

AOCA-Association of Official Analytical Chemists

BA-Basal area

CCA- Canonical Correspondence Analysis

DAF- dry evergreen Afromontane Forest and Grassland complex

DBH - Diameter at Breast Height

DMR- Direct matrix ranking

EBI- Ethiopian Biodiversity Institute

EPHI- Ethiopian Public Health Institute

EVMPs-Ethnoveterinary medicinal plants

FGDs- Focus group discussions

FL- Index of fidelity level

FPs-Forest patches

GPS-Geographic Positioning System

HMPs-Human medicinal plants

ICF- Informant Consensus Factor

ICPC- International Classification of Primary Care

ILK - Indigenous and local knowledge

Livestock TB- Livestock tuberculosis

LsAs- Livestock ailments

LSD- Lumpy Skin Disease

LsMPs - Livestock medicinal plants

MPs-Medicinal plants

NCD-New Castle Disease

ENMSA- Ethiopia National Meteorological Services Agency

PPR- Peste des petits ruminants

PR-Preference ranking

SD- Standard deviation

SDARDO- Soro District Agricultural and Rural Development Office

SDFPEDO- Soro District Finance, Planning, and Economic Development Office

SNNPR - Sothern Nations, Nationalities and Peoples Region

SPSS- Statistical Package for the Social Sciences

TMK - Traditional medicinal knowledge

TMPs -Traditional medicine plants

WEPs - Wild edible plants

WHO - World Health Organization

General summary

This PhD dissertation was conducted to document the floristic composition of the forest patches and the ethnobotany of the medicinal and wild edible plants in Soro District, central Ethiopia. The investigation targeted the vegetation of the remnant forest patches and the indigenous and local knowledge on plant use and management of the Hadiya ethnolinguistic community of Soro District. The floristic composition, the traditional medicinal plants used for the treatment of human and livestock ailments and the wild edible plants, the latter including the determination and analysis of the nutritional values of selected species constitute the main focus areas. Vegetation data were collected in different months in 2021, 2022 and 2023 from 98 systematically laid plots of 20 m x 20 m (400 m2) for trees at every 50 m altitudinal drop, 250 m far apart along transects, 5 m x 5m (25 m^2) small sub-quadrats for shrubs, and 1 m x 1 m (1 m^2) for herbs. Woody plant species with a diameter at breast height (DBH) $\geq$ 2 cm were counted, whereas basal area (BA), important value index (IVI) and height classes were computed and used to determine the regeneration status of the dominant species and the R software was used for the analysis. Ethnobotanical data about the human and livestock traditional medicinal plants were collected by interviewing systematic randomly sampled 387 informants consisting of 255 male and 132 female research participants in addition to key informants and focus group discussions. Descriptive and quantitative approaches, and different ethnobotanical analytical tools were applied to analyze the data. The t-test statistic was used to compare indigenous knowledge based on the mean values reported in the cases of the medicinal and wild edible plants considering different parameters. A total of 280 plant species distributed in 214 genera and 88 families were documented from the four forest patches sampled and studied that yielded 34.64% trees, 27.86% shrubs, 24.64% herbs and 6.79% climbers including hemiparasites, grasses, lians, ferns, and orchids. Families with highest number of species included the Asteraceae that accounted for 11.07% and the Fabaceae constituting 8.93% of the species. The analysis produced five clusters corresponding to five plant community types. The vegetation of the forest patches of Soro District is of the Dry Afromontane type has been classified as *Erica arborea-Olea europaea subsp. cuspidata-Olinia rochetiana-Spiniluma oxyacantha, Afrocarpus gracilior-Apodytes dimidiata-Olinia rochetiana, Croton macrostachyus-Ficus vasta, Combretum molle-Combretum aculeatum,* and *Dodonaea viscosa* subsp. *angustifolia-Balanites aegyptiaca* community types. The total basal area of forest patches is 61.85% m^2/ha. The species *Olinia rochetiana*, *Juniperus procera*, and *Afrocarpus gracilior* were the dominant species at the sites of mountainous forest patches, with a high density of 47%, 42%, and 38%, respectively, and the most common and frequently-recorded IVI values of the woody species were also for *Afrocarpus gracilior* (14%), *Erica arborea* (13.84%), *Juniperus procera* (13%), *Olinia rochetiana* (12.10%), and *Gymnosporia arbutifolia* (11.45%). Overall, the highest Shannon Wiener diversity index, Shannon Evenness, and Simpson Diversity values of Soro forest patches were 4.299, 0.91, and 0.51, respectively, and the least were 3.767, 0.86, and 0.36. The most common woody species, and unique species in each four forest sites were identified, and these are importance for conservation priory setting, sustainable management and utilization. The ethnobotanical study recorded a total of 246 human and 132 livestock traditional medicinal plants, and 64 wild edible plant species. The nutritional values of the three most-preferred wild edible (non-cultivated) nutraceutical plant species revealed food values of high potential as indicated by the bioactive

compounds, antioxidant levels and vitamin C contents with some anti-nutritional factors. The family Asteraceae is represented by 24 (9.76%), Lamiaceae by 18 (7.32%), Fabaceae 16 (6.50%), and Solanaceae 13 (5.28%) species of the human medicinal plant species. In the LsMPs, Asteraceae 10 (7.58%) species, Fabaceae nine (6.82%), Lamiaceae seven (6.82%) species and Solanaceae seven (5.30%) species. In the case of wild edible plants, the highest value of 4 (6.25%) species was recorded for families Salicaceae, Solanaceae and Moraceae. In human and livestock medicinal plants, leaves and roots were the most frequently used as herbal medicine, as were concoctions and decoctions. The fruits were the most palatable contributing to 53.13% of the wild edible species, while the leaves accounted for 29.69%. Significant differences (using a t-test) in ethnobotanical knowledge ($P < 0.05$) was shown in the mean number of medicinal and wild edible plants among differences in gender, key and general informants, and other parameters. In human and livestock medicinal plants, leaves and roots were the most frequently used as herbal medicine, as were concoctions and decoctions. While differences among different plant species nutritional values, anti-nutritional factors, bioactive compounds, antioxidants, and vitamin C were analysed using a one-way ANOVA test ($p<0.05$) in mean comparisons using Duncan's multiple range test. The highest plant use citation, ICF value (0.76) was recorded for human healthcare for gastro-intestinal ailments and 0.72 for livestock dermatological ailments. The highest fidelity level values were recorded for *Afrocarpus gracilior* (100%) to treat rabies and diarrhoea of humans; and *Datura stramonium* (100%) to treat rabies and evil eye while *Dodonaea viscosa* subsp. *angustifolia* and *Asparagus africanus* were used for the treatment of livestock pestedes petits ruminants and evil eye respectively, at 100% of the FL value of each.

There was a significant difference ($P < 0.05$) in the mean number of medicinal plants claimed by males and key respondents in human medicinal plants, while males, illiterates, distance $\geq$ 5km from modern veterinary healthcare center (s), key informants, and their experiences. In the three WEPs, the values of proximate composition were recorded in their respective ranges. The fresh leaves and shoots of *Amaranthus tortuosus* and fruits of *Landolphia buchananii* and *Oncoba spinosa* had moisture and pH values of (85.36%, 6.80), (81.22%, 4.59), and (61.35%, 5.74), respectively. The total soluble solids (TSS) content of the respective fruit juices of *Landolphia buchananii* and *Oncoba spinosa* was 2.4 and 8.4 ^{o}Brix. The other dry basis nutrients were: total ash (3.00-20.60 g/100g), crude protein (5.51-33.77g/100g), crude fat (3.00-5.50 g/100g), crude fiber (6.05-9.60 g/100g), utilizable carbohydrate (24.07-66.09 g/100g), gross energy (283.70-330.23 kcal/100g); the mineral contents: calcium (868.33-10595 mg/kg), iron (20.99-342.24 mg/kg), zinc (12.57-50.08 mg/kg); and vitamin C composition of (26.42-43.15 mg/100g). The highest crude protein content (38 g/100 g) was observed in *Amaranthus tortuosus*, and total ash (20.60 g/100g) for *Landolphia buchananii*; and utilizable carbohydrate (66.09 g/100g) for *Oncoba spinosa.* The highest total phenolic (171.39 mgGAE/100g), flavonoid (132.43 mgQE/100g), and vitamin C (44.15 mg/100g) contents were in *Landolphia buchananii* fruit. The *Landolphia buchananii* extract had comparable IC50 value (84 µg/ mL) with ascorbic acid (82 µg/ mL) in scavenging 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical. The highest percentage of DPPH inhibition was for ascorbic acid (96.42%), followed by *Landolphia buchananii* (94.63%) fruits at the concentration of 200 µg/ mL, and it indicated that WEPs had more antioxidant activity than popular crops, and their non-food values were within acceptable limits, suggesting that they can be incorporated to make more nutrient-dense and healthy diets. Nowadays, the forest patches and ethnomedicinal plants are being affected by anthropogenic factors. Therefore, decreasing access to vegetation in the area leads to the decline and local

extinction of medicinal, wild edibles, and multipurpose native plant species from the natural habitats. Taking strong attention to the forest patches with joint management actions for in-situ and ex-situ conservation in the District with the linkage of the local people and nearby higher learning and research institutions is crucial. Such actions can increase the conservation potential of the natural vegetation with the rich floristic composition and ethnobotanical plants that would save and rehabilitate them with the associated indigenous and local knowledge and curb their rapid decline.
Keywords: Ethnobotany, forest patches, medicinal plants, nutrition, Soro District, wild edible plants

CHAPTER ONE

1. General introduction

1.1. Background and justification

Forest patches play a crucial role in maintaining biodiversity in a wide range of ecological settings and provide habitats for flora and fauna. Forests have been used to protect land from degradation, stabilize the environment, and keep soil moisture. Furthermore, forests are used as the sources of various purposes (like constructions, fuels, medicine, and wild edible food for human beings and other uses (Kuma and Shibru, 2015). Ethiopia is situated in the Horn of Africa with a diverse physiogeographic mountainous areas (Getaneh and Seid, 2015; Masresha et al., 2015; Kebede et al., 2016) and endowed with rich plant diversity (Kelbessa et al., 1992), and a rich forest cover (Yinebeb et al., 2023). Moreover, Ethiopia has a very heterogeneous and many endemic species in its flora. According to different authors (Woldu et al., 1999; Soromessa et al., 2004; Friis et al., 2011; Soromessa and Kelbessa, 2013, 2014; Birhane et al., 2020; Birhanu et al., 2021; Ahmed et al., 2022), these unique plants are mainly distributed in various vegetation types in different agroecological zones and ecosystems. Among them, dry evergreen Afromontane Forest and Grassland complex, *Combretum-Terminalia* woodland and wooded grassland, and *Acacia-Commiphora* woodland and bushland vegetation types are the major representatives with riverine plant species in the present study area. These vegetation types constitute among the most species-rich ecosystems (Bussmann, 2004; Masresha and Melkamu, 2022), also mountainous forest patch of Shonkola and other semi-desert 2nd Hankota (Haba) and 2nd Oda forest patches in Soro District. They have many montane and semi-desert plant species within the giant steeply rocky slopes towards the bottom and hilly to plain land areas associated with *Afrocarpus gracilior, Carissa spinarum*, *Erica arborea*, *Juniperus procera*, *Rubus steudneri, Combretum aculeatum, Combretum collinum, Combretum molle, Commiphora kua, Vachellia abyssinica, Vachellia bussei, Vachellia seyal* var. *fistula, Ximenia americana,* and other dominant plant species were found. The vegetation of Soro is mainly classified as a dry afromontane forest, characterized by its unique ecosystem and floristic composition. It has important forest sites for conservation priority due to its rich biodiversity and role in the mitigation of climate change. The forest, like other dry Afromontane forests in Ethiopia, is home to a variety of woody species, including endemic plants (Kelbessa and Demissew, 2014; Tadele et al., 2014; Birhane et al., 2020). Conservation efforts are crucial to protect these forests from degradation and ensure the sustainability of their biodiversity. The forest patches contained a plains and slopes at the top of the mountain in association with grasses, very short and dwarf *Erica arborea*, and other dominant representative woody tree species *J. procera*, *Agarista salicifolia*, and *Gymnosporia arbutifolia.* Majority Ethiopian forests mostly occur in the high mountain regions (Kelbessa and Demissew, 2014) and are internationally recognized as the eastern Afromontane biodiversity hotspot (Mittermeier et al., 2004; Masresha and Melkamu, 2022) and dry Afromontane forests in Ethiopia (Ahmed et al., 2022).

Ethiopia is situated in the East African phytogeographical region with diverse ethnic groups, biological diversity and enormous traditional practices, many parts of it are still unexplored or under explored with regard to the ethnobotanical knowledge. Soro District of Hadiya Zone is among the unexplored areas of Ethiopia for its ecological, floristic, and ethnobotanical wealth; thus, this study is designed to fill this gap by running a floristic composition and ethnobotanical study of human and ethnoveterinary medicinal plants, and wild edibles with associated indigenous knowledge and traditional practices in Soro District. Also, this research is aimed to evaluate the nutritional values, antioxidant activity and anti-nutritional factors of the most selectively consumed wild edible plants in the study area. And also, Ethiopia has diverse, heterogeneous, ecological and floristic diversity, species diversity, and is also the center for plant diversity and distribution. Plants are one of the principal bases for designing and performing natural resource utilization and management systems in a country (Han et al., 2011). In fact, natural forests play important roles by provision of various services such as a source of woods, medicine, food, spices, and many other multiple uses. In contrast different investigations confirmed that all the natural vegetation types of Ethiopia speedily became under harsh threats and this led depletion of forests. These have brought significant decrease in their biodiversity that cause species to be on the border of local extinction (Meshesha et al., 2015). Thus, natural forests are rapidly decreasing because of excessive anthropogenic influences and other driving factors (Ampornpan and Dhillion, 2003). Habitat dispersion and deforestation of natural forests, changing forest areas into agricultural land, over-utilization of forest resources to timber, fuels, and exponential growth of human populations are the major challenges to the forest and forest patches (Teketay et al., 2010). In Ethiopia, 120 endemic plant species have been reported to be threatened due to forest destruction (Erenso and Maryo, 2014). According to Lemenih and Teketay (2004), there is an ardent need to ensure suitable and sustainable utilization and management of the remnant natural forests (small natural forest patches) to maintain the rich biodiversity of the country from complete disappearance. This current study would contribute its part by investigating and documenting the floristic composition and regeneration status of woody plant species in mountain forest patches, and other hilly, plain or flat protected forest sites of Soro District in order to provide information for the sustainable utilization and management.

Natural forests and forest patches have been repositories for different biodiversity, including soil and soil types, microbes, fungi, fauna, and flora with diverse ethnobotany of traditional medicinal plants, and wild edible plants (Kidane et al., 2018). Various floristic composition studies were carried out in different parts of Ethiopia (Bekele, 1993; Teketay and Bekele, 1995; Woldu et al., 1999; Senbeta and Teketay, 2003; Yeshitela and Bekele, 2003; Ayalew et al., 2006; Lulekal et al., 2008a; Yineger et al., 2008; Asefa et al., 2020), yet the studies are not exhaustive when compared to the floristic richness of the country. Newly local protected sites of forest patches in Soro District have not been scientifically explored for their plant species diversity, richness, distribution, and indigenous knowledge of the useful plants; hence, they are targeted as the subject of investigation in this research.

Ethnobotany defines the whole relationship of plants with local people, including their reciprocal interactions, classification, management, and many or extensive uses for various purposes (Sathiya and Muthuchelian, 2008). It is an endeavour in various science disciplines that applies plant-based investigations to traditional medicines for healthcare uses and potential healing efficacy methods for multiple ailments and illnesses (Muthuchelian, 2008; Kefalew et al., 2015; Sathiya and Tadesse and Dereje, 2015). Plants are a good source of new medicines and therapeutic products for about 85% to 90% of the human population in developing countries, including Ethiopia, which depend on plant remedies for healthcare and form mutual relationships with nearby ecosystems (Martin, 1995). Most of the Ethiopian population depends on plant remedies to meet their primary healthcare needs (Sathiya and Muthuchelian, 2008; Tadesse and Dereje, 2015). Ethiopia has a diverse flora of approximately 6,027 vascular plant species, and

10% of them are endemic (Kelbessa and Demissew, 2014), which provide important healthcare requirements for millions of people.

Ethnobotany of livestock medicinal plants is concerned with the study of the intimate association between the plants and the people, which is encoded in indigenous and local knowledge and the practices that went on deepening and enhancing through human generations. This body of knowledge needs further enhancement before the knowledgeable elderly people of the community pass away, the social fabric is transformed, and the environment changes in one way or another along with the decline of the useful plant resources takes place.

An exhaustive investigation of traditional knowledge in ethnoveterinary herbal medicine with the cooperation between herbalists, ethnobiologists, veterinary scientists and anthropologists can continue to move forward through integration and intimate relations with modern veterinary medicine. Such collaboration and cooperation among the key stakeholders helps to engage the society and governmental institutions (d'Avigdor et al., 2014). In addition, higher proportion of the African people (about 80% of the population) (Bekalo et al., 2009; Belayneh et al., 2012) or more use potential medicinal plants for treatment of various livestock ailments. In Ethiopia, ethnoveterinary medicinal practices using medicinal plants are alternative options to cure more than 90% of the country's huge livestock population (Tadesse and Dereje, 2015; Temeche and Asnakew, 2020). Furthermore, plant remedies are used against livestock health retribution in more proportion (Gidey et al., 2012; Birhan et al., 2018; Agize et al., 2022). Although modern veterinary services have been there for a long period (Fullas, 2010), traditional herbal medicine has been repeatedly and increasingly shown to have effective healing power for a number of livestock ailments.

Limited distribution of modern veterinary healthcare services, unaffordable costs and lack of accessibility to healthcare benefits makes herb-based ethnoveterinary practices more preferable strategy by local communities (Abera and Mulate, 2019). Thus, to cover the gap in healthcare service through centuries in developing countries of the world, farmers and pastoralists in rural communities have been depending on the wealth of traditional medicines to manage livestock ailments (Abera and Mulate, 2019) to increase their productive yield and most of this is achieved through herbal medicine. Various livestock ailments are the major constraints that decrease livestock yields and development in different marginal rural areas of Africa (Marandure, 2016).

Traditional herbal medicine provides a safeguard for the group of livestock such as bovines (cattle), equines (horses, donkeys and mules), goats, sheep, chicken and directly related to the local and household food security, and to the sources of economic income due to the systems of healthcare (Fullas, 2010). However, the treatment of livestock ailments using traditional herbal medicine had begun before the formulation of modern drugs as reported from many countries (Agize et al., 2022). Nowadays, the use of the ethnoveterinary medicinal plants along with the associated indigenous knowledge is transferred among successive generations orally without written records and as yet there is no adequate scientific documentation (Tadesse et al., 2014).

Wild edible plant species have different ripening periods (Addis et al., 2013). According to Haq et al. (2011) wild edible plants have been a matter of high potential for human beings during starvation. Beside serving as regular food sources in developing countries, wild edible plants are important in different parts of southern Ethiopia and other parts as dietary sources of food values (Wondimu et al., 2006). They are important in the prevention of malnutrition and contribution to food security, and provide major food supplies and accessory chemical elements from popularly used wild edible plant species (Addis et al., 2013). They serve as sources of edible fruits, leaves and shoots, herbs, spices, gums, and fibers used for construction of shelter and housing, utensils, and plant products for medicinal uses, *etc*., to fulfill various human needs (Yirga, 2010). WEPs have always been an essential and widespread food sources for food-insecure families living in poverty in developing countries (Umaru et al., 2007; Mavengahama et al., 2013; Berihun and Molla, 2017; Yumkham et al., 2017). They are relevant to household food security and nutrition in some rural areas and are relied on to supplement the staple food, to fill seasonal food shortages, and to serve as emergency food during famine. They are also important for many communities in urban areas, among the poor and marginalized (Duguma, 2020). According to Lulekal et al. (2011), about one billion people in the world use wild foods (mostly from plants) on a daily basis. Ethiopia is also known as the biodiversity hotspot and center of origin and diversification for a significant number of food plants and their wild relatives (Duguma, 2020). In fact, Ethiopia is the fifth country in tropical Africa in terms of the diversity of flora (Kelbessa and Demissew, 2014). Lulekal et al. (2011) reported that a total of 413 kinds of WEPs are consumed in Ethiopia and assert that studies on the biochemical composition of Ethiopian WEPs are limited. Similarly, insufficient attention is given to research on the dietary values and anti-nutritional factors of WEPs in Soro District, central Ethiopia.

1.2. Concise literature review

In the global natural forests and forest patches cover about 30% of the world's forest vegetation, about 3,952 million hectares. However, world forest coverage is being lost due to human activities (Masresha and Melkamu, 2022). In addition, nowadays, the forest vegetation land cover in Africa is highly decreasing due to natural and anthropogenic factors. In Ethiopia, widely varied and diverse physiographic, altitudinal, climatic, and edaphic features enable various types of vegetation ranging from alpine to desert and semi-desert plant communities (Kuma and Shibru, 2015), and provide economic, socio-cultural, and environmental benefits. These are characterized by various situations: flat plateaus, topographic, rolling plains, mountainous, rugged mountains, gorges, and river valleys (*e.g.* Gibe River valley in the present study area). There are different elevations below sea level in the Dallol depression, from 110 m below sea level to 4620 m.a.s.l. at the highest peak of the Ras Dejen (Bekele, 1993). Ethiopia has two biodiversity hotspots among 34 global biodiversity hotspots of the Eastern Afromontane and Horn of Africa biodiversity hotspots (Myers, 1988).

Ethnobotanical studies create all the direct interrelations between people and plants and how they are used, managed, and perceived in human societies (Cotton, 1996; Balick and Cox, 2020). All these mutualistic relationships between people and plants can exist through various practices such as social, religious, symbolic, artistic, and commercial values (Cotton, 1996; Grenier, 1998; Cunningham, 2001; Balick and Cox, 2020). Different types of human ailments rely on folk beliefs, skills, and traditional herbal medicine knowledge that are applied through practices and with various methods (Taye et al., 2011). According to (Rindos, 2013) indigenous knowledge of people on plant uses is the result of many years of human interaction with and selection of the most important plants that occur in the immediate environment at a given time. The need for the well-being of a society is the ultimate driver of millennia-old interaction with and selection of the most successful medicinal plants. Traditional knowledge on plant use would be lost in the absence of continuous cultural interaction (Winter and McClatchey, 2008). Human population demographic, social, economic, ecological, religious and cultural entities co-existing in a community are key drivers of traditional knowledge development in any given community

(Cetinkaya, 2009). Since ancient time, people mainly depend on plants for survival and restricted purposes (for food, shelter and medicine) and is absolutely used for traditional medicine preparations for humans and livestock ailments (Dery, 1999). However, humans became civilized and used plants for various purposes such as medicine, food, and food additives such as spices and condiments, fodder, construction, fences, material cultures, ecological and economical uses, and other multiple functions (Dery, 1999). Also, people explored the potential of plants for a number of other uses (Bekalo et al., 2009; Asfaw, 2018) and it is crucial to supply important components of human culture in addition to food and medicinal values (Schaal, 2019). As a consequence, the dependency of people on plants increased both directly and indirectly.

From the earliest time, large quantity of indigenous knowledge system is also connected with the use of traditional medicine in different countries (Lulekal et al., 2008a). The use of traditional medicines is different from different perspectives; it is long-term experience, culturally based, not scientific healing practice, and commonly indigenous, folk, and largely orally transmitted practices used by different cultures (Cotton, 1996). According to the WHO definition, traditional medicine is a health practice that approaches local knowledge and beliefs by incorporating plant, animal, and mineral-based medicines and spiritual therapies applied to diagnose, treat, and prevent illnesses (Lulekal et al., 2008a). Nowadays, the chemical and genetic diversity constituents of herbal medicine plants are being increasingly exploited for human benefit (Gerique, 2006).

The role of veterinary practices to treat livestock ailments is also a long-time practice in all parts of the world, especially in developing countries where livestock healthcare facilities and services are still very few and located scarcely in urban centers (Mesfin et al., 2009). Even those people living in close proximity to areas where modern drugs/pharmaceutical products are readily available in preparations of traditional medicinal plants to treat livestock. This is related to shortage of modern drugs, cultural acceptability, relative efficacy against certain ailments, and economic affordability for the rural communities (Teklehaymanot and Giday, 2007). Furthermore, the use of traditional plant-based medicines fits well with the necessity of healthcare system and management of different multifunctional livestock, but the knowledge of veterinary practice is declining as the plants become less and less in their local habitats due to many threatening factors. The consequence is the decline of food serving domestic livestock and other multipurpose livestock, wild forage plants, and ecological services. The anthropogenic activity of deforestation for expansion of settlement areas, farming and grazing lands, and overexploitation of plants for various purposes leads to environmental degradation and threats to medicinal plants (Tadesse and Dereje, 2015; Temeche and Asnakew, 2020), which may in turn lead to the loss of livestock lives. Indigenous knowledge on livestock herbal medicine and practices is being transmitted to the young generation via oral message rather than the form of written documents and stories (Gidey et al., 2012). As a result, veterinary traditions went on eroding without adequate documentation based on suitable and effective analysis of medicinal plant alongside the associated indigenous knowledge (Abera and Mulate, 2019).

Ethnobotanical wild edible plants (WEPs) are also defined as wild edibles of plant species that are found in their natural habitats and are mostly not domesticated or cultivated by human dwellers purposely as sources of food (Beluhan and Ranogajec, 2011). Food and nutrition insecurity is one of the major challenges facing the world. Globally approximately two billion people estimated to suffer from micronutrient deficiencies (FAO, 2012). The issue of food security is severe in sub-saharan Africa (FAO, 2011). However, the continent has highly biodiverse environment with valuable, wild edible plants (WEPs) which are often neglected (Chennai Platform for Action, 2006). Wild edible plants are those plants with edible parts that grow naturally on the wild farm land, on fallow or uncultivated land (Duguma, 2020). Different WEPs have played a significant role in different geographical regions of the world throughout human history (Duguma, 2020). Traditionally WEPs have been used for medicinal purposes to treat various ailments (diarrhea, constipation, wound, cancer, jaundice, heart disease, diabetes) (Mir, 2014). Also, they have a potential to be used as supplementary foods to combat malnutrition and to contribute for food security (Lulekal et al., 2011; Getachew et al., 2013; Adamu et al., 2022b). They have remarkable nutrient values and can be an important source of vitamins, fibers, minerals, and fatty acids (Dansi et al., 2008; Adedapo et al., 2011; Getachew et al., 2013; Datta et al., 2019). In fact, the nutritional values of wild edible plants are comparable with cultivated varieties of the plant species (Ebert, 2014), and they are also potential sources of bioactive compounds, including phenolics and flavonoids, which have high antioxidant capacity (Yu et al., 2021). These bioactive compounds can boost protection against various diseases including chronic ones and cancer (Raghavendra et al., 2018;Yu et al., 2021). However, the different parts of WEPs contain antinutrients like phytate, oxalate, tannin and cyanide (Toh et al., 2013), in which their concentration can reduce the bioavailability of nutrients, protein digestion, and growth (Kumar et al., 2010; Rout and Basak, 2015).

1.3. Statement of the problem

In the country, there is an insignificant study on the floristic composition of forest patches and their vegetation ecology. There are limited studies that combine the floristic composition of an area with the ethnobotany of human and livestock medicinal plants and the wild edible plants with their nutritional values seen together with the associated indigenous and local knowledge of the people. Soro District in central Ethiopia is one among many areas that still lack such studies. Sharing scientific knowledge through vegetation data analysis and interpretation might be one of the interference mechanisms to stand against the negative impacts on forest patches, and it positively contribute to the conservation of vegetation and biodiversity. The vegetation in Soro District has continued to be under pressure by the people living surrounding the remnant forest patches due to settlement, rearing domestic animal/livestock that overgraze and damage the vegetation, illegal cutting for dry fence, construction, timber production, sources of fuel woods (firewood and local charcoal), different traditional agricultural tools, household utensils and harvesting for other services and seasonally selling in the market for various agricultural and household purposes.

Our country has a rich source/heritage of indigenous and local knowledge on traditional medicinal and wild edible plants. In most parts of Ethiopia, many communities have developed the habit of using wild edible plants as food (Asfaw and Tadesse, 2001; Balemie and Kebebew, 2006). However, people more commonly use WEPs for food consumption in food-insecure parts than in other parts of the country (Teklehaymanot and Giday, 2010). Lulekal et al. (2011) reported that despite the wide availability and use of wild edible plants in Ethiopia, ethnobotanical data on the socio-economic, cultural, and nutritional values of the plants is limited. On the other hand, the plants are threatened by extinction due to less attention and decreasing vegetation status and adaption and integration of the culture as modernization of Ethiopia advances. In addition, people living in Soro District are highly dependent on plant species for their various needs. Currently, the existence of plant resources in the area is being endangered due to population growth, deforestation, environmental degradation, over exploitation, over grazing, habitat loss, agricultural land expansion and acculturation (Asfaw and Tadesse, 2001). Therefore, there should be an urgent need to document the plant species focusing on the ethnobotanical potential of plants and analyze the knowledge of people linked with plant use and management. Thus, this research is aimed to document floristic composition of the forest patches and ethnobotanical local knowledge on the uses of plants in Soro District, central Ethiopia. The study has brought useful information on plant diversity, traditional use and indigenous knowledge of the people in Soro District, Hadiya Zone, central Ethiopia. This work adds useful information to Ethiopia's database of plants and to the documentation of the ethnobotanical knowledge of the people.

1.4. Research questions, hypotheses, and objectives

1.4.1. Research questions

This study was carried out to answering the following research questions related to the remnant forest patches, traditional medicinal plants, wild edible plants and the nutritional status of selected wild edible plants.

- What are the similarities and differences among forest patches of Soro District in terms of floristic composition?
- What are the major plant community types found in the study area?
- What is the status of the diversity and regeneration potential of medicinal and wild edible plants in the forest patches in the District?
- What are the human and livestock ethnomedicinal plants used by people in the District?
- Why and how do people of the study area use traditional medicinal and wild edible plants?
- What major cultural and socio-economic factors affect traditional medicinal knowledge (TMK) in the study site and how do these factors affect the knowledge and use of medicinal plants (MPs)?
- What are the nutritional values and antioxidant activities of wild edible plants in the study area?
- How do the local people manage the woody species of the forest patches and the traditional medicinal and wild edible plants of Soro District?

1.4.2. Research hypotheses

- Even though under threat, protected forest patches in Soro District have high plant species diversity and composition;
- The plants in locally protected forest patches of Soro District serve the local people as sources of traditional herbal medicine and as wild edible plants;
- People in Soro District have rich traditional knowledge of medicinal and wild edible plants found in the surrounding natural habitats;
- Medicinal and wild edible plants in the study area have poor regeneration potential even though they provide essential medicine and nutrition for the local community;
- Even though there is high ethnobotanical plant diversity in the District, the local people do not generate sufficient income from the sell of medicinal and wild edible plants in the local markets.

1.4.3. Research objectives

1.4.3.1. General objective

The main aim of this research is to document and analyze the floristic composition of the forest patches and to carry out ethnobotanical studies focusing on traditional medicinal and wild edible plants in Soro District located in central Ethiopia.

1.4.3.2. Specific objectives

- To describe the similarities and differences among forest patches found in Soro District in terms of their floristic compositions and distribution patterns;
- To classify the vegetation of forest patches of the District into major plant communities;
- To assess the diversity and regeneration potential of medicinal and wild edible plants in forest patches and investigate how this is related to their availability on local markets;
- To document and analyze the plants used for human and livestock traditional herbal medicine, wild foods and other purposes of these plants as used by people in the District;
- To identify major cultural and socio-economic factors that affect traditional medicinal knowledge (TMK) in the study area; and
- To assess the nutritional compostion and values of selected wild edible plants used by people in the study area.

1.5. The dissertation structure

This dissertation research is organized into different chapters: Chapter one, General introduction including a general, brief background on the subject of the study, and concise literature review followed by a statement of the problem, research questions, hypotheses, and objectives. Chapter two is “The study of the floristic composition of forest patches in Soro District, central Ethiopia (former Southern Nations, Nationalities, and Peoples' Region/SNNPR).” Chapter three, “Traditional medicinal plants used by local people for the treatment of human ailments in Soro District, Hadiya Zone, central Ethiopia.” Chapter four, “Ethnoveterinary medicinal plants and their utilization by the people of Soro District, Hadiya Zone, central Ethiopia.” Chapter five, “Ethnobotany of wild edible plants in Soro District of Hadiya Zone, central Ethiopia.” Chapter Six, “Nutritional values, anti-nutritional factors and antioxidant activity of three wild edible plants in Soro District of Hadiya Zone, central Ethiopia.” Chapter Seven deals with the general discussion, general conclusion, and general recommendation parts. Articles published during the course of this of PhD work are:

1. Mulatu Hankiso, Bikila Warkineh, Zemede Asfaw and Asfaw Debella (2023). Ethnobotany of wild edible plants in Soro District of Hadiya Zone, central Ethiopia. Journal of Ethnobiology and Ethnomedicine (BMC) 19:21 https :// doi.org /10.1186 /s13002-023-00588-2.

2. Mulatu Hankiso, Zemede Asfaw, Bikila Warkineh, Abiy Abebe, Bihonegn Sisay and Asfaw Debella (2024).

Ethnoveterinary medicinal plants and their utilization by the people of Soro District, Hadiya Zone, central Ethiopia. Journal of Ethnobiology and Ethnomedicine (BMC) 20:21 https://doi.org/10.1186/s13002-024-00651-6.

3. Mulatu Hankiso, Ermias Lulekal, Zemede Asfaw, Bikila Warkineh, and Paulos Getachew. Biochemical composition and antioxidant activity of three wild edible plants from Soro District of Hadiya Zone, central Ethiopia. Taylor and Francis/Cogent Food and Agriculture (QAFA-236756069).

The following two articles are also in preparation:

4. Floristic composition of the forest patches in Soro District, central Ethiopia.

5. Traditional medicinal plants used by local people for the treatment of human ailments in Soro District, Hadiya Zone, central Ethiopia.

CHAPTER TWO

2. Floristic composition of forest patches in Soro District, central Ethiopia

Mulatu Hankiso, Zemede Asfaw, Bikila Warkineh

Abstract

This study was conducted in Soro District of Hadiya Zone in central Ethiopia. The study was aimed to document floristic composition of forest patches in the study area. We collected floristic data and surveyed the forest patches in three different agro-ecologies on three different occasions between September 2020 and October 2022 to capture season data. The data collection was conducted with the help of the local people by taking their indigenous knowledge into consideration on use of plants for medicinal, wild edible and other uses. The floristic data were collected from 98 systematically laid quadrats of 20 m x 20 m size for trees at every 50 m altitudinal drop along 15 transects that were 250 meters far apart from each other. Small sub-quadrats of size 5m x 5m at the center of the main plot and 1m x 1m at the four corners were laid to collect data on shrubs and herbs, respectively. The vegetation was classified into community types using agglomerative hierarchical cluster analysis and canonical correspondence analysis (CCA) was employed to figure out environmental factors that contributed to community differentiation. Five clusters were generated from the R software, and the names of plant community types were identified from agglomerative hierarchical cluster analysis and canonical correspondence analysis (CCA) to show the relationship between plant community types and environmental variables. The species regeneration for some dominant woody plant species with the height ≥3 m and DBH ≥2 cm was determined. The diversity of plant species, richness, Shannon Wiener diversity index (H'), Shannon, and Simpson Diversity was calculated. A total of 280 plant species, 99 trees, 83 herbs, 76 shrubs, 19 climbers, 3 lians, belong to 88 families and 214 genera. Trees were represented by 35.36% followed by herbs (29.64%), and shrubs (27.14%). Asteraceae was the top of 31 species rich family followed by Fabaceae 25 species, Rubiaceae 16 species and Lamiaceae 14 species. Of the total identified plant species, *Aloe gilbertii, Erythrina brucei*, *Millettia ferruginea*, and some six others are endemic plant species among 22 endemic species and highly vulnerable species according to the category of IUCN Red List due to many threats, also other indigenous *Prunus africana*. Expansion of agricultural land, local charcoal production, firewood collection, and selective cutting of woody plants were

anthropogenic threats to the forest patches in the study area. These human activities are the main threats to the forest patches and contribute to the decline of plant species in each forest patch. As consequences, in-situ and ex-situ conservation priorities are the main requirements to reforest to save the losing natural forest patches that enrich natural resources in the forest.

Keywords: Central Ethiopia, Forest patches, Plant structure, Soro District, Spices diversity

2.1. Background

World natural forests and forest patches cover approximately 30% of the global forest vegetation, which could be around 3,952 million hectares (Masresha and Melkamu, 2022). Moreover, nowadays, the forest vegetation land cover in Africa is highly decreasing due to anthropogenic factors, and natural forest coverage might be estimated at 650 million hectares in the late early period, with seventeen percent global forests as well as remnant forest patches (Masresha and Melkamu, 2022). Ethiopia has diverse physiographic, altitudinal (that varies from 110 m. below sea level to 4620 m.a.s.l.) , climatic, and edaphic features that enabled the existence of various vegetation types ranging from alpine to desert and semi-desert plant communities (Tewolde-Berhan et al., 2002). Many studies confirmed that forests have important roles in providing goods and services (Kuma and Shibru, 2015). In the Horn of African countries, Ethiopia has diverse geographic features (Getaneh and Seid, 2015; Masresha et al., 2015; Kebede et al., 2016) and endowed with rich biodiversity resources and biodiversity hotspots in the world (Kelbessa et al., 1992). Moreover, it has very high heterogeneity and many endemic species in its flora (Asefa et al., 2020). According to different authors (Woldu et al., 1999; Friis et al., 2011), these plants are mainly distributed in three vegetation types including dry evergreen Afromontane Forest and Grassland complex, *Combretum-Terminalia* and *Acacia-Commiphora* vegetation types, which integral part of the vegetation of Soro District. Dry Afromontane vegetation is one of the most species-rich ecosystems (Bussmann, 2004; Masresha and Melkamu, 2022). In the current study area dry Afromontane Forest patches have many species diversity within the giant steeply rocky slopes towards the bottom associated with *Erica arborea* and *Juniperus procera* as dominant species. Also, Shonkola forest patch has a plain slope at the top of the mountain with association grasses, very short and dwarf *Erica arborea*, and other species *Afrocarpus gracilior,* Juniperus *procera*, *Agarista salicifolia*, *Gymnosporia arbutifolia, Olea europaea* subsp. *cuspidata*. Vegetation types of *Combretum-Terminalia* include mainly *Combretum molle*, *Combretum* *aculeatum, Terminalia schimperiana*, and other species. Whereas *Acacia-Commiphora* includes the species of *Vachellia bussei*, *Vachellia seyal* var. *fistula, Vachellia tortilis*, and *Commiphora kua* are some examples. In addition, most Ethiopian forests mostly occur in the high mountain regions (Kelbessa and Demissew, 2014) and are internationally recognized as the Eastern Afromontane Biodiversity Hotspot (Mittermeier et al., 2004; Masresha and Melkamu, 2022). The floristic composition of the four forest patches in Soro District has not yet been investigated until today. This current study attempts to fill the gap by documenting the plant floristic composition of forest patches, which will contribute to the management plan for conservation and sustainable use of the plants in the area.

2.2. Materials and methods

2.2.1. Study area

The study area is located in Soro District, central Ethiopia (former Southern Nations, Nationalities, and Peoples' Region/SNNPR), and lies between 37º 20' 0" to 37º 47' 23"E longitudes and 07º 19' 4" to 07º 33' 48" N latitudes, within the altitudinal ranges of 1479 m.a.s.l to 2 836 m.a.s.l. The area coverage of the Soro District is 36473.337 km^2 (3647333.7 ha). The study area is one of the fifteen Districts in Hadiya Zone, central Ethiopia. The District is located 232 kilometers southwest of Hawassa town and 264 kilometers southwest of Addis Ababa, the capital of Ethiopia. Geographically, the map of the study area and the selected sites are as given in our recent publication on the wild edible plants of Soro District (Hankiso et al., 2023).

Most of the study District sites are classified into three agroecological zones, such as dega (cool and humid), which includes cool humid mid-highlands, cool moist mid-highlands, and cold humid sub-afro-alpine to afro-alpine, followed by woina dega (cool sub-humid), which includes tepid arid mid-highlands, warm humid lowlands, hot sub-moist lowlands, and cool sub-moist mid-highlands, and kola (warm semi-arid), which includes warm arid lowland plains, hot moist lowlands, hot sub-humid lowlands, and warm sub-moist lowlands (EBI, 2022).

The mean annual rain fall is in between 900-1500 mm, with the temperature in between 12◦C to 26◦C (SDFPEDO, 2020). The total human population size of Soro District is 287,589, with 143,835 males and 143,754 females. The majority (87.42%) of the people live in rural areas, where they rely on the agricultural economy, and 12.58% of the people live in urban areas.

A reconnaissance survey was conducted from July 2019 to August 2019, across the forest patches to obtain information on the conditions of the forest patches and identify potential forest sites. Accordingly, four potential forest sites (forest patches), namely Shonkola forest patch, share, 2nd Hankota, and 2nd Oda were considered for the study (Figure 2.1). Soro District is one of the 15 Districts in Hadiya Zone. In the survey, three agro climatic zones such as high land/dega, middle land/woina dega and low land/kola were identified. From these agroclimatic regions also three main vegetation types namely dry evergreen Afromontane Forest and Grassland Vegetation Complex found in Shonkola forest patch (2836-2287 m.a.s.l.), *Combretum-Terminalia* vegetation forest patch in 2nd Hankota *(*1990-1672 m.a.s.l.) and *Acacia-Commiphora* woodland vegetation in 2nd Oda Forest patch (1762- 1479 m.a.s.l.) vegetation types are considered representative of the vegetation of Soro District where the study was conducted.

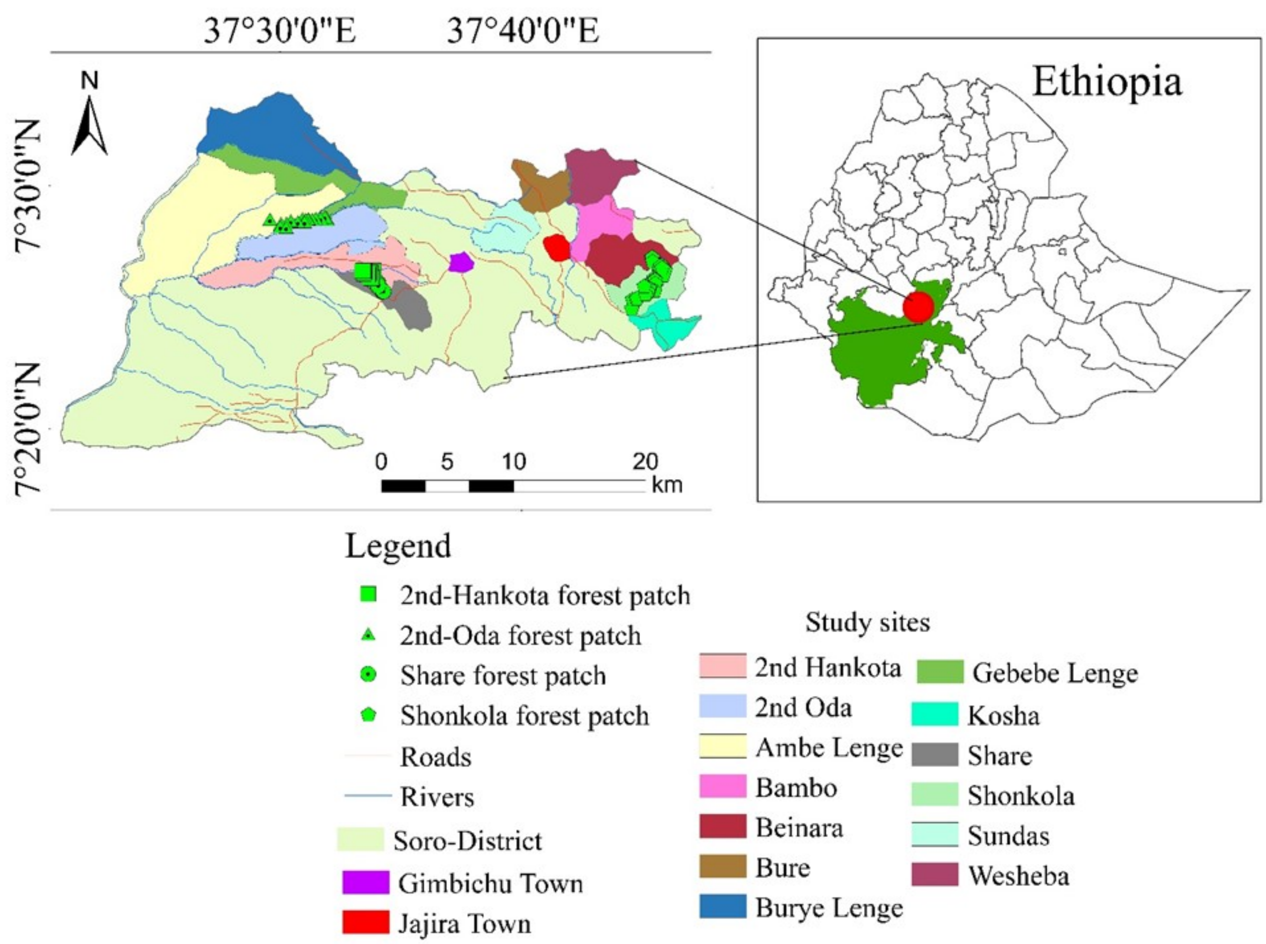


Figure 2. 1. Map of Ethiopia showing the location of Soro District in central Ethiopia

2. 2.2. Collection of the vegetation data and quadrats establishment

In this investigation fieldwork instruments such as supportive letters for collection permission, smart personal mobile to capture images, and plant press with its associated equipment were used during the fieldwork to press plant specimens.

Specimens of the vegetation data were collected in different long rainy seasons at different months among three different year intervals. Among the samples of plant collection periods, long rainy periods were preferred. The selected forest patches were located in different administrative kebeles in three agroclimatic zones in the District and floristic data were collected during fertile flowering seasons. The actual fieldwork took place in different preferred months, which include September, October, and November 2021; March, April, and June 2022; and September, November, and October 2023. A method of systematic sampling technique was used for the collection of vegetation data from various quadrats. Transects were laid along an altitudinal gradient, extending from the ridge top of the mountain where the forest patches were located to the bottom, where human interference was relatively low. Along elevation gradients, 15 line transects were laid in the forest patches. The number of sampling quadrates varied in each forest patch based on forest cover, altitudinal gradients (differences), and habitat variability of the forest patches (Figure 2.2) and (Table 2.1). In the forests, the distance between two respective quadrats was 50 m altitudinal drop, and the transect was 250 m far apart from each other. A total of 98 sampling plots of each 20 m x 20 m (400 m2) were taken from all forest patches. Small subplots were laid in 5 x 5 m (25 m2) at the center of the main plot for shrubs and 1 x 1 m (1 m2) at the corner for herbaceous plants within the main quadrats. Primarily, we focused on only woody species composition and diversity; later, herbaceous species and other habits such as climbers, lianas, ferns, grasses, hemiparasites, and others were also included for a comprehensive list of plant species diversity in the sites of study forest patch.

Different habits of vegetation data of trees, shrubs, herbs, climbers, and lianas, as well as some grasses, and hemiparasites were recorded from the forest patches. The structure of all woody plant species was measured, determined, and recorded in each quadrat. In each quadrat, altitude and geographical coordinates (latitudes and longitudes) were measured using Garmin eTrex GPS- Geographical Position System, and aspects were determined using the Suunnto Compass. Codes were given to aspects following (Woldu et al., 1989): North 0, Northeast 1, East 2, South 4, Southeast 3, Southwest 3.3, West 2.5, Northwest 1.3, ridged top 4. The slope gradients affect plant growth and diversity by having a giant slope to the steep slope, and aspect gradients also affect plants facing towards or away from the solar radiation, which distinguishes regeneration and vegetation cover of the forest patches. Different disturbances of the forest patches, like grazing and browsing, and anthropogenic activities such as deforestation due to various needs like agricultural land, firewood, local charcoal, and others, were recorded as environmental factors of forest patches. The intensity of grazing without limitation was another estimated factor, according to Woldu and Backéus (1991) and Tekle et al. (1997) as 0= null; 1= slight; 2= moderate and 3= heavy. Human interference in each forest patch of each quadrat was estimated as follows (Yeshitela and Bekele, 2003; Woldemichael et al., 2010; Kidane et al., 2018) using a 0-3 scale to record the degree of the impacts (from cutting, fuel wood collection, local charcoal production, and others using: 0 = null; 1= low; 2= moderate; and 3=heavy.

Three to five transects (15 transects) were laid in each of four forest patch sites of the area depending on altitudinal gradients such as mountainous forest patch of Shonkola has remnant forest patches and it has six mountain chains locally said to be **Qeere'i dunna** (Hadiyissa/Had.), '**Sarkee'e dunna**'(Had.), '**Woo'lli dunna'**(Had.), '**Shufee'e dunna'** (Had.) and '**Musse'i dunna'** (Had.), **'Baanna'lli dunna'**(Had.), Share, 2nd Hankota and 2nd Oda locally protected forest patches. Where plots were laid along altitudinal gradients from the mountain top to the highest elevation (2836 m a.s.l.) to the bottom of the lower elevation (2287 m a.s.l.) at every 50 m altitudinal drop where low human interference occurred.

Figure 2. 2. Forest patch of Mount Shonkola (dry Afromontane Forest vegetation type)

In each quadrat, all trees and shrubs with a diameter at breast height (DBH) $\geq$2cm and a height greater than 2.5m were counted and measured (Bekele, 1993).

Plots were laid, and a systematic sampling method was used to study vegetation structure and other aspects to collect the vegetation data following (Ellenberg and Mueller-Dombois, 1974; Kent and Coker, 1992; Bekele, 1993). Growth forms like trees, shrubs, herbs, climbers, and lians from the forest patches were collected. In the study, woody plant diversity of the forest patched was based on the structural analysis of density, frequency, dominance, diameter at breast height (DBH), basal area (BA) per hectare, IVI, and other suitable methods used by the description of vegetation structure (Bekele, 1993; Lulekal et al., 2008; Yineger et al., 2008; Kuma and Shibru, 2015; Asfaw, 2018).

Diameter at Breast Height (DBH $\geq$ 2cm) for all woody species of trees and shrubs greater than 2.5m tall (in height) was measured by meter tape (Bekele, 1993) including some woody lianas and herbaceous climbers. DBH was measured at 1.3 m above ground using meter tape. During data collection, if the plant has many stems (shrubs) below 1.3 m in height, it was treated as a single individual plant, and the DBH of all dominant plant species stems was taken, and the average diameter was used for basal area calculation. In cases where a tree was buttressed /bulged and abnormal at 1.3 m (*i.e.*, at breast height), the diameter was measured just above and below the buttress separately; the sum average of both was recorded. The individual tree's height was measured and estimated using a pole marked at 3 metres long.

Whereas altitudes, latitudes, and longitudes were also measured at the center of each quadrat using GPS 60 (Geographic Positioning System). Cover abundance values for each woody species, estimated 1–9 following the modified Braun-Blanquet scale by Van der Maarel Cover abundance of vegetation data. It is defined as the proportion of canopy cover area in a plot (quadrat) covered by each species of tree or shrub recorded and gathered from each plot, which was converted to the 1–9 Braun-Blanquet scale in the form of: rare (0.1%) = 1 (generally one individual); occasional (0.1%–1%) = 2 (with less than 5% coverage of the total); abundant (1%–2%) = 3 (with less than 5% coverage of the total); very abundant (2–5%) = 4 (with less than 5% coverage of the total); 5: 5-12% cover of the total area = 5; 6: 12–25% cover of the total area = 6; 7: 25–50% cover of the total area = 7; 8: 50–75% cover of the total area = 8; and 9: 75–100% cover of the total plot area = 9 were determined.

2. 2.3. Collection and identification of voucher specimens

Voucher specimens of plants were collected with the help of local field assistants from different habitats of locally protected forest patches in different representative administrative kebeles. Identification of common and well-known species was made in the field (Bridson and Forman, 1998). All identifications were performed using the published volumes (volumes I–VIII) of the Flora of Ethiopia and Eritrea and comparing them with authentic specimens deposited in the National Herbarium of Ethiopia (ETH), Addis Ababa University. Also, they were checked at https://powo.science.kew.org/.

2.2.4. Methods of Data Analysis

2.2.4.1. Vegetation data analysis

The vegetation data were collected from all quadrats and analysis the species composition and vegetation structure of the forest patches. Vegetation structure of the forest patches was done on the basis of density, frequency, height, diameter at breast height (DBH), basal area (BA) per hectare, and important value index (IVI) following the studies (Bekele, 1993; Shibru and Balcha, 2004; Lulekal et al., 2008; Yineger et al., 2008; Kuma and Shibru, 2015) (Appendix 3-8). The frequency of a species was computed as the proportion of samples within which a species is found. According to Kent and Coker (1992), density is computed by converting the total count of the individual species from all quadrats into a hectare basis. DBH (diameter at breast height) values were classified into a distinct set as used by Bekele (1993) and Lulekal et al. (2008), and the density distribution of each shrub and tree species was computed per DBH category (Kent and Coker, 1992). Vegetation data was analyzed using the R software version 4.2.2 (R Core Team, 2021) and Microsoft excel spread sheet software version 2016. R software was used for agglomerative cluster analysis and hierarchical cluster analysis (McCune and Mefford, 1999; McCune et al., 2002). Different plots were grouped into the clusters based on floristic composition of dissimilarity, differences and species abundance in order to give the meaning to specific types of plant community (Bekele, 1993; Lulekal et al., 2008). The identified community types were filtered from the output in a synoptic table and presences of species were summarized as synoptic cover-abundance values (Van der Maarel et al., 1987). The values of synoptic tables were calculated using cover-abundance values of species and their frequency in a specific community type according to the rule of Van der Maarel et al. (1987). The community types were named after one or more dominating features of the species per community. The structural analysis of forest patch was analyzed following (Mueller-Dombois and Ellenberg, 1974; Martin, 1995):

Density = number of individuals of species A/area sampled on a hectare basis

Frequency (%) = number of quadrats in which species A occurs/total number of quadrats studied

Dominance = basal area of species A/area sampled

Basal area (BA) of woody species = $C^2/ 4\pi$ or $\pi(d^2/4)$ or π $(DBH/2)^2$, where, d= DBH and π= 3.14, C=Circumference and the diameter at Breast Height (DBH) values was calculated from circumference measurements by using the formula: DBH or d =C/π; therefore, BA= $\pi d^2/4$.

Basal area was computed for tree and shrub species with a DBH $\geq$2 cm. The population structure of all tree species in the sample plots was analyzed by using stems with a DBH $\geq$ 2cm and the pattern that emerged interpreted as an indication of variation in population dynamics in the forest patches (Yeshitela and Bekele, 2003).

The basal area (BA) of trees (using a meter square) was computed to determine their dominance using $(DBH/_2)^2$ x 3.14 to measure dominance or the degree of coverage of a species as an expression of the space it occupies (Barbour et al., 1980).

The relative density of species in different DBH classes was used to get representative patterns of species population structure, following (Popma et al., 1988).

An importance value index of woody species (shrubs and trees) was computed by the sum of relative density, relative frequency and relative dominance of the respective species, following (Mueller-Dombois and Ellenberg, 1974);

Relative density of species (RD) = number of individuals of species A/total number of individual species x 100.

Relative frequency of species (RF) = frequency of a species A/total frequency of all species x 100.

Relative dominance of species (RDom) = basal area of a single species A/total basal area of all species

An importance value index (IVI) was calculated using the relative density of species, the relative frequency of species, and the relative dominance of species (*i.e.,* RD+RF+RDom), which is useful to compute the ecological importance (significance) of the species in nature (Lemenih and Teketay, 2004). Hence, an importance value index (IVI) was performed by adding the data of three important parameters, such as RD+RF+RDom, respectively, and it was computed for dominant species to determine their diversity or dominance, according to Kent and Coker (1992).

In this study, plant communities were identified using agglomerative hierarchical cluster analysis by the Ward method and similarity ratio. The MRPP (Multi-Response Permutation Procedure) was employed to test the clustering of plant communities or groups. The distance matrix used was the same for classification and MRPP. The cluster analysis was performed using, R statistical software version 4.2.2 (R Core Team, 2021), along with the Cluster and Vegan packages (Oksanen et al., 2013; Woldu, 2017). Also for diagnostic species for naming plant communities, the analysis of indicator species was performed using the indicator value method in the R packages cluster, and Vegan (De Cáceres, 2013; Woldu, 2017). The indicator value index is based on the abundance and occurrence of a given species within a given set of samples. A species with a significant indicator value of $p < 0.05$ is considered an indicator species of a community in this analysis. The plant community types were then named after two of the dominant species that had a $p < 0.05$ indicator value.

Shannon Wiener diversity Index was calculated to measure species composition of identified plant communities according to the same author in protected areas of the forest patches, using:

$H' = \sum_{1=1}^{S} Pi \ln Pi$ or $H' = \sum_{1=1}^{s}[(\frac{ni}{n})\ln(\frac{ni}{n})]$

Where H' = Shannon diversity index, **s** = number of species, Pi = proportion of individuals or abundance of the i^{th} species expressed as a proportion of total cover in the sample; and *ln* = the natural logarithm or ni is the number of individuals belonging to i^{th} of S species in the sample and n is the total number of individuals in the sample.

Shannon's evenness index (J) was also calculated for species equitability and evenness using:

$$\mathbf{J} = \frac{\mathbf{H'}}{\mathbf{H'max}}$$, where,

Diversity Index; and H'max = ln S where S is the number of species in the sample (Kent and H' = Shannon Wiener Coker, 1992). Here the ratio of the observed Shannon index to maximum diversity (Hmax = lns) can be taken as a measure of evenness (J') (Kent and Coker, 1992).

Floristic similarity analysis between each protected forest patch in the study area was computed using Sorensen's similarity coefficient formula **(Ss);**

$$Ss = \frac{2a}{2a+b+c}$$, where,

a = number of species common to both forests compared; b = number of species found only in one forest among forest patches in Soro District; and c = number of species in the other forest (Kent and Coker, 1992). The same similarity index was also used to measure the pattern of species similarity among communities identified at the study site.

Ordination is a multivariate analysis method that uses ordination diagrams to articulate the relationships between plant species, plots, and environmental variables along one or many axes representing this ordered relationship (McCune et al., 2002). Vegetation data analysis using detrended correspondence analysis (DCA) can also aid in determining the appropriate methods to use in the analysis. For the analysis if the first axis length is > 4, the unimodal method should be used, and if it < 3, the linear model should be used. When the range is between 3 and 4, both types of ordination methods (DCA and RDA) work reasonably good (Šmilauer and Lepš, 2014). Detrended correspondence analysis (DCA) was performed to determine whether the species were responding linearly or unimodal to environmental gradients. The length of the first DCA axis in this study was 6.427 indicating the data was heterogenous and which given the chance to use it.

2.3. Results

2.3.1. Plant diversity in the forest patches

The floristic composition of four forest patches provided a total of 280 plant species representing 214 genera, and 88 families were identified and documented in Soro District (Appendix 2.1). We recorded different plant habits of them are 99 trees (including 3 endemics), 83 species are herbaceous plants (with 5 hemiparasites, 5 grasses, 2 ferns, and 2 endemic orchids) with 8 endemic plants including two orchids, 76 shrubs (with 6 endemics), 3 lianas, 19 climbers (with 3 endemics), (Figure 2.3). Among the total families, we found Asteraceae 31 (11.07%), Fabaceae 25 (8.93%), Rubiaceae 16 (5.71%), and Lamiaceae 9 (5%) to be dominant families accounting for a large number of plant species (30.71%). While three tree species, *Acacia mearnsii* De Wild. (Fabaceae*), Eucalyptus camaldulensis* Dehnh., and *Eucalyptus globulus* Labill. (Myrtaceae) were recorded both inside and outside the plots, *Erythrina brucei* (Fabaceae-occurred from outside the sample plots surrounding the forest patch sites of Shonkola forest patch.

Among the whole floristic composition of the four forest patches provided, a total of 80 woody plant species: in the Shonkola Forest patch, 51 trees, 27 shrubs, and two climbers; in the Share Forest patch, a total of 68 woody plant species: 42 trees, 24 shrubs, and 2 climbers were recorded; in the 2nd Hankota Forest patch, of the 81 total plant species, 51 trees, 26 shrubs, and 4 climbers were recorded. In 2nd Oda Forest patch, 42 trees, 25 shrubs, and 4 climbers were recorded in various proportions (Figure 2.4). In this varied ecological vegetation, different ethnobotanical plant species were collected from the remnant forest patches.

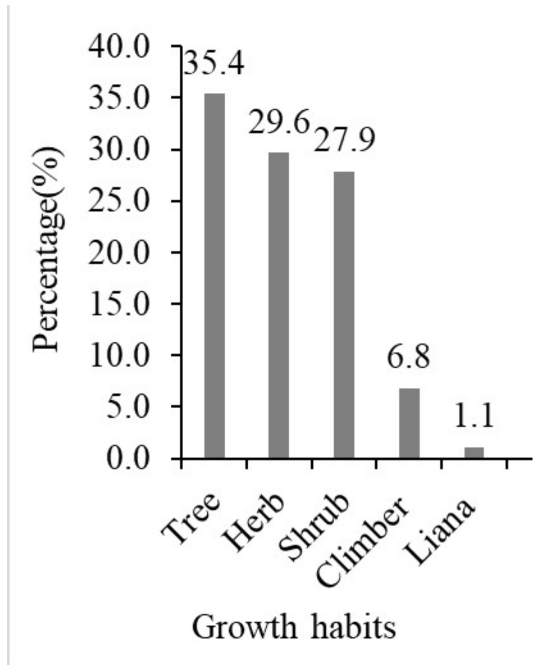
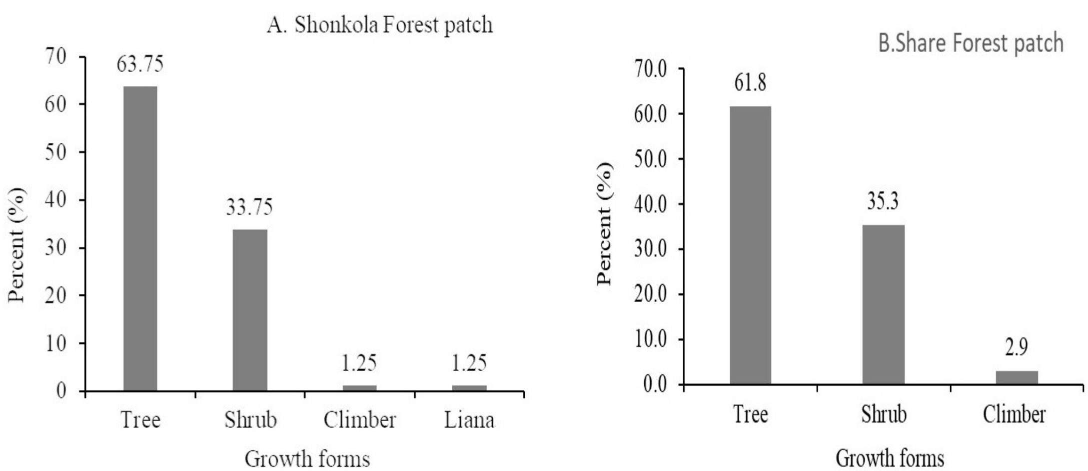


Figure 2. 3. Proportion of the vegetation habits of the four forest patches



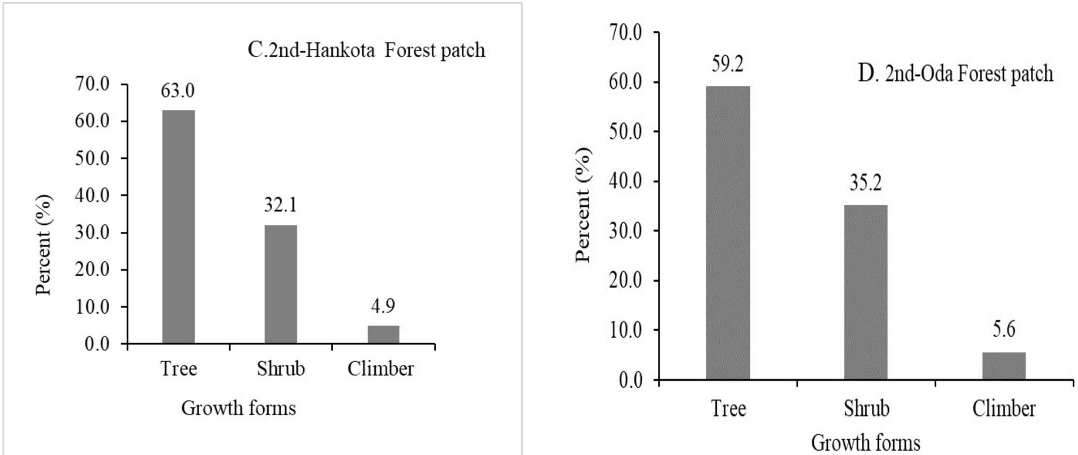


Figure 2. 4. Proportion of each four forest patches growth forms

About 52.27% of the total family members represented by more than one species, whereas 47.73% represented only by one species. The highest numbers of species were recorded for families Asteraceae with 31 (11.07%) species and 24 (11.21%) genera followed by Fabaceae 25 (8.93%) species and 17 (7.94%) genera, Rubiaceae 16 (5.71%) species and 13 (6.07%) genera, Lamiaceae 14 (5%) species and 10 (4.67%) genera, Euphorbiaceae and Malvaceae 9 (3.21% each) species with 7 and 6 (3.27%, 2.80) respective genera, Combretaceae and Solanaceae 7 (2.50% each) species, 2 (0.93%) and 4 (1.87%) respective genera. Whereas Acanthaceae and Apocynaceae 6 (2.14% each) species, 4 (1.87%) and 6 (2.80%) respective genera followed by the families Anacardiaceae, Celastraceae, Oleaceae, Poaceae, and Rosaceae are accounted 5 (1.79%) species each having varied or the same respective genera (3, 2, 3, 3, and 4) followed by Araliaceae, Moraceae, and Vitaceae were represented 4 (1.43%) species each with 4, 1, and 2 respective genera. Fifteen (15) families (16.09%) such as Boraginaceae, Capparidaceae, Cucurbitaceae, Ebenaceae, Salicaceae, Loranthaceae, Myrtaceae, Polygonaceae, Ranunculaceae, Rhamnaceae, Rutaceae, Sapotaceae, Verbenaceae, Scrophulariaceae, and Primulaceae have accounted for 3 (1.07%) species each with 3-1 same or varied genera numbers were contributed. And the other 13 families (14.77%), Amaranthaceae, Amaryllidaceae, Asphodelaceae, Crassulaceae, Dracaenaceae, Ericaceae, Myrsinaceae, Ochnaceae, Orchidaceae, Proteaceae, Sapindaceae, Urticaceae, and Viscaceae represented a smaller number of 2 (0.71%) species each in a different or similar number of genera (1 to 2). Forty-two (47.73%) of the total families were accounted for as the least one species (0.36%) as well as one genus (0.47%) (Appendix 1).

2.3.2. Vegetation structure of the forest patches

The distribution of woody plant species in different height classes is shown in Table 2.1. More than 75.22 % of the individual plant species were found to be highest in 2nd Oda (81.07%), which belongs to the lower height class of 3-5 metres (m), followed by 2nd Hankota (76.14%) and Shonkola (75.65%) Forest patches, respectively. Hence, the forest patches show comparatively good native woody plant species regeneration.

Table 2. 1. Height-class (m) distribution of woody plant species in the four forest patches

Forest patch	**Area (ha)**	**Total plots laid**	**Height class** (m)	**% of total species**	**No of total species frequency**
Shonkola	1.8	45	3 to 5	75.65	1137
			5.1-10	17.63	265
			10.1-15	5.72	86
			15.1-20	1.00	15
			Total	100.00	1503
Share	0.56	14	3 to 5	75.22	516
			5.1-10	19.24	132
			10.1-15	4.81	33
			15.1-20	0.73	5
			Total	100.00	686
Haba	0.84	21	3 to 5	76.14	654
			5.1-10	19.09	164
			10.1-15	4.19	36
			15.1-20	0.58	5
			Total	100.00	859
2nd Oda	0.72	18	3 to 5	81.07	728
			5.1-10	16.15	145
			10.1-15	2.45	22
			15.1-20	0.33	3

Total	3.92	98	Total	100.00	898

The analysis of the vegetation structure of each of the four forest patches (%) was done based on height, density, frequency, dominance, diameter at breast height (DBH), basal area (BA) per hectare, and important value indices (IVI). Relative density (RD), frequency, relative frequency (RF) dominance, and relative dominance (RDom) were determined for each vegetation structure (Table 2.2).

Table 2. 2. The total structure of all forest patches in Soro District, central Ethiopia

Floristic structure of each forest patch	Forest patches				
	Mountain Shonkola	Share	2nd Hankota	2nd Oda	Total
Density	835.00	1226.79	1020.25	1247.22	4329.26
Relative density	100.00	178.83	100.12	100.00	478.95
Frequency	1333.33	1607.14	1285.71	1650.00	5876.18
Relative frequency	100.00	99.56	100.00	100.00	399.56
Dominance	11.28	19.25	15.79	24.20	70.52
Relative dominance	55.35	178.24	118.20	138.89	490.68
DBH (cm)	15114.33	7433.47	10312.10	11776.93	44636.83
BA (m2/ha)	20.37	10.80	13.26	17.42	61.85
IVI (RD+RF+RDom)	255.35	456.96	318.32	338.89	1369.52

Note: R-Relative, RD-Relative density, RF-Relative frequency, RDom-Relative dominance

2.3.3. DBH (diameter at breast height)

The DBH class of the woody plant species in forest patches is shown in Figures (A–D) across six DBH classes. In which varied respective proportions and the number of classes are observed, in which the highest proportion of the DBH classes 5.1–10 cm (32.27%), relatively higher 2.0–5.0 cm (31.07%), and 10.1–20 cm (25.68%). The smallest DBH classes are observed between 30.1 and 40cm (2.13%,) and greater than 40cm (1.33%), respectively (Figure 2.5A). Also, relatively higher proportion of DBH classes for Figures B, C, and D area recorded in 2.0–5.0 cm (30.90%, 31.78%, and 27.95% respectively); lower DBH classes in 5.1–10 cm (25%, 19.91%, and 16.81%). Whereas in the Figures (B, C, and D) the highest DBH classes are also occurred at

10.1-20cm (34.26%, 34.92%, 35.75%), respectively. Relatively higher DBH classes 2.0–5.0 cm (31.07%), and 10.1–20 cm (25.68%). The smallest DBH classes of all are recorded between 30.1 and 40cm (2.13%, 0.87%, 1.98 %, and 3.56%) and greater than 40cm (1.33%, 1.75%, 1.75 %, and 1%), respectively, Figure 2.5A-D.

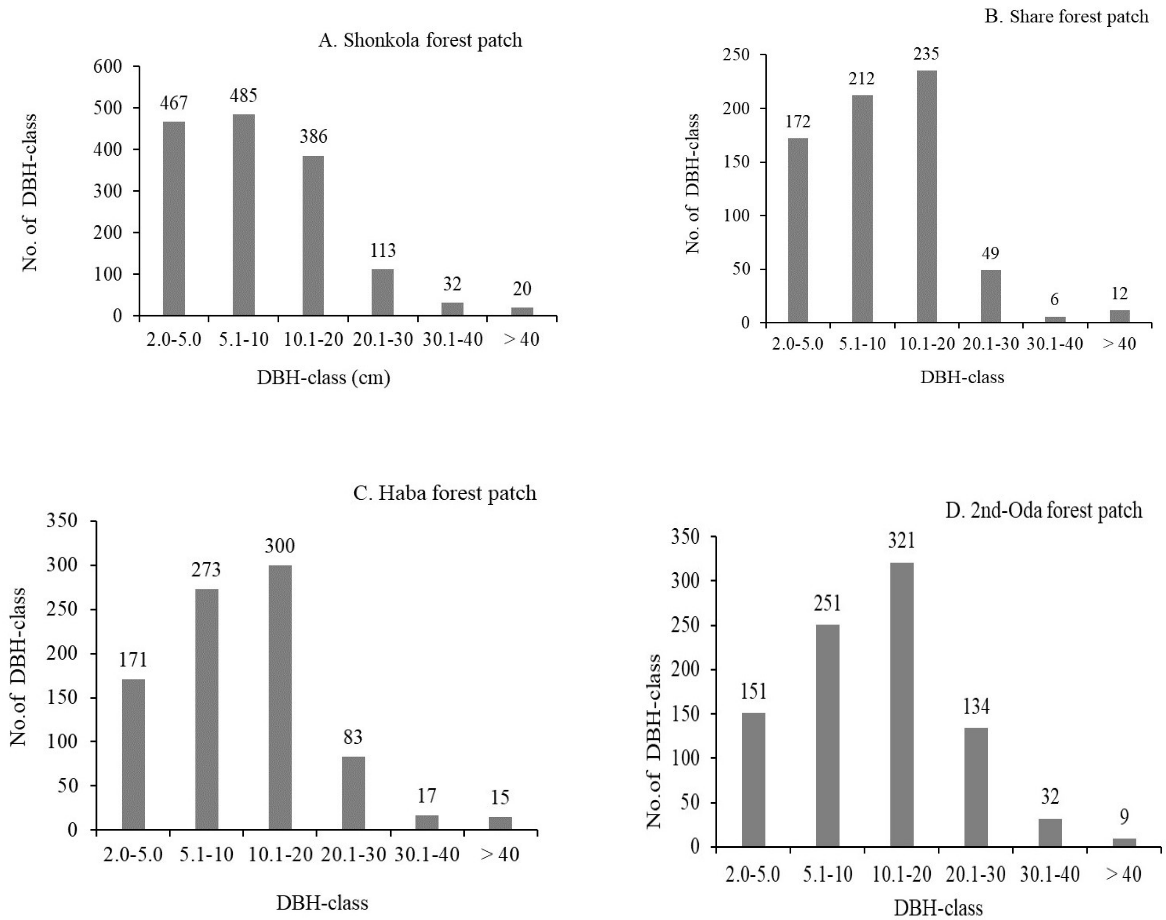


Figure 2. 5 (A-D). DBH-classes at breat height of the forest patches

2.3.4. The basal area of each forest patch

The total basal area (BA in m2/ha) of the mountain Shonkola Forest patch was 20.37%, 10.80% for share, 13.26% in 2nd Hankota, and 17.42% in 2nd Oda Forest, for a total of 61.85%. In the four forest patches, *Syzygium guineense* var. guineense was covered 29.10%, *Combretum molle* (26.59%), *Croton macrostachyus* (24.11%), *Ficus vasta* (22.98%), *Afrocarpus gracilior* (18.37%), *Warburgia ugandensis* (17.43%), and *Gymnosporia arbutifolia* (10.4%). About 89% of the total basal area was contributed by other twelve tree species such as *Albizia schimperiana* (9.67%), *Balanites aegyptiaca* (9.65%), *Combretum aculeatum* (9.25), *Ilex mitis* (8.73%), *Erythrina abyssinica* (8.55%), *Euclea divinorum* (7.52%), *Juniperus procera* (6.96%), *Terminalia schimperiana* (6.37), *Entada leptostachya* (5.59%), *Ficus thonningii* (5.57%), *Olinia rochetiana* (5.52%), and *Flacourtia indica* (5.50%), and *Syzygium guineense* subsp. *afromontanum* (4.93%).

2.3.5. Density and importance value index of woody plant species

In the mountain Shonkola Forest patch, *Olinia rochetiana*, *Juniperus procera*, and *Afrocarpus gracilior* were the dominant important plant species, with high density occurring within 47%, 42%, and 38%, respectively, of the total sampled plots, followed by *Maesa lanceolata* (30%), *Syzygium guineense* subsp. *afromontanum* (28%), and *Croton macrostachyus* (25%). Whereas woody shrub species such as *Erica arborea* (67%), *Lobelia giberroa* (55%), and *Calpurnia aurea* (32%), were represented dominantly. The IVI (importance value index) of the most common and frequent woody plant species of the mountainous Shonkola Forest patch was calculated, as was *Afrocarpus gracilior* (14%). The highest basal area of *Gymnosporia arbutifolia* (11%) and *Afrocarpus gracilior* (10%) made these species have relatively larger dominant values, and thus they have the highest important value index.

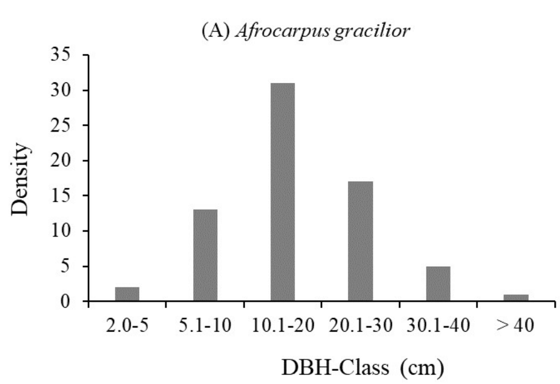
2.3.6. Population structure of four forest patches

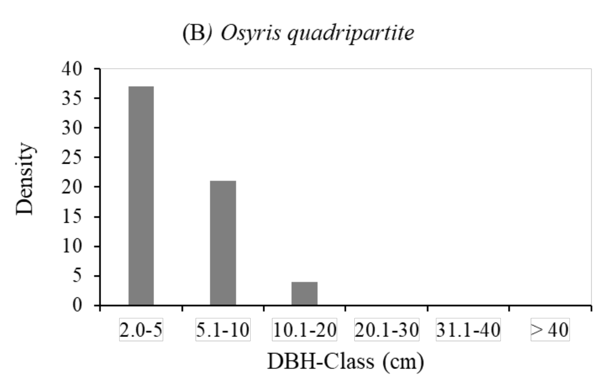
The population structure of wood plants has significant importance for conservation priory, sustainable management, and their wise use. The population structure of 20 plant species was analyzed, and four representative patterns are presented in each Figure (A-D).

The first pattern in the Shonkola Forest patch (Figure 2.6A-D) is represented by the species *Afrocarpus gracilior* (*Figure* A). This bell-shaped curve pattern indicates low frequency in the first and second DBH classes, gradually increases in the middle class, then decreases in frequency towards the higher classes. The pattern indicates poor reproduction and a decline in the number of large trees related to selective cutting by the nearby community from in the natural montane Forest patch for timber production, fence, construction, and other house utensils; thus, it calls for more investigators for conservation priority. Tree species such as *Ilex mitis* and *Ekebergia capensis* also show this pattern. The second pattern is represented by *Osyris quadripartite* (Figure B). This pattern shows a high frequency in the lower consecutive DBH classes, followed by a gradual decrease in representative individuals after the middle class loses their presence. A decline in the number of relatively large sized shurbs related to selective cutting by the local people living near the natural forest patch for the purpose of dry fence, firewood, cultural use and browsers and grazers use highly as sources of fodder; hence, this also needs conservation priority. This suggests that it has good reproduction but is in a bad recruitment state, and it also shows in shrub species of *Calpurnia aurea, Erica arborea,* and *Vepris nobilis* (synonym of *Teclea nobilis),* tree species of *Osyris quadripartite* (synonym of *Osyris lanceolata*), and *Spiniluma oxyacantha,* which also relatively show this pattern.

The third pattern is represented by *Apodytes dimidiata* (Figure C). This pattern indicates the presence of the highest density in the lower DBH classes, with a very gradual decrease in density towards the bigger DBH classes. It represented an inverted J-shaped curve, except for a slight decline in the first DBH class and a highly significant decline in the fifth and sixth DBH classes, which suggests a state of good reproduction and recruitment. This pattern is also shown in *Syzygium guineense* subsp. *afromontanum*. The fourth is represented by the *Juniperus procera* (Figure D) pattern. This bell-shaped pattern indicates good reproduction but discontinuous recruitment. The lack of a sixth DBH class in the population indicated that there was selective cutting and removal of individual Montane tree species for the sake of timber production and house utensils by the local people nearby the forest patch. Hence, this also needs conservation priority. Though the upper classes (DBH >40cm) are poorly represented, the intermediate class is well represented in this species; hence, it has a relatively high basal area, which makes the species one of the dominant trees in the Montane Shonkola Forest patch of Soro District. The tree species *Olinia rochetiana* and *Olea europaea* subsp. *cuspidata* showed this pattern; however, these species are declining due to selective cutting for firewood, construction, dry fences, and house utensils.

Population structure of Shonkola Forest patch (Figure 2.6A-D)





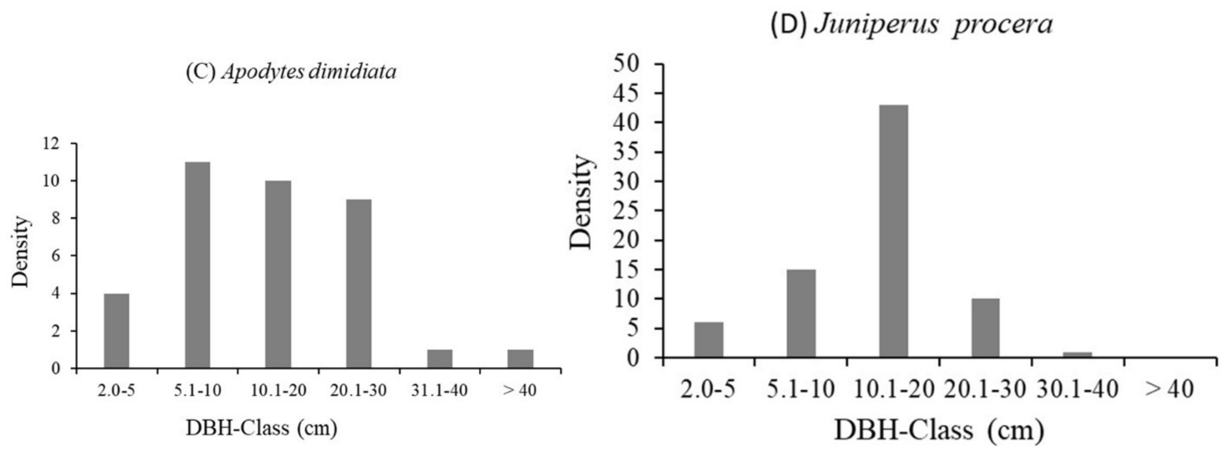


Figure 2. 6.The representative patterns of a species population structure in Mountain Shonkola Forest patch sites

Population structure of 2nd Hankota Forest patch (Figure 2.7A-D)

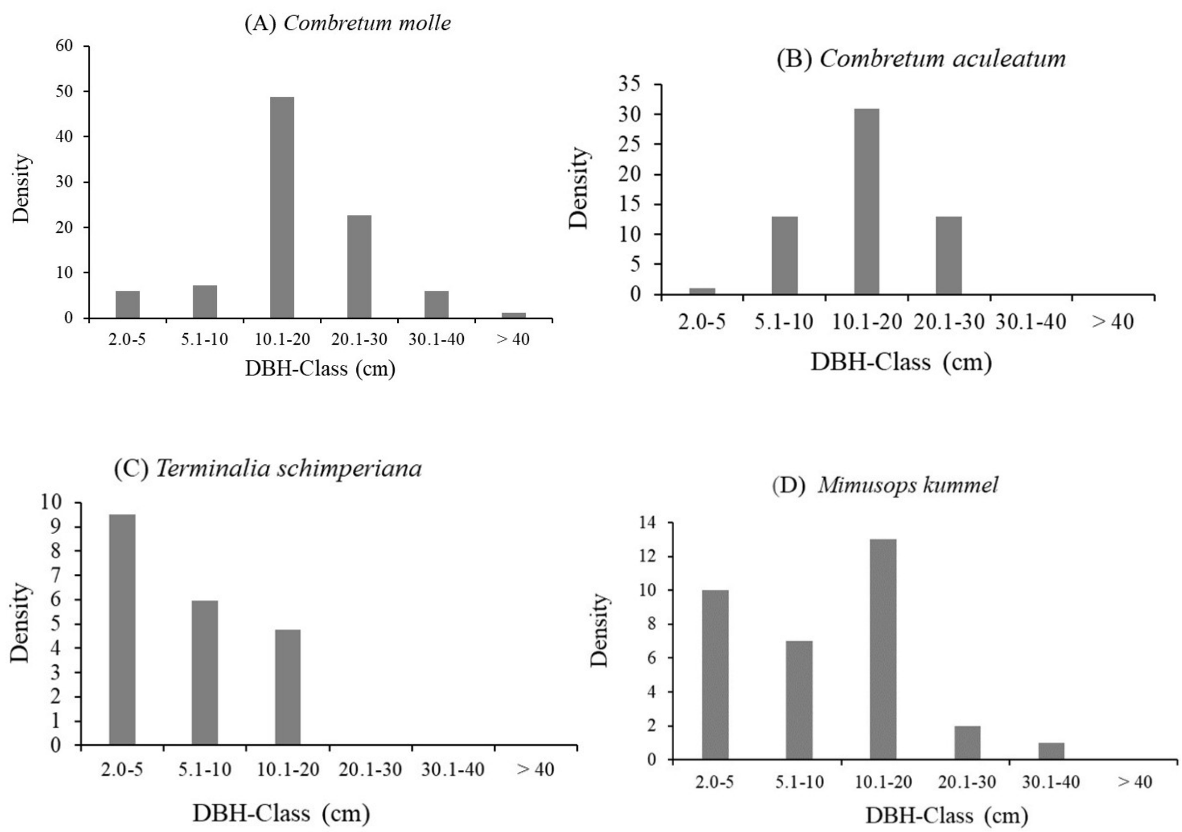


Figure 2. 7.The representative patterns of a species population structure in Haba Forest patch

The first pattern in the 2nd Hankota/Haba is represented by the tree species *Combretum molle* (Figure A). The bell-shaped curve pattern indicates that the low frequency in the first and second

DBH classes gradually increases in the middle class and decreases in frequency towards the higher classes. The pattern indicates poor reproduction and a decline in the number of large trees related to selective cutting by the nearby community for local charcoal production, fire wood, construction, and other house utensils; thus, it calls for more investigators for conservation priority. In the Haba Forest patch of trees, species of *C. molle* and *C. macrostachyus* showed this pattern and poor reproduction, as well as a decline in the number of large trees due to selective cutting for the sake of various purposes, including *C. macrostachyus* for timber production and construction and house utensils. The second pattern is represented by *Combretum aculeatum* (Figure B). This bell-shaped pattern indicates good reproduction in the intermediate class but discontinuous recruitment in the higher class. The lack of fifth and sixth DBH classes in the population indicated that there was selective cutting and removal of individual *Combretum-Terminalia* vegetation tree species for local charcoal production, firewood, and contractions by the community. Thus, this needs conservation priority in the natural forest area. The upper classes (DBH>20cm) have no basal area; the intermediate class is well represented in this species; hence, it has no basal area and no reproduction requirements. The tree and shrub species *Combretum collinum*, *Vachellia abyssinica*, *Acokanthera schimperi*, *Syzygium guineense* var. *guineense*, and *Vangueria volkensii* showed this pattern; however, these species are declining due to selective cutting for the purpose of charcoal, firewood, construction, farming tools, and fence.

The third pattern is represented by *Terminalia schimperiana* (Figure C). This pattern indicates a high frequency in the lower DBH classes, followed by a gradual decrease and absence of representative individuals after the middle class, which suggests there is good reproduction but bad recruitment. This pattern shows a high frequency in the lower DBH classes, with a gradual decrease in representative individuals until the middle class and the absence of continuity in the fourth, fifth, and sixth DBH classes. It represented an inverted J-shaped curve. The decline and absence of large-sized woody species of *Calpurnia aurea* and *Dodonaea viscosa* subsp. *angustifolia* shrubs and a tree species of *Euclea divinorum* also showed this type of pattern. Selective cutting of these species for the sake of fence, firewood, and excessive grazing by grazers and browsers are highly used as sources of fodder in the dry season; hence, this also needs conservation priority. The fourth pattern is represented by the species *Mimusops kummel* (Figure D). This pattern suggests good regeneration, but irregular recruitment. The preferred sizes of the species are: selective cutting for construction, firewood, farming tools, and walking sticks by the community around the nearby inhabitants. Also, *Albizia schimperiana* and *Warburgia ugandensis* have this pattern.

Population structure of Share Forest patch (Figure 2.8A-D)

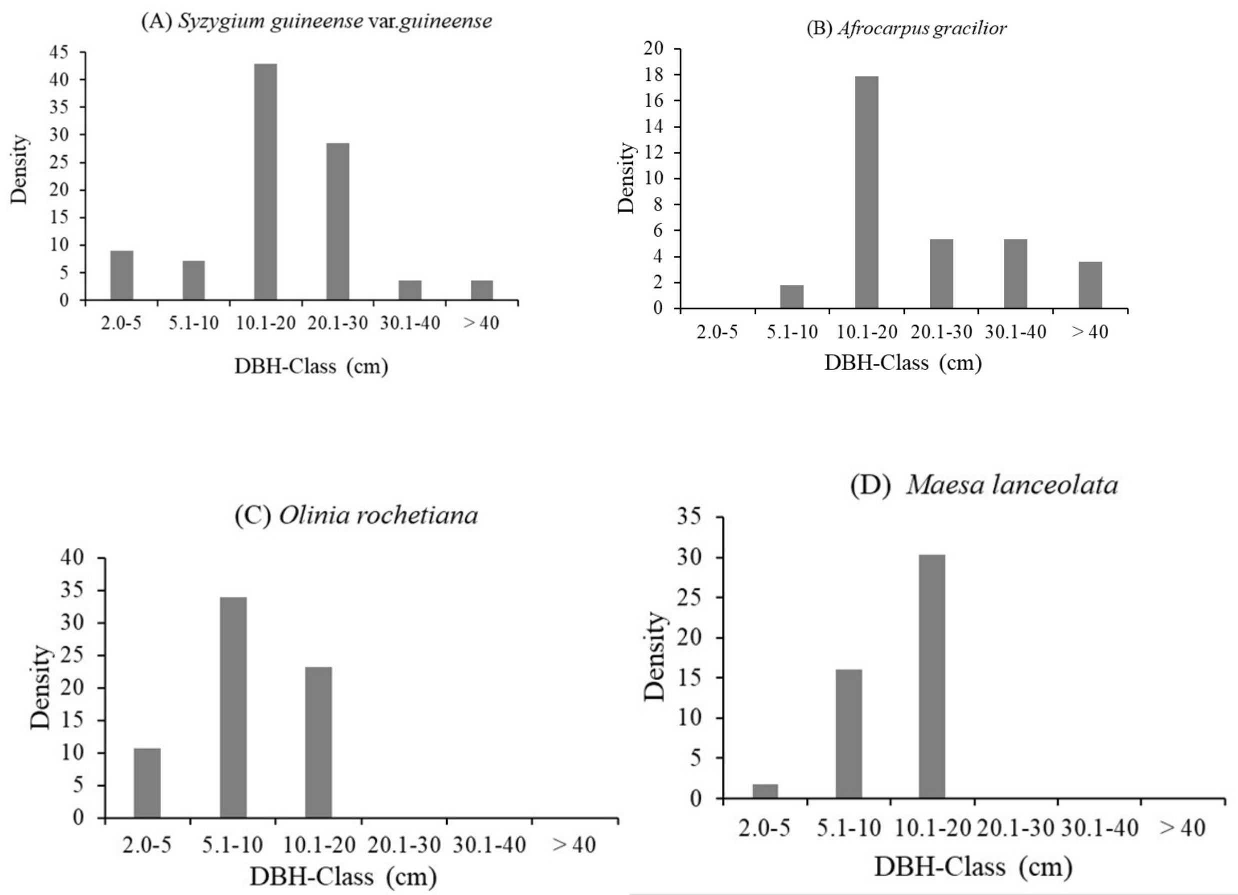
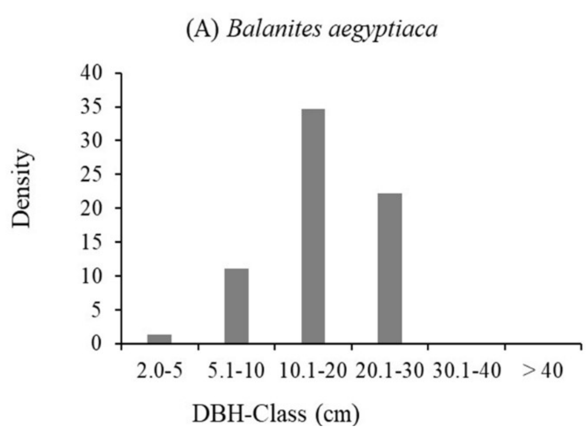


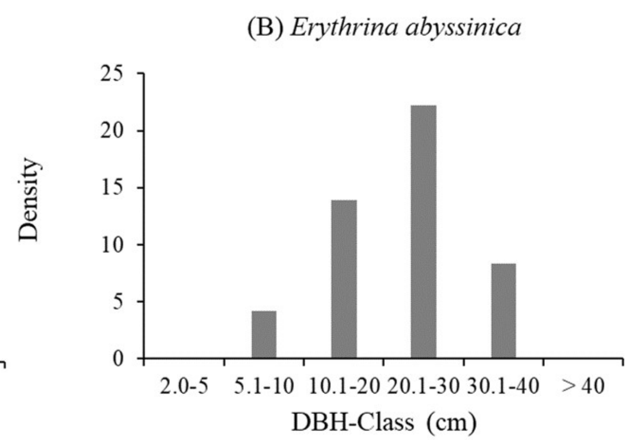
Figure 2. 8.The representative patterns of a species population structure in share forest patch

The first pattern is represented by *Syzygium guineense* var. *guineense* (Figure A). This pattern indicates a low frequency in the first and second DBH classes, the highest in the third class, followed by a decline in the fourth class, with the lowest DBH in the last classes. It shows poor reproduction and a decrease in the number of large trees due to selective cutting by local people for construction and fire; thus, it requires conservation priority. The second pattern is represented by *Afrocarpus gracilior (*Figure B). In this pattern, individual species in the first DBH class are absent, the number decreases in the second class, and the highest frequency is in the third DBH class, followed by a gradual decrease in the higher classes after the middle class to the end. The pattern indicates poor reproduction and a lower number of large tree species related to selective cutting by the people from the forest patch due to timber production, construction, fire wood and house utensils; thus, it calls for conservation priority.

The third pattern is represented by *Olinia rochetiana* (Figure C) and is bell-shaped. This pattern indicates a high frequency in the lower DBH classes and the absence of the following three higher DBH classes. It suggests good reproduction but bad recruitment. Other woody plant species such as *Bersama abyssinica*, *Euclea divinorum*, *Dodonaea viscosa* subsp. *angustifolia*, *Vangueria volkensii* (shrub), and *Osyris quadripartita* (synonym of *Osyris lanceolata*) also show this type of pattern. The fourth pattern is represented by *Maesa lanceolata* (Figure D), and it represents a J-shaped curve. This pattern indicates a higher frequency in the lower DBH classes and absence in the three classes, such as in the fourth, fifth, and sixth DBH classes. The tree species *Acokanthera schimperi* and *Dovyalis abyssinica* also showed this type of pattern. Selective cutting of these species for the sake of firewood, farming tools, house utensils, and construction; thus, this also needs conservation priority.

Population structure of 2nd Oda Forest patch (Figure 2.9A-D)





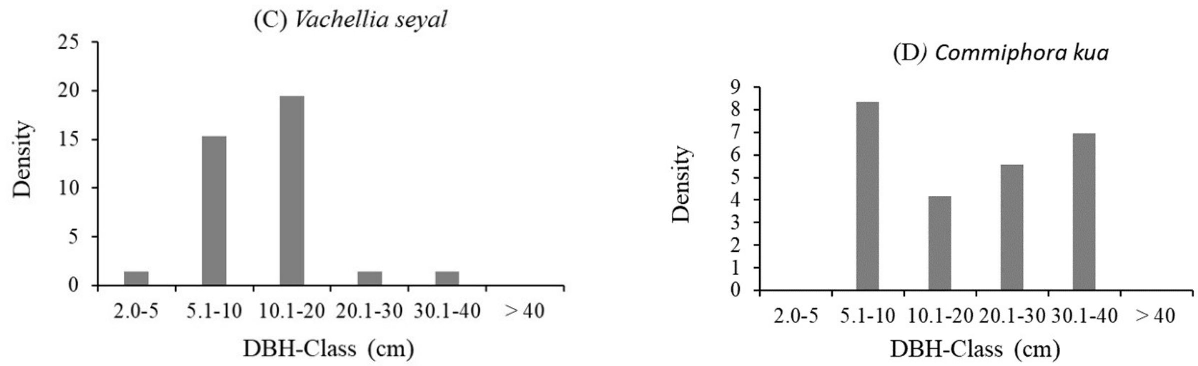


Figure 2. 9.The representative patterns of a species population structure in 2nd Oda Forest patch

The first pattern is represented by *Balanites aegyptiaca* (Figure A). This pattern shows a low frequency in the first DBH class, a gradual increase in the second class, then a high frequency in the middle class, followed by a decrease in frequency towards the higher class and the absence of representative individuals after the decrease. The pattern indicates poor reproduction but bad recruitment; a decline in the number of big trees related to selective cutting for local charcoal, fire wood, and construction by local people; it needs conservation priority. Woody plant species such as *Vachellia abyssinica*, *Combretum aculeatum, Rhus natalensis* (shrub), and *Terminalia schimperiana* also showed this type of pattern. The second pattern is represented by *Erythrina abyssinica* (Figure B). This pattern indicates the presence of the highest density in the higher DBH class, with a gradual decrease in density towards the first DBH class and a slight decrease at the bigger class, then absent at the first and last classes. It represented a J-shaped curve except for a decline in the fifth DBH class and a loss in the sixth; it suggests good reproduction and bad recruitment. The third pattern is represented by tree species of *Vachellia* seyal (Figure C). This pattern suggests good regeneration but irregular recruitment. This shows that there is selective cutting of preferred sizes for local charcoal and contraptions by local people. Also, others are included in this pattern, such as the tree species *Vachellia bussei*. The fourth pattern is a tree species of *Commiphora kua,* Figure D. This pattern also shows good reproduction but discontinuous recruitment. The lack of population structure in the first and last classes clearly indicates that there was a selective removal of the species for fuels and constructions by local inhabitants. The tree species *Acokanthera schimperi* and *Euclea divinorum* show this pattern.

2.3.7. Vegetation community types in forest patches

In the study area, phytogeographically, plant species are distributed in three different agroecological zones, and they create their relationships to the varied environmental conditions across various vegetation types.

In the categories of community types (one to five communities), plant species were identified from the hierarchical cluster analysis (Figure 2.10). Species with the highest synoptic values in the group were used to name the corresponding community names. A total of 98 square sample plots of 400 m^2 each were found sufficiently similar to any other cluster and appeared as an outlier in the output analysis of the hierarchical dissimilarities dendrogram in Figure 2.10. Transects of the total plots were established and laid in 15 transects (five in Shonkola, two in Share, three in Haba, and five in the 2nd Oda Forest patch) in the respective four forest patches of the study area to collect vegetation data, including the abundance of species, height, and diameter at breast height (DBH ≥2cm). Data on environmental conditions [altitude (m.a.s.l.), latitude (UTM), and longitude (N)] were also recoded.

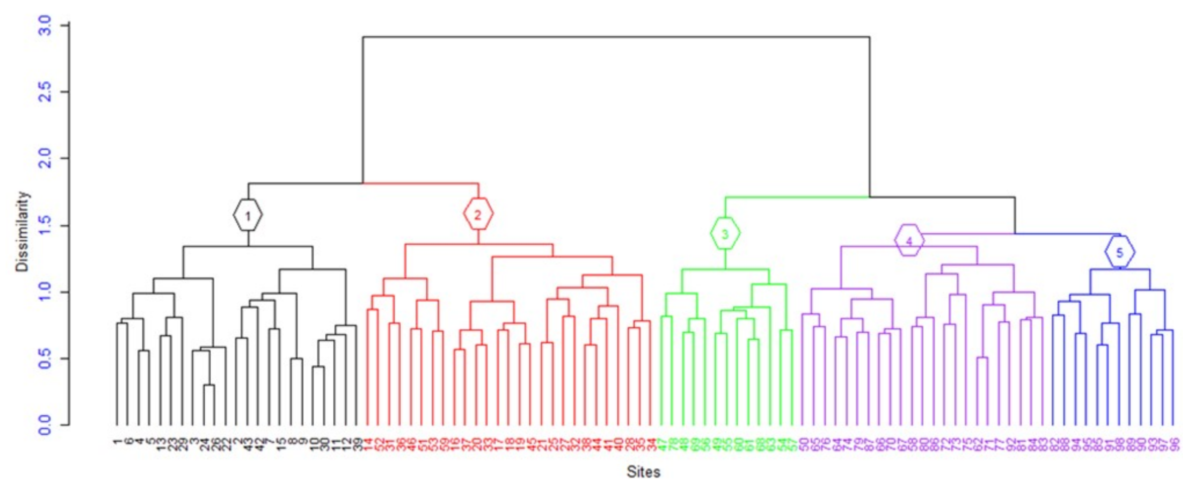


Figure 2. 10. Agromeratic dissimilarity dendrogram obtained from hierarchical cluster analysis of vegetation data from forest patches.

The level of grouping showed information on community types (*i.e.,* 1 indicates community type one, 2 indicates community type two, 3 indicates community type three, 4 indicates community type four, and 5 indicates community type five).

Table 2. 3. The values of the synoptic table used for the names of the corresponding communities with species richness in each community type of the forest patches.

Bolded values are used to refer to representative dominant species names in a community type.

Community type (C1-C5)	**C1**	**C2**	**C3**	**C4**	**C5**
Cluster size nº	**23**	**27**	**13**	**23**	**12**
Erica arborea	**4.06**	0.97	0	0	0
Olea europaea subsp. *cuspidata*	**3.56**	1.18	0.29	0.71	0.62
Spiniluma oxyacantha	**3.56**	0.15	0	0	0
Juniperus procera	**2.5**	0.85	0	0	0
Agarista salicifolia	2.22	0.06	0	0	0
Syzygium guineense subsp. *afromontanum*	2.06	2.3	0	0	0
Olea welwitschii	0.67	0.15	0	0	0
Afrocarpus gracilior	0.89	**2.97**	0.29	0	0
Apodytes dimidiata	2.06	**2.82**	0	0	0
Olinia rochetiana	0	**2.7**	0	0	0
Maesa lanceolata	0	2.18	0	0	0
Osyris quadripartite	0	1.79	0	0	0
Bersama abyssinica	0	1.24	0	0	0
Croton macrostachyus	1.06	2	**3.41**	2	0.12
Ficus vasta	0	0	**3.29**	0	0
Syzygium guineense var. *guineense*	0	0	**2.88**	0	0
Warburgia ugandensis	0	0	**2.71**	0	0
Euclea divinorum	0	0	2.18	0	0
Mimusops kummel	0	0	1.65	0	0
Albizia schimperiana	0	0	1.53	0	0
Vangueria volkensii	0	0	1.53	0	0
Combretum molle	0	0.18	1.18	**4**	2.19
Combretum aculeatum	0	0	0.47	**3.43**	0.75
Acokanthera schimperi	0	1.18	0.29	0.21	0.81

Calpurnia aurea	0.22	0.61	0.65	1.64	0.38
Vachellia abyssinica	0.28	0	0.59	1.57	1.75
Dodonaea viscosa subsp. angustifolia	0.83	0.39	1.59	2.29	**2.88**
Balanites aegyptiaca	0	0	0.35	0	**2.44**
Vachellia seyal var. *fistula*	0	0	0	0	2.38
Rhus natalensis	0	0	0	1.14	2
Vachellia bussei	0	0	0.29	0.36	1.94
Erythrina abyssinica	0	0	0	0	1.94
Ficus thonningii	0	0	0.59	0	1.75
Oncoba spinosa	0	0	0.59	1.43	1.62

In each community, there are different types of forest patches with different floristic compositions (Table 2.3).

Community type 1: *Erica arborea-Olea europaea* subsp. *cuspidata-Spiniluma oxyacantha-Juniperus procera* community types were four dominant indicator species in the community, and they were found between 2836 m.a.s.l. to 2287 m.a.s.l. It consisted of 79 total species, which were scattered over a total of 23 plot numbers. In this community type of mountain Shonkola Forest patch was dominated by representative dwarf to large-sized shrub *Erica arborea* species from top to bottom of the mountain from the shrub layer, and *Olea europaea* subsp. *cuspidata*, *Spiniluma oxyacantha,* and *Juniperus procera* were also indicator tree species from the tree layer, and they were the most species in the community.

The understory was occupied by the herbal species *Achyranthes aspera, Acmella caulirhiza, Ageratum houstonianum* (synonym of *Ageratum conyzoides), Ajuga integrifolia, Arisaema schimperianum, Artemisia abyssinica, Asparagus africanus, Bidens pachyloma, Bidens pilosa, Centella asiatica, Commelina benghalensis, Crassocephalum sarcobasis, Crassocephalum vitellinum, Crepis rueppellii, Crinum abyssinicum. Crotalaria spinosa, Cyathula uncinulata, Dicliptera foetida, Dicliptera magaliesbergensis, Dicrocephala chrysanthemifolia, Euphorbia depauperata, Galium aparinoides, Gloriosa superba, Guizotia scabra, Hibiscus calyphyllus, Helichrysum splendidum, Helichrysum traversii, Kalanchoe hypseloleuce, Kosteletzkya adoensis, Laggera crispata, Launaea cornuta, Leucas martinicensis, Oxalis corniculata, Pelargonium sp., Pellaea calomelanos, Pennisetum setaceum, Pennisetum sphacelatum,* *Pennisetum thungbergii, Phyllopentas schimperi* (synonym of *Pentas schimperiana), Phaulopsis imbricata, Physalis peruviana, Plantago lanceolata, Platostoma africanum, Plectranthus barbatus, Pteridium aquilinum, Rumex abyssinicus, Rumex nepalensis, Salvia nilotica, Satureja simensis, Scadoxus multiflorus, Solanum indicum, Thalictrum rhynchocarpum, Thunbergia ruspolii, Thymus schimperi,* and *Urtica simensis*.

Community type 2: *Afrocarpus gracilior-Apodytes dimidiata-Olinia rochetiana* community type was found between 2818 m.a.s.l to 1935 m.a.s.l. It consisted of 135 total species that were found in 27 plots. In the middle, plots of mountain forest sites are dominated by indicator tree species of *Afrocarpus gracilior*, *Apodytes dimidiata,* and *Olinia rochetiana*. The upper canopy of the community type was also dominated by *A. gracilior,* followed by *A. dimidiata* and *O. rochetiana* plant species.

Community type 3: *Croton macrostachyus-Ficus vasta* type, followed by *Syzygium guineense* var. *guineense-Warburgia ugandensis* community type. A total of 85 species were found in the 13 plots in the altitudinal ranges of 1990 m.a.s.l. to 1730 m.a.s.l. *Croton* macrostachyus tree is dominant indicator species over *Ficus vasta* tree species and the other tree species of *Syzygium guineense* var. *guineense* over *Warburgia ugandensis*.

Community type 4: *Combretum molle-Combretum aculeatum* community type. A total of 129 species were occupied in the community 23 total plots within the altitudinal ranges of 1933 m.a.s.l. to 1556 m.a.s.l. These two woody tree representative species are dominant and indicator species, including other plant species and grasses more common in the woinadega and kola forest patch sites of the 2nd Hankota and 2nd Oda Forest patches.

Community type 5*:* *Dodonaea viscosa* subsp. *angustifolia-Balanites aegyptiaca* community type. A total of 80 species were occupied in the community 12 plots within the altitudinal ranges of 1599 m.a.s.l. to 1479 m.a.s.l. Dominated by the indicator species *Balanites aegyptiaca* and *Dodonaea viscosa* subsp. *angustifolia* with respect to others in 2nd Oda, including other dominant community members of woody species like *Vachellia seyal* var. *fistula, Combretum molle*, *Rhus natalensis, Vachellia bussei, Erythrina abyssinica, Vachellia abyssinica, Ficus thonningii, Oncoba spinosa, Combretum aculeatum, Piliostigma thonningii, Euclea divinorum, Gymnosporia senegalensis, Acokanthera schimperi*, *Ximenia americana*, *Ficus vasta*, *Terminalia schimperiana,* and *Carissa spinarum* community types were found scattered in the community. The distribution of these plant communities is influenced by environmental factors, mainly anthropogenic activities such as excessive use of fuel wood and grazing, which highlights the importance of conservation strategies and efforts in these forest ecosystems, considering these factors for effective forest patch management and conservation.

2.3.8. Sorensen's similarity analysis between communities in the forest patches

Moreover, the overall plant species analysis of Sorensen's similarity analysis of the five communities indicated that higher floristic similarity 0.68 (68%) was recorded between communities in C1 and C2, following others between other communities, whereas lower 0.25 (25%) species similarity was also recorded in other communities in C1 and C5 (Table 2.4).

Table 2. 4. Sorensen's similarity analysis of the floristic compositions of plant communities in the forest patch

Community types	C1	C2	C3	C4	C5
C1	1				
C2	0.68	1			
C3	0.43	0.57	1		
C4	0.44	0.55	0.58	1	
C5	0.25	0.41	0.57	0.64	1

2.3.9. Relationship between plant community types and environmental variables

The DCA output of our dataset revealed that the first axis length was 6.427 (Table 2.5). A total of 98 sample quadrates of the total species and 10 environmental factors (altitude, slope, aspect, human interfaces such as cutting, grazing, browsing, fire wood (FW), charcoal (CH), and agricultural land (AL) were used in this analysis.

Table 2. 5. DCA output of vegetation composition in the data set

	DCA1	DCA2	DCA3	DCA4
Eigenvalues	0.781	0.437	0.399	0.354
Additive Eigenvalues	0.781	0.421	0.399	0.351
Decorana values	0.7924	0.467	0.399	0.359
Axis lengths	6.427	5.422	4.848	5.026

The distribution of the plant communities in Soro District is also influenced by various environmental factors (Figure 2.11) such as altitude, slope, and aspect, respectively and anthropogenic/human activities mainly excessive use of fuel woods (more for local charcoal production), grazing and cutting which highlights the importance of conservation strategies efforts in these forest ecosystems, considering these factors for effective forest patch management and conservation.

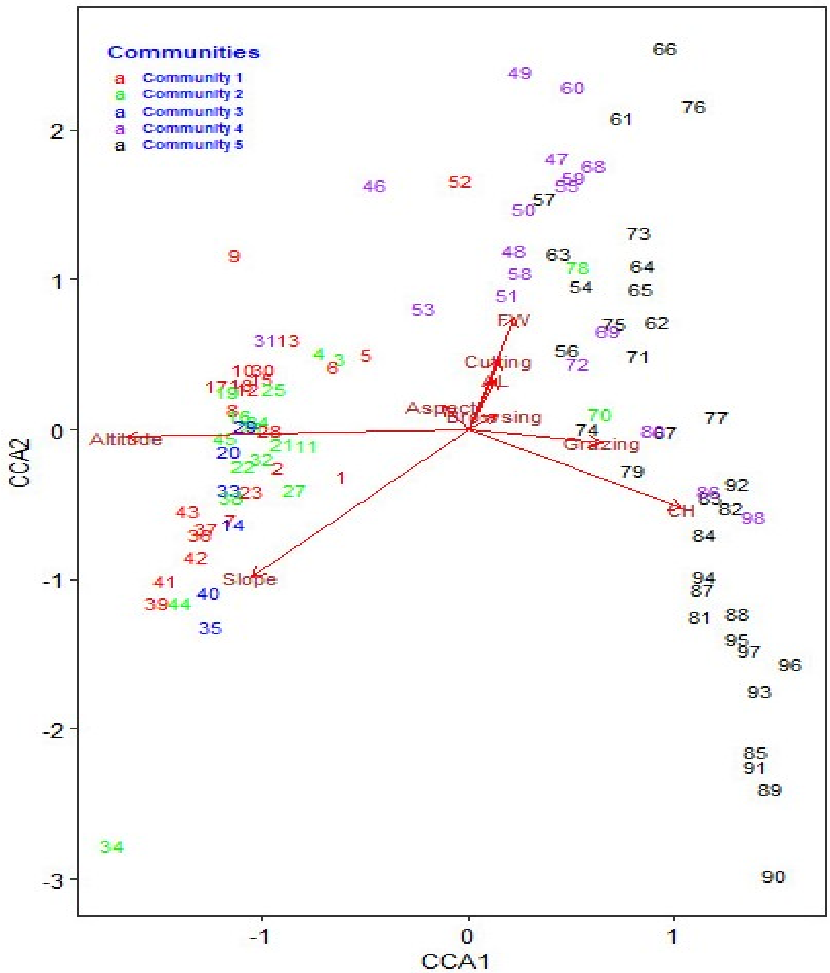


Figure 2. 11. Conical correspondence analysis (CCA) ordination graph of significant environmental variables (p< 0.05) and the plant community in the study area.

Note: CH: Charcoal, Fw: Fire wood, AL: Agricultural land

2.3.10. Common and unique plant species in four forest patches

From the all-forest patches, fourteen (14) most common woody species are identified from each forest patch. These species are *Syzygium guineense* var. *guineense* (T), *Croton macrostachyus* (tree: T), *Albizia schimperiana* (T), *Mimusops kummel* (T), *Vachellia abyssinica* (T), *Celtis africana* (T), *Dodonaea viscosa* subsp. *angustifolia* (S: shrub), *Olea europaea* subsp. *cuspidata*

(T), *Calpurnia aurea* (S), *Rhus vulgaris* (S), *Vepris nobilis* (synonym of *Teclea nobilis:* T), *Maytenus undata* (T), *Carissa spinarum* (S), *Psydrax schimperiana,* and *Rytigynia neglecta* (S). Of these dominant species, nine are trees, and five are woody shrubs (S).

Unique species in each forest site **: in Shonkola**, *Acanthus eminens, Agarista salicifolia*, *Erica arborea*, *Erythrina brucei, Gymnosporia addat, Gymnosporia arbutifolia*, *Gymnosporia obscura*, *Hagenia abyssinica*, *Halleria lucida*, *Ilex mitis*, *Juniperus procera, Lobelia giberroa*, *Myrsine melanophloeos*, *Periploca linearifolia*, *Aningeria altissima* (synonyms of *Pouteria altissima*), *Rhamnus staddo, Rosa* x *richardii, Spiniluma oxyacantha, Solanecio mannii, Syzygium* guineense subsp. afromontanum; in **share**, *Baccharoides lasiopus*, *Faurea speciosa*, *Ficus sycomorus*, *Gymnanthemum* sp, and *Gymnosporia senegalensis*; in **2nd Hankota,** *Combretum* sp, *Crotalaria cleomifolia, Crotalaria lachnophora, Duranta erecta, Embelia schimperi*, *Grewia* sp, *Lippia adoensis* var. *adoensis, Oncoba spinosa, Senna didymobotrya*, *Vicia sativa;* in **2nd Oda**, *Bridelia sp, Commiphora kua, Entada leptostachya, Erythrina abyssinica, Ochna inermis, Steganotaenia araliacea, Stereospermum kunthianum, Vachellia bussei,* and *Vachellia seyal* var. *fistula.*

Table 2. 6. Multi-diversity forest patches, Soro District in central Ethiopia

Community	Richness (S)	H'	Simpson	Shannon Evenness	Simpson Diversity
1	79	3.767	29.53	0.86	0.37
2	135	4.297	48.52	0.88	0.36
3	85	3.919	34.80	0.88	0.41
4	129	4.299	47.96	0.88	0.37
5	80	3.980	41.06	0.91	0.51

Table 2.6 shows the overall species richness, diversity, Shannon Evenness, and Simpson Diversity values of the five plant communities identified in the forest patches of the study area. In the species diversity analysis using dissimilarity analysis of the five plant communities, the highest floristic richness occurred in communities two, four, and three, respectively. Whereas the Shannon Wiener diversity Index (H') also occurred in the three communities, which resulted in 4.299, 4.297, and 3.980, respectively. The highest Shannon Evenness occurred at 0.91 in community five, and relatively the least species evenness was 0.86 in community one; in the case

of Simpson Diversity, the highest was 0.51 and the least was 0.36 in the respective communities five and two (Table 2.6).

2. 3.11. Woody ethnomedicinal and wild edible plants in each forest patch

Of the 80 total woody plant species, 50 medicinal plants were found in the sites of the Mount Shonkola Forest patch; four wild edible plant species were reported; but 26 species were neither medicinal nor wild edible plants from the sites of the forest patch. In the Share Forest patch, 68 total woody plant species, of which 43 medicinal plants were found, reported six wild edible plant species, but 19 species were neither medicinal nor wild edible plants.

In the 2nd Hankota (Haba) forest patch, of the 81 woody plant species, 53 medicinal plants were found; seven species were wild edible plants, but 21 species were reported as neither medicinal nor wild edible plants from the forest patch. Whereas in the 2nd Oda Forest patch, 71 woody plant species were reported, 35 medicinal plants were found in the forest site, six species were reported for wild edible plants, but 30 species were neither medicinal nor wild edible plants. Hence, out of a total of 181 medicinal plants and 23 wild edibles, 96 were neither medicinal plants nor wild edible species.

2. 5. Discussion

2.5.1. Diversity of plant species in the forest patches

In this study, we found the highest diversity of woody plants (a total of 300 plants) in the four forest patches of Soro District. Of these 174 woody plant species, they were totally filtered and recorded from the four forest patches. Moreover, the floristic composition of the forest patches provided a total of 280 plant species representing 214 genera; 88 families were identified and documented in Soro District (Appendix 2.1), including herbaceous plant species. The forest patches are mostly dominated by DAF forest types. This DAF (dry evergreen Afromontane Forest and Grassland Complex) is the richest vegetation type (Friis et al., 2011), followed by *Combretum-Terminalia* and *Acacia-Commiphora* vegetation types, including a mixed riverine forest patch of share. The forest patches exhibit a high level of similarity (Table 2.5), sharing 68% of the species. Mount Shonkola Forest patch has negatively impacted by altitude and slope respectively than others. While forest patch 2nd Oda affected by local charcoal fire wood collection and grazing, in share fire wood collection and grazing, in 2nd Hankota fire wood, grazing, cutting, and agricultural land expansion respectively.

A comparison of the basal area (61.85 m2/ha) of the forest patches (DAF) with other Ethiopian montane forests indicated that it was lower than that of Mana Angetu Forest (94 m2/ha) (Lulekal et al., 2008a), Masha Anderacha dry Afromontane forest patch in southwestern Ethiopia (82 m2/ha) (Yeshitela and Bekele, 2003), but higher than the forests of Dindin dry Afromontane forest patch (49 m2/ha) (Shibru and Balcha, 2004), Denkoro (45 m2/ha) (Ayalew et al., 2006), and Gennemar dry Afromontane forest, southern Ethiopia (19.42 m2·/ha) (Ahmed et al., 2022).
This was due to the presence of individual woody plants in Soro District Forest patches with a relatively higher total DBH compared to these forest patches. This also indicated that the current Soro District has dry Afromontane Forest patches (*e.g.* Shonkola Forest patch sites, which are the most priority areas for biodiversity conservation) are the most important conservation priority sites to increase to dense natural forest and forest patches as compared to other forests in Ethiopia like Dindin, Masha Anderacha, and Denkoro forest as well as other dry Afromontane forests in Ethiopia.
Among the total woody plant species compositions of the forest patches in the study area the largest number of woody plant species were recorded from 2nd Hankota followed by Shonkola Forest patch, whereas the lowest woody plants were recoded from a share Forest patch. These differences are due to agroecological differences, where unique species vary the number of plant spaces in each forest patch. A total of 280 recorded plant species compositions in Soro District are higher than that of 230 plant species recorded in Bale Mountain National Park (Yineger et al., 2008) and a total 235 plant species recorded in Gedo dry evergreen Montane Forest in West Shewa (Kebede et al., 2016). In addition, a higher number of woody species (174) were recorded than in other similar studies of dry Afromontane forests in Ethiopia, with a different number of plant species. For example, 133 species in Kumuli Forest. However, a higher number of woody species were recorded than in other similar studies of dry Afromontane forests in Ethiopia, with a different number of plant species. For example, there are 133 species in Kumuli Forest (Woldemariam et al., 2016), 95 species in Boda Forest (Fikadu and Melesse, 2014), 84 species in upland dry evergreen forest patch of Arero Forest (Shiferaw et al., 2018), 82 species in Menagesha Suba Forest (Beka, 2007), 55 woody plant species in Gennemar dry Afromontane forest including 39 similar reported plant species, 50 plant species in Denkoro Forest (Awoke and Mewded, 2019), 49 plant species in Wanzaye Forest (Asfaw, 2018), 44 plant species in Mount Duro Forest that exhibits dry afromontane forest in northwestern Ethiopia (Teshome et

al., 2020), and 31 plant species in Chilimo Forest (Tesfaye et al., 2019) are the reservoir home to plant diversity including wild animals. Also, these varied recorded numbers of species were due to the size of the forests, survey methods, and objective of the study (Kebede et al., 2016). A total of 22 (7.86%) plants were endemic plants discovered from the whole 98 squared quadrats of forest patches. Of these endemic species in the IUCN red list categories, *Acanthus sennii*, *Kalanchoe petitiana*, *Thymus schimperi*, and *Urtica simensis* were similarly reported by (Ayalew et al., 2006).

The forest patches of the study were comparable with dry montane forests in Ethiopian regions; some of the forest patches are listed and compiled. The data of the forest patches were recorded in each forest patches, between a maximum of 2836 m.a.s.l and a minimum of 1479 m.a.s.l. Besides, other remnant forest patches in Ethiopia were above and below these altitudinal limitations. In spite of that, this comparison was done among preferred dry Afromontane Forest patches. For comparison, some of the forests or forest patches were involved in different areas of Ethiopia. For example, Dodola forest patch in northern part of the Bale Mountains has the greatest altitudinal range of 2400 m.a.s.l to 3600 m.a.s.l (Hundera, 2003), Jibat forest patch in western Shewa has a relatively large altitudinal range of 2000 m.a.s.l to 3000 m.a.s.l (Bekele, 1993). The southwestern Ethiopian forest patch is also found stretched between 1050 m.a.s.l to 2550 m.a.s.l (Yineger et al., 2008) which have a lower altitudinal range than the present study of Soro District forest patches in central Ethiopia, with an altitudinal range of 1479 m.a.s.l to 2836 m.a.s.l.

2.5.2. Plant community types

In the investigation, forest patches comprised five plant community types and were identified using agglomerative hierarchical cluster analysis and canonical correspondence analysis. There are species-rich and diverse plant communities in the altitude range of 2836 m.a.s.l. to 1479 m.a.s.l. These forest patches have non-mountainous and plain, mountainous, and steeply sloping types. Forest patches has showed high similarity ($S > 0.5$) and less dissimilarity ($S < 0.5$) (Table 2.4). Due to the community's location, all forest patches, have more or less similar environmental factors. The MRRP test shows the five community types have significant differences ($R = 0.556$, $p = 0.001$). However, the difference could be directly related to environmental factors that cause plant communities to have distinctly distinguishing plant species (Rahman et al., 2022). In addition, these findings are supported by the findings in the different studies (Lovett, 1990; Tekle et al., 1997; Bhattarai et al., 2014; Tekle and Maryo, 2022), which showed that there is a rapid shift in temperature, rainfall, drainage, and altitudinal gradients in mountainous ecosystems. And the diversity of plant species varies over a short distance. In the study area, types of vegetation are classified mainly as DAF (Friis et al., 2010) and also *Combretum-Terminalia* and *Acacia-Commiphora* with mixed riverine plants, which are dominated by *Erica arborea*, *Olea europaea* subsp. *cuspidata*, *Juniperus procera, Spiniluma oxyacantha*, *Afrocarpus gracilior, Apodytes dimidiata, Olinia rochetiana, Croton macrostachyus, Ficus vasta*, *Syzygium guineense* var. guineense, *Warburgia* ugandensis, *Combretum molle*, *Combretum aculeatum*, *Dodonaea viscosa* subsp. *angustifolia*, *Balanites aegyptiaca, Vachellia seyal* var. *fistula, Combretum molle*, *Rhus natalensis, Vachellia bussei, Vachellia abyssinica, Oncoba spinosa, Combretum aculeatum, Piliostigma thonningii, Euclea divinorum, Gymnosporia senegalensis, Acokanthera schimperi*, *Ximenia americana*, *Terminalia schimperiana,* and *Carissa spinarum* (Figure 2.10) and (Table 2.3). Community 1 **(***Erica arborea-Olea europaea* subsp. *cuspidata-Spiniluma oxyacantha-Juniperus procera)* and Community 2 (*Afrocarpus gracilior-Apodytes dimidiata-Olinia rochetiana*) are relatively associated with higher altitudinal elevation and are more found in the Mount Shonkola forest patch and also in the Share Forest patch, which is dominated by large woody plant species. Community 2 **(***Afrocarpus gracilior-Apodytes dimidiata-Olinia rochetiana*) and Community 4 (*Combretum molle-Combretum aculeatum*) had the greatest species richness and diversity (Table 2.6). On the other hand, Community 1 and Community 3 (*Croton macrostachyus-Ficus vasta*) had relatively low species richness and diversity among community types. The highest species diversity and richness of community 4 could be due to varied altitudinal range (1556 m.a.s. l.to 1933 m.a.s.l.), which is found in the Haba Forest patch with relatively high disturbance. Also, plant species at higher altitudes have higher plant diversity due to low disturbance (Chemeda et al., 2022). The high plant species diversity and richness of community 2 could be due to the altitudinal range (2818 m.a.s.l to 1935 m.a.s.l) which is found in the mount Shonkola forest patch including Share (in low altitudinal gradient) Forest patches with relatively low disturbance.

In addition, aspects and browsing interactions are less impactful factors in the community (Figure 2.11). Community 4 and Community 5 are the most disturbed community types that are found in the 2nd Hankota and 2nd Oda Forest patches (Figure 2.11) by anthropogenic interference such as local charcoal (CH), fire wood (FW), grazing, and cutting plant species for various purposes. Community 1 and Community 2 types at the sites of the Mount Shonkola Forest patch were also affected more by altitude and slope, respectively, than Community 3 (Figure 2.11). The findings of this recent study in Soro District were relatively consistent with the findings of Mokarram and Sathyamoorthy (2015) and Yinebeb et al. (2023), and they were also primary determinant factors of forest patches in varied topographies. A similar study was conducted in Sesa Mariam Monastery, Northwestern Ethiopia (Meshesha et al., 2015b) and showed that grazing also affects the floristic composition in the study area (Figure 2.11).

2.5.3. Relationships of environmental factors with plant community

Floristic grouping patterns of within the studied forest patches were done across multivariate analyses of CCA ordination and cluster analysis (Figures 2.11) and (Table 2.7). The analysis of vegetation data using cluster analysis and ordination techniques can provide the details and comprehensive information on vegetation patterns and plant species responses to major environmental factors (Ter Braak and Verdonschot, 1995). The five communities were shown by the length of the first axis by the DCA axis is an indication of the influence of environmental factors influencing species composition and high species diversity in five plant communities. In this study, the distribution of plant communities represents the combined influence of altitude, slope, grazing, aspect, and elements of human interfaces such as CH, FW, and selective cutting. Among these factors, altitude was the most important environmental variable that explained variations in plant species distribution and community patterns, according to multivariate analyses of CCA ordination and cluster analysis. The variable associated with axis one with the highest score was altitude. Altitude was the most important variable in weighting axis one and explaining or interpreting the axis. Other factors, such as human interference like FW, cutting, AL, CH, browsing, and grazing, have an opposite effect on altitude and slope (Figure 2.11). This relatively agrees with studies (Tekle and Maryo, 2022; Yinebeb et al., 2023) that show that human interference like browsing and grazing decreased significantly as altitude increased. Ethiopian Afromontane forests confirmed the research findings of altitude as a major determinant of vegetation distribution along altitudinal gradients (Lulekal et al., 2008a; Birhanu et al., 2021; Dibaba et al., 2022). But plant species richness in Soro District is higher compared to the investigation conducted in dry afromontane forests; for instance, Kuandisha afromontane forest fragments (Berhanu et al., 2017) and dry afromontane forest patches of Northwestern Ethiopia (Yinebeb et al., 2023). The differences in species richness among these forests and forest patches could be due to the location of geography, altitude, anthropogenic factors, and other climatic conditions, as well as physiographic and edaphic factors (Brockway, 1998). The findings from the study area revealed a relatively high endemicity of 22 (7.86%). This is due to endemic plant species found in Ethiopia's mountainous forests, which contribute about 10.7% of the country's total species, according to Demissew et al. (2021). Moreover, (Gebrehiwot et al., 2020) found that 21% of the floristic plant species were endemic to north Ethiopia, whereas 10.6% were endemic to northwest Ethiopia The two dominant families in the study area are Asteraceae and Fabaceae. According to other investigations, Asteraceae and Fabaceae predominate in dry evergreen Afromontane forests (Meshesha et al., 2015; Birhanu et al., 2021). They contribute the largest and widely distributed vascular plant families (Demissew et al., 2021). Family Asteraceae shows outcrossing behavior in its inflorescences with mechanisms of diverse pollination that contributed to the cosmopolitan (Cuffia et al., 2022), and also, these are the top leading species-rich families in the world.

2. 6. Conclusion

In this study, a total of 174 woody plant species were documented from a total of 280 plant species and 88 families, of which 22 were endemic plants including five red list plant species of Ethiopia and Eritrea. Five plant communities were identified in this investigation. Forest patches in Soro District, central Ethiopia are one of the plant biodiversity conservation priority areas, mainly claimed for in-situ conservation in the forest sites of dry Afromontane Forest patch sites, *Combretum-Terminalia*, and *Acacia-Commiphora* woodland (VCWL) with mixed riverine plant species with rich biodiversity. Among all environmental impact factors, altitude, slope, charcoal (CH) production, firewood (FW) collection, grazing, and agricultural land (AL) expansion were the main impact factors determining the distributions of various woody plant species composition and community types in each forest patch. An altitude elevation was found to be the most important environmental factor influencing species distribution and community formation. Regeneration status was determined by the features of DBH classes that showed the density of individuals decreases with increasing DBH. In addition, the forest patches were also differently distributed in three agroecological zones, and they were home to diverse numbers of medicinal, wild edible, economic, recreational; ecologically important various dega, woinadega, and kola plant species; as well as the home for different wildlife. In this floristic composition studies, different service-giving plant species for herbal medicine, environmental, and economically useful plant species were highly distributed in each forest patch. However, these forest patches of the study area are highly exploited by the people of the community for various purposes, especially those living near locally protected natural forest patches, and selective cutting from the forest patches mainly for timber production (income source), for example, *Afrocarpus gracilior, Cordia africana, and Juniperus procera*, dry fences (*e.g*. *Calpurnia aurea*, *Dodonaea viscosa* subsp. *angustifolia, Olea europaea* subsp. *cuspidata, Olea welwitschii,* and *Olinia rochetiana),* and fuel woods (more for local charcoal: *Combretum aculeatum*, *Combretum collinum*, *Combretum molle*, *Vachellia abyssinica*, *Vachellia bussei*, and *Vachellia seyal* var. *fistula*). In the forest patches, anthropological factors result in deforestation of the forest patches for the sake of local fuels, grazing, agricultural land expansion, access for settlements, source of income, and to expand overgrazing land. Overall, the consequences expand erosion as well as drought, and this study recommends that the information could give serious conservation and management attention to the District for those newly protected potential forest patches. Also, in the future, it would call for more research for further investigation. Thus, due to the mentioned impact factors, conservation priorities plan in different forest are essential to meet the aims of this present study.

CHAPTER THREE

3. Traditional medicinal plants used by local people for the treatment of human ailments in Soro District, Hadiya Zone, central Ethiopia.

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Abstract

Background: Ethnomedicinal studies are important primarily to build plant based human healthcare and maintain the sustainability of human life. This study was conducted in Soro District, central Ethiopia, to identify, document, and analyze human medicinal plants with the associated indigenous and local knowledge.

Materials and methods: Data on human herbal ethnomedicinal plant species, indigenous and local knowledge were collected through semi-structured interviews and guided field walks. Focus group discussions with five to seven members and informant consensus factors were used for data confirmation. Descriptive-quantitative approaches and ethnobotanical tools were used for data analysis. A statistical independent t-test was used to compare ethnobotanical indigenous and local knowledge on the average reported values of different human medicinal plants compared.

Results: A total of 246 human medicinal plants belonging to 197 genera and 83 botanical families were documented to treat different human ailments in the Soro District. The majority of human healthcare medicinal plant species are reported in the families Asteraceae 24 (9.76%) species, Lamiaceae 18 (7.32%) species, and Fabaceae 16 (6.50%) species. The majority of medicinal plants were herbs (42.28%) followed by shrubs (24.8%) and trees (22.76%). Leaves (44.83%) were the most common remedy parts, followed roots (15.06%); concoction (29.2% followed by decoction (20.6%). Remedies are prepared mainly (82.61%) from fresh plant part followed by dried (11.68%) plant organs. Mostly (69.04%) remedies are applied via oral route followed by dermal (19.12%). Medicinal doses were prescribed by locally used coffee cups (85.6%), mugs (83%), and tea cups (68.5%). The majority of traditional medicines were used to treat various human ailments. Among various reported ailments, dermatological 18 (18.56%), respiratory 17 (17.53%), and gastro-intestinal seven (7.23%) are the most common ailment categories. As the ethnobotanical indices of: preference ranking *Momordica foetida* was used the most curing efficacy for treating tonsillitis, *Brucea antidysenterica* for diarrhoea and abdominal pain. In the informant’s consensus factor, *Hagenia abyssinica* alone or with additives of others plants was effective to heal tapeworm. In the direct materix ranking, *Cordia africana* and *Combretum molle* were the most threatening species due to construction and charcoal production, respectively.

A total of 132 plant species in 120 genera and 61 families were reported by informants as having ethnoveterinary uses. The plants are said to be used by the local communities in various ways to treat 50 livestock health problems.

Conclusion: This ethnomedicinal study in the Soro District reported various and diverse human traditional medicinal plants (246) in 197 genera and 83 families to treat different ailments. Indigenous and local knowledge were transmitted through oral means from generation to generation. Anthropogenic pressures result in the erosion of herbal medicinal plants as well as indigenous and local knowledge. Herbal efficacy and locally accepted/claimed key efficacy species are the most potential and promising species for pharmacological testing activities.

Keywords: Human ailments, Medicinal plants, Traditional medicine knowledge, Soro District.

3. 1. Background

Ethnobotany is defined as the whole relationship of plants with local people including their reciprocal interactions, classification, management, and their enormous or extensive uses for various purposes (Sathiya and Muthuchelian, 2008). It is an endeavor in various science disciplines that applies plant-based investigations to traditional medicines for healthcare uses and potential healing efficacy methods for multiple ailments and illnesses, as well as other uses (Kefalew et al., 2015; Tadesse and Dereje, 2015; Sathiya and Muthuchelian, 2008). Plants are good source of new therapeutic products for about 85 to 90% of the human population in developing countries, including Ethiopia, which depend on plant remedies for healthcare; as well as people, form mutual relationships with nearby ecosystems (Martin, 1995).

Also it creates all the direct interrelations between people and plants and how they are used, managed, and perceived in human societies (Cotton, 1996; Balick and Cox, 2020). These associations of plants with human culture and how they were used and adapted with local knowledge. These mutualistic relationships between people and plants can exist through various practices such as social, religious, symbolic, artistic, and commercial values (Cotton, 1996;

Grenier, 1998; Cunningham, 2001; Balick and Cox, 2020). Most of the Ethiopian population depends on plant remedies to meet their primary health care needs (Sathiya and Muthuchelian, 2008; Tadesse and Dereje, 2015). Ethiopia has a diverse flora of approximately 6,027 vascular plant species, and 10% of them are endemic (Kelbessa and Demissew, 2014). The rich diversity and endemism is mainly due to diverse ecological features, made the country one of the biodiversity hotspots (Bekele and Leykun, 2001; Kelbessa and Demissew, 2014; Kidane et al., 2018), which provide important healthcare requirements for millions of people. Treatments of different human ailments rely on folk beliefs, skills and traditional knowledge that have developed through long years of practices (Taye et al., 2011).

The varied physiographic, altitudinal, climatic and edaphic conditions of Ethiopia helped the existence of various vegetation types ranging from alpine to desert plant communities that provide many benefits including economic, sociocultural and ecological (Kuma and Shibru, 2015). Many studies confirmed that forests and vegetation play an enormously important role in maintaining the productivity of the environment, sustaining ecosystem balance and they provide useful natural resources in the form of fuel, medicine, wild edible fruits, and other uses for human beings. Hence, plants are the principal basis for designing and performing natural resource utilization and management in a country (Han et al., 2011).

In several countries around the world, due to a shortage of modern medicine, traditional medical healing practices have been essential in providing healthcare services. Ethiopia has diverse heterogeneous ecological and floristic plant species, genetic diversity, and distributions, including soil, soil types, microbes, fungi, fauna, and flora, as well as crops, spices, and condiments, as well as humans (Kidane et al., 2015). Hence, over the past time, since time immemorial, there has been ingenuous knowledge in different cultures that has been transmitted down from generation to generation (Abebe and Ayehu, 1993). Application of this traditional knowledge for treatment of human ailments using various herbal medicines (Kefalew et al., 2015). Due to this, practical activities are similarly applied in Ethiopia, which has many mysterious religious texts (Kibebew, 2001; Pankhurst, 2001) and a long history of applying various traditional medicines to combat different human ailments. In Ethiopia, in addition to this, indigenous culture and the integration of modern public healthcare systems are two of the main components (Getahun, 1976). Moreover, because of these rooted cultural values, individuals can’t access modern health care services. According to the Ministry of Ethiopian Development Program of the Health Sector given the National Standard, one health post provides services for 5,000 people, one health center provides services for 25, 000 people, and one hospital provides services for 100, 000 people. Based on this distribution, shortage of allopathic health professionals in a country faces and limited in ratio that is; the ratio of one health extension worker is for 2,500 people, one nurse is for 5,000 people and one doctor is for 10, 000 people (Wamai, 2004). Therefore, for achieving healthcare services, conventional medicine is a useful primary treatment means to address health services for all. Several sources of available literacy support the fact that more than 85% of the human populations in Ethiopia mostly depend on traditional medicine (Abbink, 1995; Abebe, 2001; Fassil, 2003; Ejov and Organization, 2005; Kefalew et al., 2015). This figure tells us, the knowledge of herbal drugs and their use provide a vital contribution to human healthcare in Ethiopia. Like some other places in Ethiopia, Soro District people also have rich plant-based traditional medical practices that have been handed down from generation to generation. However, plant resources of the District has been decreasing due to natural and anthropogenic factors (SDARDO, 2020). Such loss of indigenous flora is accompanied by the loss of plant-based traditional medical knowledge (Cunningham, 2001; Wassie, 2008). Hence, studying ethnobotany (particularly ethnomedicine) will help to document and preserve medicinal plants and the associated indigenous knowledge for sustainable utilization. Ethnomedicine reveals that there is no sufficiently conducted documentation of human medicinal plant investigation in Soro District. Thus, this study of human traditional medicinal plants in the District plays a crucial role, and it helps to compile sufficient information for healthcare from indigenous and local knowledge of the people to document various human medicinal plants and add to the community's database.

3.2. Materials and methods

3.2.1. Study area

The study was carried out in Soro District, Hadiya Zone, central Ethiopia. The study area is one of the fifteen Districts in Hadiya Zone. The District is located 264 kilometers southwest of Addis Ababa, the capital of Ethiopia. Geographically, the map of the study area and the selected sites are as given in our recent publication on the wild edible plants of Soro District (Hankiso et al., 2023).

3.2.2. Sampling design

There are a total of 33 kebeles (the smallest administrative units) in Soro District. Of these, 13 kebeles, such as Burye-lenge, Gebeba-lenge, Ombe-lenge, 2nd Oda, 2nd Hankota, Share, Sundusa, Bure, Wosheba, Banbo, Beinara, Shonkola, and Kosha, were purposefully selected from three agroclimatic zones.

A purposive sampling method was used for the selection of study sites, and sampling was made based on the availability of knowledgeable traditional healers identified with the help of the information from the focus group discussion (FGD) in the District with kebele administrators, and local elders. Specific localities in each sampled kebeles were identified based on the information taken from study area within three agroclimatic zones [from 8 (24.2%) kola, 12 (36.4%) woinadega, and 13 (39.4%) dega], including potential vegetation sites, potential homegardens, agricultural lands, grasslands, wood lands, grazing lands, cultivated lands, and conservation areas of native plants. The selection was done based on purposive selection criteria, which is the best sampling design to capture representative human medicinal plants with associated local and indigenous knowledge in the area. However, each type of habitat mentioned bove is not evenly distributed in each kebele.

3.2.3. Informant selection

General informants were sampled using systematic random selection approaches, and key informants (with at least 7 key informants per kebeles) were selected using purposive approaches (Martin, 1995; Alexiades, 1996). Both informant informants were chosen to select those whose ages ranged from 20 to 90 years old among those who lived, were born, or lived in the study area for a long time. A total of 387 informants were used from 13 representative kebeles (variable numbers of informants per kebele). Local and knowledgeable key informants (traditional healers) were selected based on the information that was taken from a FGD in the center of the District, local people, local elders, kebeles administrators, community leaders, and religious leaders at each study site. Whereas local informants were sampled using a systematic random sampling technique from total households. The number of total households (11, 908) was obtained from Soro District Finance, Planning, and Economic Development Office (SDFPEDO, 2020). A total number of individual households was multiplied by the sample size, then divided by total households, with a result of 45. For instance, the informant size of Shonkola kebele, with a total household number of 1380, was $\frac{1380}{11908} * 387 = 45$). Hence, a similar calculation formula was used for all the remaining twelve (12) selected study administrative kebeles and a different number of informants, following the standard procedure of (Kotrlik and Higgins, 2001).

3.2.4. Ethnobotanical data collection

Data on human ethnomedicinal plants were collected from different habitats of the District, from community localities of homegardens, farming and agricultural lands, crop fields, temporary and permanent river areas, grazing and grasslands, and forest patches of the representative administrative kebeles. Permission for data collection was obtained from the District administration and administrative kebele offices to conduct the study by showing formal written official letters that were written from Department of Plant Biology and Biodiversity Management, AAU; Ethiopian Public Health Institute, EPHI. Agreement consents were obtained from the District offices. Oral consent was obtained from participants after the objective of the study was presented in the local language and respondents were involved in the data collection and information sharing. Different materials were used for data collection mainly alcohol, smart mobile to capture important photos, GPS, plant presses, and others. Medicinal plants were collected and undertaken at four-time intervals, including a reconnaissance survey from September 2021 to May 2022. Ethnobotanical data collection was employed, starting with participant observations, focus group discussions, semi-structured interviews using ethnobotanical checklists, market surveys, and finally scoring and ranking the data. In the study, individual informants were visited three times in order to validate the reliability of the ethnomedicinal information, and it was done with planned appointments. As a result, the uncertain responses of individuals who did not agree with each informant were discarded from the analysis.

3.2.5. Specimen identification

Voucher specimens of medicinal plants that were reliably reported three or more times when informants were visiting, excluding certain cultivated common plants (*i.e*., cereal crops and cultivated fruit plants) and others that were identified in the field. Preliminary identification of these common and well-known plant species was made in the field by the investigator. All collected specimens were brought to the National Herbarium, Ethiopia. The specimens, which are difficult to identify in the field, were pressed and taken to the National Herbarium (ETH/Ethiopia) at Addis Ababa University, where they were deep frozen for three days, then dried, and herbarium specimens were prepared as per standard herbarium techniques (Bridson and Forman, 1998). Hence identification was performed using the keys of published volumes (volumes I–VIII) of the Flora of Ethiopia and Eritrea and secondly supported by comparing with already authentic specimens that were deposited in the national Herbarium of Ethiopia (ETH/Ethiopia), Addis Ababa University. Finally, properly dried, numbered, pressed, identified, and confirmed all collected specimens with the help of taxonomic experts in AAU were deposited in the AAU herbarium for further references. All specimens were checked at https://powo.science.kew.org/.

3.2.6. Market survey

Rich sources of ethnomedicinal data from sampled local markets were observed and collected from four (4) towns, such as Gimbichu, Jajura, Kosha, and Humaro towns. Both Gimbichu and Jajura towns are the main markets that most people used in the District. Ethnomedicinal information was collected by interviewing different people who sell or buy plant species, products, or other resources. Market surveys were conducted at different times between March 25, 2020, April 22, 2021, and June 21, 2020; between August 17, 2021, and September 29, 2021. Direct observations, guider and other participants' observations, interviews, and surveys of traders and consumers/buyers were used to obtain socio-economic data and ecological and cultural aspects of plant resources in the study area, which were explained as follows (Cotton, 1996) and (Martin, 1995). The price, local measurement unit, and availability of each marketable ethnobotanical plant were documented and analyzed so as to identify the extent of use and income-producing potential of the respective ethnomedicinal plants.

Also, among the sampled market surveys, the two major and largest market towns (Gimbichu and Jajura) were used for people who came from nearby other Districts. And they give a clear representation of the District food crops, plant products, and multipurpose plant materials that are marketable in the area in addition of marketable human medicinal plants.

Market survey of voucher specimens were collected with the use of local field assistants, with some general and key informants' interviews and interested participants of some traditional healers. Specimen identification process was followed above explained procedure.

3.2.7. Focus group discussions

A focus group discussion in the District administrative town of Gimbichu consisting of male and female participants with various key stakeholders from Soro District administrative offices of human health, culture and tourism, agriculture, education, environmental protection, forest and climate change, biodiversity, public service/capacity building, children, women, and youth office. A total of 13 focus group discussions were conducted during actual data collection in each selected kebele site with the collaboration of different professionals, and semi-structured interviews of purposively selected key and randomly sampled general informants. A FGD with five to seven participants was conducted in each site of data collection using semi-structured interviews with knowledgeable kebele participants, farmers, key informants, community elders and leaders, religious leaders, inhabitants of forest patches, woodworkers, apiculturists, and potters. They reported information on the diversity of human herbal medicinal plants, their usage, threats to indigenous plant species, and methods of conservation and management. In addition, participants received information about the use of medicinal plants and were involved in the collection of specimens. Each discussion was guided by the kebele principal, an environmental protection expert, and an officer of forest and climate change, who served as local language translators for other team members during discussions. In the meetings, verbatim information was chaired and recorded by the first author (researcher). Local names of ethnoveterinary plants, habits, parts used, locations, flourishing periods, time of remedial collection, dosage, preparations using different methods, causes of health problems and feelings if they occurred when the poisonous plant parts were eaten, an antidote, and other important notes were discussed.

3.2. 8. Ethnobotanical data analysis

The information that was obtained based on field observations, guided field walks, semi-structured interviews, focus group discussions, preference ranking, direct matrix ranking, informant consensus factor (ICF), fidelity level, paired comparison (PC), and use value was used to compute, tabulate, summarise, and describe. For data analysis, both qualitative and quantitative tools were used, following the approaches of (Martin, 1995; Alexiades, 1996; Cotton, 1996; Albuquerque et al., 2014). The percentage composition was also used for summarizing some of the descriptive ethnomedicinal data obtained from the interviews on reported human medicinal plants and associated indigenous knowledge. The frequency of percentage composition was also used for summarizing some of the descriptive ethnomedicinal data obtained from the interviews on reported human medicinal plants and associated local knowledge. Microsoft Excel Spread Sheet Software Version 2016 was employed for analysing and organising ethnomedicinal data (for example, PR, DMR, ICF, FL, PC and UV). Ethnomedicinal data on ailments gathered from the District of the study area and informant interviews were categorised according to understanding local and indigenous uses of traditional medicine and ailments signs and symptoms based on the ICPC (International Classification of Primary Care) according to Staub et al. (2015)

A preference ranking was made to arrange and analyze the most preferred and popular human medicinal plants (HMPs) in the context of the local people who used them against tonsillitis and a pair of ailments such as diarrhoea and abdominal pain. They are one of the most frequently reported human ailments in the study sites; 15 and 10 key informants were used for scoring and ranking, respectively. A direct matrix ranking method was conducted to rank the top ten multipurpose ethnomedicinal plants reported commonly for various uses; 10 key informants were used. The Informant Consensus Factor (ICF) was used to find out the most commonly used curing potential plants from each group of human ailment categories that are claimed to be more common in the District following the standard approach of (Martin, 1995; Alexiades, 1996; Cotton, 1996; Heinrich et al., 1998; Heinrich, 2000; Heinrich et al., 2009). It was also used to identify the effective healing capacity of human medicinal plant species in the relative ailment categories. The ailments were grouped using the formula: $ICF = \frac{Nur - Nt}{Nur - 1}$

Thus, the number of use citations in each aliment category (Nur) minus the number of taxa or species used (Nt) is divided by the number of use citations in each aliment category minus one (Nur-1) (Heinrich et al., 1998). Moreover, another investigators (Schlage et al., 2000) has shown that this analytical approach is a good means of assessing the agreements of informants on the common ailment categories, and thus we used it to test the consensus of the people in the study area on healing the aliment categories for which the plants were claimed to be effective. The values of ICF were also calculated to identify the most effective human medicinal plants against common diseases in the study area.

The index of fidelity level (FL) is also one of the commonly used methods in ethnobotanical and ethnomedicinal research. It has been used to compare and determine the relative healing potential of each reported ethnomedicinal plant used to treat human ailments (Alexiades, 1996). The index of fidelity level (FL) is given by FL=Ip/Iu x 100, where Ip is the number of informants who independently cited the importance of a species for treating a particular disease and Iu is the total number of informants who reported the plant for any given disease. During this medicinal analysis, the reported consensus of a species for treating a particular human ailment is compared with the report of that plant species for treating any given ailment in the study District (Ankli et al., 1999).

The paired comparison method was also used to determine the relative importance of plant species; for example, eight medicinal plants were paired to compare the efficacy of a specific human aliment based on the informants' perceptions. In paired comparison, items are presented in pairs, and decisions are made by individual respondents on the relative importance of one of the items in a pair (Martin, 1995). In this case, some plants were paired with each other to be chosen by five key informants, and others were also chosen by five general informants. The total numbers of possible pairs were obtained by applying the formula: $n = \frac{n(n-1)}{2}$, where **n** is the number of ethnomedicinal important plants being compared**.**

3.2.9. Use values

Use value is important to run a quantitative assessment of the relative cultural importance of any individual plant species. It provides a valuation of species based on interview data. It makes efficient use of all available information; every interview contributes to calculation; and it works even if the data are negative or the plants under consideration are not used (recognized for any purpose).

$UV_S = \Sigma Uis/n_s$, where: UVs = Use value of species **s**; Uis: number of uses of species S according to informant i; ns: total number of informants, or participants, interviewed/consulted about use of species S. Therefore, the use value (UV) of indigenous useful plant species in the District was computed to make a quantitative assessment of the cultural importance of individual species (Phillips and Gentry, 1993).

3.2.10. Threats to endemic plant species

Endemic plant taxa in Ethiopia and the extent of their threats have been determined (Vivero et al., 2005) and (Kelbessa and Demissew, 2014), and the threats levels have been identified. This was also determined by considering the restricted range of geographical areas as a criterion to classify plant taxa as endemic taxa, which helped an investigator identify those plant taxa that should be given first priority in future conservation activities in the study area.

3.3. Results

3.3.1. Demographic information and Indigenous knowledge on informants

In the main town of the District 12 focus group informants (eight males and four females) were resulted. During FGDs in each kebele conducted with five to seven participants and 88 informants representing 13 sites of study area. In the study of human ethnomedicinal plants to treat human ailments in Soro District, 255 males and 132 females of the 387 informants were involved. Most informants belonged to the Protestant religion (313; 80.88%), followed by Adventists (30; 7.75%), Catholics and Apostles (16; 4.13% each), Orthodox (11; 2.84%), and Muslim (one; 0.26%). The most respondents occupation were farmers 285 (73.64%), housewife 89 (23%), unemployed five (1.29%), government employee four (1.03%), artesian, artecraft, and wogesha three (0.77%), retired and trader one (0.26% each).

Of these, 91 (76 males and 15 females) were key informants, and 296 (179 males and 117 females) were systematic random sampled total general informants within the ages of 20–90 years. Regarding educational status, most of them were literate 242 (176 males and 66 females) and could read and write (R & W), followed by illiterate (not R&W), 79 males and 66 females (145). They were categorized in between young ages (20–35), adult ages (36–59), and old ages $\geq$ 60 years old, which accounted for 94 (51 males and 43 females), 197 (127 males and 70 females), and 96 (77 males and 19 females), respectively (Table 3. 7).

Table 3. 7. Statistical independent t-test of significance on the average number of human ethnomedicinal plant species knowledge reports among various variables in the study area

Participants	Informants group	N	Average ± SD	F- value	p-value
Gender	Males	255	9.71±6.84	9.362	0.002
	Females	132	7.67±4.78		

Age category	Young (20–35 years old)	152	8.26±5.04	1.854	0.158**
	Adult (36–59 years old)	165	9.48±6.69		
	Elderly (≥60years old)	70	9.59 ±7.53		
Educational status	Illiterate	144	8.37±5.77	2.464	0.117**
	Literate	243	9.40±6.55		
Proximity to the main town	Less than 5 km	94	8.49±5.93	0.879	0.349**
	Greater or equal to 5 km	293	9.19±6.39		
Informants' category	Key informants	91	15.31±7.15	172.047	0.000
	General informants	296	7.08±4.48		
Agroclimatic zone	Dega	84	9.82±5.99	1.341	0.263**
	Woina dega	239	8.97±6.63		
	Kola	64	8.13±5.18		

*A significant difference ($p<0.05$) at 95% conference interval for mean between groups, ** in-significant ($p>0.05$), t (0.05, two tailed), df=N-1; 386, N=number of respondents =387.

3.3.2. Taxonomic diversity of human medicinal plants (HMPs) in Soro District

A total of 246 species of human medicinal plants were collected, identified, and categorized into 197 genera and 83 families (Appendix 3.11). Of these 170 (69.11%) native species without asterisks, 51 (20.73%) introduced plants or exotic plant species with two asterisks (**) and 25 (10.16%) endemic species with one asterisk (*) in the 15 families (18.07%). Most of the HMPs are angiosperms (flowering plant species) 242 (98.37%); of them *Oncocalyx glabratus*, *Tapinanthus* sp, *Viscum congolense*, and *Viscum tuberculatum* were hemiparasites, and a few species (*i.e., Afrocarpus gracilior*, *Hesperocyparis lusitanica*, and *Juniperus procera*) are gymnosperms (1.22 %), and one *Pteridium aquilinum* (0.41%) fern plant species. Among the dominant multipurpose families of human medicinal plants in the study area that took the highest, higher and other number of medicinal plant species are Asteraceae, with 24 (9.76%) species and 19 (9.64%) genera; Lamiaceae, with 18 (7.32%) species and 12 (6.09%) genera; and Fabaceae, with 16 (6.50%) species and 15 (7.61%) genera; Solanaceae, with 13 (5.28%) species and eight (4.06%) genera; followed by Euphorbiaceae and Poaceae, with an equal number of species 10 (4.07% each), 7 (3.55%) genera and 10 (5.08%) genera, respectively; and Other 77

(92.77%) families of 155 (63%) species and 126 (63.96%) genera were also frequently reported for indigenous healthcare systems of humans (Appendix 3.11). Of these plant species, herbs accounted for the highest medical proportion 104 (42.28%), whereas lianas accounted for the least proportion at 0.41% (Figure 3.12).

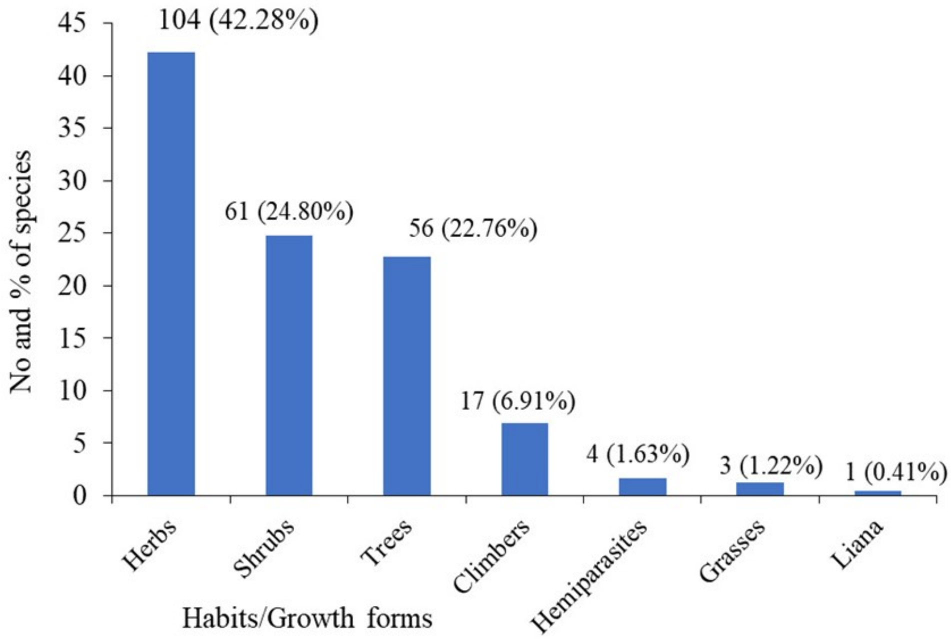

Figure 3. 12. Growth habits of medicinal plants

3.3.3. Parts of plant species used for remedy preparation

Different plant parts were reported for the preparation of traditional herbal medicine that was used for various ailments in the communities of the study area. Of these, leaves were the most dominantly used plant part, followed by roots, with the least used fruit latex for remedy preparation, including various other parts (Figure 3.13).

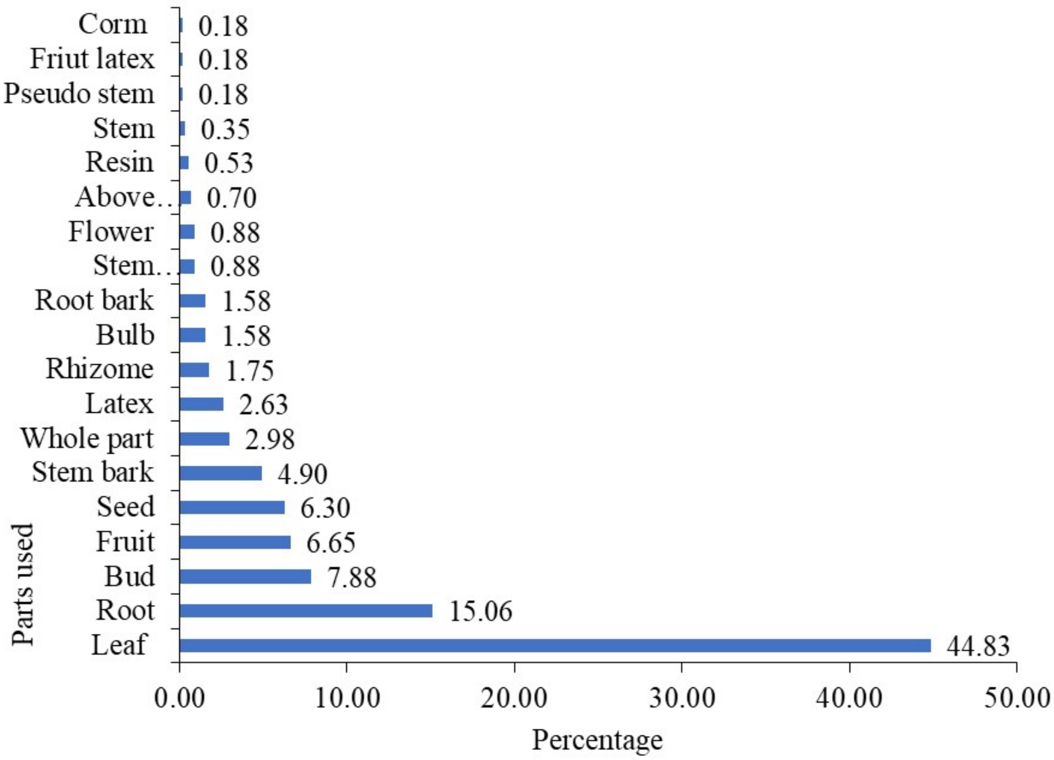

Figure 3. 13. Medicinal plant parts used to treat various human ailments in Soro District

3.3.4. Category of human ailments

Ninety-seven (97), Appendix 3.11, various human ailments were identified from different stakeholders during the first focus group discussion in Soro District at the center of Gimbichu town. Among the various reported ailments, dermatological 18 (18.56%), respiratory 17 (17.53%), and gastro-intestinal seven (7.23%) are the most common ailment categories, followed by intestinal parasitic six (6.18%), systemic five (5.15%), and digestion four (4.12%), whereas the remained respective categories are shown below (Table 3.8) and Appendix 3. 11. Most of the informants used more than two plant species to treat different human ailments in combination rather than using a single plant species.

Table 3. 8. Human ailment category and number of ailments

Disease category	Nº of aliments	% of ailments
Neurological and systemic, UTS (urinary tract system), STD (sexually transmitted disease), and circulatory.	Three	3.13 each

Sensory system or auditory system, reproduction or pregnancy problem, exocrine system, muscular system, cancer (malignant tumor, dermal cancer), and central nervous system (CNS).	Two	2.08 each
Endocrine, haem parasitic/protozoan, orbital, orthopedics, dental, dental and gum, neurological disorder, cardiovascular, musculo-skeletal/joint problem, psychiatric, gynaecological, and glandular.	One	1.04 each
Others: Malnutrition/kwashiorkor (**Wonannada**-Had.), Dingetegn/sudden illness (**Qasimmi jabbo**-Hadiyissa), Physical/external, spiritual: evil eye (**Manni ille**-Hadiyissa) and evil spirit (**Goromota**-Hadiyissa), and febrile illness (**Michi**).	Six	6.25 each
Total	40	40.6

3.3.5. Medicinal parts, additives, modes of remedy preparation, and administration routes

In the current study, interviews were made with mostly with traditional medicine practitioners to treat various human ailments. Results showed that 35.54% remedies are prepared from a single medicinal plant part or a combination of two or more plant parts mixed with some additives, whereas 64.46% are prepared without any additives. The most human medicine preparations were reported by single plant part 373 (65.78%). Moreover, another mode of human traditional medicine preparations was reported with the addition of two plant species, 82 (14.46%), and more than two plants, 112 (19.75%); that is, remedy preparations with the mixing of three different plant parts, 39 (6.88%), four plants 23 (4.06%), the addition of five plants 27 (4.76%), six plants nine (1.59%), eight plants seven (1.23%), seven, 11, and 14 plants were two (0.35% each), and a combination of 10 plants for one remedy preparation (0.18%) out of the 567 total reported in the study area. The addition of more traditional medicinal plants as well as additives was preferred to decrease medicines' side effects in addition to their increasing efficacy in curing human ailments. Of the most common medication preparation forms, concoction (29.20%) with different modes of remedy preparation was accounted for the most common form of preparation with two or more than two HMPs and with universal solvent and other additives followed by decoction (20.76%), which was prepared from a single plant species with or without more processes; chewing accounted for 15.29%; and other preparations (Figure 3.14).

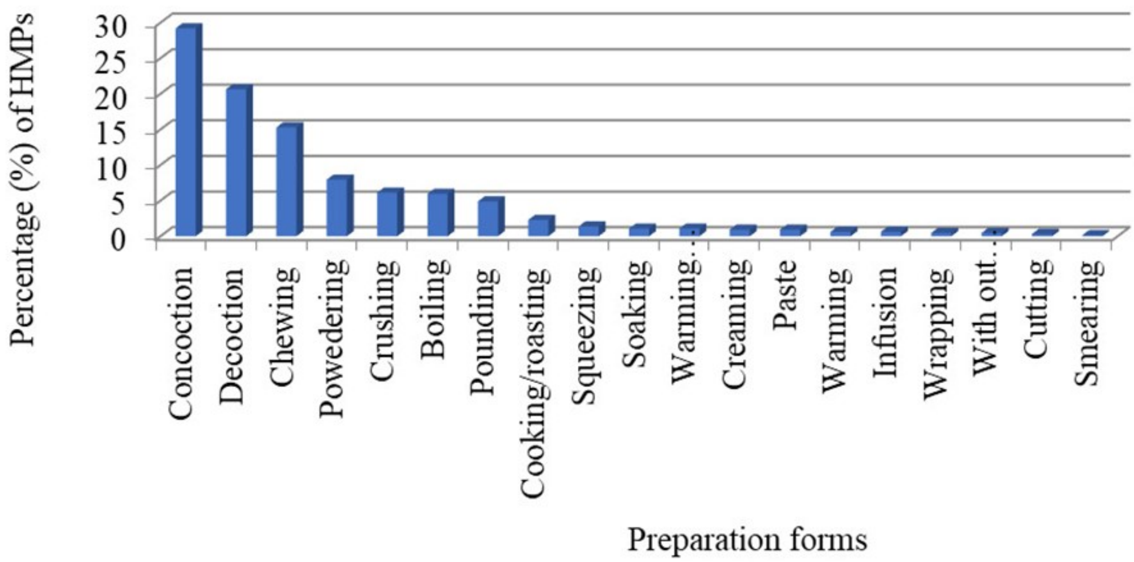

Figure 3. 14. Preparation forms of human medicinal plants

In the study District, human traditional medicines were reported with diverse application routes using various modes of remedy preparation. Hence, modes of administration, routes, and application methods differed in the different study sites with different types of ailments (Table 3.9).

Table 3.9. Administration routes of human traditional medicine

Nº.	Routes of administration	Nº. of cited HMPs for varied ailments	Percent of HMPs
1	Oral	437	69.04
2	Dermal	123	19.43
3	Dental	34	5.37
4	Nasal	26	4.11
5	Eye (optical)	Five	0.79
6	Ear (auricular)	Four	0.63

7	Reproduction organ (penis and vagina)	Two	0.32
8	Anal	Two	0.32

HMPs: human medicinal plants, **№**: number

3.3.6. Preparation conditions for human medicinal plants

Most indigenous people in the community confirmed that they commonly prefer fresh plant parts over dried conditions were used for the preparation of herbal medicine. Of the total reported HMPs, 418 (82.77%) were used in fresh form, 59 (11.68%) were used in fresh or dried form, and 28 (5.54%) were used in dried form.

3. 3.7. Medicine prescriptions and tools for the provision of doses

In the different study sites of the district, traditional drug prescriptions and their doses varied by age categories (like adult and child without sex differences), considering pregnancy. Different locally available measurement tools were used for traditional medicine doses prescription like water drinking glass or mug, can, jug, coffee cup, tea cup, spoons (small, medium, and large spoons), syringe, liter, half of a liter (for example, half of a highland and its lid (Figure 3.16 on the right side), dry fruits of *Lagenaria siceraria* drinking tool, finger sizes (like a thumb, index, middle, ring, and little fingers), fingertips, and index fingers, spoon, very small lids, syringe, small tea cup and coffee cup, and other smaller locally available 'malekes', small pots, number of plant parts, and other cooking materials were used for dose determination.

The measurements of the concoction, decoction, and other medicine preparations were provided either in minimal numbers, which cannot be given to children or pregnant women, or given in larger numbers for adults. Also, traditional healers gave human medicine using appropriate prescriptions for a specific ailment to take a specific dose at different time intervals, taken three times a day at 12 hours, six hours, and 12 hours, as well as once before or after breakfast on a particular day (mainly on locally accepted Wednesday and Friday) until cure after diagnosis by observing the physical appearances of the patient (*e.g.* eye and skin colors, palm of hand).

3.3.8. Medicinal additives and antidotes

In the study area, key and general informants reported various locally available types of medicinal additives as well as antidotes, and they were used alone or in combination with medicinal plants (Figure 3.15); and other domestic and wild animal waste products. Furthermore, wild animal waste products and their horns were used by herbal medicinal healers mineral salt locally known as **Borra**, which is given to domestic animals with grasses (Figure 3.1 6 on the left). The patient was also swept alive by an owl. In addition, powdered house soot was mixed or homogenized with medicinal plant parts, either to add effective healing ability or to decrease the causing impact of the medicinal dose. Local beverages, *basso*, *bord'e*, and *atimita*; *Ensete ventricosum* products such as **Bu'o**-Had./**Bula**-Amh. /**Waasa**-Had. /**Kocho**-Amh.; and metals (addition of one of them: axle, nail, knife, and spoon) were used to add to the prepared traditional medicine to increase the efficacy of the healing potential.

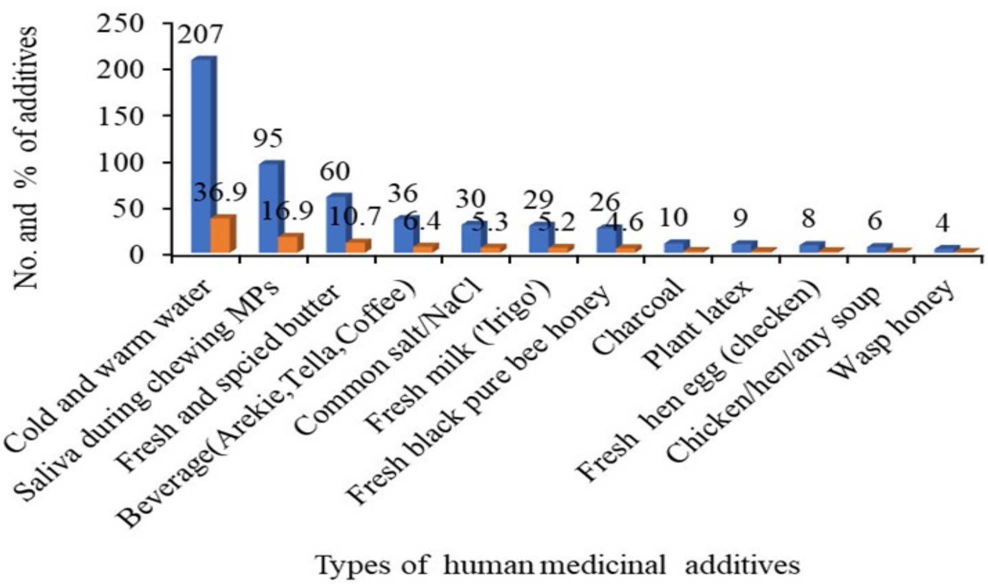

Figure 3. 15. Human medicinal additives used in the study area

MPs-medicinal plants, **NaCl**- Sodium chloride

Figure 15 included the most proportional additives; the remainders among them were **keeneto (**Hadiyissa/Had.), sugar, domestic animal red meat and liver, youghurt, **atimita** (Had.)**,** and baseline (creaming synthetic substance), which were commonly reported three (0.53% each) of 561; hyena liver and feaces, metals/axle, hen feces, cheese, tea, fresh black pure honey, **bord'e** (Had.)**,** and cattle/oxen fresh urine were reported two (0.36% each); and some others seven were also reported: **basso** (Had.)**,** eagle meat and feaces, soil and mice soil, monkey feaces, human urine, resin, and sweep with an owl alive were reported one (0.18% each).

Certain additives, in addition to their curative effects, are also used as antidotes, which are able to prevent various traditional drug problems or toxicity and neutralize the burden of bad medicine effects. These include excessive use of water, milk ('Irigo'), fresh pure butter, cheese, yoghurt, sugar, tea, porridge, *boride, basso*, and *keneto.*

Figure 3. 16. An example of a locally available plastic bottle lid and an additive

This measurement tool was used to prepare human traditional medicine, measure and determine dose in the study area using synthetic plastic bottle lid (on the right side), and 'Borra', a medicinal additive that was observed and recorded by a market survey informant in Gimbichu market (on the left side).

3.3.9. Means of human ailments treatment

Therapeutically, all the documented ethnomedicinal plants were used to treat various reported specific human ailments using different means of application (Figure 3.17). In this scientific world, many human ailments reported by most informants are not explicable; for instance, depression, michi, the evil eye, and the evil spirit. They were treated by local healers applying traditional medication using some of the specific medicinal plant species, such as *Ruta chalepensis*, *Artemisia absinthium,* and *Artemisia abyssinica*, giving and smelling, as well as polishing, to cure those above human ailments.

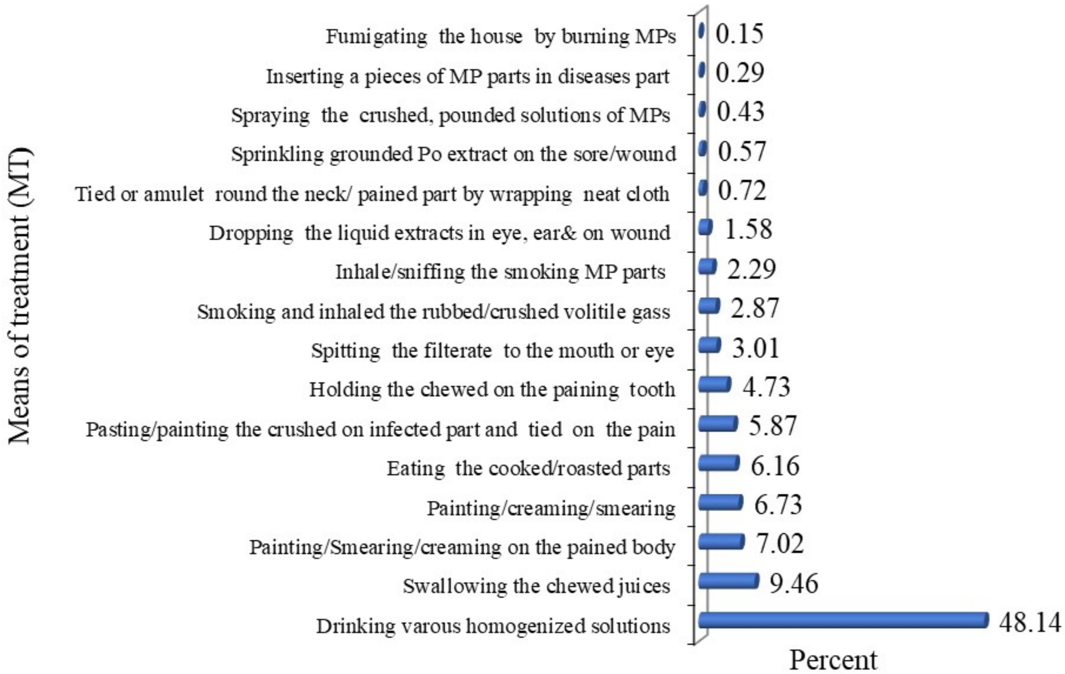

Figure 3.17. Means of treatment by applying various traditional therapeutics

3.3.10. Habitat diversity of HMP

The human medicinal plants were distributed in different habitats. Of these medicinal plants, 186 (75.61%) were collected from wild natural habitats, 59 (23.98%) were collected from cultivated croplands, and one (0.41%) was gathered from semi-wild habitats. These HMPs were also categorized in various specific localities/sources such as 48 (19.51%) of them were from forest patches, 46 (18.70%) plants were collected from communities homegardens, 33 (13.41%) plants were recorded from homegarden and market survey, 31 (12.60%) plants were from roadsides, 15 (6.10%) recorded from both homegarden and forest patch, 13 species (5.28%) from agricultural lands growing with crops, 12 (4.90%) recorded from both grazing or/and grass lands and other 48 (19.51%) different plant species were collected from various localities that contain the less dominant percent of the remainders (Figure 3.18).

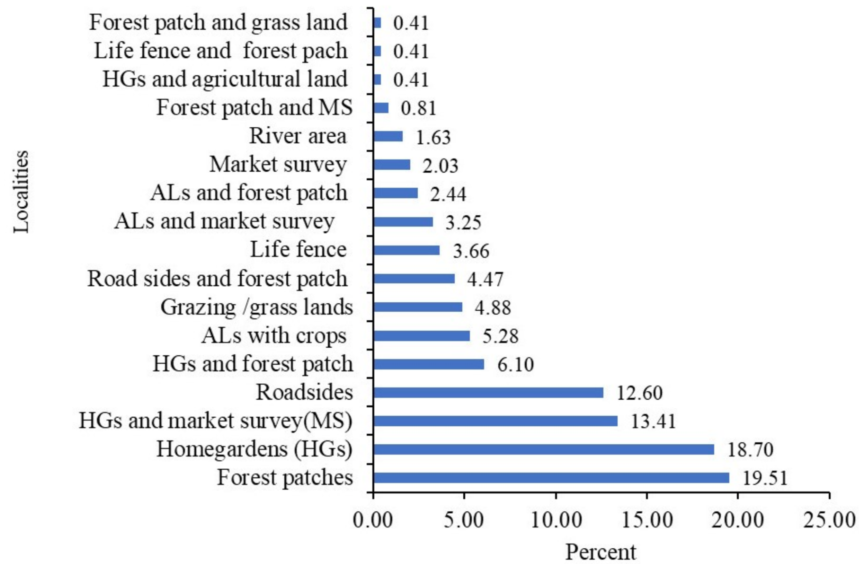

Figure 3.18. Localities of human medicinal plants

Dominant human medicinal plants that were obtained from various habitats such as forest patches, along sides of rivers, roadsides, wood or bush land, grass or grazing lands, farming lands (agricultural cropping lands), and others were also located among naturally growing plants. The diversity of multipurpose ethnomedicinal plants was reported and collected from home gardens, which included spices and condiments, tubers and roots, food plants, vegetables, stimulants, oil crops, and pulses. Some of the medicinally useful plant species were collected and photographed from aid of male and female informants and from the market survey (Figures 19A and 20B if multipurpose marketable plants). These plants in the communities were mostly grown for various uses: spices, marketing for income source, food, stimulants, life and dry fences, and ornamental values.

3.3.11. Most useful human medicinal plants (HMPs) in the study area

Human medicinal plants were ranked, scored, and compared using different ethnobotanical tools such as the informant census factor, simple preference ranking, index of fidelity level, direct matrix ranking, and paired comparison. These tools are very important to decide and judge the most effective medicinal plants in each category by verifying their efficacy with frequent citations, and they are also important to give clues for conservation. The results of preferentially ranking using fifteen randomly selected key informants on the seven most commonly cited human medicinal plants against tonsillitis (Table 3.10), a pair of ailments, diarrhoea and abdominal pain or stomachache (Table 3.11), direct matrix ranking, informant consensus factors, index of fidelity level, as well as the paired comparison and use values of the most commonly used multi-purpose human medicinal plants were used.

Table 3. 10. Results of the preference ranking exercise for seven human medicinal plant species against tonsillitis

Medicinal plants used for tonsillitis	Fifteen randomly selected key informants labeled from A to O																
Respondents	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Total score	Rank
Momordica foetida	7	5	3	4	5	3	5	4	1	4	5	7	3	5	6	67	1st
Acmella caulirhiza	1	4	7	4	6	3	4	3	3	7	3	3	6	3	6	63	2nd
Juniperus procera	4	3	7	4	3	3	4	5	3	1	5	3	4	6	7	62	3rd
Cordia africana	6	4	5	7	2	5	3	4	3	6	2	3	3	5	1	59	4th
Gymnosporia arbutifolia	5	3	6	4	3	2	5	2	4	2	3	1	6	2	3	51	5th
Artemisia absinthium	3	2	4	5	2	1	3	4	3	3	4	3	4	3	5	49	6th
Erythrina brucei	2	3	7	4	3	2	3	1	2	5	2	2	5	2	3	46	7th

Note: The ranking scores in the table were used for widely reported potential plants based on their efficacy as perceived by key informants; hence, 1=least preferred; 7 = most effective.

Table 3.11. Preference ranking of the top 10 human medicinal plants frequently reported for diarrhoea and abdominal pain

These plants for treating a pair of popular and common human ailments against diarrhoea and abdominal pain are based on the efficacy of each plant in curing a pair of ailments.

Respondents designated A-J												
HMPs used for a pair of diarrhoea and abdominal pain	A	B	C	D	E	F	G	H	I	J	Total	Rank
Brucea antidysenterica	10	8	9	8	10	9	1	9	10	9	83	1st
Vepris nobilis	8	9	1	10	9	8	9	8	9	9	80	2nd
Croton macrostachyus	9	8	9	8	7	9	8	1	9	7	79	3rd
Coleus abyssinicus	10	7	9	8	9	1	9	10	8	5	76	4th

Ruta chalepensis	9	8	5	9	1	9	8	7	10	8	74	5th
Cucumis ficifolius	6	5	7	6	5	1	4	5	9	8	72	6th
Asparagus africanus	5	9	6	7	5	4	1	7	8	7	59	7th
Microglossa pyrifolia	6	1	8	7	2	5	4	3	3	8	47	8th
Celtis africana	4	6	4	5	1	8	3	4	7	2	44	9th
Afrocarpus gracilior	1	3	5	2	3	5	7	6	8	1	41	10th

Note: Ten (10) is the highest score for the most effective for both ailments, and one is used for the least effective.

Table 3.12. Direct matrix ranking of the ten top medicinal plants used for multipurpose species, which exercise was used for conservation measures in the community

Based on use criteria in Table 3.12, five is for the best; one is for the least used value; and zero is for no used value.

HMPs used for different uses diversity	Respondents were designated (R1-R10) for various uses of each plant.										
	M	WE	Ch	Fw	TP	Hb	Ft	Con	Fo	Sha	Total	Rank
Cordia africana	3	5	4	3	5	5	3	5	2	3	38	1
Combretum molle	3	0	5	5	0	5	0	5	4	3	30	2
Afrocarpus gracilior	3	0	5	3	5	0	2	5	1	5	29	3
Prunus africana	4	0	4	3	4	3	4	3	1	2	28	4
Hagenia abyssinica	1	0	3	3	5	3	3	4	1	4	27	5
Juniperus procera	3	0	1	5	2	4	5	3	0	3	26	6
Ehretia cymosa	3	0	3	3	5	0	4	5	0	1	24	7
Apodytes dimidiata	5	0	2	3	4	3	1	3	0	2	23	8
Landolphia buchananii	2	5	0	1	0	4	0	4	4	2	22	9
Commiphora kua	3	0	5	2	0	0	2	5	2	3	21	10
Total	30	10	32	31	29	27	24	42	15	28		
Rank	4	10	2	3	5	7	8	1	9	6		

Table 3.13. Results of the informant's consensus factor (ICF) for more common and prevalent ailments that affect human health in the study area

Prevalent human ailments category	List of used plant species and number of citations	No. of total species in each ailment category (Nt)	No. of total use citations (Nur)	ICF
Taeniasis (*Taenia saginata*)	*Hagenia abyssinica* alone (35) or with stem bark of *Croton macrostachyus (*from sunrise*),* and with the leaf of *Dodonaea viscosa* subsp. *angustifolia*	1	35	1.00
Michi; Clitoris/vaginal infection (**Micha**/**Cabala-**Hadiyissa)	*Ocimum lamiifolium* (132) with *Clausena anisata*, *Dicliptera laxata*, *Rubia cordifolia* and *Microglossa pyrifolia, Foeniculum vulgare* (6), and *Lepidium sativum* (23)	3	161	0.99
Ascariasis	*Zanthoxylum asiaticum* (2), *Olea europaea* subsp. *cuspidata* (7) with *Croton macrostachyus* and *Ruta chalepensis, Coleus cylindraceus* (6), *Platostoma africanum* (4), *Coleus abyssinicus* (80), and *Solanum nigrum* (12)	8	111	0.94

Myalgia (cold)	*Ajuga integrifolia* alone (30*)* and with *Ruta chalepensis*, and *Nigella sativa* (60), *Asparagus africanus* (8) with *Rubia cordifolia, Allium sativum* and *Nigella sativa, Rosmarinus officinalis* (14),*Clausena anisata* (5),*Hesperocyparis lusitanica* (11), *Discopodium penninervium* (3), Euclea divinorum (1), *Ocimum lamiifolium* (1), *Coleus hadiensis* (3), *Coleus abyssinicus* (1) with *Dicliptera laxata, Clausena anisata, Croton macrostachyus* and *Gymnanthemum amygdalinum* and *Ruta chalepensis* (30) with *Ajuga integrifolia* with powdered of *Brassica oleracea* var. *oleracea* and *Nigella sativa,* fresh black pure honey, *Zingiber officinal, Thymus schimperi, Cymbopogon citratus* and fresh pod of *Capsicum frutescens.*	12	167	0.93
Typhoid fever	*Allium sativum* with *Allium cepa*, *Citrus × aurantiifolia*, *Citrus × aurantium, Zingiber officinale* and *Capsicum frutescens* (36), *Coleus abyssinicus* (32), *Mangifera indica (*10*)*, *Foeniculum vulgare* (5), *Ruta chalepensis* (3)*, Aloe gilbertii* (2)	7	88	0.93
Malaria	*Carica papaya* (16), *Croton macrostachyus* (8), *Justicia1 chimperiana* (16*), Ajuga integrifolia* (5), *Coleus abyssinicus* (7)*, Hagenia abyssinica* (2), *Ruta chalepensis* (3), *Eucalyptus globulus* (1), *Clausena anisata* (1), *Coleus abyssinicus* (2)*, Solanum nigrum* (3*), Allium sativum* (15)*, Momordica foetida* (1), *Brassica oleracea var. oleracea* (13), *Gymnanthemum amygdalinum* (4*), Solanum indicum* (1), *Cucumis ficifolius* (1), *Nigella sativa* (2), *Capsicum frutescens* (1), *Zingiber officinal* (1*), Habenaria decumbens* (1), *Allium cepa* (1), *Trigonella foenum- graecum* (1).	23	104	0.79

Diarrhoea	*Securidaca longepedunculata* (8), *Coleus abyssinicus* (6), *Sida schimperiana* (2), *Landolphia buchananii* (3), *Cucumis ficifolius* (4), *Dodonaea viscosa* subsp. *angustifolia* (5), *Microglossa pyrifolia* (3), *Mikaniopsis clematoides* (2), *Platostoma africanum* (2), *Coleus cylindraceus* (2), *Afrocarpus gracilior* (7). *Ensete ventricosum* (13), *Foeniculum vulgare* (5), *Clausena anisata (*2)	14	64	0.79
Eczema/atopic dermatitis (**Jenje'na**-Had.)	*Acmella caulirhiza* (2), *Agarista salicifolia* (1), *Olinia rochetiana* (4), *Bersama abyssinica* (1), *Crotalaria cleomifolia* (2), *Cucumis ficifolius* (2), *Ipomoea tenuirostris* (5), *Dodonaea viscosa subsp. angustifolia* (2), *Erythrina brucei* (1), *Sida schimperiana (*18*),* *Momordica foetida* (15), *Phytolacca dodecandra* (1), *Pteridium aquilinum* (1), *Triticum aestivum* with *Eucalyptus globulus* and *Croton macrostachyus* (1), *Gymnanthemum auriculiferum* with *Croton macrostachyus*, *Commelina benghalensis, Coleus abyssinicus, Solanum indicum* and *Solanum marginatum* (9), *Plantago lanceolata* (5).	16	70	0.78

Among the eight illness categories, values of ICF greater than 0.76 were noted to be the most common and prevalent problems of human health in Soro District (Table 3.13). The highest plant use citation was recorded for the ailment categorized as intestinal parasitic (*Taenia saginata*/Tapeworm followed by ascariasis, gynecological disorder (problems of reproduction system category such as michi locally said to be **'Cabala'**), muscular (Cold/Muscle pain), gastro-intestinal parasitic (Typhoid fever), haem parasitic (Malaria), and dermatological ailments (*e.g.* Eczema) categories.

Fidelity level is an important means to see for which ailment a particular species has more curing potential, and those species with a high-fidelity level (FL> 54.55%) are assumed to have more healing ability (Table 3.14) for the respective twelve (12) diseases based on the context of the local people's human ailments. Hence, also those traditionally used HMPs with more fidelity or preference ranking can be used for future pharmacological tests.

Table 3.14. Values of fidelity level for some human traditional medicinal plants for different disease categories in Soro District

No	Medicinal plant	Ailments to be cured	Iu	Ip	Ip/IuX100 %
1.	*Afrocarpus gracilior*	Rabies	7	7	100
2.	*Rosmarinus officinalis*	Hypertension	9	9	100
3.	*Coleus abyssinicus*	Diarrhoea	31	31	100
4.	*Ruta chalepensis*	Abdominal pain	45	45	100
5.	*Olinia rochetiana*	Tooth pain	35	35	100
6.	*Moringa stenopetala*	Diabetes mellitus	8	8	100
7.	*Spiniluma oxyacantha*	TB and pneumonia	11	9	81.82
8.	*Solanecio gigas*	Pyelonephritis	10	8	80
9.	*Thymus schimperi*	COPD	18	14	77.78
10.	*Sida schimperiana*	Worm stinging	12	9	75
11.	*Ocimum gratissimum*	Bat urine disease	6	9	66.67
12.	*Croton macrostachyus*	Liver cirrhosis	11	6	54.55

Table 3.15. Paired comparison of eight human medicinal plants from market survey

	Mixed five key and five general informants, R1-R10								Frequency	Rank
Human medicinal species (HMPs)	Sl	Ls	St	Ha	Ap	Ab	Aa	Lu		
Securidaca longepedunculata (*Sl*)	-	*Ls*	*Sl*	*Sl*	*Sl*	*Sl*	*Sl*	*Aa*	5x	3^{rd}
Lepidium sativum (*Ls*)		-	*Ls*	*Ha*	*Ls*	*Ha*	*Ls*	*Aa*	4x	4^{th}
Solanum tuberosum (*St*)			-	*Ha*	*Ap*	*St*	*St*	*Aa*	2x	6^{th}
Hagenia abyssinica (*Ha*)				-	*Ha*	*Ha*	*Ha*	*Aa*	6x	2^{nd}
Antherica sp *(Asp)*					-	*Ap*	*Ap*	*Aa*	3x	5^{th}
Artemisia abyssinica (*Ab*)						-	*Ab*	*Aa*	1x	7^{th}
Asparagus africanus (*Aa*)							-	*Aa*	7x	1^{st}
Linum usitatissimum (*Lu*)								-	0x	8^{th}

Among these ranks of human medicinal plants using the rank of paired comparison, healing efficacy one to four is the most prominent indication on the most dominantly marketed plant in the local markets, following other selling plants. The ranks one to three are preferably human medicinal plants to treat various ailments in the study area.

A total of 246 human ethnomedicinal plant species have different use values in addition to their remedial uses for various ailments. Among them, the relatively highest ethnomedicinal use values (UV-ethnomed) are illustrated (Table 3.16). Of these, some selected twelve plant species with 12 genera and 10 families with the highest human medicinal use values (UV-hmed) were accounted for: *Croton macrostachyus* (9.7), *Eucalyptus globulus* (9.6), *Ruta chalepensis* (9.5), and *Clausena anisata* (8.9), and following others.

Table 3.16. Use values of some the human traditional medicinal plants

Family	Botanical name	No. of ailments treated	No. of informants citing the species	No. of total citations for different ailments frequently reported	Remedial use value (Uv)
Euphorbiaceae	*Croton macrostachyus*	45	209	2024	9.7
Myrtaceae	*Eucalyptus globulus*	30	198	1898	9.6
Rutaceae	*Ruta chalepensis*	24	177	1685	9.5
Rutaceae	*Clausena anisata*	23	173	1549	8.9
Lamiaceae	*Ajuga integrifolia*	19	164	1444	8.8
Asparagaceae	*Asparagus africanus*	16	154	1345	8.7
Boraginaceae	*Cordia africana*	14	141	1214	8.6
Asteraceae	*Gymnanthemum amygdalinum*	12	125	1058	8.5
Rutaceae	*Vepris nobilis*	12	113	897	7.9
Rosaceae	*Hagenia abyssinica*	9	104	789	7.6
Podocarpaceae	*Afrocarpus gracilior*	9	677	98	6.9
Oliniaceae	*Olinia rochetiana*	8	596	89	6.7

UV-ethnomed = **UV**-use value, **ethnomed** = ethnomedicine

3. 3.12. Market survey of medicinal plants

In this research, a total of 66 species were identified and categorised into 56 genera and 28 families; of these, 48 (72.73%) introduced plant species (asterisks **), 12 (18.18%) native species (no asterisk), and 6 (9.09%) endemic species with an asterisk (*) (Appendix 3.12). Among them, the dominant multi-functional ethnomedicinal families were Fabaceae and Poaceae, with an equal number of species and genera accounting for seven with 10.61% of species and 12.50% genera; Solanaceae, with five (7.58%) species and four (7.14%) genera, followed by Asteraceae, Brassicaceae, Lamiaceae, and Rutaceae which accounted for an equal number of species four (6.06% each) but varied numbers of genera of three, one, four , and two (5.36%, 1.79%, 7.14% , and 3.75%) , respectively. The other 21 families have 31 (46.96%) species, and 27 (49.09%) genera were frequently reported from the market for traditional medicinal use by the local people.

In the habits of the market survey plant species, herbs accounted for the highest proportion at 43 (65.15%), shrubs at 12 (18.18%), trees and grasses were recorded with equal numbers and proportions at five (7.58%) each, whereas climbers accounted for the least proportion at one (1.52%). Different reported ethnomedicinal plants were sold in the market for various other uses rather than ethnomedicinal uses for preparation of local drinks *(i.e*., arekie, tej, ale, or locally said 'tella' or 'qaribo'-Had.), *Ocimum basilicum, and Ocimum basilicum* var. *cinnamon* and *Lippia adoensis* var. *koseret* to be used as spice and condiment in the preparation of milk, butter, cheese, and yoghurt to give better organoleptic taste and flavor; *Cyperus rotundus*, and *Olea europaea* subsp. *cuspidata* were used for fumigation of houses for a better smell and against houseflies; and utensils (*e.g.* pot) produce better flavor of milk and milk products; ale, local **'bord'e**'. Their burning also gave a better smell and a good feeling to the house, and their smoke fought house flies. *Rhamnus prinoides* and *Saccharum officinarum* were used in the preparation of tej, and *Ruta chalepensis* was commonly used in the local drinking of coffee and tea as an additive. *Cyperus rotundus* and *Artemisia absinthium* were used for childbirth to create better perfumes in the house. The other ethnobotanical market survey plants were also discussed (Appendix 3.12).

Most market surveys reported that human medicinal plants were mainly spices, condiments, or food additives. Seventeen (17 plant species) plant species (25.76%) were spices and condiments (food additives), 14 (21.21%) plant species were fruits, eight (12.12%) plant species were vegetables, six plant species were pulses (9.09%), and others were sold as the sources of cereal food crops, contributing five (7.58%), stimulants with three (4.55%) plant species, and other oil crops, both medicinal and ritual (*e.g. Artemisia absinthium* and *Artemisia abyssinica),* and only medicinal use plants contributed two (3.03%) plant species each. Whereas both medicinal and vegetable (food), corm/Pseudostem, and sugar plant species were reported with one plant species each (1.52%).

Dominant medicinal plants were sold in the markets as spices; very few plants were sold only for medicinal use; also, both medicine and spices. Some medicinal plant species *Antherica* sp. (**Dashshi maracca**-Hadiyissa/Had.), *Securidaca longepedunculata* (**Mukke'e**-Had.), *Asparagus africanus* (**Hundufaanna**-Had.), *Lepidium sativum (***Suunfa/shuunfa**-Had.), *Ajuga integrifolia (***Annaamura**-Had*.),* and *Hagenia abyssinica* (**Suuxo-**Had.) were recorded from the four agroclimatic open markets (Figure 3.19A and 3.20B).

Figure 3.19A. Mukke'e-Hadiyissa (*Securidaca longepedunculata*)

Its light red color root bark) and **Dashshi maracca**-Hadiyissa (*Antherica* sp/black color rhizome both sell on the Gimbichu town open market for various medicinal values on the right and left sides in Figure 3.19A).

Figure 3. 20B. Hundufaanna (Hadiyissa)

3.3.13. Marketability and market values of medicinal plants (MPs)

The results of the marketability of human medicinal plants and their products in the selected local markets were sold and bought as the source of spices and condiments, food and food additives, fruits, sugar, stimulants, and beverages. Before decades of the study area, some medicinal plants about 16.67% were commonly sold for traditional medicines in excess like *Amaranthus caudatus* (**Haliba**-Hadiyissa/Had.), *Ajuga integrifolia* (**Annaamura**-Had.), *Asparagus africanus* (**Hundufaanna**-Had.), *Echinops kebericho* (**Toosa**-Had.), *Hagenia abyssinica* (**Suuxo**-Had.), *Lepidium sativum* (**Suunfa**/**Shuunfa**-Had.), *Artemisia absinthium* (**Naatira**-Had.), *Artemisia abyssinica* (**Aguffa**-Had.), *Coleus cylindraceus* (**Dubbi hancuura**-Had.), *Nicotiana tabacum* (**Tambaa'i koshsho'o**) and *Securidaca longepedunculata* (**Mukke'e**-Had.) were sold and purchased for the functions of traditional medicine. However, due to various impact factors, nowadays, as reported in this research, a small percentage (about 13.64%) of human medicinal plants were affordable on the market during the market survey. These plants, *Amaranthus caudatus*, *Ajuga integrifolia*, *Asparagus africanus*, *Artemisia absinthium*, *Artemisia abyssinica*, *Lepidium sativum*, *Coleus cylindraceus*, *Nicotiana tabacum*, and *Securidaca longepedunculata*, were marketable on the open local markets. However, these indicate that most human medicinal plants have no reported marketability for medicinal use, and they were not obtained on the four main sampled markets. This indicated that most people used a large percentage of medicinal plants in their homes from their communities and rich homegarden (Figure 3.21) rather than buying them from the market.

Figure 3. 21. Homegarden medicinal plants are collected, and local people use them from their surroundings in the District

Figure 3. 22. Market survey results of medicinal plants in Soro District Gimbichu market

Marketable medicinal plants were measured using fingertips/pinch, feast (**ciibix**-Had.), small, medium, and large spoons, bottle lids, tea and coffee cups, mugs (can, water glass, jug), liquid drops, and numbers of plant buds and leaves, and they were also sold for one to 100 Ethiopian Birr. For example, the price of a coffee or tea cup of *Amaranthus caudatus* seeds and seeds of

Lepidium sativum was five to ten EthBirr. Thus, those numbers of HMP species in the community were potential demands for money generation.

During the market survey of the sampled available markets, various useful marketable ethnobotanical plants were recorded. They were sold for various other uses of plants: food, construction and utensils (*e.g.* timber, stool, pestle, mortar, tables, chairs), fuels (firewood and local charcoal), agricultural tools (for farming, digging, cutting, and chopping tools recipients), beehives, walking sticks, and other uses (Figure 3.23), which led to the threat of multipurpose medicinal plants due to these unwise uses of various human influences.

Figure 3. 23. Other used of ethnobotanical plants

Many human traditional medicinal plants are reported for different uses in the study area discussed by 15 key informants. These each multifunctional and the most useful plant species were explained.

Table 3.17. The most cited ethnomedicinal plants for various other uses discussed by key informants

Types of multi-purpose uses	Ethnobotanical plants	Nº. of uses
Beehives, honey, construction, environmental uses, fire wood, hold beive, materials, mortar, stool, seat, utensils, wild edble, door, window, and shade.	*Cordia africana*	15

Beehives, construction, cultural value, environmental uses, fuels, medicine, ritual, seat, door, window, roof, timber, utensils, and shade.	*Afrocarpus gracilior*	14
Beeives, honey, construction, environmental uses, farming tools fence, fodder, fire, charcoal, fumigation, medicine, toothbrush, etc	*Olea europaea* subsp. *cuspidata*	12
Beehives, honey, construction, environmental uses, farming tools, fodder, fire, medicine, toothbrush, and utensils.	*Clausena anisata*	11
Beehives, honey, construction, environmental uses, farming tools, fuels, demarcation, medicine, timber, seat, and utensils.	*Croton macrostachyus*	11
Beehoney, construction, environmental uses, farming tools, fodder, fire, medicine, toothbrush, and utensils	*Dodonaea viscosa* subsp. *angustifolia*	10
Beehives, honey, construction, environmental uses, farming tools, fodder, fire, medicine, toothbrush, utensils, and shade.	*Olinia rochetiana*	10
Beehive, honey, construction, environmental uses, farming tools, fuels, medicine, utensils, and shade.	*Prunus africana*	10
Beehives, honey, construction, environmental uses, farming tools, fence, demarcation, medicine, fire, and utensils.	*Calpurnia aurea*	9
Beehives, honey, construction, environmental uses, farming tool, fire wood, fence, demarcation, and medicine.	*Erythrina brucei*	9
Beehoney, construction, environmental uses, fodder, fire, medicine, toothbrush, utensils, standing bed of equines and WEP.	*Phoenix reclinata*	9
Beehoney, construction, environmental uses, farming tools, fodder, fire, medicine, utensils, and shade.	*Vepris nobilis*	9
Construction, enivironmental uses, fuels, hive, medicine, shade, wild edible, and fodder.	*Balanites aegyptiaca*	8

Beehive, honey, construction, environmental uses, farming tools, fuels, utensils, trap, and shade.	*Combretum molle*	8
Construction, environmental uses, fence, fire, medicine, utensils, soil fertility, and shade.	*Juniperus procera*	8
Beehoney, construction, timber production, enivironmental uses, fuels, hive hold, medicine, and shade.	*Apodytes dimidiata*	7
Beehives, honey, construction, farming tools, fuels, medicine, and utensils.	*Eucalyptus globulus*	7
Beehive, honey, construction, environmental uses, fire, medicine, and utensils.	*Millettia ferruginea*	7
Beehoney, construction, environmental uses, fodder, fuels, medicine, utensils	*Terminalia brownii*	7
Beehoney, construction, cultural walking sticks, farming tools, environmental uses, fodder, fuels, medicine, and utensils	*Ochna holstii*	7
Construction, environmental uses, fodder, fuels, medicine, utensils, and wild edible.	*Ximenia americana*	7
Beehives, construction, cultural value, seat, environmental uses, medicine, and utensils.	*Oldeania alpina*	6
Beehives, Construction, enivironmental uses, fenece, fuel woods, medicine.	*Albizia schimperiana*	6
Beehives, honey, construction, environmental uses, farming tools, fodder, fire, medicine, utensils, and toothbrush.	*Ilex mitis*	6
Beehives, honey, environmental uses, fire, medicine, and utensils.	*Maesa lanceolata*	6
Beehoney, construction, environmental uses, life fence, material uses, and medicine.	*Agave sisalana*	6

Beehoney, environmental uses, construction, medicine, toothbrush, and spices.	*Ruta chalepensis*	6
Beehoney, environmental uses, construction, medicine, toothbrush, spices.	*Rosmarinus officinalis*	6
Beehoney, environmental uses, pestle, cultural use, and fire wood,	*Bersama abyssinica*	5
Beehoney, environmental uses, cultural value, fire wood, demarcation.	*Brucea antidysenterica*	5
Environmental uses, honey, life fence, ornamental, soil fertility.	*Brugmansia suaveolens*	5
Construction, bee honey, environmental uses, fire wood, utensils, and toothbrush.	*Trichocladus ellipticus*	5
Beehoney, environmental uses, medicine, toothbrush, and fodder.	*Ocimum lamiifolium*	5
Beehoney, environmental uses, construction, medicine, toothbrush, and fodder.	*Premna schimperi*	5
Beehoney, environmental uses, medicine, toothbrush, and fodder.	*Rotheca myricoides*	5
Beehoney, environmental uses, construction, medicine, wild edible, cultural walking sticks, toothbrush.	*Rytigynia neglecta*	5
Beehoney, environmental uses, construction, medicine, toothbrush.	*Lippia adoensis* var. *adoensis*	5
Beehoney, environmental uses, medicine, toothbrush, and fodder	*Sida schimperiana*	5

3.3.14. The most potential plant species to treat different human ailments

In the study area, traditional healers diagnose various human ailments. For them, some of the ethnomedicinal plant species were potentially efficacy species to treat different specific human ailments in the study area in combination with one or more plant species, alone with additives, or without additives. These key potential efficacy and novel species were *Afrocarpus gracilior*, which was used to treat diarrhoea and rabies, *Ageratum houstonianum*, a novel species to treat diarrhoea, *Allium sativum* to treat typhoid fever and yellow fever; *Aloe gilbertii* to treat ascariasis and typhoid fever; *Baccharoides adoensis* for gardiasis; *Bersama abyssinica* for rabies, pyelonephritis, tooth pain, and eczema; *Bidens pilosa* to treat malaria, and tooth pain; *Combretum molle* to treat epistaxis (nasal bleeding); *Cucumis ficifolius* for anthrax, malaria, gastritis, ascariasis, pyelonephritis, and diarrhoea; *Datura stramonium* for tooth pain, tinea capitis, and rabies; *Euphorbia abyssinica* for liver cirrhosis and swelling*; Ficus sycomorus* for nasal bleeding and pyelonephritis, bat or eagle disease/jaundice, hepatitis, and wound; *Hagenia abyssinica* for gardiasis, ascariasis, and amoebiasis; *Lagenaria siceraria* novel species to treat tuberculosis; *Lasiosiphon glaucus*, abdominal pain/ache and anthrax; *Microglossa pyrifolia* for diarrhoea, michi, evil eye/spirit, and rabies; *Mikaniopsis clematoides* for taeninsis and diarrhoea; *Rotheca myricoides* used to treat jaundice, COPD, epilepsy, and pyelonephritis; Solanecio gigas for cold, pyelonephritis, diarrhoea, scabies, boils; *Stephania abyssinica* for malaria, typhoid fever, hepatitis, dingetegna, pyelonephritis, and rabies; *Vepris nobilis* for michi, amoebiasis, hemorrhoids, and tumor; *Spiniluma oxyacantha* for mumps, common cold, headache, pneumonia, tuberculosis, and rabies; *Urtica urens* was to treat cystitis/bladder inflammation, urine irritation, kideny disease, impotence, spider stinging, snake bite, anaemia, and gonorrheae, heart disease, menstrual pain/disturbed or irregular, and hypertension; *Viscum congolense* has potential efficacy to treat tooth pain; *Viscum tuberculatum* to treat cold/myalgia and tooth pain; *Zanthoxylum asiaticum* was used to treat ascariasis, amoebiasis, rabies, taeninsis (taenia saginata), gardiasis, abdominal pain, stomach ache, common cold, headache and tooth pain; and *Withania somnifera* to treat stomach ache, dingetegna, cancer, and chest pain.

3.3.15. Threats to human medicinal plants in Soro District

Reported endemic plant species 25 (10.16%) in the study area are *Aframomum corrorima* (H), *Aloe gilbertii* (S), *Bidens pachyloma* (H), *Brassica carinata* (H), *Clematis hirsuta* (Cl), *Clematis longicauda* (Cl), *Coleus abyssinicus* (S), *Cyphostemma pannosum* (H), *Echinops kebericho* (H), *Echinops longisetus* (S), *Ensete ventricosum* (H), *Eragrostis tef* (H), *Erythrina brucei* (T), *Habenaria decumbens* (H), *Kalanchoe hypseloleuce* (H), *Kalanchoe petitiana* (H), *Lippia adoensis* var. *adoensis*(S), *Lippia adoensis* var. *koseret* (S), *Mikaniopsis clematoides* (Cl), *Millettia ferruginea* (T), *Solanecio gigas* (S), *Solanum marginatum* (S), *Thunbergia ruspolii* (H), *Thymus schimperi* (H) and *Urtica simensis* (H). Of these, some are categorized as least concern, common threatened, and local threatened species. Major threats to these and other multipurpose ethnomedicinal plants are anthropogenic activities for the sake of framing land expansion by applying deforestation and new settlement.

3.4. Discussion

3.4.1. Human medicinal plant species diversity and their occurrence

In this research, diverse (246 species) vital human traditional medicinal plant species were documented, along with their local uses for the treatment of various human ailments (97 human ailments), as shown in Appendix 11. Most indigenous and local people in the study communities prefer herbal medicine in the area due to traditional beliefs about medicinal efficacy, the level of economy, cultural acceptability, the distance of some modern health centers, and the high cost of modern healthcare medicines. These findings were similarly reported by Bekalo et al. (2009) and Lulekal et al.(2013). Of these, some HMPs were reported to be used as sources of herbal medicine in other parts of Ethiopia. For example, in Seharti Samre District and among the indigenous people of Gozamin Wereda, *Cucumis ficifolius* was herbal traditional medicine to treat cough, headache, gastritis, ear infection, asthma, and tetanus (Araya et al., 2015). *Vachellia abyssinica* in the present study was used for the treatment of tooth pain, similarly used in the Hawassa Zuria District, southern Ethiopia (Tefera and Kim, 2019). *Allium sativum* was the most frequently used plant in the present study to treat typhoid fever, yellow fever, malaria, haemorrhoid, tumor, asthma, headache, gastritis, digestion problems, bloating, cold, common cold, and michi. Of these, malaria, abdominal pain, and michi were similarly reported in the study of (Mesfin et al., 2009; Giday et al., 2010; Maryo et al., 2015; Temam, 2016; Getu, 2017; Tefera and Kim, 2019). However, in Amaro and Sheko Districts, it was used for the treatment of headache (Giday et al., 2010; Mesfin et al., 2014) and also its product for upper respiratory system ailments (Temam, 2016).

Rotheca myricoides (synonym of *Clerodendrum myricoides*) was reported in the present study to treat pneumonia, jaundice, tooth pain, COPD, headache, epilepsy, anaemia, gonorrhea, pityriasis, and pyelonephritis. Similarly by Tefera and Kim (2019) and reported the use of this plant for tooth pain in Hawassa Zuria District and Kochore District. In addition, the plant (*Moringa* *stenopetala*) reported by Asnake et al. (2016) in Boricha District can be used against malaria. *Moringa stenopetala* in the present study reported to treat malaria, hypertension, mumps, diabetes mellitus (DM), abdominal pain, and stomachache. The treatment of malaria and hypertension similarly reported by this plant species in Boricha District by Asnake et al. (2016) and used to treat diabetes mellitus (DM) (Temam, 2016) in Mirab-Badwacho District.

In the present study in Soro District, *Ricinus communis* was reported to treat carbuncles, boils-skin problem, and wound, but it was reported for treatment of constipation, coughing, and swelling (Tefera and Kim, 2019). In present study, in Soro District *Eucalyptus globulus* was the most frequently reported plant species for use of common cold, michi, dingetegn, headache, malaria, vomiting, wound, ants, hypertension, ascariasis, diarrhoea, bloat, gastritis, and conjunctivitis. Similarly, this plant species was reported to be used for headache, michi, and common cold in study (Tefera and Kim, 2019) , and it has been reported for common cold by other studies (Megersa et al., 2013; Abera, 2014; Andarge et al., 2015), and Regassa (2013) reported it to treat malaria and ascarsis in City of Hawassa. *Croton macrostachyus* was used in this recent study for the treatment of impotence, liver cirrhosis, abdominal pain, amoebiasis, taeniasis, bloat, abdominal pain, diarrhoea, malaria, asthma, typhoid fever, gardiasis, dengetagn, hemorrhoids, gastritis, and snakebite. In other studies similarly reported for gastritis (Tefera and Kim, 2019), in addition to goiter, bone fracture, and tuberculosis. Also, the plant species mentioned for treatment of snakebite (Giday, 2009; Maryo et al., 2015) and malaria (Mesfin et al., 2014; Asnake et al., 2016). *Ensete ventricosum* was used for constipation, amoebiasis, trauma (broken bones), mumps, and severe headache, as reported in the present study. Similarly, diarrhoea was reported in the study of Regassa (2013) and in the treatment of bone fractures by Giday et al.(2010). Nicotiana tabacum in the present study was used for dingetegna, stomachache, gardiasis, bloat, abdominal pain, conjunctivitis, trachoma, sore, snakebite (injection of venom). Similarly, other studies commonly reported it for treatment of stomachache, toothache, and snakebite (Yigezu et al., 2014; Temam, 2016; Tefera and Kim, 2019). *Nigella sativa* used for treatment of typhoid fever, typhus, michi, malaria, cold (myalgia), sever cough, abdominal pain, stomach ache, TB, ascariasis, cold (myalgia), tooth pain, and mumps. Similarly, this plant was reported for treatment of abdominal pain and stomachache in the studies of Regassa (2013) and Tefera and Kim (2019). *Euphorbia abyssinica* in the present study was reported to treat liver cirrhosis, swelling, and venign tumor (an external tumor on the leg), which was similarly reported for swelling by Abera (2014) Tefera and Kim (2019). In this present study, *Dodonaea viscosa* subsp. a*ngustifolia* was reported to treat diarrhoea, tapeworm, eczema, wound, burned skin, bat disease, swelling, tooth pain, malaria, placental remains, and taeniasis. Of these findings, the plant species was also reported to treat diarrhoea and wounds in the other study (Amenu, 2007; Suleman and Alemu, 2012; Regassa, 2013; Kassa et al., 2016; Tefera and Kim, 2019).

The finding of these various observed numbers of HMPs in the study District is that there are high transition trends in herbal medical knowledge from long-time, intergenerational generations to modern generations. Hence, sharing this documentation at the highest level was seen as more important by a larger number of traditional herbalists than by others (Getahun, 1976; Kassa, 2009). Like this information, Soro District is also one of the parts of Ethiopia with varied altitudinal ranges (799–2934 m.a.s.l.), including highlands; in Shewa floristic regions that belong to Cushitic language speakers (Hadiyissa) among SNNPR, there are shared cultural norms, beliefs, and rituals with traditional practices. In this study, families such as Asteraceae, Lamiaceae, Fabaceae, and Solanaceae were the leading plant families that contained a large number of human medicinal plant species, contributing about 28.99%. Also, they are the highest hierarchical families in the world and include numerous traditional herbal medicinal plants reported from other Ethiopian regions (Lulekal et al., 2013; Belayneh and Bussa, 2014). They are linked with the top 15 ranked and distributed plant families in the floral area that is contained in Soro District (Hedberg et al., 1989).

Based on the functional life forms of herbal medicines, herbs had the highest medicinal uses with respect to shrubs, trees, climbers, hemiparasites, grasses, and less commonly used liana plant species. The sequences of these growth and functional plant parts were similarly conducted in other studies in Ethiopia (Bekalo et al., 2009; Kassa, 2009; Lulekal et al., 2013; Belayneh and Bussa, 2014).These highest-frequency orders of medical herbs were representative of the highest dependency on herbal medicines, and the next sequential orders may also be an indication of vegetation types or remnant forest patches in the study area, including the partial join of the Rift Valley in the western part of Ethiopia (Friis et al., 2011) whereas herbs and shrubs are dominant and the most leading life forms, followed by climbers, hemiparasites and/or epiphytes, grasses, and liana. The study of these human medicinal plants reflected that numerous herbal plant data are gathered from wild inhabitants (about 75.61%), from cultivated crop lands (23.98%), and from varied localities like forest patches (19.51%), both homegardens and market surveys (13.41%), and roadsides (12.60%). *Antherica* sp., *Securidaca longepedunculata*, *Asparagus africanus*, *Lepidium sativum* (seed), and *Artemisia abyssinica*, and *Artemisia absinthium* were frequently sold (>50% citations) of the other herbal marketable medicinal plant species that collected from open local markets in the District. Some medicinal plants were sold in the open markets as the sources of cultivated fruits of *Carica papaya*, *Citrus × aurantiifolia*, and *Persea americana*; additive beverages (*Rhamnus prinoides*); stimulants (*Nicotiana tabacum*) and mainly as spices *(e.g. Aframomum corrorima*, *Allium sativum*, *Coriandrum sativum*, *Foeniculum vulgare*, *Lepidium sativum*, *Lippia adoensis* var. *koseret* Sebsebe, *Ruta chalepensis*, *Zingiber officinale*) and the source of food (*Eragrostis tef, Hordeum vulgare*, *Lycopersicon esculentum, Sorghum bicolor, Triticum aestivum, Vicia fava,* and *Zea may*s), Appendix 3.4. Among these, some are reported for various uses, like in other parts of (Teklay et al., 2013), and 50 similar species were reported; of these, 22 species treat 22 similar ailments in Soro District. According to Alemayehu et al. (2015a), 18 medicinal plants were similarly reported that traded in local markets for various purposes. The majority of human traditional medicinal plants exist and are collected from different habitats of wild vegetation in potential areas, which are also reported in other ethnomedicinal and ethnobotanical research that was carried out in Ethiopia elsewhere (Giday et al., 2003; Lulekal et al., 2008b; Megersa et al., 2013; Mesfin et al., 2009; Yineger and Yewhalaw, 2007). Hence, this fact indicates that mostly indigenous people depend on indigenous wild plants for various purposes. Due to this rationale, the survival of natural conventional plants is under human threat, and it invites more investigators and collaboration to conserve them in protected forest patches and in the human community for future sustainable uses.

3.4.2. Preparation of medicinal plants, forms and application routes

In the study, most of the recorded multipurpose medicinal plants were used as human medicine, and their parts are used to treat various human ailments in Soro District. This finding is in line with other studies elsewhere in Ethiopia (Giday et al., 2003; Yineger and Yewhalaw, 2007; Mesfin et al., 2009; Lulekal et al., 2008b; Megersa et al., 2019), which reported for treating different human ailments in the study sites. Also, immense knowledge has been gained by indigenous people through the preparation of human remedies. Only one with or without additives or more than two human medicinal plants have common practices in preparation of the remedy by mixing two or more plant components; in Ethiopia this similarly contributed like other inquires (Yineger and Yewhalaw, 2007; Lulekal et al., 2008b). These remedial practices, with the combination of more individual plant species, increase either curing ability or decrease overload side effects on the patients. Similarly, for treatments of human ailments, most human medicinal plants were used in only a single preparation: 373 preparations (65.78%) with or without the addition of additives. The current finding is in line with some other remedial findings reported in Ethiopia in the studies (Ragunathan and Abay, 2009; Kefalew et al., 2015); for example, most traditional medicine preparations in Ada'a district and Bahirdar Zuria are applied with single plant species (Kefalew et al., 2015). Moreover, in the current study, most preparations were also applied by two plant species (82) (14.46%) or with a greater number of remedial plant species in combination. For instance, three plant species preparations were 39 (6.88%), four plants were 23 (4.06%), five plants were 27 (4.76%), six plants were nine (1.59%), and eight plants were seven (1.23%), while seven, 11, and 14 plants had two preparations (0.35% each), and 10 plants had one (0.18% preparation). Hence, the outputs of this current study have seemed like those of other ethnobotanical and ethnomedicinal investigators (Giday et al., 2003;Yineger and Yewhalaw, 2007; Lulekal et al., 2008b; Mesfin et al., 2009; Megersa et al., 2013). Human traditional medicines by Soro indigenous ethnic people were preferentially used in fresh conditions rather than fresh or dry forms, and only in dry preparation conditions of herbal drugs using herbal plant species. The findings strongly support agreements with many other researchers (Teklehaymanot and Giday, 2007; Lulekal et al., 2008b; Mesfin et al., 2009; Belayneh et al., 2012; Mesfin et al., 2013; Teklay et al., 2013; Megersa et al., 2013; Kassa et al., 2020) in Ethiopia as well as worldwide investigators, for example (Johnson, 2006; Lewu and Afolayan, 2009; Teklehaymanot, 2009; Giday et al., 2010). These practices are strongly agreed upon with scientific facts because they are more effective for curing ailments because of the high chemical ingredients in fresh medicinal plant parts than in dry parts, in which active volatile secondary metabolites can be disappeared or degraded (Kalra, 1998). In addition, boiling fresh plant parts at optimum temperature releases important chemical potentials into boiling water, which has high disease-healing efficacy.

The ethnomedicinal study of locally reported methods of application and their use routes in the different study sites varied for different types of ailment treatment. The oral route is the most common application over dermal and dental, respectively; thus, it might tell us that most human ailments affect internal body organs more than external organs. Hence, these findings of the recent study support the agreement on various studies in different districts in Ethiopia (Teklehaymanot and Giday, 2007; Yineger and Yewhalaw, 2007; Flatie et al., 2009; Ragunathan and Abay, 2009; Lulekal et al., 2008b, 2013; Megersa et al., 2013). This study in Soro District reported that leaves with small shoots and growing buds were found to be the most familiar plant parts for medical preparations, followed by roots, buds alone, fruits, seeds and stem bark with respect to other parts. These findings (leaf and root dominantly used) agreed with the study of Alemayehu et al. (2015a) but disagreed with many other studies, like (Flatie et al., 2009; Lulekal et al., 2013; Belayneh and Bussa, 2014). Utilization of growing buds and roots is the main part of remedy preparation, which may contribute less flowering and photosynthesis as the consequence decreases medicinal fruits as well as natural potential vegetation in the District; finally eradicating forest patches from the area might be due to unwise and harsh utilization. In addition to these total functional parts, also the current findings report that more proportions of the whole medicinal part are used for remedial preparation than the above-ground medicinal part.

From the whole human medicinal part (HMP) species, *Acmella caulirhiza* was used for bat urine disease; *Ajuga integrifolia* for abdominal pain, stomach ache, and myalgia; *Corrigiola capensis* for bat urine disease; *Crotalaria spinosa* for diarrhoea, the evil eye, and pyelonephritis; *Oxalis corniculata* for treatment of bat urine disease, worm stinging, thorn infection, wound, abdominal pain, stomach ache, bloody diarrhoea, snake bite, and tooth disease; *Pelargonium* sp. for tooth disease; *Cenchrus setaceus* for nasal bleeding, abdominal pain, and stomachache; *Clinopodium simense* for diarrhoea and abdominal pain; *Solanum nigrum* for constipation, malaria, ascariasis, syphilis, abdominal pain, stomach pain, conjunctivitis, michi, TB, and heart disease; *Viscum tuberculatum* for colds and toothaches; *Plantago lanceolata* for tinea capitis, eczema, and tooth disease; *Cenchrus setaceus* for nasal bleeding, abdominal pain, and stomachache.

Moreover, the above-ground (Ag) medicinal part of *Erucastrum arabicum* is used to treat heart disease; *Crotalaria spinosa* is used for diarrhoea, evil eye, pyelonephritis, and treating snake bite; *Bidens pilosa* was reported to treat various human diseases such as malaria, cancer, constipation, michi, and tooth disease; and a concoction or powder of *Foeniculum vulgare* was used for the treatment of the common cold and heart disease, michi, stomach ache, Chronic Obstructive Pulmonary Disease (COPD), TB, pneumonia, diarrhoea, typhoid fever, and hypertension. Leaves or shoots of *Artemisia absinthium* are mostly planned to grow in the back yard inside the local ‘Gabujje', and then, by adding ash from the house, its leaves or whole parts above the ground are used as fragrant when touched or cut and as medicinal uses to treat tonsillitis, hypertension, cardio-vascular ailment, and kidney ailment.

3. 4. 3. Diagnosis, dosages, and other local prescriptions

In the District study sites, the symptoms of some common ailments are easily diagnosed and predicted by local informants, for example, abdominal pain or stomach ache, bloat, michi, coughing, evil eye, tonsillitis, pyelonephritis, and liver cirrhosis, and they are treated using traditional medicine that they prepare themselves. However, they go to herbal practitioners for dominant and chronic human ailments, as the manner of study similarly reported by (Kassa, 2009).

Ailment diagnosis by traditional herbalists in Soro District is also made as a rule of modern prescription by taking a history of a case and following physical examinations such as observing patient physical appearances, for example, skin color, eye color, and tongue. Then they gave herbal drugs based on the results of traditional investigations and their work experiences with drug prescription to treat various ailments. In the study area, medicinal doses are not measured using standardized tools, but different doses were provided by locally available measurements in the study area depending on the age groups, including perganency (*i.e*., the ages of children and adults), and based on types of disease conditions. For example, the leaf of *Ocimum lamiifolium* is cut and crushed with the fresh or dry root of *Asparagus africanus* and *Rubia cordifolia*, and one glass or mug is provided to the patient to drink the infusion of the concoction until cure to treat clitoris or vaginal infection (**micha** or **cabala**-Had.). The leaf of *Datura stramonium* and the root of *Stephania abyssinica* are drunk in one coffee cup for two weeks to treat human rabies. For myalgia (cold) and coughing, the root of *Asparagus africanus* with the leaf of *Ajuga integrifolia*, the root of Rubia cordifolia, the bulb of *Allium sativum*, the seed of *Nigella sativa* powdered and mixed with pure honey, local beverages such as ‘tella’, ‘keneto’, 'bord’e', and ‘arekie’; also, coffee, and gave one to three coffee cups for children and one mug or glass for adults in the morning before breakfast.

The root of *Crepis rueppellii* was reported to be crushed and pounded by measuring with the middle finger next to the index finger, then drunk in one coffee cup for three days and chewed and swallowed the juice to treat reproduction problems. In Ethiopia, unfitting measurement consistency was also reported elsewhere (Giday et al., 2003; Belayneh and Bussa, 2014), which is considered a serious weakness or drawback in the treatment of traditional herbals. This study revealed that sanitation of herbalist measurement tools, including containers and hands, is important to reduce drug contamination and may decrease complications when the treatments are given orally.

Herbal cures recommend not only the doses but also the duration of the remedies that have to be taken. Moreover, certain herbal medicines were recommended to be given as TRN (it is given when only the patient feels pain), BID (the prescribed dose is given two times a day), TID (the prescribed dose is given three times a day), which is equivalent to allopathic medicines, and others are prescribed for weeks or more than months. Certain local medicines may be taken in the morning before or after breakfast; some are washed and drunk early in the morning before hearing the sounds of air craft, birds, humans waking up from sleep, any conversation with human beings, and others. Locally available antidotes are given for bad side effects of traditional medicine like excess water, milk and milk products, **basso (**Hadiyissa/Had**.)**, **bord'e** (Had.), **keneto** (Had.), **tella** (Had.), and a few plant parts (Ensete products, like **bu'o (**Had.). Similar findings were reported by other studies (Mesfin et al., 2009; Belayneh et al., 2012).

3. 4.4. Some important human medicinal plants

Some of the results of human medicine recorded from key informants ranking are also prioritized for conservation and more investigations. For example, *Momordica foetida* and *Brucea antidysenterica* were reported to be the most widely used plants for treating tonsillitis and diarrhoea, respectively.

These and other preferences (Tables 3.10 and 3.11) for plants are linked with indigenous knowledge and availability for the nearby community. *A. absinthium*, *C. africana, E. brucei*, and *J. procera*, are the most prioritized important ethnomedicinal plant species, including *A.*

gracilior, C. ficifolius, C. macrostachyus, *C. abyssinicus, R. chalepensis*, and *V. nobilis*, which are also potential medicinal plant species and recommended to conserve more by establishing medicinal plant gardens or nurseries and potential vegetation areas (forest patches) as much as possible so as to conserve the declining medicinal plant wealth in the study District and they are the most commonly reported medicinal plant species to save from all sites. As for the ranking of the direct ranking matrix (Table 3.12), *C. africana* has been most important in its various utility values with respect to *C. molle, H. abyssinica, A. gracilior, and P. africana*, which is similar to the findings of Lulekal et al. (2008b). Hence, these outputs of the preference-ranking exercise indicated that they could be the most effective ethnomedicinal plant species. They have the potential to be bioactive in the local context of traditional medicine and might indicate the existence of bioactive chemical substances responsible for protecting against disease-causing foreign particles. They might also be screened more for future scientific activities, such as pharmacological tests. However, these plants were also highly exploited for the purposes of construction, firewood, and charcoal utilization more than their medicinal value, and they were also aggravating factors that severely caused species depletion in Soro District. Some authors similarly reported these highest exploitation impact factors of the multipurpose remedial plant species in Ethiopia (Yineger et al., 2007; Lulekal et al., 2013).

Informant consensus factors are important ethnomedicinal tools that are used to guide and identify more efficacious plant species and their causative agents. The highest herbal medical recorded values (1-0.78) of ICF (Table 3.13) also tell us the agreement of the informants on the use of those remedial plants reported for treatment of the most frequently reported ailments and medicinal curing capacity in the study area. Some of these were in the categories of intestinal parasitic diseases, gastro-intestinal parasites, muscular, febrile illness, dermatological, and haem parasites that were ranked from highest value to lowest (Table 3.12). These respondents highest perceived agreement was coupled with the total number of citations over the total number of species in each ailment category used for the disease categories in the District. The highest ICF values are also important for the selection of locally bioactive and highly efficacious plant species for pharmacological investigation. Similarly, according to Lulekal et al.(2013), the highest ICF values were used to identify important medicinal species in Ankober District for pharmacological activities to treat gastro-intestinal and parasitic diseases. In addition, some examples of the ICF ranks were done for the most prevalent common disease categories in Soro District. The findings disagree with the study results of (Kassa, 2009), but in this study, the parasitic ailment (malaria) category was the least prevalent among the others, whereas cold and typhoid fever were the most common and prevalent ailments. For common health disorders, some plant species in the study area were reported to have more curative or healing effects, and they were also expected to be an input for pharmacologists to test their efficacy.

The value of fidelity level is an important means to see for which disease a particular species has more healing potential, and those species with a high-fidelity level are supposed to be the best curative for the respective diseases. Thus, those traditionally used HMPs with a high-fidelity level can be a focus for future therapeutic activities to check their efficacy (Table 3.14). In the exercise of FL, the highest value (100%) was reported for *Afrocarpus gracilior*, *Rosmarinus officinalis, Coleus abyssinicus, Ruta chalepensis, Olinia rochetiana,* and *Moringa stenopetala* for treatment of respective human ailments: rabies, hypertension, diarrhoea, abdominal pain, tooth disease, and diabetes mellitus; *Spiniluma oxyacantha* (81.82%), another potential plant species to treat tuberculosis (TB) and pneumonia; and *Solanecio gigas* (80%) for pyelonephritis; from the least reported *Croton macrostachyus* (54.55%) is the most potential to against liver cirrhosis. These plant species with the highest FL could also be targeted for further phytochemical testing to demonstrate the secondary bioactive meltabilities that might have high curative potential (Heinrich et al., 1998; Lulekal et al., 2013).

3.4. 5. Threats to human medicinal plants in the study area.

Threats to some HMPs are reported by local people of the District, and some of those to be threatened are listed in the IUCN red list (Vivero et al., 2005). *Kalanchoe petitiana, Lippia adoensis*, *Millettia ferruginea*, *Solanecio gigas*, and *Thymus schimperi* are endemic and least concern (LC) category; whereas *Erythrina brucei* is highly vulnerable species in the category. The recorded other HMPs in Soro District, including *Vachellia abyssinica* (indigenous) and *Urtica simensis* (endemic) are species (Vivero et al., 2005; Hedberg et al., 2006), which are among the commonly threatened MPs in the District. *Asparagus africanus*, *Juniperus procera*, *Olea europaea* subsp. *cuspidata*, *Trichocladus ellipticus*, and *Dodonaea viscosa* subsp. *angustifolia* were reported to be locally threatened HMPs, and they need conservation priority even if they are not under IUCN red list categories.

In this present study, various ethnobotanical traditional medicinal species were reported to treat different human ailments. Some of the novel ethnomedicinal plant species were documented for future pharmacological tests for various specific ailments. These plant species were recorded from comparisons of other studies in Ethiopia, and they were novel plant species and new findings in the study area. Some of the species *A. gracilior*, *A. houstonianum*, *C. abyssinicus, B. adoensis, B. abyssinica, C. molle, C. ficifolius, D. stramonium, F. sycomorus, H. abyssinica, L. glaucus, M. pyrifolia, M. clematoides, S. gigas, S. abyssinica, Viscum spp, W. somnifera,* and *S. oxyacantha* potentially novel species to use to treat specific human ailments in the study District and they never reported in other similar investigations for some specific ailments. Thus, the pharmacological testing activities of these plants are novel findings for medicinal purposes in the future.

3. 5. Conclusion

In Soro District, investigations of human traditional ethnomedicinal plants are recorded and document comprehensive diverse ethnomedicinal plant species (246 species), and they were effective in healing various local ailments in local communities. Local people depend on numerous traditional medicinal plants and a considerable amount of ethnomedicinal plants to treat different human ailments, and they have reliable local and indigenous knowledge of the ailment's characteristics and methods of application of remedial plant species. Most of the dominantly used and harvested medicinal plant elements were leaves, followed by roots, which can cause indigenous vegetation. Of the vast documented spectrum of these human traditional medicinal plants, about 27 endemic plants were identified from the total study sites in the study area in varied habitats. Endemic and naturally occurring native plant species were highly affected by human (anthropogenic) activities for various reasons. In the vegetation patches of the study area, those highly severe species require further conservation activities associated with safeguarding. Some of dominantly reported indigenous and endemic medicinal plant species in the homegarden and market places are *Allium porrum, Amaranthus caudatus, Antherica* sp., *Artemisia absinthium, Artemisia abyssinica, Asparagus africanus, Brassica carinata, Capsicum frutescens, Carica papaya, Citrus × aurantiifolia, Colocasia esculenta, Ensete ventricosum, Lippia adoensis* var. *koseret, Ocimum basilicum var. cinnamon, Ocimum lamiifolium, Rosmarinus officinalis*, *Ruta chalepensis*, and *Thymus schimperi* frequently scored about $\geq$75% among the whole documented ethnomedicinal plant species; of these, *Antherica* sp., *Asparagus* *africanus*, and *Securidaca longepedunculata* were highly marketable plants in the open market for the purpose of traditional medicine; others were spices and condiments, and cultivated food values. The fresh leaf of *Coffea arabica* was also sold in the market as a source of vegetables for coffee soup instead of coffee seeds. These different plant benefits in the traditional healthcare system and source of income generation might be considerable for a good opportunity to support human life.

In addition, various locally processed and unprocessed medicinal plant materials were also sold in the market for the purpose of construction and utensils (*e.g.* timber, stool, pestle, mortar, tables, chairs), agricultural tools (for farming, digging, cutting, and chopping tools), beehives, and walking sticks. Thus, the result of this overall human ethnomedicinal local knowledge on traditional medicine would increase the attention of the communities to conserve and manage plants for sustainable use of the remedial plant species. Statistically, there were knowledge differences among male and female informants; among key and general informants, there were significant differences among males and key informants that quoted more herbal medical plant information on average that was associated with indigenous and local knowledge. However, ethnomedicinal knowledge between the age categories of young, adult, and elder informants hasn't shown a significant knowledge difference on average, which indicates that they have relatively sufficient knowledge for the use of herbal medicine. Also, among the differences in distance and agroclimatic zones, the usage of medicinal plants is not significantly different, even if different informants reported a varied number of medicinal plant species. This information also encourages local people to conserve more indigenous knowledge and a number of medicinal plant species through a proper management plan, including the preparation and usage of remedial doses. In addition, this information could help more for future activities of phytochemical extraction and pharmacological aspects in order to give scientific clues to the knowledge of ethnomedicine for antibacterial, anti-helminthic and others to isolate for clinical uses. Of the whole documented list, some are categorized as least concern, others are threatened, and some are local threatened species. In this study, the results of anthropogenic activities are major treats for all multipurpose ethnomedicinal plants due to numerous social activities. Therefore, conservation priority should be applied to those threatened multipurpose indigenous medicinal plants while raising awareness among local people about how to use natural resources wisely.

Also, concerning bodies, the ultimate conservation measures for the priority medicinal plant species should be taken.

CHAPTER FOUR

4. Ethnoveterinary medicinal plants and their utilization by the people of Soro District, Hadiya Zone, centeral Ethiopia

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Abstract

Ethnoveterinary studies are important to maintain the sustainability of livestock health and support people's livelihoods through the provision of food, maintaining livestock health, and other biological resources. This study was carried out in Soro District, central Ethiopia, to identify, document and analyze plant species with ethnoveterinary uses along with the associated indigenous and local knowledge. Informants were selected using purposive (key informants) and systematic random sampling (general informants) methods. Data on ethnoveterinary plants and their uses were collected through semi-structured interviews, guided field walks, 13 focus group discussions with five to seven members in each and participant observation. Informant consensus factor and fidelity level were computed to identify the most common livestock ailment categories and the best plant species with ethnoveterinary use, respectively. Preference ranking methods were used to identify the potentially effective ethnoveterinary medicinal plants for the most frequently reported livestock ailments like Lumpy Skin Disease, FMD, actinobacillosis/wooden tongue, anthrax, babesiosis, acidiosis (bloating), blackleg, New Castle Disease, and diarrhoea.

The use diversity of multipurpose plants with ethnoveterinary importance was analyzed using the analytical methods of ethnobotany including priority ranking, comparisons and important indices. The T-test statistic was used to compare knowledge differences among different social groups. A total of 132 plant species in 120 genera and 61 families were reported by informants as having ethnoveterinary uses. The plants are said to be used by the local communities in various ways to treat 50 livestock health problems. Higher number of informants (23.77%) cited *Momordica foetida* for the treatment of 16 livestock ailments. The highest informant consensus value for this species is associated with its use for treating blackleg in cattle; *Nicotiana tabacum* was cited for the treatment of 15 livestock ailments mainly recommended for the Lumpy Skin Disease/Ailment of bovines; *Croton macrostachyus* for treatment of 13 livestock ailments including wooden tongue, FMD in bovines; and *Gymnanthemum amygdalinum* for nine ailments mainly diarrhoea of all livestock types. *Achyranthes aspera* is claimed to provide the most effective treatment for *Aspiration pneumonia* (severe coughing in bovines, sheep, and goats) alone while *Croton macrostachyus*, *Ximenia americana*, *Allium sativum*, and *Juniperus procera* were indicated as potential plant species to treat Lumpy Skin Disease in bovines in the order given. The fidelity level analysis showed that *Datura stramonium*, *Dodonaea viscosa* subsp. *angustifolia*, and *Asparagus africanus* were potential medicinal plant species to treat rabies, Peste des petits ruminants (PPR), and evil eye/ evil spirit respectively. Multipurpose plant species including *Prunus africanus*, *Combretum molle*, and *Afrocarpus gracilior* have been highly threatened as indicated by direct matrix ranking mainly due to collection of fuel wood, construction materials and making household utensils, and farm implements rather than for other uses. Soro District has rich and diversified livestock herbal medicinal resources, and indigenous knowledge of remedy preparations and applications is transmitted through generation lines. This resource faces anthropogenic threats with deforestation being the leading factor. Consequently, ethnoveterinary medicinal plants continue to decline before adequate and proper scientific documentation and testing are made. There is a dire need for planning and implementation of appropriate in-situ and ex-situ conservation strategies and to strive towards ensuring the survival and sustainable utilization of such important plant resources of Soro District. This must be supported by further documentation of the associated indigenous knowledge and pharmacological testing of the key promising species including, *Balanites aegyptiaca* (novel species/NS to treat specific ailment), *Brugmansia suaveolens* (novel species/NS reported first to treat Livestock ailments/LsAs), *Euclea divinorum* (NS to treat specific ailments), *Grevillea robusta (*NS), *Hagenia abyssinica* (NS for the reported specific ailment), *Pentanema confertiflorum* (NS), *Juniperus procera (*NS), *Maesa lanceolata* (NS), *Millettia ferruginea* (NS for reported specific ailments), S*chrebera alata*/NS, *Securidaca longepedunculata*, *Spiniluma oxyacantha*/NS, *Vepris nobilis* (novel species reported first to treat LsAs), *Zanthoxylum asiaticum* /NS, and *Ximenia americana* (NS for specific ailments). This ethnoveterinary study attempted to fill part of the gaps concerning the prevalent livestock health problems and the associated indigenous and local knowledge in the area.

Keywords: Ethnoveterinary medicine, Herbal drug knowledge, Livestock ailments, Medicinal plants

4.1. Background

Ethnobotany of livestock medicinal plants is concerned with the study of the intimate association between the plants and the people and is encoded in the indigenous and local knowledge and practices that went on deepening and enhancing through human generations. This body of knowledge system needs further enhancement before the knowledgeable elderly people of the community pass away, the social fabric is transformed and the environment changes in one way or the other along with the decline of the useful plant resources. An exhaustive investigation of traditional knowledge in ethnoveterinary herbal medicine with the cooperation between herbalists, ethnobiologists, veterinary scientists and anthropologists can continue to move forward through integration and intimate relations with modern veterinary medicine. Such collaboration and cooperation among the key stakeholders helps to engage the society and governmental institutions (d'Avigdor et al., 2014). In addition, higher proportion of the African people about 80% of the population (Bekalo et al., 2009; Belayneh et al., 2012) or more use potential medicinal plants for treatment of various livestock ailments. In Ethiopia, ethnoveterinary medicinal practices using medicinal plants are alternative options to cure more than 90% of the country's huge livestock population, and also for more than 80% human population (Tadesse and Dereje, 2015; Temeche and Asnakew, 2020). Furthermore, plant remedies are used against livestock health retribution in more proportion (Gidey et al., 2012; Birhan et al., 2018; Agize et al., 2022). Although modern veterinary services have been there for a long period (Fullas, 2010), traditional herbal medicine has been repeatedly and increasingly shown to have effective healing power for a number of livestock ailments. Moreover, Ethiopian traditional veterinary practitioners contribute to the welfare of domestic animals, their productions and management (Mesfin and Obsa, 1994).

Limited distribution of modern veterinary healthcare services, unaffordable cost and lack of accessibility to healthcare benefits makes herb-based ethnoveterinary practices mandatory (Abera and Mulate, 2019). Thus, to cover the gap in healthcare service through centuries in developing countries of the world, farmers and pastoralist in rural communities have been depending on the wealth of traditional medicines to manage livestock ailments (Abera and Mulate, 2019), to increase their productive yield and most of this is achieved through herbal medicine; various livestock ailments, pathogenies, and vectors are the major constraints that decrease domestic animal production and development in different marginal and rural areas of Africa (Marandure, 2016). Traditional herbal medicine provides a safeguard for the group of domestic livestock such as bovines (cattle), equines (horses, donkeys and mules), goats, sheep including poultry (chickens/hens) and is directly related to the food security, and to the sources of economic income due to the systems of healthcare (Fullas, 2010). However, the treatment of livestock ailments using traditional herbal medicine had begun before the formulation of modern drugs as reported from different countries (Agize et al., 2022). Nowadays, the use of the ethnoveterinary medicinal plants along with the associated indigenous knowledge is transferred among successive generations of people only orally without written records and no adequate scientific documentation exists (Tadesse et al., 2014). The same source explained that the transfer of this herbal medicinal heritage system is heading to deterioration and decline and may even lead to the eventual extinction of the indigenous medicinal plants, which also leads to impacts on food security as well as negative impacts on ecological transition.

The role of veterinary practices to treat livestock ailments is a long-time practice in all parts of the world, especially in developing countries where livestock healthcare facilities and services are still very few and located scarcely at urban centers (Mesfin et al., 2009). Even those people living in close proximity to areas where modern drugs/pharmaceutical products are readily available use preparations of traditional medicinal plants to treat their domestic livestock. This is related to shortage of modern drugs, cultural acceptability, relative efficacy in fighting certain ailments, and economic affordability for the rural communities (Teklehaymanot and Giday, 2007). Furthermore, the use of traditional plant-based medicines fits well with the necessity of healthcare system and management of different multifunctional livestock, but the knowledge of veterinary practice is declining as the plants become less and less in their local habitats due to many threatening factors. The consequence is the decline of food serving domestic livestock and other multipurpose livestock, wild forage plants, and ecological services. The anthropogenic activity of deforestation for expansions of settlement areas, farming lands, rearing livestock, overexploitation of plants for various other purposes lead to environmental degradation and to threats of medicinal plants (Tadesse and Dereje, 2015; Temeche and Asnakew, 2020), which may in turn lead to the loss of livestock lives.

Indigenous knowledge on livestock herbal medicine and practices is being transmitted to the young generation via oral message rather than in the form of written documents and stories (Gidey et al., 2012). As a result, veterinary traditions went on eroding without adequate documentation based on suitable and effective analysis of medicinal plant alongside the associated indigenous knowledge (Abera and Mulate, 2019). Soro District, an area of agriculturists and agropastoralists where mixed agriculture is widely practiced, has long been inhabited by people who have a long tradition of using medicinal plants to treat livestock ailments, and there has been very little effort to assess and document ethnoveterinary plants and associated knowledge and practice. Given the absence of livestock medicinal plant studies so far in Soro District, a strategic plan was made and this study is an initiative to assess and document ethnomedicinal plants of veterinary importance with the associated uses and local practices particularly focusing on Soro District of Hadiya Zone.

Moreover, in different phytogeographical regions of East African countries, many studies in various areas of Ethiopia with diverse ethnic groups and biodiversity have also documented ethnoveterinary healthcare of livestock with medicinal plants along with the associated traditional knowledge. In addition, solely ethnoveterinary study in Soro District also contributes rich sources of livestock medicinal plants with traditional knowledge, which also provide wild food and ecologically important plants. Thus, the objective of this study was to document the diversity of livestock medicinal plants paying special regard to fill the information gap on ethnoveterinary plants and their associated functions that enhance livestock welfare and food security. This indigenous knowledge documentation and transfer to future generations could determine the status of livestock, their health management system, and their threats in the study area and beyond. Therefore, the study also planned to assess and document ethnoveterinary medicinal plants and associated indigenous knowledge and traditional practices in Soro District, Hadiya Zone, central Ethiopia.

4.2. Methods and Materials

4.2.1. Study area description

The ethnobotanical study was conducted in Soro District, geographically located between the coordinates 37^0 20’ 0’’ to 37^0 50' 0’’E longitudes and 07^0 0′ 0’’ to 07^0 40′ 0’’N latitudes; and the altitude ranged from 799 m.a.s.l to 2934 m.a.s.l. The District is located 264 kilometers southwest of Addis Ababa, the capital of Ethiopia. The total land area covers 36473.337 km^2/3647333.7 ha. Most of the study District sites are highlands followed by middle and low land agroclimatic zones, and the mean annual rain fall is in between 900-1500 mm, with the temperature in between 12°C to 26°C.

The study area, Soro District, was selected purposively by the researcher whereas sampled kebeles were chosen by a focus group discussion conducted at the District level at the beginning of the research when reconnaissance study was conducted. Soro District is grouped as one of the high agricultural potential areas in Hadiya Zone, and the main economic activity is agriculture. The main interest in this study is to document the ethnobotanical information with the associated indigenous knowledge focusing in this study on livestock ailments and the medicinal plants used by the local community to manage these ailments. The total human population of Soro District is 287, 589; with 143, 835 males and 143, 754 females. The majority (about 87.42%) of the people live in rural communities who mainly rely on agricultural economy and 12.58% of the people live in urban areas. The indigenous people of Soro inhabiting Soro District belong to Hadiya people, who speak the Cushitic family language in Ethiopia (which is one of the major ethnolinguistic groups in Ethiopia). They speak the language of Hadiyissa and learn it in the school where it is part of the formal education of the school-aged children; they also use Amharic (the national language) for official work.

The livestock population in the District as given by Soro District Agricultural and Rural Development Office in 2020 the livestock population of the District has been estimated to be about 3, 329, 827, of which the highest proportion, about 29.62%, goes to herds of bovines (cattle), accounting for 986, 248, followed by 388,082 sheep (11.5%), 295,018 goats (8.86%), 40,291 equines,1, 620, 188 poultry including 18, 918 honeybee colonies and 0.5 tone fish. These major agricultural commodities indicate the type of agricultural activities and that the communities are more of semi-pastoralists and agropastoralists that keep very high livestock population. However, in spite of the presence of high livestock population there are only few numbers of veterinary clinics in the District and most households rely on traditional herbal medicine to treat different kinds of livestock ailments.

The Head of Veterinary Office in the District reported that Lumpy Skin Disease (LSD), blackleg, trypanomiasis, Foot and Mouth Disease (FMD), PPR, New Castle Disease (NCD), cattle pasteurellosis, African Horse Sickness (AHS), rabies, livestock tuberculosis, anthrax, shoat pox, fowl typhoid, coccidiosis, livestock lice/tick infection, and other parasitic diseases were among the most common ailments frequently affecting livestock in the District. There are 14 rural veterinary healthcare posts and one main clinic in the main town of the District. The rest of the 18 administrative kebele's get veterinary service from nearby health posts and a clinic. There were eight veterinarians; three DVMs, five Bsc and 15 diploma holders without any livestock healthcare assistants working in the District. The mentioned veterinary healthcare centres are not sufficient to provide proper health services for the total number of livestock heads present in the study area. This was due to the migration of veterinarians, health clinics, and professionals. Health services were more or less used in clusters.

Furthermore, the rising human population and expansion of farming are the main contributing factors to the declining vegetation of the study area. This was the key factor that motivated initiation of this research that investigated ethnoveterinary medicinal plants and the associated community knowledge of the people of Soro District.

Based on the information gathered during the reconnaissance survey and archival sources (Forman and Bridson, 1989) at the District level, the research was informed that there are 33 total kebeles, of which 13 rural kebeles/subdistricts (the smallest administrative units) or resident sites including nearby urban kebeles were purposively selected and involved in this research.

4.2.2. Focus group discussions

A focus group discussion in the centre of the District (Gimbichu town) consisted of different members of key stakeholders from Soro District administrative offices representing relevant professions and social groups, including health, veterinary and fisheries, culture and tourism, agriculture, education, environmental protection, forest and climate change, biodiversity, public service (capacity building), children, women, and youth offices. During actual data collection, 13 focus group discussions were conducted, in the entire research area with the collaboration of different professionals, and semi-structured interviews of purposively sampled key and systematic randomly sampled general informants.

In a focus group discussion, 12 informants (eight males and four females) were involved in Gimbichu town. One FGD was conducted at each data collection site using semi-structured interviews with knowledgeable kebele participants, farmers, key informants, community elders and leaders, religious leaders, inhabitants of forest patches, woodworkers, apiculturists, and potters. During FGDs, each kebele resulted in five to seven participants representing 88 informants in 13 study sites. A total of 62 males and 26 females were involved with different age groups, genders, and respective numbers of participants (20–35 years old with 12 males and five females, 36–59 years old with 24 males and 12 females, and $\geq$ 60 years old with 26 males and 12 females). The total number of informants involved in this ethnoveterinary medicinal plant survey was 387, comprising 255 (65.89%) males and 132 (34.11%) females, and their ages ranged from 20 to 90 years. Of these, general informants were 296 (76.49%) with 179 (60.47%) males and 117 (39.53%) females; key informants were 91 with 76 (23.51%) males and 15 (16.48%) females.

They reported information on the diversity of ethnoveterinary herbal plants, their usage, threats to indigenous plant species, and methods of conservation and management. In addition, participants received information about the use of medicinal plants and were involved in the collection of specimens. Each discussion was guided by the kebele administrator, an environmental protection expert, and an officer of forest and climate change, who served as local language translator for other team members during discussions. In the meetings, verbatim information was chaired and recorded by the first author (researcher). Local names of ethnoveterinary plants, habits, parts used, locations, flowering or blooming periods, time of plant part collection for remedy preparation, dosage, preparations using different methods, causes of health problems and symptoms shown by the livestock if they consume poisonous plant parts, antidotes, and other important notes were discussed and recorded.

4.2.3. Informant sampling techniques in the study sites

Respondents were sampled based on information from the reconnaissance survey, the FGD session at the District level, community recommendations and researcher's observations during the initial direct interactions with informants. General informants (sampled using systematic random sampling approaches) and key/knowledgeable informants using purposive selection approaches were used for identification of traditional veterinary herbal medicine end users and practitioners following standard methods described in the literature (Martin, 1995; Alexiades, 1996). Selection of key informants relied more on information provided by recommendations of knowledgeable inhabitants, elderly people, community members, and kebele administrators. General informants were sampled from the total households. The total household number (11, 908) was obtained from Soro District Finance office, Planning and Economic Development Office. This number was multiplied by the sample size then divided by total households found in each kebele. For instance, the total number of households for Bure kebele was 660 and the number of general informants was calculated as $(\frac{660}{11908} * 387) = 21$. Similar calculations were made for all kebeles and different number of informants were obtained which added up to an overall total sample size of 387 (Table 4.18) for the study area following this sample size determination formula (Kotrlik and Higgins, 2001).

Table 4. 18. Sampled administrative kebeles with informants interviewed, altitudinal ranges, agroclimatic zone, and socio-demographic profile

Nº.	Subdistrict (kebele)	GPS-altitude (m.a.s.l)	Agroclimatic zone	Total number of informants	Socio-demographic profile			
					Gender		Ethnicity	Language
					M	F	Had, Amh, Kam, Oro, Wol, Tig	Hadiyissa, Afaan Oromo, Amharic
1.	Shonkola	2451-2754	D	45	30	15	Had	Hadiyissa
2.	Kosha	2334-2436	D	37	28	9	Had, 1 Amh	Hadiyissa, Amharic
3.	Beinera	2162-2446	D	25	17	8	Had, 1 Kam	Hadiyissa, Kambatissa
4.	Bambo	2082-2105	WD	17	12	5	Had	Hadiyissa
5.	Wosheba	2110-2120	WD	33	19	14	Had	Hadiyissa
6.	Bure	2070-2080	WD	21	14	7	Had	Hadiyissa
7.	Sundusa	2042-2067	WD	44	30	14	Had	Hadiyissa

8.	Share	1900-2009	WD	39	23	16	Had	Hadiyissa
9.	2nd Hankota	1975-2287	WD	33	20	13	Had	Hadiyissa
10.	2nd Oda	1758-2015	WD	26	21	5	Had	Hadiyissa
11.	Ambe-lenge	1588-1665	K	21	11	10	Had, 1 Oro	Hadiyissa, Afaan Oromo
12.	Gebebe-lenge	1555-1565	K	25	18	7	Had, 1 Wol	Hadiyissa, Wolyitegna
13.	Burye-lenge	1472-1555	K	21	12	9	Had, 2 Tig	Hadiyissa, Tigrigna, and Amharic
Total		-	13	387	255	132	381Had, 6 others	381 Hadiyissa, 6 others

Note: D = dega (highland); WD = woinadega (temperate zone); and K = kola (lowland); Had = Hadiya/Hadiyissa; Amh=Amhara/Amharic/Amharigna; Oro=Oromo/Afaan Oromo; Kam= Kambeta/Kambatissa; Wol =Wolyita and Wolyitegna; Tig = Tigre and Tigrigna.

4.2.4. Data collection

Ethnomedicinal data on ethnoveterinary plants were collected using field observations, guided field walks, semi-structured interviews and focus group discussions following methods described in relevant sources (Martin, 1995; Cotton, 1996). The semi-structured interview questions were prepared in the English language and then orally translated into Hadiyissa, informants' mother tongue. Informant interviews were conducted individually to obtain sufficient information on livestock medicinal plant species, parts used, preparation methods, commonly treated ailments, routes of administration and dose determination. Data regarding diversity, habitat distribution, and threats to ethnoveterinary medicinal plant species were gathered from the community. Voucher specimens of all reported medicinal plants were collected from various locations in the three agroclimatic habitats by interviewing traditional medicine practitioners/healers working as key informants and general informants as well.

Important georeferenced data using the geographic positioning system (GPS), vernacular plant names, habitats and habits of each plant specimen were recorded. Voucher plant specimens were numbered and coded, pressed, dried, and identified with the help of the Flora of Ethiopia and Eritrea (Hedberg et al., 1989; Hedberg et al., 2003). The identification was verified by comparison with authenticated plant specimens found at the National Herbarium, Addis Ababa University, confirmed by taxonomic experts and finally deposited there (AAU).

4.2.5. Data analysis

Microsoft Excel spread sheet software version 2016, SPSS version 25 and one-way ANOVA and values of F-tests were employed for the analysis of data on ethnoveterinary medicinal plants with the use of indigenous knowledge in various informant groups. The collected herbal ethnoveterinary data sets were analysed mainly by qualitative as well as quantitative approaches and descriptive statistics (Martin, 1995). Preliminary informants' demographic information, livestock ailments categories, and ethnoveterinary medicinal plant frequency and percentages based on general features (such as forms of plant life cycle, parts used in remedy preparation, route of administration, preparation forms, means of applications, and dose determination) and analyzed using tables, figures and descriptive texts.

Ethnoveterinary ailments were collected from the District, and informants' interviews were categorized to reflect on understanding of the local and indigenous uses of traditional herbal medicine and ailment signs and symptoms based on the ICPC (International Classification of Primary Healthcare) as stated by Staub et al.(2015).

As a consequence, ethnobotanical scoring and ranking using values of informant consensus factor (ICF), index of fidelity level (FL), preference ranking (PR), and direct matrix ranking (DMR) were conducted for crosschecking and verification of the potential priority ethnoveterinary medicinal plant species to heal different ailments and to ensure the level of consistency as recommendations of (Friedman et al., 1986; Tardío and Pardo-de-Santayana, 2008; Heinrich et al., 2009), as well as to identify the priority species for conservation, and statistical analysis was used to create charts and graphs.

Informant consensus factor was used to describe the agreement between informants when choosing the most cited medicinal plant species that was used to treat a group of ailments in the ailment category. It was used to evaluate and to prioritize the reliability of medicinal plant data. The formula was $\mathrm{ICF} = \frac{\mathrm{Nur-Nt}}{\mathrm{Nur-1}}$, where, ICF is the informant consensus factor, Nur is the number of each selected medicinal plant species use citation, and Nt is the number of selected plant species used (Heinrich et al., 1998; Vitalini et al., 2013).

Index of fidelity level (FL=Ip/IuX100) was used to estimate the relative curing/healing efficacy of each potential medicinal plant species based on the proportion of respondents who agreed on its use against a given category of the ailments (Alexiades, 1996; Cotton, 1996; Tardío and Pardo-de-Santayana, 2008). Where Ip is the number of informants who independently cited the importance of a species for a particular main ailment and Iu-the total number of informants who reported the same plant for any ailment (Friedman et al., 1986). In the ethnobotanical studies index of FL, was recommended to use medicinal plants for their future phytochemical analysis, activities of antimicrobial test, characterization, bioactive chemical isolation, for drug formulation, and characterization (Heinrich, 2000).

Preference ranking is defined as arranging a rank of most preferential medicinal plants that was scored for treatment of specific ailment by respondents responses following relevant sources (Martin, 1995; Alexiades, 1996). Mainly key informants were used to assess the degree of preferences of medicinal plants that were scored by informants.

DMR was used to compare multipurpose medicinal plants commonly reported for diverse use and diversity of a specific plant species using key informants following the methods (Martin, 1995; Alexiades, 1996; Cotton, 1996). The uses of multipurpose medicinal plants were selected from the total of confirmed livestock medicinal plants. Samples of key informants were listed and discussed the uses of the plant species. They were asked to assign and order the use values to each species (best = 5, very good = 4, good = 3, less used = 2, least used = 1 and not used = 0). The values of the average scores were given to individual medicinal plant species that were summed up and ranked. In addition, randomly selected ten (10) key informants were involved in a priority ranking exercise that focused on perceived threatening factors of the five medicinal plant species. Direct matrix ranking score of randomly taken 10 key participants for five ethnomedicinal livestock plants for different use categories. In general, these overall ranking exercises help to check targeted indigenous plants with associated local knowledge for those claimed multipurpose indigenous plant species in the study community.

4.3. Results

4.3.1. Demographic features and Indigenous knowledge of informants

Most informants belonged to the Protestant (80.88%) and Hadiya ethnic groups, followed by Adventists (7.75%). The occupations of most respondents were farmers (73.64%), followed by housewives (23%), and others (Table 4.19). Key informants reported more number of ethnoveterinary medicinal plants, and they have relatively more knowledge of their uses than general informants; they reported one or more medicinal plant species for the healing purposes of various livestock ailments. They were categorized in between young ages (20–35), adult ages (36–59), and old ages (> or equal to 60 years old) and accounted for 24.29% (94, 51 males and 43 females), 50.90% (197, 127 males and 70 females), and 24.81% (96, 77 males and 19 females), respectively. Most of the informants, 62.53% (242, 176 males and 66 females), were literate people who are able to read and write (R &W), followed by illiterate people (who cannot R and W), and 37.47% (145, 79 males and 66 females). Statistically, males (4.59 ±3.55) have rich veterinary drug information compared with females (3.29 ±1.37), and the difference was statistically significant P-value ($P < 0.05$). Literates, 242 (4.43 ± 3.16) reported more average numbers of medicinal plants in the community for various ailments and this is highly significant ($P < 0.05$) than illiterates. This could be related to the fact that literates keep written information rather than oral retention of information alone. The same trend was observed considering 145 (4.12 ±2.27) as well as distantly (4.34 ±3.06) than nearby (4.20 ±2) to the town. Similarly, significantly ($P < 0.05$) more medicinal plants were reported by key informants (91, 8.22±4.70) than general informants 296 (2.46±1.17). However, higher average number of medicinal plants were reported by elderly informants (5 ±3.44) who are older/senior members of the community than adults (4.22±2.70) and the young age (3.77 ±2.47), though the difference was statistically non-significant ($P > 0.05$, $P = 0.257$) that informed and reported higher numbers of medicinal plants than young and adult ages (Table 4.20). Also, there was no significant variation that was observed among three agroecology of the District ($P > 0.05$, $p= 0.112$).

Table 4.19. Informants demographic background characteristics

Religion background	Religions	N	Percent (%)
	Protestant	313	80.88
	Adventist	30	7.75
	Catholic	16	4.13
	Apostles	16	4.13
	Orthodox	11	2.84
	Muslim	1	0.26
	Total	387	100
Informants' occupations	Farmers	285	73.64
	Housewives	89	23
	Unemployed	5	1.29
	Government employees	4	1.03
	Artists, artecraft, and wogesha	3	0.77
	Retired and traders	1	0.26
	Total	387	100
N = number of informants			

Table 4.20. Statistical test of significance using one-way ANOVA on the average number of ethnoveterinary medicinal plants reported among various variables on the data collected from Soro District

Participants	Informants group	N	Average ± SD	F- value	p-value
Gender	Males	255	4.59±3.55	13.62	0.000
	Females	132	3.29 ±1.37		
Age category	Young (20–35 years old)	94	3.77±2.47	1.36	0.257**
	Adult (36–59 years old)	197	4.22 ±2.70		
	Elderly (≥60 years old)	96	5 ±3.44		
Educational status	Illiterate	145	4.12 ±2.27	3.88	0.050
	Literate	242	4.43 ±3.16		
Proximity to the main town	Less than 5 km	86	4.20±2	4.06	0.045
	Greater or equal to 5 km	301	4.34 ±3.06		
Informants' category	Key informants	91	8.22±4.70	352.32	0.000
	General informants	296	2.46 ±1.17		
Agroclimatic zone	Dega	107	3.19±3.63	2.20	0.112 **
	Woinadega	213	2.98±4.77		
	Kola	67	1.84±4.33		

*Significant difference ($p < 0.05$) at 95% conference interval for mean between groups, ** non-significant ($p>0.05$), t (0.05, two-tailed), df=N-1; 386, N=number of respondents =387.

4.3.2. Taxonomic diversity of livestock medicinal plants (LsMPs) in Soro District

A total of 132 ethnoveterinary plant species belonging to 120 genera and 61 families were collected from the altitudinal ranges of 1472-2754 m.a.s.l., identified and documented (Appendix 4.14). These plants are used for the treatment of different ailments of domestic livestock in the study District as reported by informants. Of these, 13 (9.85%) species are endemic medicinal plants (*). The majority about 129 (97.73%) of LsMPs are flowering plants, and there are three (2.27%) gymnosperms and 26 exotic plants. The recorded plants include 14 spices, four cereal crops, two pulses, and two stimulants involved in medicinal preparations. These plants are used by the community primarily as first-aid materials to handle various health problems in livestock. Based on the results of the growth form analysis of livestock medicinal plant species, herbs contributed the highest species proportion of 51 (38.64%), followed by trees at 36 (27.27%); hemiparasites accounted for the least proportion of one (0.76%); and others lie in between (Figure 4.24). These ethnoveterinary medicinal plant species have dominant families, with the highest number of plant species (Figure 4.25) accounting for a different number of families and genera. Of these Asteraceae accounted 10 (7.58%) species, Fabaceae nine (6.82%) species and both with eight (6.67%) genera, and Lamiaceae seven (6.82%) species and Solanaceae seven (5.30%) species both with seven (5.83%) genera were the dominant families followed by Rubiaceae six (4.55%) species and genera (5%), both Euphorbiaceae and Poaceae five (3.79% each) species with respective four (3.33%) and five (4.17%) genera, Rutaceae and Amaryllidaceae four (3.03%) species each and with four (3.33%) and three (2.5%) genera, respectively; Cucurbitaceae, Acanthaceae, Oleaceae, and Ranunculaceae three (2.27% each) species; three (2.50%) genera of the former family, and two (1.67% each) genera of the later three families, and other 48 families were 61 (46.21%) species and 59 (49.17%) genera were also reported frequently to use for local healthcare systems of livestock. All these collected livestock medicinal plants were distributed in different living habitats, mainly wild habitats (105 species, 79.54%), some gathered from cultivated lands (27, 20.45%); of these 106 (80.30%) native species (with one asterisk, 13 endemic species, and without asterisks, 93 indigenous species) and 26 (19.70%) introduced plant species (asterisks **) Table 4.20 and Appendix 4.14. These LsMPs (livestock medicinal plants) were also collected in different specific localities (*i.e.*, forest patches, homegardens, markets, roadsides, agricultural lands with croplands, grazing, or/and grasslands). These ethnoveterinary medicinal plants were used to treat livestock ailments in the District.

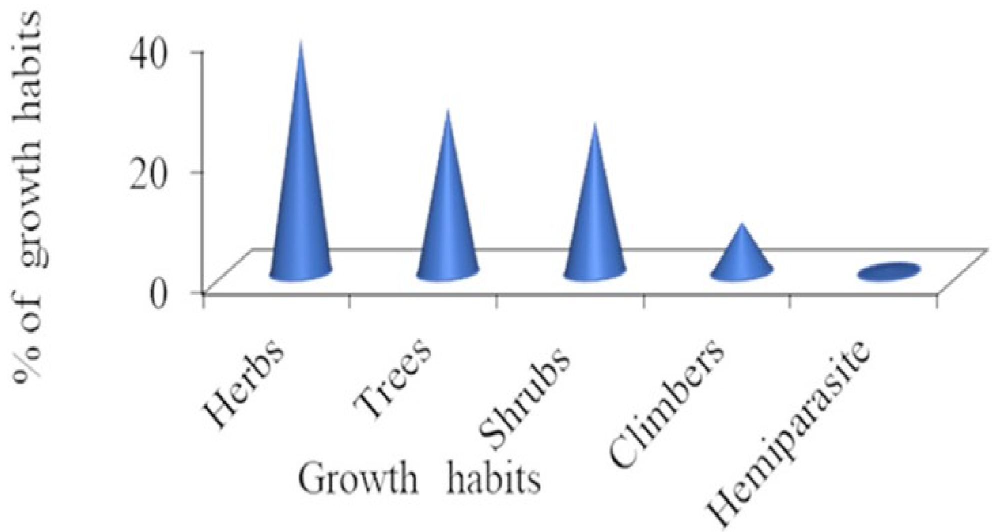

Figure 4. 24. Growth Habits of livestock medicinal plants in Soro District

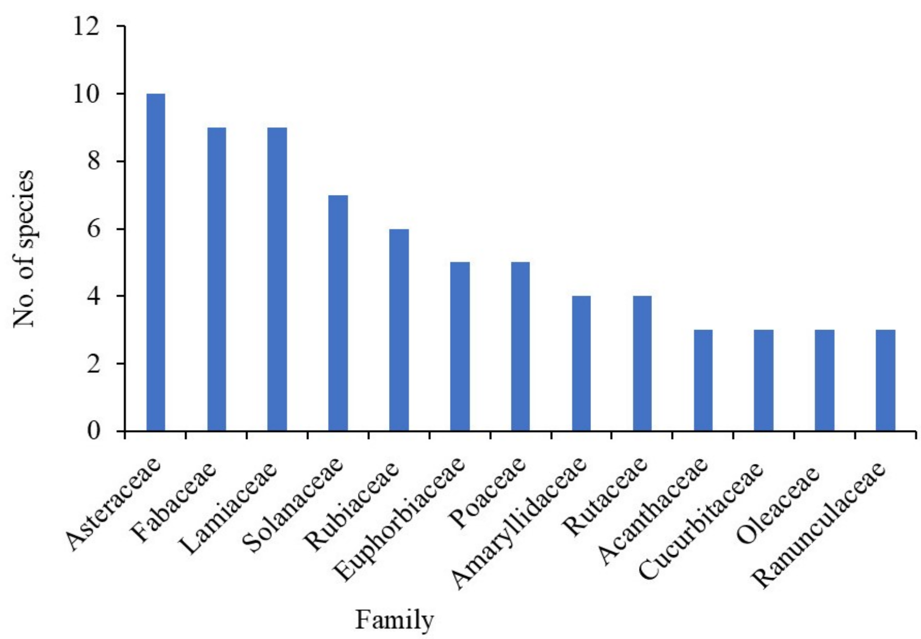

Figure 4. 25. Families of livestock medicinal plants in Soro District

4.3.3. Medicinal plant parts, medicinal additives, use conditions and administration routes

The result of this study indicated that many medicinal plant parts were picked from mother plants and prepared to treat diverse types of specific livestock ailments, either in the form of single or more varied plant parts, with the use of other additives 199 (48.54%) and without the addition of additives 211 (51.46%). Ethnoveterinary medicines were prepared more with a mixture of two different plant parts, about 47 (33.33%), and the combination of more than two plant parts accounted for about 68.08% [*i.e.*, with the addition of three different plant parts 23 (16.31%), four plants 10 (7.09%), five plants eight (5.67%), six plants four (2.67%), seven plants three (2.13%), and nine plants one (0.71%)] than remedy preparation from a single plant part accounted for 45 (31.92%) preparations.

In the study area, Soro District, different informants frequently reported that various types of additives were used for the preparation of ethnoveterinary herbal drugs, and they were also used for medicinal purposes such as cold and warm water 190 (71.97%) out of 264, saliva during chewing medicinal plants 20 (7.58%), NaCl salt 16 (6.06%), milk ('Irigo') and its products 10 (3.79%), beverage/arekie five (1.89%), salty soil/locally 'Borra'-Hadiyissa name for salty soil occasionally given to livestock five (1.89%), cattle dry dung four (1.52%), enset ('hamicho','bu'o', 'kocho') four (1.52%), and plant latex three (1.14%). Whereas among the total number of all the different additives reported, other less frequently used additives include charcoal two (0.76%); soil from a depth of 50 cm; dry faeces of donkeys one (0.38%); and others one (0.38% each) like petroleum gas, penicillin, and sprite were used by local people to mix with medicinal plants.

Some of those additives were used as antidotes for various traditional drug problems; these include the use of excessive water, milk ('Irigo'), and its products. Of all, water is the universal natural mixing medium among different dilution solvents and serves as a universal additive. Certain plants, such as *Carduus schimperi* and *Clutia abyssinica,* have medicinal uses in cases where toxic or poisonous plants are eaten by livestock to neutralize their bad effects. Key informants reported that they also have nutritional uses for livestock fattening.

The data collected showed that fresh leaves (57 species, 43.18%) were most frequently used in familiar preparations, followed by seeds (6.82%), roots with leaves (6.82%), fruits with leaves (6.06%), root alone (5.30%), stem bark alone (4.55%), leaf with stem (3.03%), Rh (2.27%), Fr, Bu, L with Wh, L with Sb parts two (1.52% each), and with other parts (Figure 4.26). Moreover, many other parts with one (0.76% each) were also used by healers, including flowers and inflorescences, whole parts, leaves, and resin.

The various traditional herbal medicine parts were used in fresh form about 109 (82.58%), followed by dry, 12 (9.09%), and 11 (8.33%) fresh/dry parts. The results of the reported analysis of the application route of this study pointed out the relative numbers of varied routes of administration for traditional medicines to treat different types of livestock ailments. Oral administration through the mouth was the most commonly used route 191 (65.41%), followed by dermal 32 (10.96%), nasal 30 (10.27%), anal 21 (7.19%), and others like optical and reproductive organ, whereas both the ear and spraying plant extract prepared by herbal medicine on the physical (external) environment to against or kill ailment-causing agents similarly contributed the least number one (0.34%) each of the 292 total reports (Figure 4.26).

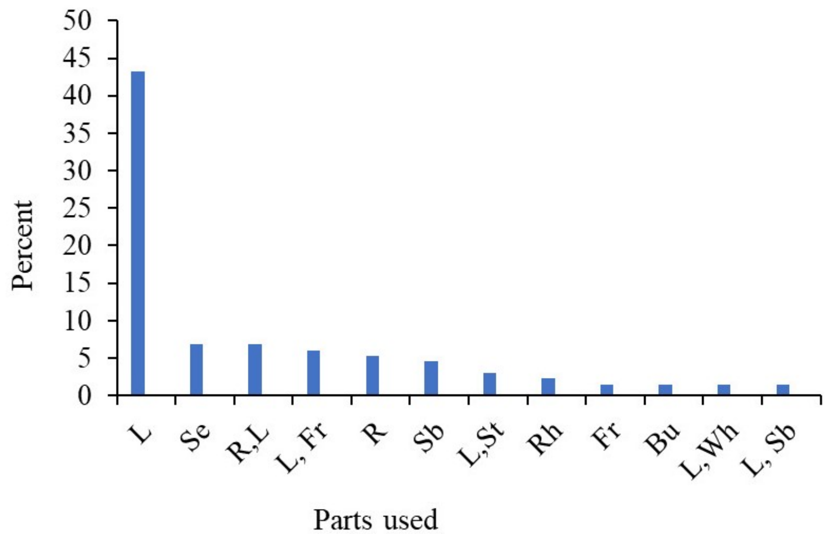

Figure 4.26. Parts of livestock medicinal plants used in Soro District

Note: Key: L = leaf; Se = seed; R, L= root or leaf; L, Fr = leaf or fruit; Sb = stem bark; L, St = leaf or stem; Rh = rhizome; L, Wh = leaf or whole part; Bu = bulb; L, Sb = leaf or stem bark, and No= number.

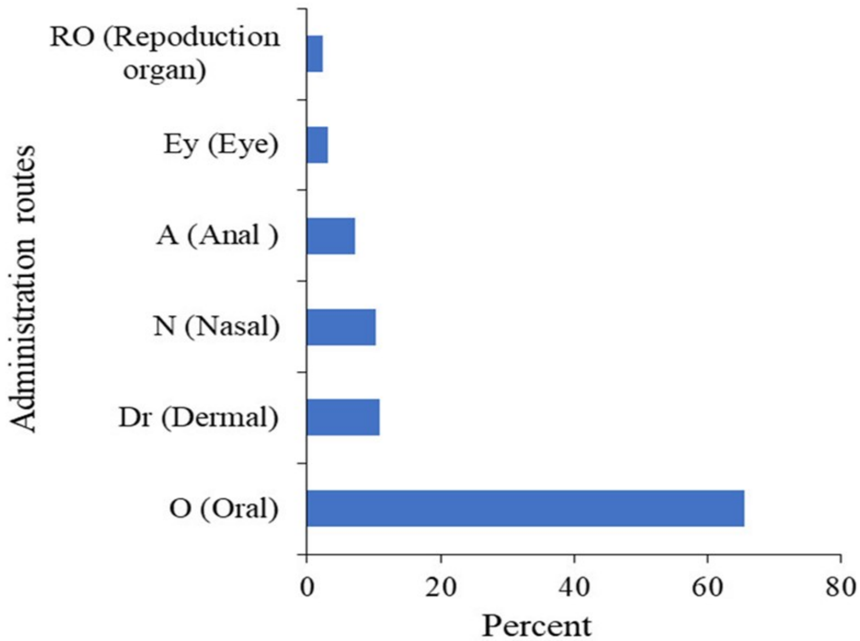

Figure 4.27. Reported routes of administration of livestock medicinal plants medicines

Note: % = percent; no = number

4.3.4. Forms of medicinal preparation and application methods

Results of the analysis of medicinal preparation of medicinal plants showed that decoction 94 (36.7%) for remedy preparation from a single medicinal plant species made the largest proportion whereas concoction 76 (29.7%) by mixing plant material from different species came in the next place following by crushing 20 (7.8%), chewing 14 (5.5%), boiling 13 (5.1%), and others (Figure 4.28). In addition, some of the herbal preparation out of the 256 total preparations, pasting and infusion accounted three (1.2% each); burning two (0.8%); with others cooking/roasting, holding, chopping, and without processing accounted one (0.39% each).

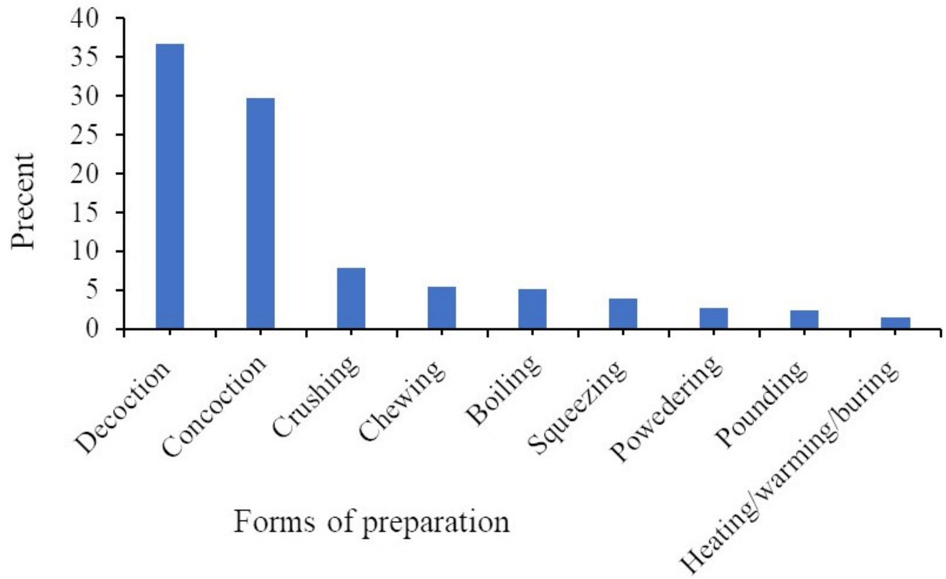

Figure 4. 28. Forms of medicinal preparation

Ailment treatment through drinking by mouth (181 (70.43%) of the 257 total reports) was widely used, and the most common method for traditional remedies application method following spitting through the nose (8.56%) and eating (3.89%) came up in higher proportions flowing pasting, others (Figure 4.29). Whereas inhaling the steam by nose, smearing (creaming/ontiment) to the body, and smoking through nose accounted three (1.17% each); swallowing through mouth two (0.78%); and spraying to the physical environment, sprinkling on the wound, and inserting to the body each one (0.39%).

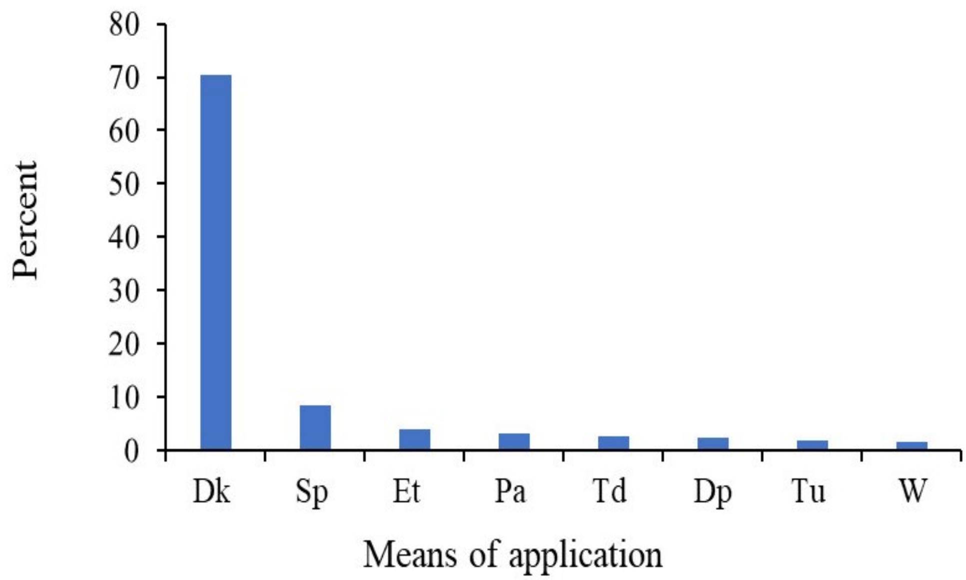

Figure 4. 29. Means of livestock medicinal application

Note: Key: Dk = drinking through the mouth; Sp = spitting through the nose; Et= eating; Pa = pasting to the painful area; Td = tying on the painful area; Dp = dropping to the eye; Tu = touching the external painful area; W = washing the body; and %= a symbol of percent.

4.3.5. Marketability of livestock medicinal plants

Marketable traditional medicinal plants, both medicinal and spices, were recorded in four sampled and surveyed markets from three agroecological areas (Gimbichu (Dega), Jajura (Woinadega), Kosha (Dega) and Humaro (Kola) local markets). They were mainly purchased for medicinal use and accounted for seven plant species (5.30%). These medicinal plants were *Ajuga integrifolia (***Annaamura**-Hadiyissa/Had.), *Antherica* sp (**Dashshi maracca**-Had.), *Asparagus africanus* (**Hundufaanna**-Had.), *Artemisia absinthium (*Naatira-Had.) sold for sources of spices and medicinal uses, *Nicotiana tabacum* (**Tambaa'i-koshsho'o**-Had.), *Securidaca longepedunculata* (**Mukke'e**-Had.), *Hagenia abyssinica* (**Suuxo**-Had.), were recorded from the three agroclimatic open markets, and they were sold and purchased for the purpose of traditional medicine.

The prices of each species varied from market to market. For example, the prices of a bunch of **Dashshi maracca**-Had (*Antherica* sp)., and **Mukke'e**-Had (*S. longepedunculata*), and a mug/water glass of **Suuxo**-Had (*H. abyssinica*) were sold and purchased each 40-50 EthBirr. One coffee or tea cup of Naatira-Had. (*A, absinthium*), **Tambaa'i koshsho'o**-Had. (*N. tabacum*, and were sold by 10-20 EthBirr.

As reported for decades in the study area, some medicinal plants were commonly sold for the purposes of livestock herbal medicines, such as *Ajuga integrifolia* (**Annaamura**-Had.), *Echinops kebericho* (**Toosa**-Had.), and *Hagenia abyssinica* (**Suuxo**-Had.), were sold and purchased in excess for functions of traditional medicine. However, nowadays, due to various impacts, these plant species have become locally extinct in the area because of human activities such as harvesting for various uses and the removal of those potential plants from the community. Thus, they require systematic *in-situ* and *ex-situ* conversation plans to conserve them with the relationships of people living there.

4.3.6. Ethnobotany of the best livestock plant species in Soro District

In the study area, Soro District, the highest ICF values were recorded for a group of ailments under dermatological ailments (0.72) followed by gastro-intestinal (0.71) and respiratory (0.70) ailments which depicted the agreement on knowledge of medicinal plants used to treat best by the community (Table 4.21 and Table 4.22).

Table 4.21. Values of informant consensus factor of ethnoveterinary medicinal plants used by communities of Soro District for treating certain livestock aliments

No	Ailment category	No of plants	% all plants	Use citations	% all use Citations	ICF values: Nur-Nt /Nur-1
1.	Lumpy Skin Disease/Ailment, FMD, blackleg, PPR, bat urine ailment, skin wound	56	42.42	198	38.08	0.72
2.	Diarrhoea, abdominal pain, acidiosis/bloat, anthrax, actinobacillosis (wooden tongue), telleriosis	46	35.85	157	30.19	0.71
3.	*Aspiration pneumonia*, coughing, parasitic leech, asthma	27	20.45	89	17.11	0.70
4.	Livestock ascariasis (cysticercus), Babesiosis (liver ailment)	11	6.11	30	5.77	0.65
5.	Coccidiasis, New Castle Disease/ Ailment	4	5.34	9	1.73	0.62
6.	Eye pain (conjunctivitis)	7	5.30	14	2.7	0.54
7.	Rabies, listeriosis	9	3.79	18	3.46	0.53
8.	Evil eye, evil spirit, michi	3	2.27	5	0.96	0.50

Table 4. 22. FL values of 20 most frequently used ethnoveterinary medicinal plant species of Soro District

No.	Livestock ailment	Ethnoveterinary medicinal plant	I_p	I_u	FL values (%)
1.	Rabies	*Datura stramonium*	9	9	100
2.	PPR (Pestedes petits ruminants)	*Dodonaea viscosa* subsp. *angustifolia*	17	17	100
3.	Evil eye (sprit)	*Asparagus africanus*	25	25	100
4.	Foot and Mouth Disease (FMD)	*Croton macrostachyus*	49	50	98
5.	*Aspiration pneumonia*	*Albizia schimperiana*	56	58	96.55
6.	Diarrhoea	*Brugmansia suaveolens*	70	76	92.10
7.	Retained placenta	*Cyphostemma pannosum*	19	21	90
8.	Blackleg	*Cyathula uncinulata*	9	10	90
9.	Anthrax	*Bersama abyssinica*	60	67	89.55
10.	Acidiosis (bloat)	*Scepocarpus hypselodendron*	40	45	88.89
11.	Livestock *ascariasis*	*Coleus abyssinicus*	20	23	86.96
12.	Bat urine ailment /jaundice	*Momordica foetida*	39	48	81.25
13.	Toxicity curing	*Clutia abyssinica*	26	32	81.25
14.	Livestock mites, fleas and lice	*Calpurnia aurea*	14	18	77.78
15.	Parasitic leech, snake bite, insects	*Nicotiana tabacum*	28	40	70
16.	Trauma (broken bones); placental	*Ensete ventricosum* (red)	15	22	68.12
17.	Snake bite (injection of venom)	*Sida rhombifolia*	8	13	61.54
18.	Dingetegna	*Euclea divinorum*	16	30	53.33
19.	Asthma/stenosis, livestock tumor	*Euphorbia abyssinica*	15	29	51.72
20.	Livestock hepatitis /jaundice	*Clematis hirsuta*	6	12	50

Simple preference ranking exercises/practice with the best ten (10) randomly chosen key knowledgeable informants for the most 10 livestock plants were reported against the most prevalent ailment category among gasto-intestinal ailments in the study sites. It is effectively used for treating LSD which was repeatedly reported in the study District. Samples of key informants were involved in the interview and asked to assign the number one for the least effective medicinal plant species, and 10 for the most effective plant. As a result, *C. macrostachyus* was ranked first and *X. americana* ranked second, *A. sativum* was ranked third, and *J. procera* was ranked fourth, however, *Z. officinale* was ranked in the lowest categories (Table 4.23).

Table 4. 23. Ranking values of 10 most preferred medicinal plant species widely used to treat the dermatological ailment known as Lumpy Skin Disease (LSD)

Ethnoveterenary plant species used to treat Lumpy Skin Disease	Randomly taken key informants A-J										Total score	Rank
	A	B	C	D	E	F	G	H	I	J		
Croton macrostachyus	10	8	10	9	7	9	8	7	10	8	86	1st
Ximenia americana	10	9	7	8	9	7	10	5	1	9	75	2nd
Allium sativum	6	5	6	6	8	8	9	7	9	10	74	3rd
Juniperus procera	1	7	5	10	6	5	8	9	4	8	63	4th
Nicotiana tabacum	10	5	4	1	5	9	9	3	5	7	58	5th
Euclea divinorum	8	7	5	6	4	6	5	4	6	1	52	6th
Momordica foetida	7	6	8	4	6	5	6	3	1	5	51	7th
Solanum incanum	5	1	6	1	7	3	5	1	4	5	38	8th
Ocimum spicatum	3	4	1	3	1	2	1	4	5	3	27	9th
Zingiber officinale	2	1	3	2	5	1	1	3	1	4	23	10th

Key information: Total scores in the table indicated the ranks which assigned to ethnoveterinary medicine rely on their efficacy with highest number 10 and the least one to treat a given ailment.

4.3.7. Multi-use multipurpose traditional livestock medicinal plant species and conservation activity

The result of the average output of the direct matrix ranking score of 10 key informants for six use diversities showed that some multipurpose ethnoveterinary species are highly exploited for firewood, charcoal and house construction and utensils rather than the use of medicinal values. These 1st, 2nd and 3rd ranked plant species became locally extinct and endangered due to the relatively highest harvesting activities of each plant species for the sake of various functions (Table 4. 24). Thus, these medicinal plants were used for livestock ailments and they needed conservation priority based on the present status in the communities of the study area.

Table 4. 24. DMR scores of five ethnomedicinal plants used to treat livestock ailments by 10 key informants

Ethnoveterenary medicinal plant species	M	Fo	Con &Ut	Sha	Ch	Fw	Total score	Rank
Olea welwitschii	1	3	5	0	5	5	19	4th
Afrocarpus gracilior	3	0	5	5	3	4	20	3rd
Combretum molle	3	2	5	2	5	5	22	2nd

Apodytes dimidiata	3	0	1	1	4	4	13	5th
Prunus africana	5	1	5	3	5	5	24	1st
Total score	15	6	21	11	22	23	98	
Rank	4th	6th	3rd	5th	2nd	1st		

Note: M = medicine, Fo = fodder, Con & Ut = construction and utensils, Sha = shade, Fw = firewood, and Ch = charcoal.

Here, five is given for the highest score number, and the least score is given by one. Agricultural expansion, new settlements, local charcoal, and overgrazing were the main threats to ethnoveterinary medicinal plants. For this reason, educational training with economic support is a prominent need for relatively well-known intellectual and knowledgeable herbal medicine practitioners in the District to use herbal medicine in a sustainable way.

4.3.8. Livestock aliment categories, types and methods of ailment diagnosis

A total of fifty (50) livestock ailments were identified and categorized from the reports of different stakeholders (Appendix 4.5) including local name and ailment categories). In this study, the most commonly and repeatedly reported livestock ailments were recorded and identified. The occurrence of these identified veterinary ailments was classified with the help of veterinary experts from the District. They were collected from the District FGD report, the District Veterinary Health Office report, and different study sites as follows: FMD, Lumpy Skin Disease/Ailment (LSD/A), actinobacillosis (wooden tongue), anthrax, babesiosis, acidiosis (bloat), blackleg, livestock trypanosomiasis, New Castle Disease/Ailment (NCD/A), PPR (Peste des petits ruminants-ailment of goats), and diarrhoea were the top 10 frequently reported livestock ailments, following coccidiasis, *aspiration pneumonia*, abdominal pain, rabies, eye pain, evil eye/evil spirit, and livestock ascariasis. They frequently attack bovines, equines, sheep, goats, and poultry are treated with indigenous herbal medicines by local people, who said they mainly rely on different medicinal plant species to treat them in addition to modern healthcare services.

Of the reported potential livestock ailments that commonly cause health problems, most of them were categorized into dermatological (including 15 types of ailments, 30%), gastrointestinal (14 types of ailments, 28%), and respiratory (five types of ailments, 10%). Dermatological ailments category is the most common category, followed by gastro-intestinal and respiratory ailments.

Informants use a single uni-medicinal plant or more than one plant (a poly-medicinal plant) in the study area to treat different ailments. Other remainder ailment categories and their numbers like parasitic (ecto and endo parasitic) and neurologic ailment together six ailments (each three types) in the proportion of 12% (each type 6%); orthopedics, musculoskeletal, infertility, placental, and fibril illness together six ailments (each one ailment) and accounted 12% (each 2%); orbital and other ailments together four ailments (each two types) accounted 8% (4% each).

Different key and general informants reported the use of a single species to treat many different livestock ailments and the combination of two or more different medicinal plant species involving either the same or different parts in the study area to treat different specific ailment types (Appendix 4.6). For example, *Momordica foetida* was used to treat 16 (4.91%) ailments of the 326 total frequently reported livestock ailments alone or more in combination, which was used to treat bovines/cattle LSD; evil eye, evil spirt, diarrhoea, dingetegna, acidiosis (bloat), and bat urine of all livestock were treated; epizootic lymphangitis of equines (horses, donkeys, and mules); anthrax of bovines, equines, and sheep; telleriosis (anaplasmiosis-spleen enlargement due to tick-borne) of bovines and sheep; actinobacillosis that causes wooden tongue of bovines; abdominal pain or ache in all livestock; to treat body swelling and blackleg pain in bovines with a combination of *Hesperocyparis lusitanica* and *Euclea divinorum*; *Nicotiana tabacum* was used to treat 15 ailments (4.60%), *e.g.* LSD, pasteurellosis (livestock TB, *i.e.*, livestock tuberculosis) or coughing, and blackleg of bovines with a combination of *Allium sativum* and other four medicinal plant species (Appendix 4.6); insect infection and *aspiration pneumonia* of bovines, sheep, and goat; anaplasmiosis of bovines and sheep; back sore of equines; skin ailments, wound or sore, swelling, nasal bote, eye pain, acidiosis, and snake bite (venom injection) of all livestock were treated.

Croton macrostachyus was used to treat 13 ailments (3.99%): FMD, blackleg, bloat, perganency, and actinobacillosis of bovines; abdominal pain and abdominal ache of bovines and sheep; livestock tumor of bovines and equines; used to treat all livestock diarrhoea, livestock hepatitis/jaundice, dingetegna, snake bite, and skin wound; both *Allium sativum* and *Gymnanthemum amygdalinum* plant species (0.75% each) used to treat nine ailments (2.76% each): the former was used to treat NCD of poultry; bovines LSD, blackleg, and wooden tongue; anaplasmiosis of bovines and sheep; constipation bovines, sheep, and goat; dingetegna, bloat, parasitic leech, and coughing of all livestock; whereas the latter also was used to treat PPR (peste des petits ruminants) of sheep and goats; diarrhoea of bovines, sheep and goat; placenta remain of bovines, sheep, goats, horses, and donkeys; babesiosis (liver ailment), eye pain, dingetegna, bloat, and trauma (blood accumulation in the body) of all livestock; and actino-bacillosis/wooden tongue of bovines.

Securidaca longepedunculata was used to treat eight ailments (2.45%), anthrax of bovines, equines, sheep; actinomycosis of bovines; diarrhoea of bovines, sheep, and goat; dingetegna, abdominal pain/ache, bloat, swelling, and babesiosis of all livestock were treated. Both *Cucumis ficifolius* and *Zingiber officinale* plant species (both treat 1.51%) were used to treat seven ailments (2.15% each); among these, *C. ficifolius* was used to treat mainly blackleg of bovines; anthrax of bovines, sheep, and equines; external tumor of bovines and equines; and all livestock of babesiosis, rabies, abdominal pain/ache, and dinegetegna were also treated; whereas *Z. officinale* was used to treat livestock ailments of swelling, actinomycosis, and LSD of bovines; diarrhoea of bovines, sheep, and goat; coccidasis of poultry ailment; bloat and abdominal pain/ache of all livestock were treated in the study area.

The other three plant species (2.27%) that were used to treat six (1.84% each) individual ailments: *Cyphostemma pannosum* was used to treat skin wound and bloat of all livestock; placenta remains in bovines, sheep, and goats; blackleg in bovines; telleriosis (spleen enlargement) in bovines and sheep; anthrax in bovines, sheep, and equines. *Eucalyptus globulus* was used to treat listeriosis, dingetegna, bloat, nasal bote, and coughing in all livestock; it was also used to treat insect infections in bovines, sheep, and goats. *Euclea divinorum* was used to treat actinobacillosis of bovines, conjunctivitis, bloat, dingetegna, and diarrhoea of all livestock, and blackleg of bovines.

Four plant species (3.03%) were used to treat five ailments (1.53% each), such as *Capsicum frutescens* was used to treat poultry coccidiasis and NCD in chickens; spleen enlargement in bovines and sheep; LSD and livestock TB in bovines; *Ensete ventricosum* was used to treat placental remain of bovines, sheep, and goats; diarrhoea, bloat, and trauma (broken bones) of all livestock; and toxicity in poisoned livestock of bovines, sheep, and goats; *Solanum incanum* was used to treat actinobacillosis and actinomycosis of bovines; bloat, swelling, and conjunctivitis of all livestock; *Stephania abyssinica* was used to treat bloat, diarrhoea, and rabies in all livestock; anthrax in bovines, sheep, and equines; and pasteurellosis in bovines.

Among the lower number of ailment-treating plant species, nine plant species (6.82%) were used to treat four ailments (1.23% each): for example, *Calpurnia aurea* was used to livestock mites, fleas, and lice in bovines*;* skin ailment in all livestock; *Coffea arabica* was used to treat LSD and pasteurellosis in bovines; abdominal pain and *aspiration pneumonia* of all livestock; *Coriandrum sativum* was used for bloat, abdominal pain, and swelling in all livestock, including blackleg in bovines; *Erythrina brucei* was used for *aspiration pneumonia*, constipation, bloat, and abdominal pain/ache in all livestock. *Euphorbia abyssinica* was used to treat asthma/stenosis of respiratory organs in equines; swelling, wound, and tumor in all livestock; *Maesa lanceolata* to treat babesiosis*, aspiration pneumonia,* diarrhoea, and rabies in all livestock; *Ocimum spicatum* was used to treat LSD in bovines; AHS in equines; eye pain in bovines; and michi in all livestock; *Rubia cordifolia* was used to treat *aspiration pneumonia* in bovines, sheep, and goats; it was used to treat all livestock diarrhoea, bat urine ailment, and michi. *Sida rhombifolia* was used to treat bloat and snake bite in all livestock; abdominal pain/ache and constipation in bovines, sheep, and goats.

Thirteen plant species (9.85%) were used to treat three (0.92% each) ailments: *Aframomum corrorima* was used to treat abdominal pain, *aspiration pneumonia*, and bloat in all livestock; *Aloe* sp was used to treat body swelling, diarrhoea, and skin wound in all livestock; *Brucea antidysenterica* was used to treat blackleg of bovines; diarrhoea and bloat in all livestock; *Clematis longicauda* was used to treat perganency of bovines; babesiosis, and bloat in all livestock; *Clutia abyssinica* for *aspiration pneumonia* and toxicity of bovines, sheep, and goats; actinomycosis of bovines; *Hesperocyparis lusitanica* was used to treat livestock trypanomiasis in bovines and equines; blackleg in bovines and dingetegna in all livestock.

Foeniculum vulgare was used to treat *aspiration pneumonia* of bovines, sheep, and goats; blackleg and livestock TB of bovines; *Grevillea robusta* for LSD of bovines; constipation of bovines, sheep, and goats; and bloat of all livestock. *Gymnanthemum* sp was used to treat dingetegna and diarrhoea of all livestock; livestock trypanomiasis of bovines and equines; *Prunus africanus* for swelling and bloat of all livestock; back sore of equines; *Ruta chalepensis* was used to treat abdominal pain/ache, bloat, and trauma in all livestock; *Scepocarpus hypselodendron* was mainly used to treat constipation and livestock ascariasis in bovines, sheep, and goats; bloat in all livestock; *Urtica simensis* was used to treat all livestock evil eye (evil spirit) and ailment of bat urine.

Of the 34 (25.76%) plant species, a single species was used to treat two livestock ailments (0.61% each), such as *Acmella caulirhiza* was used to treat the pregnancy (to initiate fertility) of bovines and bat urine ailment in all livestock; *Agave sisalana* swelling of all livestock and NCD of chickens; *Ajuga integrifolia* and *Asparagus africanus* were used to treat the evil eye and evil spirit of all livestock. *Allium cepa* was used to treat actinomycosis and livestock TB; *Artemisia absinthium* and *Cordia africana* were used effectively as livestock medicinal plants for *aspiration pneumonia* (severe coughing) in cattle, sheep, and goats in addition of livestock trypanomiasis (bovines and equines), and bloat of all livestock respectively. *Cymbopogon citratus* and *Gymnosporia arbutifolia* were also potential species used to treat eye pain (conjunctivitis) in all livestock separately including *aspiration pneumonia*, and *Brugmansia suaveolens* was used to treat diarrhoea and bloat in all livestock. *Carduus schimperi* was used for bovines perganency for fetus attachment; poisonous/toxicity plant eaten bovines, sheep, and goats; *Bersama abyssinica* was used to treat anthrax and swelling of bovines, sheep, and equines; swelling of all livestock; *Cyathula uncinulata* was used to treat *aspiration pneumonia* of bovines, sheep, and goats, and blackleg of bovines; *Cyphostemma adenocaule was* used to treat bovines body swelling and bloat of all livestock.

Echinops kebericho used to treat abdominal pain/ache and bloat; and *Euphorbia depauperata* to treat diarrhoea of all livestock and Lumpy Skin Disease of bovines; *Ilex mitis* was used to treat dingetegna and bloat; *Pentanema confertiflorum* was used to treat coughing and livestock TB in all livestock. *Justicia chimperiana* to treat diarrhoea in all livestock; FMD of the bovines; *Millettia ferruginea* was used to treat coughing and *spiration pneumonia* in all livestock; *Ocimum lamiifolium* for bloat and abdominal pain in all livestock; *Olinia rochetiana* was used to treat *aspiration pneumonia* in all livestock and bovines perganency for fetus attachment; *Phaseolus lunatus* for dingetegna and diarrhoea in all livestock; and *Phytolacca dodecandra* was used to treat *aspiration pneumonia* and diarrhoea of all livestock.

Ricinus communis was used to treat eye pain and body swelling of all livestock; *Shirakiopsis elliptica* for diarrhoea and bat urine ailment in all livestock; *Scadoxus multiflorus* was used to treat bloat in all livestock and shoat pox in sheep and goats; *Vepris nobilis* and *Dodonaea viscosa* subsp. *angustifolia* were used to treat diarrhoea and bloat in all livestock; *Zanthoxylum asiaticum* was used to treat rabies and dingetegna in all livestock; *Gymnanthemum auriculiferum* was used to treat skin wound in all livestock and *fowl typhoid* in poultry; *Ximenia americana* was used to treat arthritis (gouge or mondy-morning ailment) of equines and Lumpy Skin Disease of bovines; *Phyllopentas schimperi* and *Coleus abyssinicus* was used to treat cysticercus (livestock ascariasis) of bovines, goats, and sheep; *Withania somnifera* was used mainly to treat arthritis of the equines and all livestock bloat.

Moreover, among the total reported plant species, 61(46.21%) plants were used to treat one (0.31%) different ailment for instance *Achyranthes aspera*, *Albizia schimperiana, Crepis rueppellii, Rotheca myricoides, Lysimachia ruhmeriana, Olea welwitschii, Thymus schimperi,* and *Verbascum sinaiticum* were used to treat *aspiration pneumonia* more in bovines, sheep, and goats. *Antherica* sp*, Carissa spinarum, Helianthus annuus,* and *Kalanchoe hypseloleuce* were used to treat swelling in all livestock. *Apodytes dimidiata, Dicliptera foetida, Hagenia abyssinica,* and *Pavetta oliveriana* were used to treat the ailment of bat urine or jaundice in all livestock.

Oldeania alpina was used to treat trauma (bone broken attachment) in bovines, sheep, and goats; *Balanites aegyptiaca* was used to treat arthritis (gouge) of equines*; Citrus x aurantiifolia* for actinomycosis of bovines; *Clematis hirsuta* was used to treat hepatitis of all livestock; *Colocasia esculenta* and *Lathyrus oleraceus* were used to treat nasal bote (parasitic leech) of all livestock. *Combretum molle, Myrtus communis,* and *Platostoma africanum* to treat all livestock of diarrhoea; *Commelina benghalensis, Erica arborea, Ocimum basilicum* var. *cinnamon*, and *Terminalia brownii* were used to treat constipation of bovines, sheep, and goats*; Lavandula dentata, Oncoba spinosa,* and *Verbena officinalis* were used to treat abdominal pain/ache of bovines and sheep; *Melia azedarach* and *Physalis peruviana* were also used to treat dingetegna of all livestock*; Olea europaea* subsp. *cuspidata* was used to treat livestock tumor.

Oxalis corniculata was used to treat snake bite in all livestock; *Phyllopentas schimperi* was used to treat bovines, sheep, and ascariasis of goats. *Peponium vogelii* was used to treat telleriosis of bovines and sheep. *Phoenix reclinata* and *Schrebera alata* were used to treat conjunctivitis (eye pain) in all livestock; *Rumex abyssinicus* was used to treat babesiosis in all livestock. *Rumex nepalensis* was used to treat livestock tumor (skin warts or venign external tumor) in bovines and equines; *Tapinanthus* sp of hemiparasite was used to treat LSD of bovines and equines, and *Trigonella foenum-graecum* was used to treat faciolosis of bovines, sheep, and goats*; Crinum abyssinicum* was used to treat skin wound of all livestock; *Cyperus rotundus*, *Erythrina abyssinica, Hordeum vulgare, Nigella sativa, Piliostigma thonningii, Rytigynia neglecta*, and

Zea mays were used to treat bloat of all livestock; *Datura stramonium*, *Ekebergia capensis*, *Afrocarpus gracilior,* and *Spiniluma oxyacantha* were used to treat all livestock aliment rabies; *Dicliptera magaliesbergensis* was used to treat reproduction problem of bovines; *Eragrostis tef* was used to treat sore of equines; *Lasiosiphon glaucus* was used to treat FMD of bovines; *Hymenodictyon floribundum* was used to treat livestock ascariasis of bovines, sheep, and goats; *Juniperus procera* was used to treat bovines actinobacillosis. All mentioned ethnoveterinary medicinal plants were used with different applications, preparation forms, means of treatment, and roots of administration (Appendix 4.14) to treat dermatological, gastrointestinal, respiratory, and other categorical different livestock ailments (Appendix 4. 13).

In the study District, traditional healers diagnose livestock ailments before giving traditional medicines, mainly by observation, interviewing sick livestock owners, and touching sick livestock body parts. During the diagnosis exercise, a traditional herbal practitioner identifies the ailment of a sick livestock; he or she has started well preparation and given the proper route and application. Moreover, herbal practitioners dealing with livestock ailments in the communities living in the study sites prepare remedies from different plants that play useful functions against infectious and non-infectious ailments.

4.3.9. Toxicity/poisonous traditional livestock medicinal plants

From the study of livestock ailment-treating medicinal plant species *Calpurna aurea* (Fabaceae), *Datura stramonium* (Solanaceae), *Agarista salicifolia* (Ericaceae) and germinating *Sorghum bicolor* (Poaceae) at the growing stage with two leaves were also reported toxic plant species in addition to medicinal uses, and the traditional extracts of these ethnobotanical plants are used for various purposes. For example, informants reported that the traditional extract of *A. salicifolia* kills rats, and it also kills livestock when they eat the fresh leaves. *C. aurea* kills insects (repelling) and other livestock like mites, fleas, and lice (for skin ailments). This species is said to be fata if swallowed and hence requires attention to neutralize its toxicity. Agricultural expansion, new settlements, local charcoal and overgrazing were the main threats to ethnoveterinary medicinal plants. These maximize the extinction of multi-purpose medicinal plants; attention was required for these poisonous species to neutralize toxicity.

4.3.10. Threats of ethnoveterinary medicinal plant species in the District

Plants in Soro District are threatened by different natural and anthropogenic factors as in many other districts. The major threats to medicinal plants identified by informants are deforestation due to the need for new farmlands for agricultural expansion and new settlements. Excessive use of shrubs and trees, from all habitats, for various functions. Overgrazing in the protected vegetation patches without awareness. The consequences of these activities lead to loss of vegetation, and decrease heritage of indigenous knowledge held by elders and the young generation would not have knowledge about use and management. These all-impact factors contribute to changes in climatic conditions to the environment which cause serious threats. Informed suggestions from different study sites for solutions of those different threats, to conserve those threatened medicinal plants either in the community or vegetation areas of Soro District. Mainly in-situ conservation in their natural habitats, teaching educational awareness in the community for the domestication of indigenous ethnoveterinary medicinal plants by local people around their lives, agricultural areas as shades, roadsides, nursery sites, and reducing exotic substitutions. Hence, these help the sustainability of vegetation of the remained forest patches of the District.

4.4. Discussion

In the study area, livestock are one of the main sources of the agricultural economy, providing power for crop production and livelihoods for the local community. In addition, mostly they provide various services for the rural community, including as pack animals, income sources, aspects of employment with survival values for human life. Furthermore, indigenous people in the local communities have different knowledge, practices, and attitudes toward livestock medical healthcare. Besides, these ethnoveterinary ailments are controlled and prevented by various medicinal plant species, it is important to plan and apply implementation against specific ailments of livestock healthcare systems and their yield improvement (Wirtu et al., 1997; Lulekal et al., 2014; Dinbiso et al., 2022). The reason is that the owners of livestock and semi-pastoralists in Soro District have rich indigenous knowledge and ethnoveterinary practices of herbal medicines and the use of medicinal plants for treating various specific livestock ailments. However, the inherited indigenous knowledge of the individuals varied with gender, age, literacy level, distance between humans and plants, knowledgeable and local informants, and agroecology.

The gender differences showed that males (about 65.89%) have rich information, inherited knowledge, and healing practices on the use of livestock herbal medicinal plants on average (Table 4.20) compared with females (34.11%). This agrees with the findings reported from different parts of Ethiopia (Lulekal et al., 2014; Yigezu et al., 2014; Birhan et al., 2018; Abebe, 2022). In addition, (Yirga et al., 2012) also reported similar outcome information about 100% of herbal practitioners being males; similarly, 94.05% was reported by Yigezu et al. (2014). Abroad in China, the majority of the traditional livestock medicine practitioners relatively 56.7% were also dominated by males (Shen et al., 2010). However, this result of the current study analysis, contrasting the findings of Yineger et al.(2007), showed that female herbal practitioners were as knowledgeable as males. Elderly respondents (*i.e.,* highly experienced older informants) quoted and knew more ethnoveterinary plant species on average than adults and youngsters; however, their differences were statistically insignificant ($P > 0.05$), and the findings did not agree with those of (Lulekal et al., 2014; Yigezu et al., 2014). Whereas, educated informants shared and informed more knowledge on herbal medicine than the non-educated informants (Table 4.20), which was highly significant ($P < 0.05$) and might enhance the application of modern medicine practices due to written information rather than historical telling. These findings also disagree with those of the same authors. Similarly, there was a significant difference in medicinal plants reported from distantly rather than nearby to the main town. This is due to the fact that most of the informants were far from the veterinary healthcare centre, and they relied more on MPs to cure their livestock ailments; they were also highly significant among key respondents compared to general respondents. Because of this, more elder informants were involved in key informants than youngsters, which might increase the rate of local knowledge and biodiversity loss and stop the progress and continuity of knowledge from elders to future generations, likewise the study by Wondimu et al. (2007). Similarly, as observed, indigenous knowledge is disappearing due to most knowledgeable descendants dying without proper documentation of their knowledge, as reported by the same author. Even though a higher average number of medicinal plants were reported from Dega than from Woinadega and Kola, the difference was statistically not significant ($p = 0.112$; $p \geq 0.05$); in this way, most informants can share indigenous knowledge information from different agroecologies.

In the various current study sites, the most informed herbalists were more men than women, with more herbal medicine practices that were related to various parts of Ethiopia (Wirtu et al., 1997; Lulekal et al., 2014;) the reason is that most females take care of their children in their houses more than males; usually, they are culturally household owners with home activities more than males who work near and far from their living houses (Tura, 2014; Yigezu et al., 2014), and shared more experienced information than females. In addition, males had opportunities to gain more enriching indigenous knowledge from their colleagues as well as the elders because they had the freedom to move from place to place. In addition to this, most experienced herbalists have the choice to transfer their indigenous knowledge to the preferable boy or mystery-holding girl when they approach death (Yineger et al., 2008; Cheikhyoussef et al., 2011). The study also agrees with the result of (Yigezu et al., 2014), and it indicated that about 90% of livestock were treated by male owners rather than female owners with traditional medicines. Furthermore, another study also supports the output of this discovery (Birhan et al., 2018; Agize et al., 2022). This finding refers to the unequal knowledge distribution among genders, which disagrees with the study of local knowledge of medicinal plants by (Lulekal et al., 2014), in the world, which stated that females gained and inherited more knowledge than males (Merétika et al., 2010); the differences are due to the culture of the society and the related intellectual achievements and interests in the various countries.

Different agroecological features, ages, and vegetation differences in the study area contribute to diverse medicinal plants under varied agroecological and weather conditions. For example, from Shonkola kebele, a Mountain Shonkola forest patch of dry evergreen Afromontane Forest and Grassland complex vegetation types (DAF), the species *Agarista salicifolia*, *Oldeania alpina, Cordia africana, Erica arborea*, *Calpurnia aurea*, *Carissa spinarum*, *Clutia abyssinica*, *Euclea divinorum, Gymnosporia arbutifolia, Pentanema confertiflorum, Juniperus procera*, *Olea europaea* subsp. *cuspidata*, *Maesa lanceolata*, *Prunus africanus, Afrocarpus gracilior,* and *Spiniluma oxyacantha* were some of the collected multipurpose medicinal indicator plant species; some species of *Combretum-Terminalia* vegetation types are *Combretum molle, Oncoba spinosa*, and *Terminalia brownii*; from riverine plant species such as *Albizia schimperiana*, *Apodytes dimidiata, Croton macrostachyus*, *Erythrina abyssinica, Millettia ferruginea*, *Olea welwitschii, Olinia rochetiana, Phoenix reclinata, Vepris nobilis,* and *Schrebera alata*; from the *Acacia-Commiphora* wood land forest patch area, plant species like *Balanites aegyptiaca, Piliostigma thonningii, and Ximenia americana* were collected, where all representatives have various uses in the different local communities using different traditional knowledge in the three different agroecologies. Thus, the presence of this enormous traditional medicinal plant species in this current finding is highly important to sustain and continue indigenous knowledge with associated attributes, including multi-purpose plant species in natural habitats. Which prevent the loss of vegetation cover from the forest patches as well as elsewhere and increases the status of ethnoveterinary medical plant species, indigenous knowledge, herbal practitioners, and wild edible plant species. The presence of this rich traditional knowledge and plant diversity among the people in the study area, the Soro people, could help to maintain and manage livestock health, food security, and sovereignty, as well as conserve their foods for human beings against different livestock ailments. Although these knowledge practices are linked to the presence and sustainable continuity of ethnoveterinary traditional knowledge through the linkage of modern medicine and wild food plants with associated traditional knowledge for future generations. In the study area, the revitalizing lek linked to folk veterinary practices could be a concrete tool for promoting food sovereignty and traditional livestock healthcare, which can contribute to improving livestock health with food security. This also enhance livestock food security and provide many ecological transition advantages by increasing biodiversity and environmental balance.

Moreover, in developing countries, traditional medicine plant species have been indicated as being the most easily affordable and accessible to treat different types of veterinary ailments (Khan et al., 2019; Dzoyem et al., 2020; Gonfa et al., 2020) and to use for economic purposes. The findings of the diverse use of ethnoveterinary plant species and the use of dominant families collected from high, mid, and low lands were relatively comparable with the findings of other studies in different study areas of Africa, including Ethiopia and other world communities. For instance, in Ethiopia in the Dawuro Zone, Southern Ethiopia, local communities utilized, 103 EVMPs under 47 families for treatment of different LsAs; at the National Park of the Bale Mountains and adjacent areas, 74 medicinal and other multipurpose plants under 37 families were documented for treating 25 ailments (Yineger et al., 2007); in Sekota and Lalibela Districts, 74 medicinal plants (MPs) under 31 families were also reported in four Districts of Jimma Zone, Ethiopia, to treat 22 ailments (Yigezu et al., 2014), 53 medicinal plants under 31 families were documented for treating 22 different livestock ailments (Assefa and Bahiru, 2018), with significant knowledge differences between gender, key and general participants, rural and urban inhabitants, and informant age categories.

Information on ICFs, FL, and PR values of documented medicinal plants would be necessary for future conservation priority species identification, antimicrobial activity, and phytochemical studies. Whereas direct matrix ranking exercise values are also useful impact factors to call urgent conservation attention to those locally threatened multipurpose livestock medicinal plants in the study area through anthropological activities (Assefa and Bahiru, 2018).

Another study conducted in North Shewa, Ankober District 51 EVMPs under 35 botanical families and 50 genera to treat 33 different ailments were documented and published by (Lulekal et al., 2014), 49 EVMPs in Ada'a District of Afar Regional State to treat various livestock ailments (Giday and Teklehaymanot, 2013), 48 EVMPs that belonging to 35 families used to treat 22 livestock health constraints in Dabo Hana District, in Western Ethiopia (Tamiru et al., 2013). Similarly, other studies reported 34 LsMPs under 23 families for the treatment of 22 livestock ailments in Enarj Enawga District, East Gojjam Zone (Birhan et al., 2018). Moreover, the findings of the current study in central Ethiopia, Soro District Hadiya Zone documented relatively more varied numbers of livestock medicinal plants [132 LsMPs] under 61 families and 120 genera and associated indigenous knowledge to treat various veterinary ailments (about 50 ailments; Appendix 4.13) to prevent their impact on the livestock population. Also, varied agroclimatic plant species were reported, and the same medicinal plants were also used to control and treat different ailments in the three climatic conditions of the study sites. Some of the documented LsMP species in Soro District were similarly reported in other ethnoveterinary studies conducted in various parts of Ethiopia.

In this current study 132 of documented livestock medicinal plants, 29 species were reported by Temeche and Asnakew (2020) in the review status of ethnoveterinary medicine in Ethiopia; 29 species were reported in the National Park of the Bale Mountains and adjacent areas (Yineger et al., 2007); 28 species by (Yigezu et al., 2014); 25 species in Abergelle, Sekota and Lalibela districts of Amhara region, Northern Ethiopia (Assefa and Bahiru, 2018); 24 species in selected Districts of Southern Ethiopia by Eshetu et al. (2015); 23 species from Ankober District, North Shewa Zone Amhara Region by Lulekal et al. (2014); 21 species from Ensaro District, North Shewa Zone (Asfaw et al., 2022); 20 species from Wolmera District, Oromia Region (Abera and Mulate, 2019); 19 species by Tadesse and Dereje (2015); 16 species of Ethiopian medicinal plants for veterinary healthcare (Fullas, 2010); 15 species by Mesfin et al. (2009); 14 species from Leka Dullecha District, Western Ethiopia (Tesfaye and Erena, 2020); 13 species from

Seharti-Samre District, Northern Ethiopia (Gidey et al., 2012); 12 species from Enarj Enawga District, East Gojjam Zone (Birhan et al., 2018); 11 species in the study of southern African medicinal plants (McGaw and Eloff, 2008); nine species in South Wollo Zone (Wodegebriel et al., 2018); six species in both Mojana Wodera District, Central Ethiopia (Abebe, 2022) and Ada'ar District, Afar Region (Giday and Teklehaymanot, 2013) were similarly well documented. These findings indicated that the widespread use of livestock medicinal plant species was indicated as LsMPs and associated local knowledge in preventing and controlling various veterinary ailments in different parts of Ethiopia. Furthermore, these traditional medicinal plant species are used to treat domestic livestock ailments in different geographical locations. It disseminates indigenous knowledge more widely across the community's geographical sites.

Some of the ethnoveterinary plant species were widely used and popular in Soro District to treat various specific livestock ailments. For example, *Momordica foetida* was used to treat and manage diarrhoea, *aspiration pneumonia*, blackleg, anthrax, LSD, actinobacillosis (wooden tongue), and *Withinia somnifera* was used to treat and manage bloat, blackleg, and arthritis (gouge or mondy-morning ailment). Similarly, other ethnoveterinary practitioners used *Withania somnifera* for the treatment of listeriosis and blackleg, which was also reported in different parts of Ethiopia, in Ada'ar District, Afar Region (Giday and Teklehaymanot, 2013), and Ankober District, Amhara Region (Lulekal et al., 2008a). Another study, according to Tolossa et al.(2013), also reported *Momordica foetida* ethnoveterinary medicinal use and management of blackleg in South Omo, Southern Ethiopia. This wide spread use of the ethnomedicinal plant species in these different cultural groups of Ethiopia suggests their effectiveness in alleviating blackleg and deserves pharmacological investigations. *Cucumis ficifolius* was the other important recommended plant species used against anthrax, rabies, babesiosis, blackleg, dinegetegna, and venign tumors in the study area. It agrees with the findings of other ethnoveterinary surveys conducted in different parts of Ethiopia, which witnessed the common use of *C. ficifolius* for the treatment of blackleg, according to Yigezu et al. (2014), and rabies by Tadesse and Dereje (2015). Moreover, *Nicotiana tabacum* was used in the management of nasal bote/leech, snake bite and insects' infection infestations in Soro District. Similarly, in Libo Kemkem District of the Amhara Region (Chekole et al., 2015), suggested in a similar way the use of *N. tabacum* to treat leech infection, which agrees with (Teklay et al., 2013) in Kilte Awulaelo District, Tigray Region, using leech.

The majority of the rich ethnomedicinal plants were collected and reported from wild habitats (79.54%), which relatively agreed with the findings of the wild plant sources (78.79%) reported by Abebe (2022) and 81.08% by Yigezu et al.(2014), also, some were collected from agricultural croplands, and another few plant species such as *Antherica* sp, *Asparagus africanu*s, and *Securidaca longepedunculata* were reported from the market survey in Soro District that were highly commercialized for the purpose of livestock medicines. In contrast in other parts of Ethiopia, *Embelia schimperi* and *Withania somnifera* were documented marketable plant species in the local markets of the Ankober District, North Shewa (Lulekal et al., 2014). In addition, some numbers of food, food spices and condiments were reported from market survey of Soro District, plant spices, of these *Trigonella foenum-graecum* sold in the findings of Teklay et al.(2013) in Kilte Awulaelo District, Tigray Region State reported similar species from a market survey that were sold as sources of food and spice. Moreover, a few others, indirectly from other ethnobotanical uses, like *Artemisia absinth*ium mainly sold by women, whereas *Nicotiana tabacum* sold from other social drug smoking in the market Jajura market by men traders. Moreover, our analyzed results data of Soro District showed that Asteraceae ranked 1st, Fabaceae and Lamiaceae (2nd), Solanaceae (4th), Rubiaceae (5th), both Euphorbiaceae and Poaceae (6th), Amaryllidaceae and Rutaceae (8th) were dominant and frequently reported medicinal plant families (Figure 4. 22) and share livestock medicinal values in the country; in addition, in the world. The study similarly reported that Asteraceae, Lamiaceae, and Euphorbiaceae were dominant families in Ethiopia which similarly studied by another investigators (Yineger et al., 2007; Lulekal et al., 2013; Yigezu et al., 2014; Tekle, 2015; Birhan et al., 2018; Asfaw et al., 2022). Similarly, Asteraceae, Fabaceae and Solanaceae were dominant families in the study (Abebe, 2022).Whereas, Asteraceae was the most commonly used and diversified medicinal plant family, which in line with the findings of (Mesfin et al., 2009; Lulekal et al., 2014; Abera and Mulate, 2019; Dinbiso et al., 2022), and it was one of the world leading largest families.

In Soro District, herbs were dominant finding and used for various medicinal preparation purposes by indigenous people, followed by shurbs (Figure 4.24) and similarly reported by (Yineger et al., 2007; Tekle, 2015a; Birhan et al., 2018), and this information might be important for the survival of shrub and tree species from excessive harvesting. In addition, leaves (43.18%) were the most frequently utilized, preferable, easily available, and simplicity in remedy preparation, and dominant harvesting plant parts in the current study for livestock medicinal use, and which agrees with many other studies in Ethiopia (Lulekal et al., 2014; Yigezu et al., 2014; Tekle, 2015a, 2015b; Feyera et al., 2017; Shimels et al., 2017; Assefa and Bahiru, 2018; Abera and Mulate, 2019; Abebe, 2022) and also in South Africa (Chakale et al., 2022). Moreover medicinal practitioners use this highly available leaf part rather than root and bark parts to decrease the loss of plants from natural habitats (Yineger et al., 2007; Getnet et al., 2016; Moges and Moges, 2019).

In the current study most herbal medicine preparations were done mainly by decoction, concoction, and crushing (Figure 4.28); many livestock medicinal local practitioners used fresh plant parts to heal effectively and efficiently, mainly in the form of decoction using a single species followed concoction using two or more medicinal plant species to treat a single ailment, and this was disagreed by (Yineger et al., 2007; Abera and Mulate, 2019), and agreed with study of (Wondimu et al., 2007). In many sites of the study area, like several study areas in Ethiopia, medicinal preparation for use in different applications (Figure 4.29) using fresh plant medicinal parts in combination or alone was documented. In addition, those dominantly useable medicinal fresh organs might be retained secondary bioactive metabolites that occurred more in fresh parts than in dry matters (Gazzaneo et al., 2005; Njoroge and Bussmann, 2006; Yineger et al., 2007; Lulekal et al., 2014; Tekle, 2015a). In the current study most herbal medicine preparations were done mainly by mixing a single, with two and more medicinal plant parts to treat a single ailment with cold and warm water, and using other locally available types of additives or without additives; which was similarly reported in other study parts (Gebremedhin et al., 2018; Maryo et al., 2015). The oral treatment route is the main route of remedy administration in the study area (Figure 4.25) and agrees with finding of other study parts of Ethiopia (Yineger et al., 2007; Giday, 2009; Giday and Teklehaymanot, 2013; Tekle, 2015b; Maryo et al., 2015; Assefa and Bahiru, 2018; Birhan et al., 2018; Temeche and Asnakew, 2020), followed with dermal treatment which also agreed with (Yineger et al., 2007; Birhan et al., 2018; Temeche and Asnakew, 2020) in common.

Informant consensus factor (ICF=0.72, 0.71, and 0.70) showed the most prevalent ailments in each category in the study area and the least prevalent ailments with smaller ICF values had effective healing potential plant species (Table 4.21). Similarly Lulekal et al. (2014) reported a high informant consensus factor (0.71) to treat gastrointestinal ailments with popular curative plants. According to Sharma et al. (2012) also similarly have shared high ICF for dermatological ailments that have a high incidence of livestock ailments and are treated using high curative potential plant species. Since values of high ICF are indicative of the selection of target plant species for the sake of future therapeutic drugs and other useful photochemical compounds (Heinrich et al., 1998). Likewise in Soro District, curative potential plants were used to treat the most prevalent livestock dermatological ailments for instance Foot and Mouth Disease/Ailment and Lumpy Skin Disease/Ailment were treated using *Croton macrostachyus,* blackleg treated by *Cyathula uncinulata* and ailment of bat urine by *Momordica foetida*; among gastro-intestinal potential ailment, diarrhoea, abdominal pain, acidiosis, anthrax, actinobacillosis (wooden tongue), telleriosis, and New Castle Disease/Ailment (NCD/A) were treated by different healing effective plants discussed on preference ranking and FL values as well as a series respiratory infection like *aspiration pneumonia*, pasteurellosis (livestock TB) treated by *Pentanema confertiflorum* and *Stephania abyssin*ica. According to Lulekal et al. (2014) plants with higher informant consensus values are thought to have more secondary bioactive metabolites for frequently occurring livestock ailments. These ranking activities showed that indigenous people highly depend on ethnoveterinary medicinal plants, even though the distribution of modern healthcare systems is rapidly increasing. The highest FL values (Table 4. 22) among curative medicinal plants were accounted for *Datura stramonium* (100%) is highly effective to treat rabies from the neurological ailment, *Dodonaea viscosa* subsp. *angustifolia* (100%) in treating gastrointestinal PPR, *A.africanus* (100%) to treat evil eye/evil spirit; *Croton macrostachyus* (98%) for FMD among dermatological ailments, and which is in line with the studies of (Kloos, 1977; Lulekal et al., 2014; Yigezu et al., 2014). Moreover, it indicated that *Croton macrostachyus* has the highest dominantly reported healing potential of plant species to treat dermatological ailments, and it was used to treat a variety of ailments alone or with combinations of other medicinal plants and additives in the study area. Others medicinal plant species *Albizia schimperiana* (96%) was used to treat *aspiration pneumonia*, and *Brugmansia suaveolens* to treat diarrhoea (92%), and they were the most important potential medicinal plants reported in the study area. FL is an important botanical tool to measure potential medicinal plants with the healing ability of the individual plant species and provide good information for future pharmacological investigation techniques, and it supported by (Trotter and Logan, 2019). Also, in preference ranking exercise (Table 4. 23), *C. macrostachyus* also reported the highest (86%) and most efficacious to treatment Lumpy Skin Disease/Ailment followed *Ximenia americana*

(75%) and *Allium sativum* (74%). In the study area, there were significant knowledge differences in ethno-therapeutic practices to protect livestock health between males and females, key and general participants, rural and urban inhabitants, and different age groups of informants (Table 4.20). Information on ICF, FL, and PR values of documented ethnoveterinary medicinal plants would be necessary for future antimicrobial activity and phytochemical studies. Whereas DMR exercises (Table 4.24) also call for urgent conservation attention to those locally or nationally threatening multipurpose livestock medicinal plants in the study area through anthropological activities.

4. 5. Conclusion

This study showed that Soro District has diverse traditional medicinal plants used for treating various livestock ailments, using indigenous and local ethnoveterinary knowledge, and ethnoveterinary skills and practices. In this investigation, 132 ethnoveterinary medicinal plants were documented to treat 50 livestock ailments. The data on medicinal plant species were collected, confirmed, and documented from different study sites (n = 13) in the District that help to defend against various types of potential livestock ailments and are used for various functions. Most of them were used to treat a single livestock ailment; others were used to treat poly-ailments with different plant parts prepared alone or poly-medicinal plants with the use of other additives or without additives. Through the study in the selected kebeles, *Carduus schimperi* and *Clutia abyssinica* were cited for use as antidotes in the event of severe reactions of poisonous plant species eaten by livestock. In addition, they are also important medicinal plant species. The majority of the medicinal plants were reported from the natural wild habitats in different agroecological areas. Some were reported in the localities of agricultural lands and stalling vendors of an open local market, for example, *Antherica* sp., *A. africanus, Securidaca longepedunculata,* and some others were from market-stalling sites for spices that were sold as food, food flavors, or indirectly sold by women for medicinal uses that were brought from their rich homegardens, commonly *Artemisia absinthium*, *Allium sativum, Coriandrum sativum, Foeniculum vulgare, Ocimum basilicum,* and *Ruta chalepensis*. Among food products: *Ensete ventricosum*, *Eragrostis tef*, *Hordeum vulgare,* and *Zea mays*; vegetable foods of *Colocasia esculenta*; and stimulants: *Coffea arabica* and *Nicotiana tabacum.* Moreover, knowledge use in medicinal plants exists with significant differences among parameters. Ethnobotanical tools (ICF, FL, and PR) provided good information for setting more conservation priorities, remedy utilization, and future anti-microbial activities on claimed highest-ranked potential curative medicinal plant species, making them more essential inputs for future therapeutic drug inquiries to develop modern medicines. DMR exercises on use attributes hinted at the need for setting up conservation priority for plant species such as *Prunus africana*, *Combretum molle, Afrocarpus gracilior*, and *Olea welwitschii*, and species reported in preference ranking (PR) from homegardens *A. sativum* and *Croton macrostachyus* in woinadega*, Ximenia americana* in kola, and *Juniperus procera* more from dega agroecology. In the FL, *Datura stramonium* against rabies*, D. angustifolia* against PPR*, A. africanus* against evil eye (evil spirit, including other ailments), and *C. macrostachyus* efficacy to treat FMD and potentially promising species with respect to others treating different livestock ailments were recoded. These important ethnoveterinary plants were found under various threats as a result of various anthropological and environmental factors, and hence conservation attention is required to prevent the decline of these flora. Also, it calls for researchers to raise awareness with the consultation of community-targeted traditional practitioners, including agriculturalists and ethnobotanists, and ecologists to adopt lifestyles focused to sustainable use. Therefore, this would enrich and save diverse multipurpose medicinal plants with associated indigenous herbal knowledge in the study area. Most of the identified and confirmed ethnoveterinary plant species in the current study could be effective for future phytochemical and pharmacological activities, and they have also warranted the future profile of the plant species reported by indigenous people.

CHAPTER FIVE

5. Ethnobotany of wild edible plants in Soro District of Hadiya Zone, central Ethiopia

Mulatu Hankiso, Bikila Warkineh, Zemede Asfaw and Asfaw Debella

Abstract

Despite their paramount importance all over the globe in supporting food security, information about wild edible plants is generally patchy. In this study, we investigated the wild edible plants used by the local people in Soro District of Hadiya Zone, central Ethiopia. The main purpose of the study was to document and analyze the indigenous and local knowledge of the people on their abundance, diversity, use and management. Purposive and systematic random sampling were used to identify informants who can give information about the wild edible plants of the area. Data were collected by interviewing 26 purposively sampled key informants and 128 systematically random sampled general informants using semi-structured interviews. Guided observations and 13 focus group discussions (FGDs) consisting of 5-12 participants/discussants at each FGD session were also undertaken. Statistical analyses (mainly descriptive statistics approaches) and common analytical tools of ethnobotany including informant consensus, informant consensus factor, preference ranking, direct matrix ranking, paired comparison and index of fidelity level were applied to the data sets. A total of 64 wild edible plant species belonging to 52 genera and 39 families were recorded. All of these species are indigenous, 16 are new additions to the data base and seven of them, including *Urtica simensis* and *Thymus schimperi* are endemic to Ethiopia. In about 82.81% of the species the edible plant part is also used in the Ethiopian traditional herbal medicine. It is striking to see that almost all wild edible plants recorded from the study area are nutraceutical plant species, serving multiple roles as food and therapeutic sources for the local people. We recorded five growth habits of 34.38% trees, 32.81% herbs, 25% shrubs, 6.25% climbers, and 1.56% liana. We found the Salicaceae, Solanaceae, and Moraceae to be families that represented by more species (4 each), followed by Acanthaceae, Apocynaceae, Amaranthaceae, and Asteraceae, which accounted for 3 species each. Fruits (53.13%) and leaves (31.25%) were consumed in more proportions than other edible parts (15.63%); mostly the ripe, raw fruit is eaten upon simple processing, followed by leaves eaten after boiling, roasting, and cooking. The frequency and intensity of consumption of these plants varied significantly ($P < 0.05$) with gender differences, key and general informants, and people's religious backgrounds. We postulate that priority setting for in-situ and ex-situ conservation of multipurpose wild edible plants in human-inhabited landscapes is essential to warrant sustainable use and conservation of the species as well as use of new modes of application and valorization.

Keywords: Ethnobotany, nutraceutical plants, Soro District, wild edible plants

5.1. Background

In the world, there is an accumulation of ethnobotanical knowledge of wild edible plants (WEPs) that are used for the survival of human life. The use of these essential WEPs has been well-documented in different regions of the world, particularly those used more frequently during times of food insecurity (Grivetti and Ogle, 2000; Ogle, 2001; Jman Redzic, 2006) and in low-income communities. They are a supporting basket of global food (sometimes referred to as the wild supermarket) feeding numerous human populations in situations of various environmental shocks, drought, and famine (Tebkew et al., 2018). Moreover, people mainly living in rural areas depend on different types of wild foods from various growing habitats (from agricultural lands, forest and forest patches, grazing woodlands, permanent and temporary riversides, and the like) based on indigenous culture (Ju et al., 2013; Tebkew et al., 2018). WEPs have paramount importance all over the globe for supporting food security (Chakravarty et al., 2016) to improve the nutritional values, and antioxidants in diets, and this is more so for people in the developing countries (Arnold et al., 2011). According to the reports of FAO (Aberoumand, 2009), more than one billion people in the world use mostly wild plants as food sources.

Consumption of wild edible plants is one of the feeding habits and features of the community in developing countries including Ethiopia (Balemie and Kebebew, 2006; Teklehaymanot and Giday, 2010; Tebkew et al., 2018). Different parts of WEPs such as fruits, leaves, roots, tubers, seeds, rhizomes, and other parts used for the supply of different food types (Tebkew et al., 2018) and used for sources of local tea spices (like leaves with young shoots as observed in *Ageratum conyzoides* and *Dicliptera laxata* in the current study District).

In the plant use habits of the indigenous communities, WEPs also serve as a source of local cash income for the rural communities (Asfaw and Tadesse, 2001; Amente, 2017; Aragaw et al., 2021). WEPs could also be used as regular food (sometimes utilized as complementary food) and supplementary foods (*i.e.,* mainly serving wild edibles for children and other indigenous community members. WEPs are important in food/nutrition diversification to complement and balance the modern cereal-dominated nutrient sources (Bhatia et al., 2018; Dejene et al., 2020) including as means for ensuring the food sovereignty of indigenous local communities. However, despite their significance as food and medicine as well as dietary antioxidant sources and as components of community-valued food ingredients, at present traditional knowledge and practices of WEPs are being eroded through acculturation and loss of biodiversity due to human activities. Aboriginal people could be cited as examples to verify the importance of traditional WEPs and the eroded indigenous knowledge, culture and biodiversity loss that led to the challenges in livelihood (Asfaw, 2008). Hence more ethnobotanical investigations are very crucial for future societies to maintain and overcome impacting factors of indigenous plants on the ethnobotanical knowledge of the people. Such knowledge can serve to conserve many important WEPs for overcoming a painful period of modern food problems that many countries are facing today.

Despite all these benefits and values, WEPs are not adequately documented in many parts of Ethiopia. So far, information on 413 WEPs under 224 genera in 77 families, further showing that these were documented from only about 5% of the 494 Ethiopian weredas/districts (Lulekal et al., 2011). These species are used as seasonal supplementary foods having a potential role to combat food shortage that leads to famine. Another study provided information on 378 WEPs used in Ethiopia (Lulekal et al., 2011). Soro District is among those administrative Districts not covered in the various reports available to date. A publication by Asfaw and Tadesse (2001) had earlier indicated that about five percent of the total WEPs contribute to human food consumption and are utilized during normal periods and in famine situations when the food insecurity challenges escalate (Lulekal et al., 2011).

In Ethiopia, the favorable climatic conditions, topographic features, ethnicity, linguistics and religious diversity led to the accumulation of wild plant lore (Addis et al., 2005). The study undertaken recently in other parts of Ethiopia showed the indigenous use of plants and the possibility of conserving various multipurpose plants in different agroclimatic settings (Alemayehu et al., 2015b; Kidane and Kejela, 2021). Ethnobotanical studies on WEPs are growing in various natural habitats (Beluhan and Ranogajec, 2011). They are neither cultivated nor domesticated but available in wild habitats and harvested at different seasons to fill the gap of food insecurity (Lulekal et al., 2011; Melaku and Ebrahim, 2021) and to supplement the regular food at other times (Addis et al., 2005, 2013; Kidane et al., 2015). Studies made in parts of southern and western Ethiopia (Addis et al., 2013; Kidane et al., 2015; Regassa et al., 2015; Ashagre et al., 2016) have shown that WEPs are important for nutrition, particularly for children and women.

Geographically, Ethiopia is located in the East African phytogeographical region with diverse ethnic groups, and biological diversity with enormous traditional practices. Many parts of the country are still unexplored or under-explored about ethnobotanical knowledge. Like many parts of Ethiopia, indigenous people in Soro also used wild plants as foods and nutraceuticals in addition to other multiple purposes (*i.e*., different WEP species are used as sources of food and medicine).

5.2. Methods and Materials

The field study on WEPs of Soro District was conducted at the time intervals of March 2021 to April 2021, and October 2021 to November 2021. Major towns in the District include Gimbichu, the center of the District, and Jajura. The District is one of the fifteen Districts of the Hadiya Zone, and the people of Soro are Cushitic language (Hadiyissa) speakers of the Hadiya ethnic group. The District is located 32 km away from Hossana town (the center of central Ethiopia) in the southwest (SW) direction, 200 km SW of Hawassa town of former Southern Nations, Nationalities and Peoples Region, and 264 km SW from Addis Ababa, the capital of Ethiopia. Geographically, Soro District lies between 37^0 20' 0" to 37^0 47' 23"E longitudes and 07^0 19' 4" to 07^0 33' 48" N latitudes, with altitude ranges from 799 masl to 2934 masl. The Kembata Tembaro Zone borders it on the south, the Dawro Zone on the SW, the Omo River on the west, the Duna District on the southeast, the Gomibora District on the north, the Lemo District on the northeast, and the Mountain chains of Gibe River valley on the western lower part nearby Yem Special District/Zone (SDARDO, 2020). It has features of the Omo-Gibe basin with two tributaries of the Gibe River (Figure 2.1).

This study District has 33 rural kebeles with two rural towns of Kosha and Abuna. The total land area covers 36473.337 km^2 (3647333.7 ha). The population of Soro is 287 589; of these, 143 835 are men, and 143 754 are women (SDFPEDO, 2020). The majority (87.42%) live in rural environments, and the rest (12.58%) live in urban centers (SDFPEDO, 2020).

The economic activities and livelihoods of the community are agriculture (85%), livestock and crop production, beekeeping, and limited commerce (SDFPEDO, 2020). Each household's land possession ranges from 0.5–2.5 hectares on average agricultural land tenure per farmer household; 10% of the population is employed, 3% merchants, and 2% others (SDFPEDO, 2020).

The topography is characterized by high mountains of dega/highland (*e.g.* Mountain Shonkola with its high peak at 2836 m.a.s.l), surrounding hills, and flat lands. This topographic variation contributes to the diversification of wild food plants. All study information was captured with a map of the study area, a climate diagram, a pie chart, tables, and numbers with percentages.

The vegetation of the study area is characterized by the Afroalpine belt (AA), Dry evergreen Afro-Montane Forest and Grassland complex (DAF), and *Combretum-Terminalia* vegetation types that make suitable habitats for various plant compositions and diversity including WEPs. The current vegetation classification of Ethiopia is characterized by the presence of different indicator species (Friis et al., 2011). *Lobelia giberroa* and *Erica arborea* are indicator species of the Mountain Shonkola Forest patch of the study area, representing the vegetation type of AA and other representative indicator species of DAF, of which *Carissa spinarum, Euclea divinorum, Syzygium guineense*. subsp. *afromontanum* are WEPs and other wild edibles like *Asparagus africanus, Myrsine africana, Phoenix reclinata, Rubus apetalus, Rubus steudneri, Rumex nervosus, Spiniluma oxyacantha, Thymus schimperi, Zanthoxylum asiaticum* synonym of *Toddalia asiatica,* among others. The *Combretum-Terminalia* vegetation type includes some representative WEP species such as *Acokanthera schimperi, Carissa spinarum, Diospyros mespiliformis, Ficus thonningii, Ficus vasta, Oncoba spinosa, Piliostigma thonningii, Maytenus senegalensis, Syzygium guineense* var. *guineense, Warburgia ugandensis*, *Ximenia americana,* and *Ziziphus spina-christi.* During different rainy seasons, these vegetation types provide ample supplementary wild edible foods to the community with medicinal and other uses. However, the vegetation of the study area (variously characterized types of remnant forest patches is under the pressure of human activities and mainly agricultural expansion as a consequence of wild edibles, medicinal and extractive use for other purposes, and these resources are declining.

Agroclimatic features of the District are mainly categorized into 39.4% dega (high land), 36.4% woinadeg*a* (middle land) and 24.2% kola (low land) climates. The altitudinal range of the main agroclimatic zones is classified respectively into 2300-3500 m.a.s.l, 1500-2300 m.a.s.l, and 500-1500 m.a.s.l (Reusing, 2000).

Patterns of rainfall distribution and temperature regimes vary within the study area. The rainfall has a bimodal pattern with a short (March to May) and long rainy season that extends from June to August (Kibemo, 2011), sometimes extending from June to September (SDARDO, 2020). According to the District Agricultural Office, the mean annual maximum rainfall is 900 mm-1500 mm which has an opportunity for the growth of common crops. The most extended longest rainy season is summer, traditionally "Kiremt," which is the time of the main cropping and growing season. The harvesting season is winter ("Bega"). While the short rainy season Mehere ("Belg"); the cropping season of *Zea mays* (Boqqolla-Hadiyissa/Had.), *Solanum tuberosum* (Dinnichcho-Had.), varieties of *Hordeum vulgare* (Gillaloo'i so'o-Had.), *Phaseolus lunatus* (Lob otongora-Had.), *Vigna unguiculata* (Hoffi otongora-Had.) and harvesting in June to replace other cereal crops. For instance, *Vicia faba* (Baaqeela), *Triticum aestivum* (Arasa-Hadiyissa/Had.), *Pisum sativum* (Gite'e-Had.), *Hordeum vulgare* (So'o-Had.), *Eragrostis tef* (Xaafe'e-Had.), *Brassica carinata* (Fiishsho'i shaana/Asussa-Had.).

According to climate data (2010-2019) from the center of the Ethiopia National Metrological Services Agency, ENMSA, the mean annual rainfall is 1226 mm; the peaks are between March and August and the beginning of September. The yearly mean annual temperature of the District is 23.5 ºC (Figure 5. 30). At the same time, a dry season occurs from November to February. March to April and mid-June, the long rainy season, is also the time of flourishing and ripening wild edible plants. The highest rainfall occurs in July and August, the time of main cropping and growing cereal crops; later, rain decreases in September. According to secondary data, the highest average maximum temperature of the study area in Gimbichu is 34.8ºC in the warmest month. The lowest average minimum temperature is 14.7 ºC and is recorded relatively coldest month.

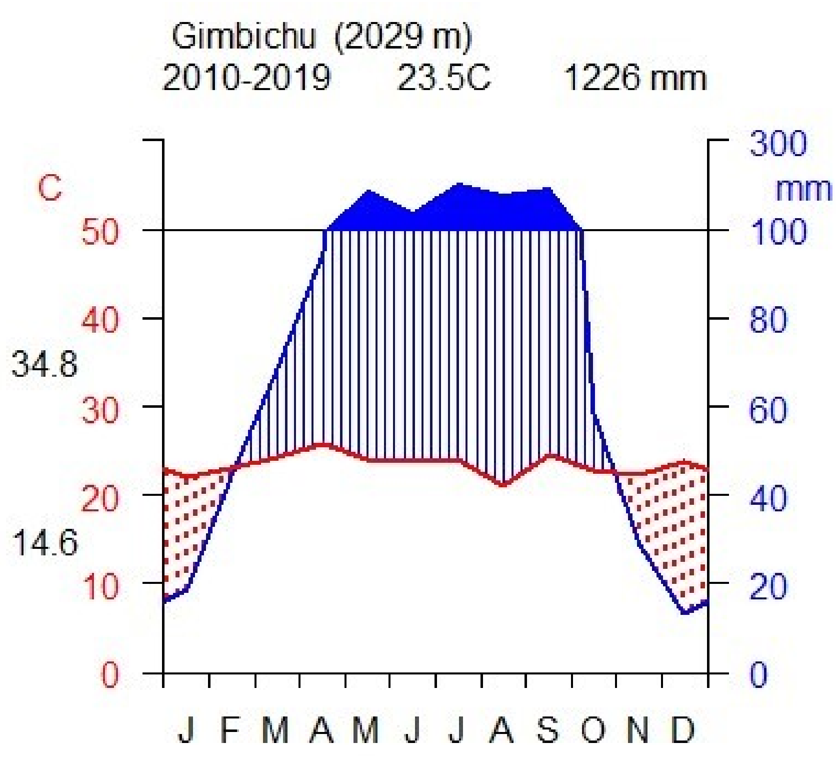

Figure 5. 30. Climate diagram of Soro District, Gimbichu (Data source: NMSA, Ethiopia)

5.2.1. Site selection and sampling methods

The investigation and data collection of wild edible plants was conducted in the three agroclimatic zones in Soro District, central Ethiopia at different time intervals during their flowering and fruiting times. Guided observations and reconnaissance surveys were made first before site selection. A focus group discussion was made in Gimbichu town that involved 12 participants (11 males and one female), Soro District, in November 2021.

Different stakeholders were involved from various offices, and thirteen potential kebeles were purposively selected from the three agroclimatic zones of dega (cool and humid) with 2300–3200 m.a.s.l. having 11.5–16 °C mean annual temperature, and 900–1400 mm of mean annual rainfall; woina dega (cool sub-humid) with 1500–2300 m.a.s.l., having 16.0–20.0 °C mean annual temperature and 900–2200 mm of mean annual rainfall; and kola (warm semi-arid) traditional agroclimatic zones with the altitude ranging from 500–1500 m.a.s.l., having 20.0–27.5 °C mean annual temperature and 300–900 mm of mean annual rainfall (EBI, 2022).

Each kebele administrator was involved in facilitating the processes of informants selection and FGDs and gave guidance and information on potential vegetation areas where WEPs and their uses are expected to be higher. Four potential sites were identified from four directions for data collection, focusing on wild edible plants with participation of different informants. The basic data about the study sites (kebeles) including altitudinal ranges, agroclimatic zones, informants' sociodemographic attributes (gender, ethnicity and language) are given in Table 5.25. Three of the 13 sites are found in the highland dega agroclimate, seven in woinadega and three in kola. In these sample villages, almost all informants (152; 122 males and 30 females) belong to the Hadiya ethnic group and speak Hadiyissa language; the rest two informants, speak the local language Hadiyissa of the study area and other languages (Afaan Oromo and Amharic). Of the interviewed total informants, 141 (111 males and 30 females) are Protestants, 7 Adventists, 4 Apostles and 2 Orthodox. Most of the interviewees (117, 75.97%) were farmers, others housewives (12, 7.79%), non-employed, traders, government employees, unemployed and with no regular income, and farmer and artesian. Most of the informants were married (151, 98.05%), two widowed and one single. About 81% of the informants had primary school education (grades1-4), (5-6), and 7-8; and 16% secondary school (9- 12) and two higher educational level.

Table.5.25. Sampled administrative kebeles with informants interviewed, altitudinal ranges, agroclimatic zone, and socio-demographic profile

No.	Kebele (Subdistrict)	Altitude (masl)	Agro-climatic zone	Socio-demographic profile			
				Gender		Ethnicity (Had, Oro, Amh)	Language (Hadiyissa, Afaan Oromo, Amharic)
				M	F		
1	Kosha	2322-2487	D	8	1	Had	Hadiyissa
2	Shonkola	2321-2826	D	11	2	Had	Hadiyissa
3	Beinera	2186- 2453	D	10	1	Had	Hadiyissa
4	Bambo	2061-2111	WD	12	3	Had	Hadiyissa
5	Wosheba	2043-2118	WD	11	4	Had	Hadiyissa
6	Bure	2044-2096	WD	13	3	Had	Hadiyissa
7	Sundusa	2038-2120	WD	10	2	Had	Hadiyissa
8	Share	1755-2062	WD	12	3	Had	Hadiyissa
9	2nd Hankota	1552-1982	WD	13	4	Had	Hadiyissa
10	2nd Oda	1705-2097	WD	12	4	Had	Hadiyissa
11	Ambe-lenge	1345-1568	K	6	1	6 Had,1 Oro	Hadiyissa, Afaan Oromo
12	Gebebe-lenge	1541-1550	K	2	1	Had, 1 Amh	Hadiyissa, Amharic
13	Burye-lenge	1495-1548	K	4	1	Had	Hadiyissa
Total		-	13	124	30	-	-

Note: Had = Hadiya/Hadiyissa; Amh = Amhara/Amharic/Amharigna; Oro = Oromo/Afaan Oromo; D = dega; WD = woinadega; and K=kola.

5.2.2. Design of sampling and informant selection

A sample size of the study sites was determined following standard procedure (Kotrlik and Higgins, 2001) based on the heterogeneity of the three agroclimatic zones having altitudinal variation and agroecology (high land, middle land, and low land), potential vegetation areas, forest patches, information on the occurrence of knowledgeable informants, elderly knowledgeable people are known to have rich indigenous knowledge on uses of multipurpose wild edible plants. A total of 154 informants were involved; 128 general informants were taken by systematic random sampling, and purposively selected 26 key informants (two knowledgeable key informants from each kebele) were chosen to get sufficient information about WEPs following the recommended in different literature sources (Martin, 1995; Alexiades, 1996).

5.2.3. Data collection and identification of voucher specimens

Ethnobotanical data of wild edible plants were collected from different elevation sites ranging from 1345 to 2836 masl following the guided field observation, reconnaissance survey, and semi-structured interviews of the purposively selected key and systematically random sampled general informants. The key local informants were selected using purposive sampling techniques, which were made at each study site. Market surveys in four markets of the study area (Gimbichu, Jajura, Humaro, and Kosha) and focus group discussions using various representatives were made. Voucher specimens were collected from thirteen kebeles of selected sites with the help of local field guides and information from the FGDs. Collection sites include home gardens, agricultural lands, roadsides, forests, grasslands, and river sides/margins. Notes on growth form, living habitat, and other particular features of each plant were recorded. Identification of common and easily known voucher specimens was made in the field. Specimens of all plants recorded (identified and unidentified) were brought to the National Herbarium [ETH], Addis Ababa University, and identified, confirmed, and standard labels were prepared following the usual herbarium techniques (Forman and Bridson, 1989). For example, the scientific names of the species collected were determined using the relevant volumes of the Flora of Ethiopia and Eritrea (Hedberg and Edwards, 1989; Hedberg et al., 2006). The determination was further refined with visual comparison using authenticated herbarium specimens, and finally, the accuracy was checked by a senior plant taxonomist. The plant specimens with their labels were finally deposited at the National Herbarium (ETH) in Addis Ababa, Ethiopia.

5.2.4. Focus group discussions (FGDs)

During actual data collection, 5-12 participants were involved in focus group discussions representing various groups of people. One FGD was conducted in each kebele using semi-structured questions where knowledgeable cattle-keeping young children, kebele managers, key informants, community elders, religious and community leaders, forest patch dwellers, apiculturists and woodworkers, potter's men, and women were participating. They responded to questions on the diversity of wild edible plants, most preferable WEPs, common and rare edibles, threats to wild edible plant species, and ways of conservation and management. Moreover, participants provided information about using wild edibles and helped collect specimens. Each discussion was guided by the kebele administrator, guide and environmental protection expert, and forest and climate change officer, who also served as language translators for other team members' discussions. Verbatim information from the meeting was chaired and recorded by the investigator (first author). Local names of wild edible plants, parts used, maturity level used for consumption, seasons/months of ripening, consumption time (during a shortage of regular food such as during drought and famine or normal periods), how and who prepares more using different preparation methods for consumption, causes of health problems and feelings if occurred when the parts are consumed; antidote and other uses were discussed.

A total of 113 FGD participants in 13 kebeles, 12 males and 25 females aged 18-35; 31 males and 20 females aged 36-59, and 22 males and three females aged $\geq$ 60 years were involved. Different numbers of participants in each FGD were involved.

5.2.5. Methods of data analysis

Gathered data were analyzed by qualitative and quantitative approaches, and descriptive statistics (Martin, 1995). Microsoft Excel spread sheet software version 2016, SPSS version 25, and one-way ANOVA and R program using R.4.2.2 software were employed for the analysis of certain ethnobotanical data. Informant consensus and ICF, preference ranking, direct matrix ranking, paired comparison and index of fidelity level were conducted for data analysis through crosschecking and verification of the information.

5.2.5.1. ICF (Informant consensus factor)

Informant consensus describes the agreement between respondents when choosing the most cited specific wild edible plant species (Table 5.27). It was used to evaluate and prioritize the reliability of the edible plants. Also, the informant consensus factor values were calculated by applying the number of citations of individual species minus the number of selected species (Heinrich et al., 1998). It was calculated to check in-between 0 and 1, based on the number of each selected wild edible plant species use citation (Nur), which accounted for 40, and the number of selected species used (Nt) was 12.

5.2.5.2. Preference ranking

Simple preference ranking was made by arranging a rank of the most preferred as well as popular ethnobotanical wild edible plants following common sources (Alexiades, 1996). Key informants were used to assess the degree of preference for edible fruits and leaves highly cited by informants. Based on the total score of each species, the rank was determined by the informants' preference.

5.2.5.3. Direct matrix ranking

The direct matrix ranking (DMR) method was conducted for multipurpose use values of wild edible plants commonly reported by key informants (Alexiades, 1996; Cotton, 1996). DMR is one of the multi-faceted types of preference ranking techniques. Based on the relative benefits obtained from each chosen ten plant species, ten key informants were asked to assign values by giving order to each attribute among different uses such as medicinal, wild food, fodder, construction material, timber production, farming tools, utensils, firewood, fuels, shade, and live fence. Each chosen informant was asked to assign use values (5= best, 4 very good, 3 good, 2= less used, 1= least used and 0= not used). The average values of a score of each species were summed up and ranked. By adding the score values, it was possible to assess the relative importance and to check the major impacts due to the higher exploitation of each plant species than other species in the study site. Such data could be used for setting conservation priority.

5.2.5.4. Paired comparison

The paired comparison method was used to determine the relative importance of some WEPs to evaluate the degree of use and community preference as edibles. Eight WEPs were paired to compare individual respondents to each other, and decisions were made by individual respondents on the relative importance of one edible plant from a pair (Martin, 1995). A couple was chosen by some of the four key and four general informants (Table 5.30). The total number of possible pairs was obtained by the formula: $n = \frac{n(n-1)}{2}$, where n is the number of important WEPs being compared. For this exercise, equal numbers of informants were randomly involved (4 key and 4 general informants).

5.2.5.5. Index of Fidelity Level (FL = Ip/IuX100)

Index of fidelity level (FL) is a commonly used method to quantify, compare and determine the relative importance of a plant species for a given function (Alexiades, 1996), using the following formula: where Ip is the number of informants who independently cited the importance of a species for a particular purpose and Iu-the total number of informants who reported the plant for any given use. The knowledge comparison on WEPs based on age, gender, educational status, key and general informants, and an agroclimatic zone among various socio-demographic groups in the study area was also computed.

5.3. Results

5.3.1. Diversity of wild edible plants (WEPs) in Soro District

In this research, a total of 64 species of WEPs that belong to 52 genera and 39 families were documented (Appendix 15). Further analysis showed that the family Salicaceae had 4 (6.25%) species in 3 (5.77%) genera, Solanaceae 4 (6.25%) species in 2 (3.85%) genera, and Moraceae 4 (6.25%) in 1 (1.92%) genus. Other 36 families contributed 52 (81.25%) species distributed in 46 (88.46%) genera. These WEPs were collected from various habitats of forest patches, riverine areas, grasslands, agricultural lands, roadsides, and homegarden yards with or without cultivated crops. Some wild edibles are cultivated/grown by households in association with other naturally growing wild useful plants.

The records also included collected edibles, most of them used for herbal medicines with nutraceutical values in addition to supplementary as well as regular wild edible food sources during drought and famine which support human food security. For example, the roasted or cooked leaves and young shoots of *Amaranthus dubius* and *Bidens pachyloma* were mostly used during famine and consumed like some cultivated species of leafy vegetables such as *Brassica oleracea* var. *oleracea* and *Brassica carinata* , and the fruits of *Ficus sycomorus, Ficus sur,* and *Oncoba spinosa* are eaten by removing the exocarp whereas the tuber of *Dioscorea schimperiana* is eaten as corm of *Ensete ventricosum* and tuber of *Solanum tuberosum* by cooking and peeling the thin exocarp.

FGD participants explained their observations that the diverse wild edibles are eaten more as snacks/refreshments and supplementary as well as regular wild food sources during food insecurity. A good number of the species are also said to have traditional medicinal and other uses. The WEPs provide edible fruits, leaves with terminal and lateral shoots/buds, tubers, and other parts used as chewing gum and spices of tea by the society. They are consumed by picking raw ripe fruits and mature leaves. Common examples in the study area are *Ficus sur, Ficus sycomorus,Syzygium guineense* subsp. *afromontanum, Syzygium guineense* var. *guineense, Warb urgia ugandensis, Landolphia buchananii, Carissa spinarum, Ximenia americana, Flacourtia indica, Zanthoxylum asiaticum* (synonym of. *Toddalia asiatica*), and *Piliostigma thonningii.* Some WEPs are eaten as regular wild food through rarely and other dominants are eaten as supplementary foods, in the study area, households and individuals during food shortages (*e.g. Ficus sycomorus*, *Ficus sur*, *Amaranthus dubius*, *Dioscorea schimperiana*, *Bidens pachyloma*, and *Oncoba spinosa*).

Specimens of these and other non-crop ethnobotany of edible plants were reported and collected from wild areas of dega, woinadega, and kola agroclimatic zones within the altitudinal rages of 1345 masl to 2836 masl. Wise use of the above-explained results of edible leafy vegetables, tubers and fruits could ensure the sustainable availability to ensure presence of food security as well as food sovereignty in the local community of the study area. However, today a large number of proportions of the population do not consume wild plants due to high dependency on staple food crops and they used wild edibles as accessory food sources.

5.3.2. Growth habits of wild edible plants

Of the total WEPs, trees took the highest growth form and proportion 22 (34.38%), liana took the least life form 1 (1.56%), whereas herbs (21) were the next highest life form followed by shrubs (16) and 4 climbers (Figure 5.31). Trees were also categorized into 16 families and 18 genera, herbs 13 families and 17 genera, shrubs 11 families and 15 genera, climbers four families and four genera. In contrast, liana had the least one family and one genus (Appendix 5.15).

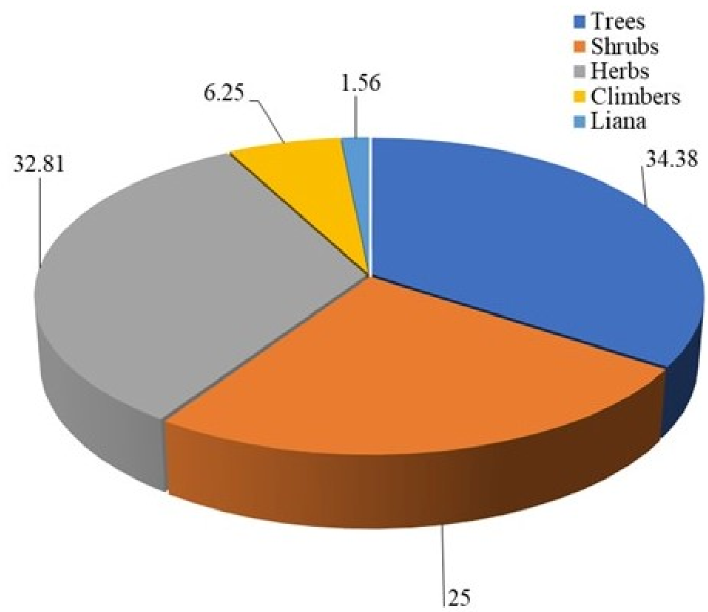

Figure 5. 31. Growth habit (life form) of wild edible plants in Soro District

5.3.3. Frequency of wild edible plant parts and their proportion

Out of the total reported and eaten parts of wild edible food resources, fruits contributed the most significant palatable amount and percentage, accounting for 34 (53.13%) species, leaves follow in the second place as edible part, and the proportion accounted for 20 (31.25%) species (Table 5.26). Species known for having edible fruit and gum accounted for 5 (7.81%), leaf and fruit 2 (3.13%), tuber 2 (3.13%), and flower-inflorescence nectar accounted for 1 (1.56%). Hence, fruits and leaves are the most dominantly consumed and widely used edible wild plant parts in the study area respectively. Of the wild edible plants, five species (*Ficus sur, Ficus sycomorus*, *Ficus thonningii, Ficus vasta* (Moraceae), and *Landolphia buchananii* (Apocynaceae) also produced milky latex used as, chewing gum, as a plastering material and sipping sap (*e.g. Landolphia buchananii)*. *Landolphia buchananii* is used for making traditional play balls with parasitic mosses using milky latex that is produced from stem bark when cut or injured the bark.

Of the total reported WEPs, 34 are fruits; of them, 16 (47.06%) trees, 12 (35.29%) shrubs, 3 (8.82%) herbs, and 3 (8.82%) climbers. Of the whole leaf edibles (20), 2 (10%) trees, 3 (15%) shrubs, and 15 (75%) herbs contributed more proportion than trees and shrubs edibles. From 5 fruits and gum consumption plants, 4 (80%) are trees, and only 1 (20%) contributed liana; of the two leaf and fruit edibles, both species are herbs (100%); from 2 tubers category herb and climber contributed 1 (50%) each.

Table 5.26. Distribution of WEPs in different agroclimatic habitats

Habitat of collection	Agroclimatic zones	No. of species collected	%
Family home garden, HG	Dega, woinadega and kola	20	31.25
Live fence and/or dry fence (Lf and/or Df)	Dega, woinadega & kola	2	3.13
Roadsides (RS)	Dega & woinadega	3	4.69
Forest patches (FPs)	Dega, woinadega and kola	25	39.06
Agricultural/farm lands (AL)	Dega, woinadega & kola	3	4.69
Riverine/River valley/areas, Ria	Dega, woinadega & kola	6	9.37
Grass/bush land (GL/BL)	Dega, woinadega & kola	5	7.81
Total	-	64	100

5.3.4. Mode of consumption

The people in Soro District consume plants in raw ripe form without processing or upon cooking or roasting. The majority (68.75%) of the species are harvested and used in raw mature form by cleaning the dirty, washing the edible parts with clean water, and removing thick or thin nonedible epicarp and some hard stone endocarp seeds. Some 31.25% were eaten upon processing by chopping with a knife, and some were roasted or cooked using local clay pots and metallic cookers. In a few ripe raw wild edible plants, stems of some plant species are injured or cut. Sweet-tasting latex is released out and sipped by herd of cattle-keeping children and also used for chewing gum by painting or smearing the milky latex on the hand and allowed to dry (*e.g.* stem latex of *Landolphia buchananii*, *Ficus sur* and *Ficus sycomorus*).

5.3.5. Marketability of wild edible plants in Soro District

People interviewed in the local markets informed that for two decades few species were sold to generate cash income, as is the case with *Syzygium guineense* var. *guineense*, *Syzygium guineense* subsp. *afromontanum* and seeds of *Amaranthus caudatus* was mainly sold as a food source in dega and woinadega, and rarely *Carissa spinarum in* kola agroecological settings. The community, in their habitats, consumed various wild food species in ripe and raw form. FGD informants also reported few WEPs were sold in the local markets to generate local income; they used the above two fruit edibles, seeds and rarely fruit of *Carissa spinarum* in kola agroecology.

5.3.6. Informant consensus on the most repeatedly and frequently reported WEPs

Certain wild edible plants were commonly used in the study area as the source of supplementary and regular wild food during food insecurity/famine than other wild food plants. As a result of this, the ripe raw fruit and leaf with shoot edible plants frequently reported as a source of stable food were *Ficus sycomorus*, reported by 147 informants and eaten fruits, *Amaranthus dubius* reported by 140 informants, and eaten leaf with shoots, *Dioscorea schimperiana* was reported as, regular wild edible by 138 informants and eaten tuber, and *Oncoba spinosa* was reported 136 as regular food and fruit eaten, *Syzygium guineense* subsp. *afromontanum* by 125 informants and eaten fruits as supplements, and *Bidens pachyloma* reported by 118 eaten leaves as regular with young shoots. The remained others were preferable supplementary wild edibles and all of them are potential plants for food security as well as food sovereignty in the study area for future food scarcity due to drought (Table 5.27).

Table 5.27.Informant consensus of most commonly eaten fruits and leaves with shoots eaten plants

Scientific name	Part (s) eaten	No. of Informants	%	Diet
Ficus sycomorus	Ripe raw fruits	147	95.4	Reg
*Amaranthus tortuosus (*synonmy of *Amaranthus dubius*	Roasted/cooked leaves	140	90.9	Reg
Dioscorea schimperiana	Mature tuber cooked	138	89.6	Reg
Oncoba spinosa	Ripe raw fruits	136	88.3	Reg
Warburgia ugandensis	Ripe raw fruits	134	87.0	Sup
Landolphia buchananii	Ripe raw fruits	132	85.7	"
Carissa spinarum	Ripe raw fruits	129	83.8	"

Syzygium guineense subsp. *afromontanum*	Ripe raw fruits	125	81.2	"
Ximenia americana	Ripe raw fruits	123	79.9	"
Piliostigma thonningii	Raw and cooked leaves	119	77.3	"
Bidens pachyloma	Cooked leaves and shoots	118	76.6	Reg
Amaranthus caudatus	Cooked leaves and seeds	115	74.7	"

WEPs = wild edible plants, Sup = supplementary food ["], Reg = regular wild food by a large proportion of the local community.

The number of ICFs (0.72) which resulted in greater than 0 approximately 1; showed that different WEPs are used for various purposes for the local people who lived in the community in addition to food.

5.3.7. Preferences for some WEPs

The key informants ranked 13 edible fruits based on the degree of preferences among the highly cited wild edible plants in Soro District. The wild edible fruit most preferred by the community scored "13" and the lowest score "1", others being in between (Table 5.28).

Table 5.28. Simple preference ranking (SPR) values of the most commonly used top 13 wild edible fruits.

Botanical name	**Respondents**													
	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	R11	R12	R13	Total	Rank
Ficus sycomorus	13	6	7	8	7	6	9	8	7	4	10	5	6	96	1
Landolphia buchananii	10	13	8	7	6	5	6	7	5	7	8	5	7	94	2
Syzygium guineense var. *guineense*	5	10	7	6	9	8	13	11	5	8	9	1	1	93	3
Warburgia ugandens	8	7	8	5	7	6	9	5	7	12	5	4	6	89	4

is														
Oncoba spinosa	5	8	5	11	6	6	5	10	5	6	4	3	7	81	5
Ficus sur	7	6	8	5	7	5	9	5	6	5	1	4	10	78	6
Carissa spinarum	6	7	6	3	6	5	4	5	6	6	12	8	2	76	7
Passiflora edulis	9	4	9	1	6	5	8	5	7	6	5	7	2	74	8
Physalis peruviana	6	1	5	4	11	6	4	5	6	1	7	8	6	70	9
Flacourtia indica	5	6	4	6	1	7	5	4	1	5	8	7	5	64	10
Toddalia asiatica	4	6	1	7	5	6	1	7	2	5	7	4	6	61	11
Rubus steudneri	1	5	5	2	4	5	2	9	6	5	7	5	3	59	12
Rubus apetalus	5	3	2	5	4	1	5	1	3	5	7	5	4	50	13

The top thirteen (13) are the most preferable wild edibles based on the criteria of availability in common in the locality, pulp content, organoleptic properties of tastes, smell, flavour, and other features, size of non-edible seeds and thickness of exocarp and one (1) is the least with relative to others. Among the compared WEPs, fruit edibles *Ficus sycomorus* was scored the highest and scored first (SPR=96) based on fleshy pulp with very small seeds and better sensation of the flavour and used as regular wild food. *Landolphia buchananii* scored second (SPR=94) and was used as supplementary wild food with better flavour and pleasant taste; *Syzygium guineense* var. *guineense* was the third score (SPR=93) and supplementary with suitable better taste, *Warburgia ugandensis* scored fourth (SPR=89) used as supplementary with light white flesh pulp and sweet pleasant taste and *Oncoba spinosa* was scored fifth (SPR=81); it has dense dark brown pulp with small sized berry seeds, with better flavour, used as regular wild food and others were scored and ranked accordingly.

In another comparison among preferable leaf edibles using ten key informants, *Solanum nigrum* (SPR=75), *Amaranthus dubius (*SPR=73), and *Bidens pachyloma* (SPR=69) were the scored highest, second and third preference ranking scores (SPR); others supplementary wild edibles of *Amaranthus caudatus, Piliostigma thonningii, Solanum* sp, *Urtica urens*, *Commelina benghalensis*, *Rumex abyssinicus,* and *Rumex nervosus* were ranked respectively with the SPR values of 68, 56, 53, 50, 48 & 37 and used as supplementary food.

Table 5. 29. Direct matrix ranking score of 10 key informants of nutraceutical plant species

Which is involved with various other uses in Soro District based on use value criteria (5= for the best, 4= for very good, 3= for good, 2= for less used, 1= for the least used and 0 = for no use category/value).

Nutraceutical plant species	**Use categories/values**										Total	Rank
	Fw	WE	Con	TP	M	Ch	Fo	Ft&Ut	Sha	Ff		
Cordia africana	5	3	5	5	4	3	1	4	3	4	37	1st
Syzygium guineense spp.	5	4	5	0	3	4	2	3	5	2	33	2nd
Warburgia ugandensis	4	4	5	1	3	4	0	4	5	2	32	3rd
Mimusops kummel	5	4	5	0	3	4	1	3	5	1	31	4th
Balanites aegyptiaca	5	5	4	0	3	3	3	2	3	1	29	5th
Phoenix reclinata	4	0	5	0	4	4	5	1	1	1	25	6th
Ximenia americana	3	2	3	0	5	3	3	2	1	1	23	7th
Trichocladus ellipticus	5	1	4	0	2	2	4	2	0	1	21	8th
Moringa stenopetala	2	0	0	0	5	4	2	1	1	1	16	9th
Bidens pachyloma	2	0	0	0	2	4	4	0	0	0	12	10th
Total	40	23	36	6	34	35	25	22	24	14	266	
Rank	1st	7th	2nd	10th	4th	3rd	5th	8th	6th	9th		

Where, Fw=Firewood, Ch=Charcoal, Con=Construction, TP=Timber production, M=Medicine, WE=Wild edible, Fo=Fodder, Ft & Ut=Farming tool & house utensils, Sha=Shade & Ff=Fire formation. The output of the DMR score of ten key informants for ten use diversities showed that some multipurpose wild edible plant species were more highly exploited for firewood, construction, and local charcoal than the other uses. As a result, 1st (*Cordia africana),* 2nd (*Syzygium guineense* var. *guineense* and *Syzygium guineense* subsp. *afromontanum*) *and* 3rd (*Warburgia ugandensis)* ranked plant species and a new record in this study area; become locally extincting and endangering due to unwise use for different functions (Table 5.29).

Table 5.30. Result of paired comparison of eight wild edible plant species used by the people in the study District

WEP species	Mixed 4 key and 4 general informants R1-R8								Frequency	Rank
	As	Vv	Da	Ea	Ed	Rv	Rn	Hd		
Acokanthera schimperi (*As*)	-	Vv	As	As	As	As	As	Hd	5x	3rd
Vangueria volkensii (Vv)		-	Vv	Ea	Vv	Ea	Vv	Hd	4x	4th
Dovyalis abyssinica (Da)			-	Ea	Ed	Da	Da	Hd	2x	6th
Erucastrum arabicum (Ea)				-	Ea	Ea	Ea	Hd	6x	2nd
Euclea divinorum (Ed)					-	Ed	Ed	Hd	3x	5th
Rhus vulgaris (Rv)						-	Rv	Hd	1x	7th
Rytigynia neglecta (Rn)							-	Hd	0x	8th
Habenaria decumbens (Hd)								-	7x	1st

The result of the pairwise ranking comparison (PWRC) edibility ranks 1-4 were the most indication of edible species concerning other compared species. The ranks 7 & 8 were relatively preferably important edibles even if they scored fewer ranks (Table 5.30).

Table 5. 31. The relative value of fidelity level for potential wild edible plants in the study area.

Scientific name	Wild edibles used as supplements or regular wild food	IP	IU	FL	FL%	Rank
Ficus sycomorus	Used during the famine as regular wild food	45	45	1	100	1
Amaranthus dubius	Used during the famine as regular wild food	29	30	0.90	90	2
Dioscorea schimperiana	Used as regular wild food	25	28	0.89	89	3
Landolphia buchananii	Used as supplementary wild food	19	22	0.86	86	4
Oncoba spinosa	Used as regular wild food	23	27	0.85	85	5
Warburgia ugandensis	Used to supplementary &	21	25	0.84	84	6

	regular wild food					
Syzygium guineense subsp. *afromontanum*	Used supplementary, more during the famine as regular wild food	14	18	0.78	78	7
Carissa spinarum	Used as supplementary wild food	15	20	0.75	75	8
Ximenia americana	Used as supplementary wild food	10	14	0.71	71	9
Piliostigma thonningii	Used as supplementary wild food	9	13	0.69	69	10

The top ten potential WEPs were quantified using the index of fidelity level (Table 5.31). The ripening and availability of these species varied and were mainly used to fill gaps in food shortages. *Ficus sycomorus*, *Amaranthus dubius*, and *Dioscorea schimperiana* had higher scores and were used as more regular wild food sources including *Oncoba spinosa.* Whereas *Landolphia buchananii*, *Carissa spinarum*, *Ximenia americana,* and *Piliostigma thonningii* were reported for use as supplementary wild food sources. Both *Warburgia ugandensis* and *Syzygium guineense* subsp. *afromontanum* were noted for being used as additional and regular wild edibles, particularly during famine and the food insecurity gaps. These species required sustainable use and conservation priority in the community of the study area.

5.3.8. Indigenous knowledge distribution in different socio-demographic members

More WEPs were reported by male informants on average (12.52 ± 6.07); frequently reported/cited 1553 (84.68%) of all respondents reported WEPs (1834) than females (9.37 ± 3.62); cited 281 (15.32%); and the statistical comparison is also significant ($P < 0.05$). This is usually because males are movable from one area to another, and they had opportunities to gain and share as well as quote more indigenous knowledge about WEPs use than females (owners of households). Although comparing gender informants for indigenous knowledge practices based on WEPs' preparation for feeding, women are better knowledgeable and familiar with food preparation and cooking, caring for their families and children in their house than men. Key informants frequently reported 474 (25.84%) species, and general informants 1360 (74.15%) frequent species, and significantly varied ($P < 0.05$) at the mean average number (18.23 ± 6.43).

On the other hand, there were insignificant differences (P > 0.05) occurred among educational status, agroclimatic zones, and age categories even if a more frequent number of WEPs were reported and accounted by literates 1044 (56.92%) than illiterates 790 (43.07%); woinadega 1318 (71.86%) than dega 365 (19.90%) and kola 151 (8.23%). As well as more indigenous knowledge of WEPs was also frequently reported by old ages (> or = 60 years); 735 (40.07%) and an ages in-between adult ages (36-59 years); 635 (34.2%) than in-between young ages (18-35 years); 464 (25.30%). It might be due to less knowledge transfer among the 26 key and 128 general interviewed informants.

Based on the distance of informants relative to the main town, frequently more WEPs 1376 (75.03%) were reported from far rural areas (> or = 5km) than nearby 458 (24.97%) of (< 5km), indicating that people were more relation with the plants and more vegetation availability in the far rural community than urban. The frequently reported result indicated that more varieties of WEPs can be available in rural communities due to potential vegetation sites along forest patches away from an urban community. Statistical it also varied insignificantly (P > 0.05) with distance from the town.

Table 5.32. Statistical test of significance using one-way ANOVA the average number of reported WEPs among various variables in the study area, Soro District.

Participants	**Informants group**	**N**	**Average± SD**	**F-value**	**p-value**
Gender	Males	124	12.52±6.07	7.46	0.007
	Females	30	9.37 ±3.62		
Educational status	Illiterate	65	12.02±5.91	0.04	0.847
	Literate	89	11.83±5.76		
Age category	18-35(Young)	39	11.90±5.07	1.00	0.369
	36-59(Adult)	57	11.14±6.23		
	> 60 (Old/Elderly)	58	12.67±5.82		
Proximity to the main town	< 5 km (Urban/Near)	36	12.72±5.92	0.92	0.338
	> or = 5 km (Rural/Far)	118	11.66±5.77		

Informants' category	Key informants	26	18.23±6.43	48.71	0.000
	General informants	128	10.63±4.75		
Agroclimatic zone	Dega dwellers	33	11.06±4.44	1.55	0.215
	Woinadega dwellers	106	12..43±6.03		
	Kola dwellers	15	10.07±6.56		
Religion	Protestant	141	11.40±5.40	6.01	0.001
	Orthodox	2	11.00±1.41		
	Adventist	7	17.29±8.30		
	Apostle	4	20.75±5.56		

A significant difference ($p < 0.05$); insignificant ($p > 0.05$), df = N-1; 153, N = number of respondents = 154.

Male informants reported more information on WEPs with ethnobotanical knowledge than females and varied numbers of wild edible plants; key informants have rich knowledge information on wild food plants than general informants when they computed their knowledge (Table 5.32). Frequently more species were reported from woinadega than dega and kola agroclimatic zones, as well as the distance from the town or population center was more in localities closer to natural forests and woodlands compared to urban areas.

Insignificant differences ($P > 0.05$) occurred in the number of wild edible plants reported by illiterate and literate; young, adult, and elderly; near and distant. Numerous WEPs were frequently reported from dominant informants living in areas from woinadega agroclimatic zone. Key informants reported more ethnobotanical knowledge on WEPs relative to the general and age-old, middle and younger; rural dwellers than urban.

5.3.9. Nutraceutical wild edible plants

Of the 64 WEPs, 53 were reported for traditional medicine to treat one or more than one human and livestock ailments (Appendix 5.15). Leaves were reported the highest numbers (54.02%) by informants' citations, followed by roots (18.97%), and other proportions of small use citations accounted for 27.01%, which include fruit, actively growing buds, stem bark, above ground and below ground part, whole part, latex, and resin. Due to the widely used traditional medicinal plants by indigenous people, fresh leaves with buds were dominantly used, followed by fresh roots and fruits. Of the total WEPs, 53 nutraceutical plant species were used to treat 70 human aliments, 18 livestock ailments, and 5 for human and livestock ailments. One or a combination of two or more wild edible plants treated those ailments.

Some species (1) *Asparagus africanus, (*2) *Carissa spinarum,* (3) *Cordia africana*, (4) *Ximenia americana*, (5) *Solanum nigrum,* (6) *Physalis peruviana,* (7) *Oncoba spinosa,* (8) *Toddalia asiatica,* (9) *Landolphia buchananii,* (10) *Moringa stenopetala,* (11) *Erucastrum arabicum,* (12) *Ficus sur*, (13) *Ficus sycomorus,* (14) *Syzygium guineense* var. *guineense* (15) *Syzygium guineense* subsp. *afromontanum*, (16) *Dioscorea schimperiana*, (17) *Balanites aegyptiaca,* (18) *Dovyalis abyssinica*, (19) *Phoenix reclinata*, (20) *Piliostigma thonningii*, (21) *Trichocladus ellipticus* and (22) *Warburgia ugandensis* were the most commonly reported wild edible and medicinal plants in the study sites by different informants used the same edible and medicinal plant parts including different medicinal and wild edible used parts. Of these food security edibles, medicinal plant species No. 1, 4, 7-9, and 12-22 were locally extinct plants. Therefore, they need attention for in-situ conservation. Here, *Moringa stenopetala* rarely occurs species in the kola agroclimatic community; it is naturalized in the wild of the study area, and it came from another site. Indigenous people practice growing and diversifying in wild natural habitats to adapt to kola (semi-desert) around Gibe River for the source of traditional food security of leaf vegetable as well as local food sovereignty.

5.3.10. Agroclimatic zones and abundance of WEPs in various habitats

Natural habitats are home to renewable wild edible plants. In the study area, WEPs were gathered from different in-situ habitats with various percentages (Appendix 5.15). Informants collected more WEPs from wild habitats 59 (92.19%) than non-wild habitats from semi-wilds 5 (7.81%). Large in and around purposively sampled vegetation areas of forest patches and community homegardens even if they were rare due to human activities, mainly deforestation for agricultural expansion and settlements. Few WEP species *Cordia africana*, *Mimusops kummel*, *Syzygium guineense* var. *guineense*, *Syzygium guineense* subsp. *afromontanum*, and *Warburgia ugandensis* are economically very important trees in addition to their uses as wild edible and medicinal plants in the area.

5.3.11. Threats and conservation strategies of wild edible plants

In the study area, human activities (anthropogenic factors) are the main threats to vegetation which causes the decline of multi-purpose indigenous wild food plant species. Deforestation is one of the leading impact factors due to the new settlement and agricultural expansion. Cutting/illegally hunting trees and shrubs from remnant forest patches, grass, riverine and bush lands unwisely for fire and selling local charcoal, timber/furniture production, dry fence, house construction, and *Eucalyptus* trees substitution are also threats that decrease potential vegetation species that provide wild edible plants for food security. For example, *Carissa spinarum*, *Cordia africana*, *Ficus sur*, *Ficus sycomorus*, *Dioscorea schimperiana*, *Landolphia buchananii*, *Oncoba spinosa*, *Piliostigma thonningii, Syzygium guineense* var. *guineense, Syzygium guineense* subsp. *afromontanum, Warburgia ugandensis, and Ximenia americana* need conservation priority in the community. Overgrazing in the protected vegetation areas, lack of attitudes toward bare land replantation to form afforestation, less knowledge share for a young new generation, and changing climatic condition in the environment also contributes to the threats.

Focus group discussions in the District in the 13 sites of the study kebeles, above various threats, were identified and discussed and followed by suggestions for solutions to conserve and manage those indigenous potential wild edibles and/or medicinal plants in the community, which help to conserve more other potential plants including wildlife in their natural habitats. Mainly in-situ conservation of plants in their natural habitats as well as ex-situ conservation and awareness education for communities. Domestication of indigenous potential wild edible and medicinal plants by local people around home guards, agricultural land, roadsides, shade, nursery expansion, reducing exotic plantation (*e.g. Eucalyptus* trees), reforestation, and afforestation. Hence these strengthening conservation strategies of vegetation (remaining forest patches) in the study area. These are with the help of nearby governmental institutes with community linkage.

5.4. Discussion

Most of the gathered and identified WEPs are used by the people of the study area for various purposes in addition to being used as wild food sources, contributing to food security in a similar way to other parts of Ethiopia and the rest of Africa. A relatively diverse number of WEPs with dominant families were documented from various agroecological zones and habitats. The number of species recoded is higher than the findings reported by some of the studies made in Ethiopia (Fentahun and Hager, 2009; Ashagre et al., 2016; Amente, 2017; Bhatia et al., 2018; Tebkew et al., 2018; Demise, 2020) and Uganda (Ojelel and Kakudidi, 2015). Various WEPs, plants with different habits and edible parts were documented and compared with data from other parts of Ethiopia. For example, indigenous fruit trees of *Phoenix reclinata* and *Rhus vulgaris* were reported as potential economic plants in Mukoro District, Uganda (Nieminen et al., 2017). These are also potential wild-growing trees with parts consumed by people of Soro District. This current study contributes a taxonomically varied 64 species distributed in 52 genera and 39 families; which is by far closely comparable with the findings of Amente (2017) which reported 60 species in 49 genera and 35 families. Moreover, this study has added 16 new species to the existing records/database of Ethiopian WEPs. Salicaceae, Solanaceae, and Moraceae were the dominant families that contributed the highest number of WEPs in this study. The Moraceae contributed to four important wild edible fruit trees in addition to their promising nutritional values as reported by Tebkew et al. (2018) and Dejene et al. (2020). The Myrtaceae and Rosaceae contributed two nutritionally useful species in agreement with previous works (Amente, 2017). Similarly, the two WEPs of the Myrtaceae reaffirm the findings of Demise (Demise, 2020) on the ethnobotanical study of WEPs in Adola District, southeastern Ethiopia. Our results are generally comparable with findings from some other Districts (Lulekal et al., 2011; Alemayehu et al., 2015b; Kidane et al., 2015; Demise, 2020; Duguma, 2020). However, the study by (Addis et al., 2005, 2013) and Balemie and Kebebew (2006) in Ethiopia and another study from Western Nepal (Khakurel et al., 2021) reported higher numbers of WEPs than the current study. The variation could be related to the agroclimatic differences, the size of the study areas, the cultural settings, and research intensity. The overall assessment showed that Soro District maintains a rich assemblage of wild edible and nutraceutical plant diversity and associated ethnobotanical knowledge.

Some multifarious WEPs were commonly reported from different study areas in Ethiopia including 25 species from Chelia District, West-Central Ethiopia (Regassa et al., 2015); 23 species in Berehet District, North Shewa Zone of Amhara Region (Alemayehu et al., 2015b);16 species in Central Ethiopia (Seyoum et al., 2015); 16 species in Konso Ethnic community, southern Ethiopia (Addis et al., 2013); 15 species in Burji District, Segan Area Zone (Ashagre et al., 2016);14 species in Chilga District, northwestern Ethiopia (Tebkew et al., 2014);14 species in Kamashi Wereda Benishangul Gumuz Region (Amente, 2017);12 species in Quara District, northwest Ethiopia (Tebkew et al., 2018); 10 species in Western Nepal (Khakurel et al., 2021); 9 species in Benna Tsemay District (Assefa and Abebe, 2011) and 8 species in Derashe and Kucha

Districts of South Ethiopia (Balemie and Kebebew, 2006); 7 species in Uganda (Ojelel and Kakudidi, 2015). Thus, the abundance of WEPs observed in the present study area is shared with numerous distribution ranges in different agroecological zones of Ethiopia (Balemie and Kebebew, 2006; Mengistu and Hager, 2008; Tebkew et al., 2014). Provenance of these WEPs in various growing habitats increases the population of species and the culture of traditional knowledge with plant diversity (Tebkew et al., 2014). Of the growth habits, trees were dominantly used life forms in the study area that strongly support the agreement of (Fentahun and Hager, 2009; Teklehaymanot and Giday, 2010; Kidane et al., 2015; Tebkew et al., 2018). This habit proportion is in contrast with Lulekal et al.(2011) in southern Ethiopia, and Agea et al. (2011) in the Bunyoro Kitara kingdom of Uganda reported that shrubs and herbs were the dominant habits contrasting with the dominant growth form (trees) found in the current study of Soro District (Amente, 2017). Similarly, trees and herbs were reported to have the highest parts consumed, followed by shrubs in agreement with (Kidane et al., 2015) which pointed out trees were consumed more by the Maale and Ari ethnic groups in southern Ethiopia. Different habits of WEPs in three agroclimatic zones and vegetation features of the study area contrast with the discussion of Ashagre et al.(2016).

Plants with edible fruits contributed the largest proportion of 34 (53.13%) species having parts eaten and mostly used as a ripe raw form, which agrees with the findings of other works (Fentahun and Hager, 2009; Addis et al., 2013; Alemayehu et al., 2015b; Seyoum et al., 2015; Dejene et al., 2020; Demise, 2020), also leaves follow as the second largest group of edible part accounting to 19 (29.69%) species in agreement with some studies (Addis et al., 2013; Amente, 2017). Wide consumption of fruits has been reported in many studies (Lulekal et al., 2011; Alemayehu et al., 2015b; Kidane et al., 2015; Tebkew et al., 2018; Demise, 2020; Duguma, 2020) investigated in different parts of Ethiopia. Leaves were also among the widely reported edible parts (Asfaw and Tadesse, 2001; Balemie and Kebebew, 2006; Lulekal et al., 2011; Ashagre et al., 2016; Amente, 2017; Demise, 2020). Most WEPs of Soro District are consumed raw when ripe without processing and cooked/roasted similar to the reports of other researchers (Addis et al., 2005, 2013; Kidane et al., 2015). During the study, about 44 (68.75%) species were observed while being eaten raw upon simple processing by cleaning dirty materials, washing the edible parts, and removing thick or thin inedible exocarp in the case of fruits, and some endocarp parts (hard stone seed/s) but 19 edibles (29.69%) were eaten by chopping with a knife after roasting or cooking using local clay pots, metallic cookers. Stems and leaf parts were the most used plant parts in northern West Bank of Palestine (Ali-Shtayeh et al., 2008) .

Parts of most WEP (fruits/leaves) are eaten raw and support community members that need snacks or emergency foods (Asfaw and Tadesse, 2001; Bhatia et al., 2018; Demise, 2020). Among species that have edible fruits, the stem latex is used by injuring or cutting the bark of the stem part for releasing out the latex, which sipped/sucked by children looking after domestic animals, also used as chewing gum by painting or smearing the milky latex on the hand and let it dry (*e.g.* stem latex of *Landolphia buchananii*, *Ficus sycomorus,* and *Ficus sur*). *Carissa spinarum*, *Ficus sur*, and *Ximenia americana* were most frequently preferred edible wild edible fruits during shortages of regular food. Similarly, Kidane et al.(2015) reported in the Debub Omo Zone of southern Ethiopia that these species were among the most widely harvested wild edible fruits during food shortages/famines due to drought. Among 52 wild and semi-wild dietary ethnobotanical fruits used by the Maale and Ari ethnic communities in southern Ethiopia (Kidane et al., 2015), 11 fruits are also found in Soro District. Of these seasonally available fruits, *Ziziphus spina-christi* and *Diospyros mespiliformis* contribute essential nutrients for Maale and Ari communities (Kidane et al., 2015), also contributed higher amounts of nutrient contents that provide the guaranteed availability than cultivators as described by Mengistu and Hager (2008). In the community among the discussed, ordered and ranked WEPs and preferential and selective plant species reported by most informants (Table 5.27, 5.28, 5.29, 5.30, and 5.31) as significant species, and they are potential plants for food security as well as food sovereignty in the study area and include *Ficus sycomorus, Landolphia buchananii, Ficus sur, Warburgia ugandensis, Syzygium guineense* var. *guineense*, *Syzygium guineense* subsp. *afromontanum*, *Oncoba spinosa*, *Ximenia americana, Dioscorea schimperiana,* and *Habenaria decumbens* reported from three different agroecologies. Some species among the leafy vegetables with young shoots with buds and fruits are preferred by some. The species *Solanum nigrum, Amaranthus dubius,* and *Bidens pachyloma* were among those preferred by most key informants as leafy vegetables and the most potential species to secure food during food shortage or unavailability.

These selectively eaten and other plant species were used for health care as sources of traditional medicine showing that the borderline between wild edible plants and traditional herbal medicine is not that sharp. Similar findings were reported by other researchers (Alemayehu et al., 2015b;

Duguma, 2020). Moreover, the above-mentioned species are fruits, leaves and young shoots, and tuber edibles that are very essential plant species in the community to give different foodstuffs, mineral contents, antioxidants, and vitamins.

Among the total collected wild edible plants, some are used for both food and medicinal value with the same part being used for food and medicine; local informants also reported others used with different edible and medicinal parts to treat various human and livestock ailments (Table 5.33) in the ailments category of dermatological, gastro-intestinal, haem parasitic, circulatory, endocrine system, orbital, cardiovascular, glandular, dental, digestion, external and internal cancer, respiratory, intestinal parasitic, protozoan, systemic and urinary tract system (UTS). The medicinal worth of nutraceutical plants lies in the fact that in most cases toxicity issues have already been pretested culturally.

Table 5. 33. Some nutraceutical wild edible plants used for the treatment of human livestock ailments

Edible plants with medicinal use reports	Disease	Human/ Livestock	Part used in TM in the study area	Part used as food in the study area	Reference for use in TM
Ageratum conyzoides	Diarrhoea	Human	Leaf	Leaf	(Duguma, 2020)
Amaranthus caudatus	Michi	Human	Seed	Seed	(Amente, 2017; Duguma, 2020)
	Cancer	Human	Leaf	Leaf	(Amente, 2017; Duguma, 2020)
Balanites aegyptiaca	Epistaxis (Nasal bleeding), Headache, Stomach ache	Human	Resin, Fruit	Fruit	(Bartolome et al., 2013)
Bidens pilosa	Internal cancer, Michi	Human	Leaf	Leaf	(Bartolome et al., 2013)
	Constipation	Human	Aboveground	Aboveground	(Bartolome et al., 2013)
	Malaria	Human	Aboveground	Aboveground	(Adedapo et al.,

					2011; Bartolome et al., 2013)
Carissa spinarum	Amoebiasis, Swelling	Human	Stem bark, Root, Fruit	Fruit	(Duguma, 2020)
	Swelling	Livestock	Root, Fruit	Fruit	-
*Moringa stenopetala (*Naturalizing in the wild habitat having been brought from another area*)*	Malaria	Human	Leaf, Root	Leaf	(Feyssa et al., 2012; Leta, 2016)
	Hypertension	Human	Leaf	Leaf	
	Diabetes mellitus (DM)	Human	Leaf	Leaf	(Duguma, 2020)
	Mumps	Human	Leaf	Leaf	
	Abdominal pain, Stomach ache	Human	Leaf	Leaf	(Duguma, 2020)
Solanum nigrum	Heart disease	Human	Abovegro und	Abovegro und	
	Breast cancer, Skin cancer	Human	Leaf	Abovegro und	-
	Internal cancer	Human	Leaf	Leaf	
	Ascariasis	Human	Leaf	Leaf	(Duguma, 2020)
	Abdominal pain Stomach ache	Human	Leaf	Leaf	(Leta, 2016; Duguma, 2020)
	Conjunctivitis/Eye disease	Human	Leaf	Leaf	-
	Pityriasis	Human	Leaf	Leaf	-
Ximenia americana	Common cold and head ache	Human	Leaf, Stem bark	Fruit	(Feyssa et al., 2012; Tebkew et al., 2018)
	Lumpy skin disease (LSD)	Livestock	Leaf, Stem bark	Fruit	(Leta, 2016; Moges and Moges, 2019)

	Tooth disease	Human	Fruit	Fruit	(Adedapo et al., 2011; Feyssa et al., 2012; Leta, 2016)
	Abdominal pain Stomachache	Human	Fruit	Fruit	(Adedapo et al., 2011; Leta, 2016)
	Pyelonephritis	Human	Stem bark	Fruit	-
	Diarrhoea	Human	Leaf, Root bark	Fruit	-
	Spleen enlargement	Human	Root bark	Fruit	-
	Malaria	Human	Root bark	Fruit	(Feyssa et al., 2012)
	Aspiration pneumoni a	Livestock	Root bark	Fruit	-
	Pyelonephritis	Human	Leaf	Fruit	-

Particular wild edible fruits, *Balanites aegyptiaca, Carissa spinarum, Ximenia americana, and Ziziphus spina-christi* were highly cited in kola agroclimatic kebeles where they occurred and are consumed widely; mostly as critical supplementary fruit food species. Excluding *Carissa spinaru m,* this finding agrees with (Tebkew et al., 2018), but *Ziziphus spina-christi* showed low informant citations in Soro District (Appendix 5.15).

The highest frequency occurred for *Ficus sycomorus* in the case of informant consensus and SPR and FL in the current study and highly cited (Tebkew et al., 2018); similarly, *Syzygium guineense* var. *guineense* was recorded relatively higher in the SPR and DMR, which is in line with other studies (Tebkew et al., 2014; Kebede et al., 2017), and contrastingly lower in another study (Tebkew et al., 2018). However, insufficient informant citations are noted in other study areas (Mengistu and Hager, 2008; Kebede et al., 2017) The species citation was varied in the study area because it depends on informants' knowledge between communities of various study sites in agreement with the report by Tebkew et al. (2018). The above species are locally prioritized traditional wild food species as shown by the current study, like in other parts of Ethiopia and some African countries such as Kenya, Sudan, and Tanzania (Tebkew et al., 2018)

As the index of FL, *Ficus sycomorus*, *Amaranthus tortuosus* (synonmy of *Amaranthus dubius*), *Carissa spinarum*, and *Syzygium guineense* var. *guineense,* and *Syzygium guineense* subsp. *afromontanum* were potential wild edibles in the study area; similarly, the latter two species shared their use values (Ashagre et al., 2016) in Burji District, in a few rural sites as the source of income generation (Kebede et al., 2017).Likewise, in the study area, indigenous fruits of *Syzygium guineense* subsp. *afromontanum* and *Syzygium guineense* var. *guineense* before decades were sold as dietary food and generated income in local markets. Nowadays, either these species or other WEP species are not targets of selling for income sources. They are commonly sold in other parts of Ethiopia as wild food while our findings differed from another study (Setalaphruk and Price, 2007).

Socio-demographic features and cultural attributes of the current study showed variations with relatively different indigenous knowledge and traditional practices in the use of wild edible plant. Adults cited a higher number of WEPs than youngsters, which may be due differences in experience and knowledge gap on WEPs in the current study, which came up with insignificant difference ($P > 0.05$); similarly, adults cited more WEPs than youngsters in another study (Tebkew et al., 2018); still in another study, youngsters reported more than adults (Wondimu et al., 2006) this may be due to less attention from adults as a result of being dependent on modern food system. The average number of male interviewees were more knowledgeable, quoted the highest proportion of WEPs than females and this is highly significant ($P < 0.05$) in contrast with one study (Regassa et al., 2015) that showed women reported more plant species than men. Key informants reported significantly higher mean average number of wild edible species than general informants ($P < 0.05$) which agrees with one study (Regassa et al., 2015).

On the contrary, males had less practical knowledge than females on wild food preparation; frequently literates reported more WEPs than illiterates, general informants reported more WEPs than the key informants but may be less retained indigenous knowledge than key informants. Informants cited more WEPs in woinadega than kola and dega, and in contrast one other study (Tebkew et al., 2014). Elderly informants were better at generating inherited information and longtime retained use experiences than youngsters in the current study in a similar way to the findings of another study (Regassa et al., 2015).

Rural dwellers reported more wild edible plants than urban dwellers in the study area. The findings are in contrast to other results (Mengistu and Hager, 2008; Kebede et al., 2017) and are similarly reported in the world (Styger et al., 1999; Setalaphruk and Price, 2007). However, more WEPs were frequently reported from far away (>5km, about 75.03%); less percentage from proximate to the main town (< 5km, approximately 24.97%). This indicated that more varieties of WEPs were collected/available in a rural site near and in forest patches of the study area than the town proximities. Seven of the WEPs (*Acanthus sennii*, *Bidens pachyloma*, *Carissa spinarum*, *Habenaria decumbens*, *Thunbergia ruspolii*, *Thymus schimperi*, and *Urtica simensis)* are unique plants endemic to Ethiopia also known to be used in the Ethiopian traditional herbal healing system in the study area. Six of the endemic WEPs were similarly reported earlier (Awas et al., 2010); and two of them (*Urtica simensis* and *Thymus schimperi)* were reported by another study (Assefa and Abebe, 2011).

In the study, *Cordia africana*, *Syzygium guineense* var. *guineense*, *Syzygium guineense* subsp. *afromontanum,* and *Warburgia ugandensis* are economically significant income source tree species in the community, in addition to their nutraceutical values (Table 5.29). Among the WEPs of Soro District, commercially important and edible fruit-yielding tree species are also reported from other parts of Ethiopia (Lulekal et al., 2014). As such species are needed for timber, they are highly vulnerable and they are prioritized for strong conservation attention.

Many WEPs and other biodiversity components in the study area are affected by various threatening factors as in other parts of Ethiopia (Balemie and Kebebew, 2006; Lulekal et al., 2011; Tebkew et al., 2014, 2018; Dejene et al., 2020). Findings of the impacting factors are in agreement with other investigations (Amente, 2017) in that agricultural activities and climate fluctuations/variability that result in drought and lead to famine are the most threating factors. Deforestation, construction material extraction, overgrazing by livestock, and collection of fuel wood usually by selective cutting were the leading causes of the loss in the study area which was similarly reported in another study (Kebede et al., 2017). Another researcher (Aberoumand, 2009) reported drought that led to the famine accounting for the major factor that resulted as a consequence of the collection of fuel wood for firewood collection and charcoal making, timber for construction, and dry fence. These uses collectively decreased the availability, affordability, diversity, number of taxa in the study area. Affordability, availability and accessibility, and utilization of WEP species have been faced with many challenging factors in agreement with findings by other researchers (Balemie and Kebebew, 2006). Utilization of WEPs is faced with challenges related to ripening or maturity time, collection time and keeping the quality (shelf-life) of the production without spoilage due to decaying. These are some of the reasons for local people in giving less attention to wild edibles as supplementary food sources. The paucity in cultural awareness and perception about yields and the benefits of the nutritional values of wild edible plants adds to the challenges.

The mode of consumption of wild edible plants is affected by various factors such as climatic (environmental) factors under which they grow, time of ripening and difficulties for harvesting, and rapid deterioration within a short time thereby decreasing their quality and food values (Fentahun and Hager, 2009; Tebkew et al., 2018). These factors are thought to be reasons behind people's reduced attention to wild edibles, thus the tendency to rely more on stable food sources (Balemie and Kebebew, 2006; Kidane et al., 2015). Fast destruction of WEPs may be caused as a result of inappropriate collecting (harvesting) practices for various functions.

Various WEPs and nutraceutical as well as antioxidant plants, for instance, *Carissa spinarum*, *Ximenia americana,* and *Cordia africana* are exposed to human pressure in the study area as also from studies undertaken by Alemayehu et al.(2015b). The limited conservation and management considerations for these and other multifunctional WEPs are leading to erosion/loss of plant resources. This increases the disappearance or local extinction of useful plant species from different habitats; the consequence tends to lead to the loss of indigenous knowledge, making conservation and management of the remaining vegetation of Soro District very crucial. Thus, planting multiuse WEPs round the home yards, grass lands, fence lines, and farming lands are helpful for easy access to nutritional, economical, medicinal, and environmental benefits to the community. In addition, it saves and secures indigenous and endemic plants from extinction and wild food sources to combat future occurrences of drought and famine. Moreover, it would strengthen the ecological and ethnobotanical sustainability of the study area from the loss of natural resources and would contribute to augmentation of the livelihoods of the local people.

5.5. Conclusion

This study documented 64 wild edible plant species as the source of wild food plants. Through the investigation in sampled kebeles (n=13), only one poisonous species (*Acokanthera schimperi*) was recorded as perceived by the local people, but not in its edible part. The people reported their use of the stem of this species for making arrow poison to track down wild animals further indicating that the leaves are as poisonous being toxic or lethal when eaten. Different habitats provide wild edible plants to the community, and many species are consumed as supplementary food at any normal time and during food insecurity, also for medicinal values and multi-functional uses. Wild trees and herbs with edible parts came up with more species than shrubs, climbers, and lianas in that order. Fruits were highly accepted and preferentially consumed by the community as raw ripe forms. Indigenous people of the District use few WEPs from their private holdings and more of them from potential vegetation sites that retain forest patches. Other parts are picked and consumed as leafy vegetables, roots/tuber, chewing gum, sucking flower sap, and tea spices, also essentials for herbal medicine and other services.

The preferences of wild edible plants using informant consensus, ICF, preference ranking, direct matrix ranking, paired comparison, and index of fidelity level gave clues to the need for conservation priority attention through in-situ as well as ex-situ strategies. In addition, the domestication of multi-functional WEPs used in connection to many anthropological activities in their natural habitats and within home gardens, agricultural lands, shades, and cultural areas is important for the community. Such actions and strategies are essential for the conservation of the wealth of various plant species which increase the affordability and accessibility of wild edibles and nutraceutical plants. Furthermore, it is useful to conserve wild life and keep the ecological balance in the environment.

The findings of this study indicated that conservation training actions for multipurpose indigenous biodiversity by giving priority and increased attention to the declining species and those on the verge of extinction. Educational training workshops targeting communities need to be considered among the solutions with the collaboration of nearby institutions and agricultural offices. It helps to take conservation measures against anthropological activities which encourage saving indigenous plants with the association of wild life in their habitats as well as giving environmental advantages.

CHAPTER SIX

6. Biochemical composition and antioxidant activity of three wild edible plants from Soro District of Hadiya Zone, Ethiopia

Mulatu Hankiso, Ermias Lulekal, Zemede Asfaw, Bikila Warkineh and Paulos Getachew

Abstract

Wild edible plants (WEPs) are widely consumed in Ethiopia, and their potential worth to local food security continued to be a point of discussion, particularly among ethnobotanists. However, studies on their nutritional and non-food components are limited. The present study aimed to investigate the nutritional, anti-nutrients and antioxidant capacities of three WEPs, *Amaranthus tortuosus* Hornem., *Landolphia buchananii* (Hallier f.) Stapf., and *Oncoba spinosa* Forssk. rigorously selected in collaboration with local informants and user from a total of 64 wild edible plant species commonly consumed in Soro District, central Ethiopia. The species were selected based on informant consensus, preferences and fidelity level of edibility and considered the most promising top priority species assessed during an initial ethnobotanical field survey. Fresh and disease-free edible parts of the three WEPs (leaves and young shoots of *Amaranthus tortuosus* and ripened fruits of *Landolphia buchananii* and *Oncoba spinosa*) collected from wild habitats were processed and assayed/tested following standard procedures and laboratory methods. The proximate, total soluble solids, pH, mineral, vitamin C, and oxalate contents of the WEPs were determined using the method by Association of Official Analytical Chemists (AOAC). The anti-nutrients (phytate and tannin), total phenolic and flavonoid contents, and antioxidant capacity of the WEPs were determined using standard spectroscopic methods. The fresh leaves and shoots of *Amaranthus tortuosus* and fruits of *Landolphia buchananii* and *Oncoba spinosa* had moisture and pH values of (85.36%, 6.80), (81.22%, 4.59), and (61.35%, 5.74), respectively. The total soluble solids (TSS) content of the respective fruit juices of *Landolphia buchananii* and *Oncoba spinosa* was 2.4 and 8.4 ^{o}Brix. The highest crude protein content (38 g/100 g) was determined in *Amaranthus tortuosus*. The other dry basis nutrient contents were in a range of crude fat (3.00-5.50 g/100 g), crude fiber (6.05-9.60 g/100 g), utilizable carbohydrate (24.07-66.09 g/100 g), gross energy (283.70-330.23 kcal/100 g), calcium (868.33-10595 mg/ kg), iron (20.99-342.24 mg/ kg) and zinc (12.57-50.08 mg/ kg), vitamin C (26.42-43.15 mg/100 g). The level of the anti-nutrients was in the respective ranges of phytate (0.47-0.89 mg/100 g), oxalate (0.04-8.66 mg/100 g) and tannin (29.11-46.71 mg/100 g). The highest total phenolic (171.39 mg gallic acid equivalent (GAE/100 g), flavonoid (132.43 mg quercetin equivalent (QE/100 g), and vitamin C (44.15 mg/100 g) contents were obtained in *Landolphia buchananii* fruit. Additionally, the *L. buchananii* extract had a comparable IC50 value (84 µg/ mL) with ascorbic acid (82 µg/ mL) in scavenging 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical. At a concentration of 200 µg/ mL, the highest percentage of DPPH inhibition was obtained for ascorbic acid (96.42%), followed by *Landolphia buchananii* (94.63%), *Oncoba spinosa* (77.37%), and *Amaranthus tortuosus* (66.85%). This study indicated that the WEPs had more antioxidant activity than popular crops, and their non-food values were within acceptable limits, suggesting that they can be incorporated to make more nutrient-dense and healthy-balanced diets. The findings hint at the possible contributions of WEPs to SDG 2, which aims to end hunger, achieve food security, and improve nutrition.

Key words: Anti-nutritional factors, Antioxidants, Proximate composition, Soro District, Wild edible plants, *Amaranthus tortuosus* Hornem.; *Landolphia buchananii* (Hallier f.) Stapf.; and *Oncoba spinosa* Forssk.

6.1. Introduction

Food and nutrition insecurity is one of the biggest problems the world is experiencing. Globally, approximately two billion people are estimated to suffer from micronutrient deficiencies (FAO, 2012). The issue of food insecurity is severe in sub-Saharan Africa (FAO, 2011). However, the continent has a highly biodiverse environment with valuable wild edible plants (WEPs), which are often neglected (Chennai Platform for Action, 2006). Wild edible plants are plants with edible parts that grow naturally on wild farm land, fallow or uncultivated land (Duguma, 2020). Different WEPs have played a significant role in different geographical regions of the world throughout human history (Duguma, 2020). Traditionally, WEPs have been used for medicinal purposes to treat various ailments (diarrhoea, constipation, wounds, cancer, jaundice, heart disease, and diabetes) (Mir, 2014). Additionally, WEPs can be used as supplementary foods to combat malnutrition and contribute to food security (Lulekal et al., 2011; Getachew et al., 2013; Adamu et al., 2022b). They have remarkable nutrient value providing an important source of vitamins, fibers, minerals, and fatty acids (Dansi et al., 2008; Adedapo et al., 2011; Getachew et al., 2013; Datta et al., 2019). The nutritional values of WEPs are comparable to those of cultivated varieties of plant species (Ebert, 2014). Hence, they can support to achieve the zero hunger (SDG2) as well as good health and well-being (SDG3) objectives of sustainable development goals (SDGs) (Ishfaq et al., 2023).

Furthermore, wild edible plants are also potential sources of bioactive compounds including phenolics and flavonoids, which have a high antioxidant capacity (Yu et al., 2021). These bioactive compounds can boost protection against various diseases including chronic diseases and cancer (Raghavendra et al., 2018; Yu et al., 2021). However, different parts of WEPs contain anti-nutrients such as phytate, oxalate, tannin, and cyanide (Toh et al., 2013), which their high amount can reduce the bioavailability of nutrients, protein digestion, and growth (Kumar et al., 2010; Rout and Basak, 2015). With their nutritional and bioactive compound composition, in recent years more ethnobotanical studies have been conducted to document the indigenous knowledge and biochemical characterization of WEPs.

Thus, there is an increasing trend in the incorporation of WEPs into dishes in many developed countries (Luczaj et al., 2012; Geraci et al., 2018). WEPs have always been an essential and widespread food source for food-insecure families living in poverty in developing countries (Umaru et al., 2007; Mavengahama et al., 2013; Berihun and Molla, 2017; Yumkham et al., 2017). They are relevant to household food security and nutrition in some rural areas, and rely on supplementing staple food, filling seasonal food shortages, and serving as emergency food during famine. They are also important for many communities in urban areas, especially in poor and marginalized (Duguma, 2020). According to Aberoumand (2009) and Lulekal et al. (2011), approximately one billion people in the worldwide consume wild foods on a daily basis. Ethiopia is known as a biodiversity hotspot, center of origin, and diversification for a significant number of food plants and their wild relatives (Edwards, 1991; cited in Lulekal et al., 2011). Ethiopia is the fifth largest country in tropical Africa in terms of the flora diversity (Kelbessa and Demissew, 2014). Lulekal et al. (2011) reported that 413 types of WEPs are consumed in Ethiopia. Despite these facts, studies on the biochemical composition of Ethiopian WEPs are limited (Lulekal et al., 2011). Similarly, insufficient attention has been paid to research on the dietary values and anti-nutritional factors of WEPs in Soro District, Ethiopia. Therefore, this research aimed to evaluate the nutritional values, antioxidant activity and anti-nutritional factors of three most consumed wild edible plants *(Amaranthus tortuosus*/synonym of *Amaranthus dubius)*, *Landolphia buchananii*, and *Oncoba spinosa*) in Soro District, central Ethiopia.

6.2. Materials and methods

6.2.1. Description of the study area

The study was conducted in Soro District, Hadiya Zone, central Ethiopia (Figure 2.1). The District is one of the 15 districts of the Hadiya Zone, with 33 kebeles (the smallest administrative units). Of the total 287, 589 population of 143, 835 were men and 143, 754 were women (SDFPEDO, 2020). About 85% of the population in the District is mainly dependent on mixed agriculture, with an average land tenure of 0.5-2.5 hectares per farmer household, 10% of the population is civil servant, 3% merchant and 2% others. The majority (87.42%) lived in rural environments and the remaining 12.58% lived in urban centers (SDFPEDO, 2020).

The District is located 264 km away from the capital city, Addis Ababa in the southwest direction and found between 37^0 20' 0" to 37^0 47' 23"E longitudes and 07^0 19' 4" to 07^0 33' 48" N latitudes with altitude ranges from 799 to 2934 m.a.s.l, and the total land area of 36473.337 km^2. Majority of the District is highlands (39.4%), midlands (36.4%), and lowlands (24.2%). The mean minimum and maximum temperatures of the study area are 12ºC and 26ºC, respectively (SDFPEDO, 2020). The mean annual maximum rainfall is 900-1500 mm. According to the current vegetation classification of Ethiopia (Friis et al., 2011), the vegetation of the study area is mainly characterized by the Afroalpine belt (AA), dry evergreen Afromontane Forest and Grassland complex vegetation types (DAF), which is a habitat of various plant compositions and diversity with several nutritionally important wild edible plants. In the District, forest patches of mountain Shonkola is characterized by the presence of *Lobelia giberroa* and *Erica arborea* which represent the vegetation type of AA, and other representative indicator species of the DAF are *Calpurnia aurea*, *Clausena anisata*, *Carissa spinarum, Clutia abyssinica*, *Euclea divinorum, Juniperus procera*, *Olea europaea* subsp. *cuspidata*, *Maesa lanceolata*, *Rhus natalensis*.

6. 2.2. Plant sample selection

Three wild edible plants from Soro District, Central Ethiopia, were selected from among 64 WEPs based on the highest values of informant consensus, preference ranking, and fidelity level for their most preferred edible parts as well as species commonly consumed in Soro District (Hankiso et al., 2023). The edible parts of the plants are shown in Figure 6.32. Matured leaves with shoots of *Amaranthus tortuosus* were collected from the community home garden (Figure 2A). For *Landolphia buchananii*, riped fruits of various exocarp colors were collected from the agricultural land and riverine habitats (Figure 2B). If the fruit was partially matured, it was allowed to ripen fully within 3-5 days. For *Oncoba spinosa*, ripened fruits with a light green color were collected and allowed for 4-6 days until fully ripened (*i.e.*, the color of the exocarp gradually changed to dark brown) (Figure 2C).

Taxonomic identification of voucher specimens of the WEPs was carried out at the National Herbarium, Addis Ababa University by comparison with authenticated specimens. Finally, the accuracy was checked by a senior plant taxonomist (Ermias Lulekal for confirming the taxonomic identification of voucher specimens and the National Herbarium, AAU). The plant specimens with their labels were finally deposited at the National Herbarium (ETH) in Addis Ababa, Ethiopia.

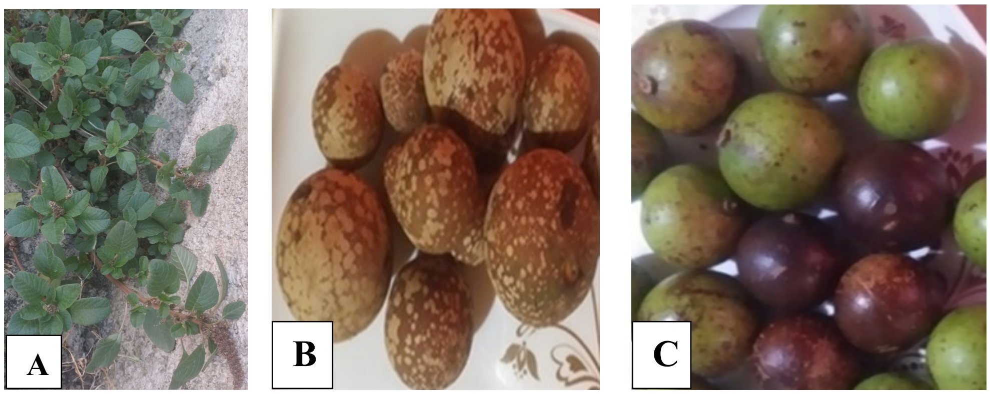

Figure 6. 32. Samples of vegetable and fruits

Samples of the leaf and young shoot of *Amaranthus tortuosus* (A) and fruits *(Landolphia buchananii* (B), *Oncoba spinosa* (C)) from left to right, respectively) of three wild edible plants collected from Soro District, central Ethiopia.

6.2.3. Collection of selected plant samples

The edible parts of the selected WEPs, fresh leaves with young shoots of *A. tortuosus,* fruit specimens of *L. buchananii* and *O. spinosa* were collected in (September) and (June and April), 2021 respectively, from different wild habitats in September, June, and April 2021, respectively (Table 6. 34). Samples were collected fresh, disease-free, at the ripened stage, and properly handled to avoid decay and degradation. In addition, some partially ripened fruits were stored at room temperature until fully matured. Unpeeled fruit samples of *L. buchananii* and *O. spinosa* were washed in the field and laboratory to remove foreign matter and debris. The fruits were then peeled, and the edible parts were separated from the exocarp. All peeled fruit and leaf samples were immediately placed in a refrigerator at -20 ºC for 48 h, followed by freeze-drying (MINI LYODEL, DIGITAL HI-PR-PIRANI GAUGE DHPG-222, HIND, HIVAC) for 72 h. The dried samples were ground to a sieve size of 0.5 mm using a high-speed sample miller (Xian Siway Scientific Instrument Co., Ltd, SIWAY), and stored in a plastic polyethylene bag in a deep freeze at -20 ◦C until analysis.

Table 6. 34. Ethnobotanical characterizations of three wild edible plants (WEPs) collected from Soro District, central Ethiopia.

Local name	Scientific name	Family	Ripening/ available time	Parts used	Use	Code	Locality	Altitude (masl)
Gude'e	*Amaranthus tortuosus* Hornem.	Amaranthaceae	March to December	Leaves & young shoots	Food, as vegetable	MH-65 (A)	Weed of home garden and agricultural land	2065
Hoomba	*Landolphia buchananii* (Hall.f.) Stapf	Apocynaceae	September to June	Fruit, Mesocarp	Food, as fruit	MH-147 (B)	Agricultural land and riverine	2093
Itakkam kuukka	*Oncoba spinosa* Forssk.	Salicaceae	September to April	Fruit, Mesocarp	Food, as fruit	MH-351(C)	Forest patch	1900

masl***:*** mean above sea level; MH: Mulatu Hankiso

6.3. Methods

6.3.1. Total soluble solids (TSS)

The total soluble solids (TSS) of the fruit juice were measured in triplicate using a digital refractometer optical prism (refractometer III, RFM-960, BS). The refractometer was auto-calibrated using 2-3 drops of distilled water. Five milliliters of the juice from *L. buchananii* and *O. spinosa* was well homogenized and three drops were added to the prism and closed, and the TSS was read directly according to Minuye (2021), and the results were recorded in ^{o}Brix.

6.3.2. pH

The ripened edible fresh fruits of *L. buchananii* and *O. spinosa* were peeled, and 5 g mesocarp of each fruit was crushed and homogenized with 100 mL deionized water to prepare the juice. The pH was determined directly with an auto-calibrated pH-meter (PHS-3DW, Campan HINOTEK China) with automatic temperature adjustment. Additionally, the pH of uncooked mature leaves of *A. tortuosus* was determined (Holcroft and Kader (1999). The results were recorded in triplicates.

6. 3.3. Proximate composition

Moisture, crude protein, crude fat, crude fiber, and total ash contents were analyzed according to the methods of the Association of Official Analytical Chemists (AOAC, 2016). Moisture content was determined by oven drying (Genlab Thermal Engineers, Model: OV/125/SS/F/D/G/A, Serial No. 11B139, UK) at 105°C to a constant weight (protocol no: AOAC. 965.17). Protein content (N × 6.25) was determined using the Kjeldahl (INOK1160 Automatic Kjeldahl Protein/Nitrogen Analyzer) method based on the determination of nitrogen content (AOAC. 965:17). The fat content was determined using a fully automated Soxhlet system, Soxtec™ 800 (AOAC 965:17; Barnstead Electro-thermal, Staffordshire, UK). The crude fiber content was determined according to AOAC (2016). Ash was determined gravimetrically in a heated muffle furnace (Furnace type CSF 12/130; Aston (AOAC, 2010). Total carbohydrate content was calculated as follows (equation 1):

$$\text{Total carbohydrate (\%)} = 100 - (\text{Moisture} + \text{Total ash} + \text{Crude protein} + \text{Crude fat}) \quad (1)$$

Gross energy was calculated from the protein, fat, and carbohydrate values (equation 2):

$$\text{Gross energy (kcal/100 g)} = 4 \times \text{protein (\%)} + 4 \times \text{carbohydrate (\%)} + 9 \times \text{fat (\%)} \quad (2)$$

6. 3.4. Minerals

The concentrations of calcium, iron, and zinc were determined using the official method of AOAC (2010). Briefly, 2.5 g of the WEPs powder was ashed using a muffle furnace at 550 °C for 4 h. The ash was dissolved in 5 mL of 10 M HCl and the solution was subsequently boiled. The digested sample was cooled, filtered, and adjusted to the required volume using demineralized water. The mineral concentration was determined using atomic absorption spectrophotometer (AA 800, Perkin-Elmer Germany).

6. 3. 5. Vitamin C

Vitamin C content was quantified using the 2,6-dichloroindophenol titrimetric method (AOAC 967.21 (Nielsen, 2017). A 10 g powder of the leaves of *A. tortuosus,* fruits of *L. buchananii,* and *O. spinosa* was dissolved in 100 mL of distilled water with 3% metaphosphoric acid in a 100 mL flask using an electric blender. The aliquot was then filtered using a cheese cloth. Subsequently, 5 mL of the filtrate was titrated against standard 2, 6-dichloroindophenol reagent. The end point of the titration was marked by the disappearance of the initial blue color. The concentration of vitamin C concentration was calculated using equation 3.

$$\text{Vitamin C} \left(\frac{\text{mg}}{100\text{mL}}\right) = \frac{[V*C*M*v*100]}{\text{Wt.of dry sample}} \qquad (3)$$

where:

V: volume consumed (mL)

C: concentration of the titrant (0.005 M)

M: molecular weight of the titrant (g/ mol)

v: volume made up

6. 3. 6. Determination of anti-nutritional factors

6. 3.6.1. Phytate content

Phytate content of WEPs was determined using the method described by Latta and Eskin (1980). In brief, about 0.1 g of dried WEPs was extracted at ambient temperature for 1 h with 10 mL of 2.4% HCl in a mechanical shaker and centrifuged at 15 g for 30 min. The clear supernatant was aged to estimate the phytate content. To 3 mL of the sample solution, 1 mL Wade reagent (containing 0.03% $FeCl_3 \cdot 6H_2O$ solution and 0.3% sulfosalicylic acid in water) was added and vortexed (VM-300P, 815424, Taiwan) for 5 s. The absorbance of the samples was determined using a UV-Vis spectrophotometer (Perkin Elmer, Lambda 950 UV/Vis/NIR spectrophotometer, CF728, UK) at 500 nm.

A series of standard solutions containing 5, 10, 15, and 20 μg/ mL of phytic acid (sodium phytate analytical grade) were prepared along with 2.4% HCl. In a 15 mL centrifuge tube containing 3 mL of water, a 3 mL standard was added as a blank. In each test tube, 1 mL of Wade reagent was added, and the solution was vortexed for 5 s. The mixture was centrifuged at 15 × g for 10 min, and the absorbance of the solution was measured by calibrating the spectrophotometer at 500 nm. The phytate content was calculated using equation 4.

$$\text{Phytic acid } \left(\frac{\mu g}{100mg}\right) = \frac{[(As-Ab)-[\text{Intercept}]*10}{\text{Slope}*W*3} \qquad (4)$$

where:

As: sample absorbance

Ab: blank absorbance

W: sample weight (g)

10: aliquot

6. 3. 6. 2. Condensed tannin content

The condensed tannin content of the WEPs was determined according to the method described by Maxson and Rooney (1972). Briefly, 1 g of powdered sample was weighed in a screw-cap test. At room temperature with a mechanical shaker, the sample solutions were extracted with 10 mL of 1% HCl in methanol for 24 h. The solution was centrifuged at 1 x g for 5 min, 1 mL supernatant was collected and 5 mL vanillin-HCl reagent was added. Forty mg catechin was weighed, and 1% HCl was dissolved in 1000 mL methanol, which was used as the stock solution. Using Catechin (60 mg/100 mL), test concentrations of 0.2, 0.4, 0.6, 0.8, and 1.0 mg/100 mL. The test tubes were adjusted with 0.12, 0.24, 0.36, 0.48, 0.60 and 1.00 mL of stock solution, and the volume of each test tube was adjusted to 1 mL with 1% HCl in methanol. Each test tube was supplemented with 5 mL of vanillin-HCl reagent. Then, the absorbance of the solution was measured at 500 nm using a UV-Vis spectrophotometer (Perkin Elmer, Lambda 950 UV/VIS/NIR spectrophotometer, at the model: Llantrisant, CF728YW, UK). The condensed tannin concentration was calculated using equation 5.

$$\text{Tannin } \left(\frac{mg}{100\ g}\right) = \frac{[(As-Ab)-[\text{Intercept}]*10}{\text{Slope}*d*W} \qquad (5)$$

where:

As: sample absorbance

Ab: blank absorbance

d: density of the solution (0.791 g/ mL)

W: sample weight (g)

10: aliquot

6.3.6.3.Oxalate content determination

The oxalate concentration of the WEPs was determined using the titration method (AOAC, 2005; Ukpabi and Ejidoh, 1989). One gram of freeze-dried and finely ground powder sample was digested using 75 mL of 3 M sulphuric acid (98%) in a 250 mL conical flask. Next, 10 mL of 6 M HCl was added, shaken, digested for 1 h at 90 ◦C, and cooled. Distilled water was added to the conical flask at a volume of 250 mL. The filterate (25 mL) was poured into flask followed by the addition of four drops of methyl red indicator solution, 1 mL of 6 M HCl, and concentrated solution of NH_4OH drop by drop until the test sample solution was changed from pink to yellow color at 4 to 4.5 pH. The solution was heated to 90 ◦C and cooled. The liquid extract was filtered and the ferrous ion-containing precipitate was extracted. A 10 mL of 5% $CaCl_2$ was mixed with the filtrate and shaked.The solution was heated, and kept in refrigerator for a night at 5 ◦C. The solution was decanted and dissolved fully in 10 mL of 98% H_2SO_4. Then, a total filtrate of 300 mL was titrated with a permanganate solution (0.1 M) until the color persisted for 15 to 30s. The volume consumed was recorded. The oxalate content was determined by the following relationship: 1 mL of 0.1M $KMnO_4$ solution = 0.006303 g of oxalate. Hence, the percentage of oxalate content in 100 g of the powder was calculated using equation 6.

$$\text{Oxalate (g/100 g)} = \text{titre} \times 100/\,W \qquad (6)$$

where:

W: Weight of dry sample (g)

titre: volume of titrant ($KMnO_4$) consumed (mL)

6.3.7. Bioactive compounds determination

6.3.7.1. Sample extraction for bioactive compounds and antioxidant capacity determination

In brief, according to Addai et al. (2013), 5 g of powdered WEPs dissolved in 50 mL (99.8%, v/v) methanol in 100 mL conical flask and extracted for 24 h at 30 ◦C in a mechanical shaker at 150 rpm (Incubator shaker, Co., Ltd: ZHWY-103B, Shanghai, P.R. China). The supernatant was filtered into a 250 mL conical flask using Whatman No.1 filter paper. The extraction was repeated by adding 50 mL methanol to the precipitates and placing them on a shaker for 2 h, followed by filtration. The filtrates were collected and stored at 4 ◦C in a freezer until determination of the bioactive compounds (phenols and flavonoids) and antioxidant activity (DPPH (2,2-diphenyl-1-picrylhydrazyl).

6.3.7.2. Total phenolic content determination

Total phenolic extracts were determined using the Folin-Ciocalteu method (Singleton and Rossi, 1965; Musa et al., 2011). Crude extracts of 100 µL for the two fruits and 50 µL for the leaf and shoot edible parts (were mixed with 0.9 mL of methanol and 1 mL of Folin-Ciocalteu's reagent (1:9 distilled water ratio). After 8 min, 1 mL of saturated sodium carbonate solution, (7.5% w/v in water) was dissolved to form a mixture, and the volume was made up to 10 mL using distilled water. The reaction mixture was kept in the dark for 30 min at room temperature, vortexed, and the absorbance was measured at 765 nm using a UV-Vis spectrophotometer (Perkin Elmer, Lambda 950 UV/Vis spectrophotometer, model: Llantrisant, CF728YW, UK) against the reagent blank. The stock solution was prepared by dissolving 62.5 mg gallic acid in 1 mL of methanol. Various concentrations of gallic acid were prepared in methanol (0.02, 0.04, 0.06, 0.08, and 0.10 mg/ mL). All determinations were performed in triplicate. The TPC was expressed in gallic acid equivalents (GAE) per gram of dry weight of each extract (equation 7).

$$\text{TPG (mg GAE/g)} = \frac{\text{CxV}}{\text{m}} \qquad (7)$$

where:

TPC: total phenolic content

GAE: gallic acid equivalent

C: gallic acid concentration obtained from standard curve (mg/ mL)

V: volume of extract solution (mL)

m: weight of the dry extract (g)

6. 3.7.3. Total flavonoid content determination

The aluminum chloride colorimetric method was used to determine the total flavonoid content of the WEP samples (Ribrova et al., 2005; Pourmorad et al., 2006; Chandra et al., 2014). Stock quercetin solution (mg/ mL) was prepared by dissolving 12.5 mg quercetin in 50 mL methanol. Standard solutions of quercetin were prepared by serial dilution in methanol (0.025, 0.050. 0.075, 0.100, and 0.125 mg/ mL). The sample extract was separately mixed with 1 mL of 2% aluminum chloride and 0.03 mL of sample was mixed with 0.97 mL methanol. After mixing, the solution (1 mL) was incubated for 10 min at room temperature. The absorbance of the reaction mixtures was measured at 415 nm against a blank using a UV-Vis spectrophotometer. Flavonoid content was calculated as quercetin equivalent (QE)/g extract (equation 8).

$$\text{TFC (mg QE/g)} = \frac{\text{CxV}}{\text{m}} \qquad (8)$$

where:

TFC: total flavonoid content

QE: quercetin equivalent

C: quercetin concentration obtained from standard curve (mg/ mL)

V: volume of extract solution (mL)

m: weight of the dry extract (g)

6. 3.7.4. Antioxidant capacity determination

6. 3.7.4.1. DPPH assay

The DPPH radical scavenging capacity of the WEP extract was determined according to the method described by Etim et al. (2015). Briefly, 50 mg/ mL crude extract of WEP samples was serially diluted to concentrations of 20, 40, 60, 80, and 100 µg/ mL with methanol. On each solution, 4 mL of 0.1 mM DPPH in methanol was added and the solution was kept at room temperature in the dark for 30 min. The absorbance was measured using a UV-Vis spectrophotometer at 517 nm. One milliliter of methanol with 3 mL of working DPPH solution was used as a blank solution. The results were compared to the same doses of standard ascorbic acid to calculate the percentage of DPPH inhibition (equation 9).

$$\text{DPPH(\% of inhibition)} = \frac{\text{A blank} - \text{A sample}}{\text{A blank}} * 100 \qquad (9)$$

where:

A blank: absorbance of control

A sample: absorbance of sample

6. 3.7.5. Statistical analysis

Results are expressed as mean ± standard deviation. Significant differences in mean values were determined at $p<0.05$, using one-way analysis of variance (ANOVA) and Duncan's multiple range test. Partly paired t-tests were used to compare the mean differences at $p<0.05$. All analyses were conducted in triplicate and analyzed using the SPSS software (version 22.0; SPSS Inc. Illinois, USA).

6. 4. Results and discussion

6. 4.1. Physico-chemical characteristics

The physico-chemical characteristics of *A. tortuosus, L. buchananii,* and *O. spinosa* collected from the Soro District, central Ethiopia are reported in Table 6.35. The three WEPs were identified either in the field or at the National Herbarium ETH at Addis Ababa University. The edible parts of these plants are shown in Figure 6.32. The average total weight of *L. buchananii* and *O. spinosa* were 541 g and 1049 g, respectively ($p<0.05$). A highly significant difference was observed in the seed and mesocarp weights of the two fruits, which were (162 and 667) g and (84 and 450) g respectively ($p<0.05$). *O. spinosa* had the highest values of all physical parameters measured, including the weight of the exocarp ($p<0.05$) (Table 6.35). The fruit can resist decay by fungi and bacteria due to the hard, thick exocarp, thus assuming fit for rural areas with less or no facilities for fruit preservation technologies (Doyle, 2009). At the ripening stage, its fruit exocarp gradually changed from a slight green color to a dark-brown, and the color of the pulp also changed from a slight yellow to a dark-brown. At the ripening stage, the fruit and pulp color of *L. buchananii* changed from white latex to slightly white, whereas the latex disappeared gradually. The fruit contains bean-sized seeds. The *Amaranthus tortuosus* is a WEP with a dark-green color, relatively broad leaves, and young shoots, which is commonly used as a vegetable by the local community.

The TSS and pH of the fresh juice from *L. buchananii* and *O. spinosa* were (2.36 ^{o}Brix, 4.53) and (8.37 ^{o}Brix, 5.53), respectively ($p<0.05$). The TSS of *O. spinosa* fruit juice (8.37 ^{0}Brix) is comparable to that of certain cultivated fruit juices, such as papaya (*Carica papaya*) (10.3 ^{0}Brix) (Minuye, 2021), and some wild edible fruits of *Hippophae salicifolia* (10.80 ^{o}Brix) and *Berberis aristata* (10.96 ^{o}Brix) (Singh et al., 2023). Some wild edible fruits had higher TSS than this value; for instance, *Malus baccata*, *Pyrus pashia*, *Ramaria botrytis*, and *Prunus cornuta* had a respective TSS content of 23.77, 21.80, 20.06, and 18.53 ^{o}Brix in the northwest Himalaya, India (Singh et al., 2023). In a similar study, a lower TSS (6.13 ^{o}Brix) was reported than that in the current study of *O. spinosa.*

Table 6. 35. Physico-chemical characteristics of *Landolphia buchananii* and *Oncoba spinosa* collected from Soro District, central Ethiopia.

Wild edible plant	Total weight (g)	Exocarp weight (g)	Seed weight (g)	Mesocarp weight (g)	TSS (ºBrix)	Fresh fruit pH
Landolphia buchananii	541.0 $\pm$ 54.0	331.7 $\pm$ 56.6	161.9 $\pm$ 80.9	83.7 $\pm$ 36.8	2.4 $\pm$ 0.2	4.5 $\pm$ 0.1
Oncoba spinosa	1049.4 $\pm$ 237.3*	399.8 $\pm$ 1.6*	667.4 $\pm$ 56.0*	449.6 $\pm$ 332.4*	8.4 $\pm$ 0.4*	5.5 $\pm$ 0.2*

Data are expressed as the mean $\pm$ standard deviation (*n=3* independent composite samples). *Mean values within a column are significantly different using paired t-test at p<0.05

6. 4.2. Proximate composition

The proximate compositions of the three WEPs, leaves and shoots of *A. tortuosus*, fruits of *L. buchananii,* and *O. spinosa* are presented in Table 6. 36. The fresh and raw leaves and shoots of *A. tortuosus* and fruits of *L. buchananii* and *O. spinosa* had moisture contents of 85, 79, and 59 g/100 g, respectively ($p<0.05$). The total ash content in the two fruit samples was 6.6 and 3.0 g/100 g ($p<0.05$) (*O. spinosa* and *L. buchananii* respectively); while the content in the leaf was 20.60 g/100 g, which was significantly higher amount than in the fruits ($p<0.05$). Adamu et al. (2022) reported a high amount of ash (15 g/100 g) in *A. hybridus* leaf. Similarly, the crude protein content of *A. tortuosus* was significantly higher than that of fruit samples (33.77 g/100 g) ($p< 0.05$). A lower crude protein content of 17.63 g/100 g in the leaf of *A. hybridus* was reported by Adamu et al. (2022). Relatively higher crude protein content in the leaves of Ethiopian WEPs of *Erucastrum abyssinicum*, *Erucastrum arabicum*, *Urtica simensis* (33.63, 30.15, 30.55 g/100 g) respectively was reported by Adamu et al. (2022b). Apparently, these groups of plants might contribute to protein intake in areas with the lowest intake. In fact, the WEPs in this study offer relatively higher protein contents than cultivated vegetable crops such as *Brassica oleracea* (1.1-2.7 g/100 g), *Brassica carinata* (2.5-2.8 g/100 g), and *Allium sativum* (1.0-4.5 g/100 g) (Getachew et al., 2013).

The crude fiber content in WEPs ranged from 6.05-9.60g/100 g ($p<0.05$) (Table 6.36). This range is lower for plant-based foods. Similarly, Adamu et al. (2022b) reported 6.21 g/100 g crude fiber content in the leaves of *A. hybridus*. The crude fat content of WEPs in this study was within the range of 3.0-5.5 g/100 g ($p<0.05$). Total carbohydrate content was 72.14, 74.02, and 33.67 g/100 g in the *O. spinosa*, *L. buchnanii* (fruits), and *A. tortuosus* (leaves and shoots) respectively ($p<0.05$). The carbohydrate content of the two fruit samples was comparable with the content in WEPs like *Pachycymbium laticoronum* (60.5 g/100 g), harvested from Southern Ethiopia (Uyoh et al., 2013). The total carbohydrate content in the WEPs in this study is greater than the value in cultivated fruits including mango (17.00 g/100 g), banana (22.84 g/100 g), guava (14.3 g/100 g), pineapple (11.82 g/100 g), and papaya (9.81 g/100 g) (Blessing et al., 2011; Afolayan and Mbaebie, 2010).

The caloric values in the leaves and shoots of *A. tortuosus*, fruit of *L. buchananii,* and *O. spinosa* were 284, 330, and 313 kcal/100 g respectively. Diets with energy densities greater than 1 kcal/g, and even 2 kcal/ g, may contribute to adequate energy intake and prevent wasting in children during food insecurity (Mahapatra et al., 2012). Thus, the WEPs in this study will significantly contribute in mitigating such forms of malnutrition, particularly during the lean season.

Table 6.36. Proximate composition of *Amaranthus tortuosus* leaves and shoots*, Landolphia buchananii, Oncoba spinosa* fruits collected from Soro District, central Ethiopia.

Proximate composition	*Amaranthus tortuosus* (leaf and shoot)	*Landolphia buchananii* (fruit)	*Oncoba spinosa* (fruit)
Moisture (fresh sample) (g/100 g)	84.80 ± 0.56^{a}	79.07 ± 2.15^{b}	59.53 ± 1.82^{c}
Moisture (g/100 g)	5.80 ± 0.38^{c}	11.33 ± 0.58^{b}	12.75 ± 0.25^{a}
Total ash (g/100 g)	20.60 ± 0.28^{a}	3.00 ± 0.28^{c}	6.60 ± 0.28^{b}
Crude protein (g/100 g)	33.77 ± 0.00^{a}	8.31 ± 0.12^{b}	5.51 ± 0.37^{c}
Crude fat (g/100 g)	5.50 ± 0.29^{a}	3.67 ± 0.76^{b}	3.00 ± 0.50^{c}
Crude fiber (g/100 g)	9.60 ± 1.6^{a}	8.03 ± 0.40^{b}	6.05 ± 0.02^{c}
Total carbohydrate (g/100 g)	33.67 ± 1.02^{c}	74.02 ± 1.60^{a}	72.14 ± 1.16^{b}
Utilizable carbohydrate (g/100 g)	24.07 ± 1.03^{b}	65.99 ± 1.56^{a}	66.09 ± 1.17^{a}
Energy (kcal/100 g)	283.70 ± 1.57^{c}	330.23 ± 2.44^{a}	313.40 ± 2.04^{b}

Data are expressed as the mean ± standard deviation (*n=3* independent composite samples) on a dry basis (except for fresh sample moisture determination). Mean values within a row with different superscripts indicate significant differences at $p<0.05$, using one-way analysis of variance (ANOVA), in mean comparisons using Duncan's multiple range test

6. 4.3. Mineral composition

The contents of the macro-mineral (calcium) and microminerals (iron and zinc) in the three WEPs from Soro District, central Ethiopia are reported in Table 6.37. The calcium content in the fruits of *L. buchananii* and *O. spinosa* was 86.83 mg/100 g and 88.02 mg/100 g, respectively ($p<0.05$), whereas the highest content was found in the leaves and shoots of *A. tortuosus* (1059.50 mg/100 g) ($p<0.05$). The calcium content of *L. buchananii* (86.83 mg/100 g) is closely comparable with the content in the WEP *Crocus sativus*, 86.25 mg/100 g in Morocco (Ibourki et al., 2022), and lower than the content in *Ziziphus spina-christi* collected from Ethiopia (339.5 mg/100 g) (Duguma, 2020). Adamu et al. (2022b) reported lower calcium content than in the present study (59.94 mg/100 g) in the dried leaves of *Amaranthus hybridus.* But (Duguma, 2020) reported a higher calcium content of 3029 mg/100 g in *Amaranthus graecizans* collected from Ethiopia. In other leafy WEPs including *Erucastrum abyssinicum*, *Erucastrum arabicum*, *Haplocarpha rueppelii*, *Haplocarpha schimperi*, *Urtica simensis,* the calcium content was between the range of 44-60 mg/100 g (Adamu et al., 2022b). In the present study, the calcium content in the leaves of *A. tortuosus* was much higher than that reported previously but much less than that of *Amaranthus graecizans*. This may be because of various environmental and genetic factors.

The iron concentration in the three WEPs was 34.22, 3.10, and 2.10 mg/100 g respectively in *A. tortuosus*, *L. buchananii,* and *O. spinosa* ($p<0.05$) (Table 6.37). The iron content was significantly much higher in the leaf and shoot sample of *A. tortuosus*. Adamu et al. (2022b) reported an iron concentration of 18.81 mg/100 g from dried leaf of *Amaranthus hybridus*. The iron content of the WEPs in this study is comparable with the content in other WEPs investigated from Southern Ethiopia (*i.e.,*1.9 mg/100 g in *Ximenia caffra*, 22.0 mg/100 g in *Launaea intybacea*) (Uyoh et al., 2013). Thus, from this study one can assume that the WEPs could be a good dietary source of iron, contributing between 0.11-1.90 times the adult recommended daily allowance (RDA) of 18 mg/day, but its bioavailability may need to be evaluated further (Azene and Molla, 2017; Khan et al., 2011). The zinc content in *A. tortuosus*, *L. buchananii,* and *O. spinosa* was 1.26, 2.90, and 5.01 mg/100 g ($p<0.05$) (Table 6.37). Adamu et al. (2022b) reported a zinc concentration of 8.35 mg/100 g from dried leaf of *Amaranthus hybridus*. Overall, the leaves and shoots of *A. tortuosus* had the highest concentration of Ca, Fe, and Zn among the three WEPs (Table 6. 37).

Table 6. 37. Mineral contents of *Amaranthus tortuosus* leaf and shoot, *Landolphia buchananii,* and *Oncoba spinosa* fruits collected from Soro District, central Ethiopia.

Minerals	*Amaranthus tortuosus* (leaf and shoot)	*Landolphia buchananii* (fruit)	*Oncoba spinosa* (fruit)
Calcium (mg/100 g)	1059.50 ± 2.20^{a}	86.83 ± 0.33^{b}	88.02 ± 0.33^{b}
Iron (mg/100 g)	34.22 ± 0.07^{a}	3.10 ± 0.03^{b}	2.10 ± 0.01^{c}
Zinc (mg/100 g)	5.01 ± 0.02^{a}	2.90 ± 0.03^{b}	1.26 ± 0.01^{c}

Data are expressed as the mean $\pm$ standard deviation (*n=3* independent composite samples) on dry basis. Mean values within a row with different superscripts indicate significant difference at p<0.05 using one-way-analysis of variance (ANOVA), in mean comparisons using Duncan's multiple range test

6. 4.4. Anti-nutritional factors

The phytate, oxalate, and tannin contents of the three WEPs from Soro district are reported in Table 6.38. The oxalate concentrations in the two fruit samples were 0.40 and 8.66 mg/100 g respectively for *L. buchananii* and *O. spinosa* ($p<0.05$). Oxalate content in the leaves of *A. tortuosus* was 1.43 mg/100g. The oxalate content in the leaves of WEPs collected in Lasta district, Ethiopia were *Amaranthus hybridus* (5.13), *Erucastrum abyssinicum* (11.73), *Erucastrum arabicum* (5.13), *Haplocarpha rueppelii* (9.09), *Haplocarpha schimperi* (5.57), *Urtica simensis* (5.13) mg/100 g (Adamu et al., 2022a). The oxalate content in the leaf of *A. tortuosus* was lower than these values. Accordingly, it was highest in licorice root (*Glycyrrhiza glabra*; 3569.3 mg/100 g), blue fenugreek (*Trigonella coerulea*; 1245.9 mg/100 g) and white beans (*Phaseolus vulgaris* L.; 547.9 mg/10 g), in sweet potatoes (*Ipomoea batatas*, 495.6 mg/100 g), cocoa powder (*Theobroma cacao*, 619.3 mg/100 g), in okra (*Abdelmoschus esculentus*, 317.2 mg/100 g). The oxalate content of the WEPs in this study was much lower than these values. Oxalate-containing foods enhance the formation of kidney stones, cause irritation of the tongue, and decrease calcium absorption (Fekadu et al., 2013).

The phytate content in *O. spinosa*, *L. buchananii*, and *A. dubius* was 0.89, 0.74, and 0.47 mg/100 g, respectively ($p<0.05$). The phytate contents in the leaves of WEPs collected in Lasta district, Ethiopia, was *Amaranthus hybridus* (0.08), *Erucastrum abyssinicum* (0.03), *Erucastrum* *arabicum* (0.17), *Haplocarpha rueppelii* (0.17), *Haplocarpha schimperi* (0.17), *Urtica simensis* (0.08) mg/100 g (Adamu et al., 2022a). The phytate content in the three WEPs in this study was higher than these values. Phytic acid interferes with daily functions of the human body, including digestion and protein breakdown (Schjønning et al., 2004). Nutritional disorders, such as rickets and osteomalacia, are associated with excessive consumption of phytate-rich diets. However, this anti-nutrient can be rapidly eliminated by soaking, boiling, and cooking (Ekop and Eddy, 2005).The tannin contents in *A. tortuosus*, *L. buchananii*, and *O. spinosa* was 29.11, 46.71, and 35.63 mg/100 g, respectively ($p<0.05$).

Table 6.38. Anti-nutritional factors of *Amaranthus tortuosus* leaf and shoot*, Landolphia buchananii,* and *Oncoba spinosa* fruits from Soro District, central Ethiopia.

Anti-nutritional factors	*Amaranthus tortuosus* (Leaf and shoot)	*Landolphia buchananii* (Fruit)	*Oncoba spinosa* (Fruit)
Phytate (mg/100 g)	0.47 ± 0.00^{c}	0.74 ± 0.34^{b}	0.89 ± 0.02^{a}
Oxalate (mg/100 g)	1.43 ± 0.16^{b}	0.40 ± 0.04^{c}	8.66 ± 0.16^{a}
Tannin (mg/100 g)	29.11 ± 0.19^{c}	46.71 ± 0.15^{a}	35.63 ± 0.26^{b}

Data are expressed as the mean $\pm$ standard deviation (*n=3* independent composite samples) on a dry basis. Mean values within a row with different superscripts indicate significant differences at $p<0.05$, using one-way analysis of variance (ANOVA), in mean comparisons using Duncan's multiple range test

6. 4.5. Bioactive compounds

6. 4.5.1. Total phenolics and flavonoids

The leaves and shoots of *A. tortuosus*, fruits of *L. buchananii,* and *O. spinosa* had total phenolic content of 114.45, 171.39, and 115.45 mg GAE/100 g, respectively (Table 6.39). The total phenolic content in the leaves of six WEPs collected from northeastern Ethiopia was within the range of 0.79 (*Urtica simensis*) to 17.02 mg GAE/100 g (*Haplocarpha rueppelii*) (Adamu et al., 2022a). In the same report, *Amaranthus hybridus* leaves had a total phenolic content of 13.13 mg GAE/100 g. This is much lower value than that obtained in the present study within the same genus. The high phenolic content in WEPs has been shown to be valuable in the prevention of various chronic diseases (Asami et al., 2003).

The leaf and shoot of *A. tortuosus*, fruits of *L. buchananii,* and *O. spinosa* had total flavonoid content of 81.70, 132.43, 74.17 mg QE/100 g, respectively (Table 6. 39). The total flavonoid content in the leaf and young shoot of six WEPs collected from northeastern Ethiopia was within the range of 2.27 (*Rumex nervosus*, young shoots) to 7.12 mg QE/100 g (*Amaranthus hybridus*) (Adamu et al., 2022a). These values are significantly lower than those reported in the present study. This variability makes WEPs a good candidate for the exploration of antioxidants (Kwinana-Mandindi, 2015).Flavonoids have antioxidant and free radical scavenging activities and may protect membrane lipids from oxidation (Williams et al., 2004).

Table 6.39. Total phenolic and flavonoid contents of *Amaranthus tortuosus* leaf with shoot, *Landolphia buchananii,* and *Oncoba spinosa* fruits were collected from Soro District, central Ethiopia.

Bioactive compounds	*Amaranthus tortuosus* (leaf and shoot)	*Landolphia buchananii* (fruit)	*Oncoba spinosa* (fruit)
TPC (mg GAE/100 g)	114.45 ± 4.29^{b}	171.39 ± 11.25^{a}	115.45 ± 0.10^{b}
TFC (mg QE/100 g)	81.70 ± 2.16^{b}	132.43 ± 19.61^{a}	74.17 ± 6.84^{c}

Data are expressed as the mean $\pm$ standard deviation (*n=3* independent composite samples) on a dry basis. Mean values within a row with different superscripts indicate significant differences at $p<0.05$, using one-way-analysis of variance (ANOVA), in mean comparisons using Duncan's multiple range test
TPC: total phenolic content; TFC: total flavonoids content; GAE: gallic acid equivalent; QE: Quercetin Equivalent

6. 4.5.2. Antioxidant activity

6. 4.5.2.1. Radical scavenging activity using DPPH assay

The DPPH free radical scavenging activity of the WEPs was estimated by comparison with an ascorbic acid standard. Apparently, with all the extracts as concentration increased the DPPH scavenging capacity also increased (Table 6. 40). At 200 µg/ mL concentration, the highest percentage of inhibition was observed for ascorbic acid (96.42%), followed by *L. buchananii* (94.63%), *O. spinosa* (77.37%), and *A. tortuosus* (66.85%). Methanolic extract of *L. buchananii* fruit showed the highest inhibition percentage, which was comparable to that of ascorbic acid. In one of the WEPs in northeastern Ethiopia, *Rumex nervosus* young shoots, Adamu et al. (2022) reported a 97.30% inhibition of DPPH at 200 µg/ mL. The lowest percent of inhibition was recorded for the seeds of *Amaranthus hybridus* (52.31%) at the same concentration. Similarly, in the present study, the lowest inhibition was observed with the extract of leaves and shoots of *A. tortuosus*. The IC50 values of the extracts from *A. tortuosus, L. buchananii*, and *O. spinosa* were

124 μg/ mL, 84 μg/ mL, and 125 μg/ mL, respectively (Table 6. 40). The *L. buchananii* extract had an IC50 value (84 μg/ mL) comparable to that of an ascorbic acid (82 μg/ mL).

Table 6. 40. DPPH free radical scavenging activities of *Landolphia buchananii*, *Oncoba spinosa* fruits and *Amaranthus tortuosus* leaf and shoot collected from Soro District, central Ethiopia.

Concentration (μg/ mL)	Ascorbic acid	*A. tortuosus* (leaf and shoot)	*L.buchananii* (fruit)	*O. spinosa (*fruit)
	Inhibition %			
20	17.41 ± 0.03^{a}	14.49 ± 0.01^{b}	13.49 ± 0.03^{c}	9.96 ±0.02^{d}
40	28.09 ± 0.09^{b}	21.70 + 0.02^{c}	46.33 + 0.03^{a}	16.89 ±0.03^{d}
80	48.46 ± 0.06^{b}	39.35 ± 0.05^{c}	53.42 ± 0.02^{a}	34.78 ± 0.04^{d}
120	74.77 ±0.10^{a}	51.66 + 0.20^{c}	63.75 ± 0.05^{b}	50.18 ± 0.10^{d}
160	96.18 ± 0.10^{a}	66.63 ± 0.03^{c}	82.10 ± 0.10^{b}	62.41 ± 0.40^{d}
200	96.42 ± 1.00^{c}	66.85 ± 0.05^{b}	94.63 + 2.00^{c}	77.37 ±1.00^{a}
IC_{50} (μg/ mL)	82	124	84	125

Data are expressed as the mean ± standard deviation (*n=3* independent composite samples) on a dry basis. Mean values within a row with different superscripts indicate significant differences at p<0.05, using one-way analysis of variance (ANOVA), in mean comparisons using Duncan's multiple range test

6. 4.5.3. Vitamin C

Vitamin C content varied significantly (p<0.05) among the WEPs species studied (Table 6.41). The results indicated that the fruit of *L. buchananii* had the highest vitamin C content of 43.15 mg/100 g (p<0.05) followed by *A. tortuosus* and *O. spinosa* 26 mg/100 g (p>0.05). Adamu et al. (2022) reported vitamin C content of 70.42 mg/100 g in leaves of the WEP *Erucastrum abyssinicum* collected from North Eastern Ethiopia. In the same report, *Amaranthus hybridus* leaves had 33.09 mg/100 g a vitamin C, while *Rumex nervosus* leaves showed the lowest vitamin C content of 2.16 mg/100 g. The highest vitamin C content (44.4 mg/100 g) of *L. buchananii* was comparable to that in cultivated fruits such as papaya (*Carica papaya* L.) (44.61 mg/100 g) (Minuye, 2021). Thus, one can assume that the WEPs under investigation are potential sources of vitamin C in Soro District to play a role in prevent of vitamin C deficiency-related diseases (Santos et al., 2016).

Table 6. 41.Vitamin C content of *Landolphia buchananii*, *Oncoba spinosa* fruits and *Amaranthus tortuosus* leaf and shoot collected from Soro District, central Ethiopia.

Wild edible plants	Edible part	Vitamin C content (mg/100 g)
Amaranthus tortuosus	Leaf and shoot	26.42 ± 0.00^{b}
Landolphia buchananii	Fruit	43.15 ± 1.25^{a}
Oncoba spinosa	Fruit	26.75 ± 0.01^{b}

Data are expressed as the mean ± standard deviation (*n=3* independent composite samples) on a dry basis. Mean values within a column with different superscripts indicate significant differences at p<0.05, using one-way analysis of variance (ANOVA) in mean comparisons using Duncan's multiple range test

Generally, based on the results, the three WEPs are good sources of human food with good amounts of the main nutrients, a good supply of antioxidant capacities, and negligible anti-nutrients. The local people, administration, and relevant offices may engage in protecting and cultivating suitable citations, including revegetating sites and promoting the tree species and others that the community has tested and consumed for millennia.

6.5. Conclusions

In comparison to cultivated vegetable crops, the WEPs (leaves and shoots of *A. tortuosus*, fruits of *L. buchananii*, and *O. spinosa*) in this study had comparatively greater protein and total carbohydrate contents. WEPs also have a high calorific value or energy density, which may facilitate sufficient calorie intake. Specifically, of all the WEPs examined, ash and protein levels were the highest in the leaves and shoots of *A. tortuosus*. Consequently, *A. tortuosus* leaves and shoots had the highest amounts of iron and calcium. The amount of iron in leafy WEP can contribute significantly to the recommended daily allowance for adults. Compared with earlier investigations, there was less oxalate in the studied WEPs. In contrast, the total flavonoid and phenolic contents was higher. Thus, there was significant free radical inhibition by the WEPs' extracts. In particular, the *L. buchananii* extract's IC50 value for scavenging DPPH free radicals was equivalent to that of ascorbic acid. Furthermore, among the WEPs, the fruit of *L. buchananii* had the highest vitamin C content, which was similar to that of the cultivated fruits. Therefore, further research on these WEPs may continue and novel food products can be developed. Additionally, these promising WEPs may be candidates for cultivation to diversify food sources.

6. 6. Recommendations

The findings of these multi-functional selective three WEPs:

- Domestication of nutritional and anti-oxidant beneficials are essential in local communities.

- Conservation training actions against anthropogenic activities for this multipurpose indigenous use diversity and giving priorities for locally disappearing or becoming locally extinct plant species should be required.
- Encourage people in the community for saving these indigenous plants with other life that giving environmental advantages with multipurpose values.
- Giving educational training workshops for the communities should require for better solution with collaboration of the agricultural sector, plant biodiversity and management office create mutualistic relationship of plants with people.

CHAPTER SEVEN

7. General discussion, conclusion, recommendations

7.1. General discussion

In the floristic study of the Soro District, 280 plant species were documented, which shows that remanent forest patches are rich in species composition, diversity, richness, structure, and the association of indigenous knowledge of the people with the use of plants. Among the East African Mountains regions that are located in the most African countries of Kenya, Tanzania, and Uganda, including Ethiopia, the Afromontane forest regions have the richest and most diverse flora (Coetzee, 1978; Lulekal et al., 2008a). Also, it was shown that the forest patch of Soro District has a rich source of 181 ethnomedicinal plant species, which is higher than the 119 traditional medicinal plants reported from Mana Angetu Dense Forest (Lulekal et al., 2008a). The current study finding shows that forests in most tropical areas are the main source of traditional medicine and serve as the basis of modern medicine for about at least 25% (Kong et al., 2003).

Vegetation data were collected in different months that were involved in the three agroecology zones within various altitudinal ranges from different forest representatives, of which DAF is the main type. This potential vegetation area is also studied together with ethnobotany of the same District that contributes ethnoecology, which comes to play for ethnomedicinal, wild edible, and other use plant species. In the study area, remanent forest patches have shown relatively higher important woody species proportions, like in other studies in Ethiopia, and they contributed a higher DBH classes (Bekele, 1993; Lulekal et al., 2008a; Yineger et al., 2008). The majority of plant species were native and flowering species; introduced and flowering plants; gymnosperm species. Few plant species endemic species were categorized under IUCN red list and similarly reported by the study of Ayalew et al. (2006). Family, Asteraceae and Fabaceae were the highest species representative in the floristic composition which similarly reported in the central highlands of Ethiopia (Angessa et al., 2020), and Fabaceae alone by (Asfaw, 2018; Warkineh, 2020).

In the vegetation structure, the total density (4329.26 ha) of Soro District forest patches was higher than the total density (2632 ha) reported by the study (Getaneh and Seid, 2015). The highest DBH proportion class occurred at 10.1–20 cm, and the lowest DBH class was observed at greater than 40cm. This indicated that it has good reproduction, but it has less recruitment. Relatively highest proportion of basal area was recorded for *Syzygium guineense* var. *guineense* covered by 29.10% and 26.59% for *Combretum molle.* A comparison of the basal area of Soro District forest patches with other Ethiopian montane forests indicated that it was lower (61.85 m2/ha) than that of Mana Angetu forest (94 m2/ha) (Lulekal et al., 2008a), Masha Anderacha (82 m2/ha) (Yeshitela and Bekele, 2003), but higher than the forests of Dindin (49 m2/ha) (Shibru and Balcha, 2004), Denkoro (45 m2/ha) (Ayalew et al., 2006), in dry Afromontane forest, south Gondar, Ethiopia (23.3 m2/ha) (Asfaw, 2018), and Gennemar dry Afromontane forest, southern Ethiopia (19.42 m2/ha) (Ahmed et al., 2022). This indicated that Soro District has mainly a dry Afromontane Forest patch, DAF (*e.g*. Shonkola Montane forest patch), and others, and is the most priority site for biodiversity conservation. In the area, the conservation priority sites to increase dense natural forests and forest patches as compared to other forests in Ethiopia (Ahmed et al., 2022).

Moreover, 174 (62.14%) woody plant species compositions of dry Afromontane type in the study District have fewer than 230 plant species in Bale Mountain National Park (Yineger et al., 2008). However, a higher number of woody species were recorded than in other similar studies of dry Afromontane forests in Ethiopia, which had a different number of plant species. For example, there are 133 species in Kumuli Forest (Woldemariam et al., 2016), 95 species in Boda forest (Fikadu and Melesse, 2014), 84 species in Arero forest (Shiferaw et al., 2018), 82 species in Menagesha Suba Forest (Beka, 2007), 55 woody plant species in Gennemar dry Afromontane forest including 40 similar reported plant species, 50 plant species in Denkoro forest (Awoke and Mewded, 2019), 49 woody plant species in Wanzaye dry Afromontane forest (Asfaw, 2018), 44 plant species in Mount Duro forest (Teshome et al., 2020), and 31 plant species in Chilimo dry Afromontane forest (Tesfaye et al., 2019) are the reservoir home to plant diversity. Density distribution of woody plant species in the mountain forest patch is recorded highly for shrub species *Erica arborea* (67%), *Lobelia giberroa* (55%), and *Calpurnia aurea* (32%), whereas *Olinia rochetiana*, *Juniperus procera*, and *Afrocarpus gracilior* were the dominant important plant species with higher respective density proportion within 47%, 42%, and 38%, respectively (*e.g.* Mount Shonkola forest patch), followed by *Maesa lanceolata* (30%), *Syzygium guineense* subsp. *afromontanum* (28%), and *Croton macrostachyus* (25%). The importance value index (IVI) of the most common and frequent woody plant species of Soro District was recorded for *A.*

gracilior, E. arborea, *J. procera*, *O. rochetiana*, *G. arbutifolia, I. mitis*, and *A. dimidiata* in also recorded from the forest sites of Mount Shonkola forest. The highest basal area of *G. arbutifolia* and *A. gracilior* made these species have relative larger dominant values, and thus they have the highest important value index. In the study area, plant species those with higher IVI considered as more ecologically significant species than species with low important value index and they also need conservation priority. Similarly, higher IVIs were reported for *A. gracilior, Juniperus procera*, *G.arbutifolia* in Gennemar dry Afromontane forest (Ahmed et al., 2022).

The population structure of wood plants has significant importance for conservation priorities, sustainable management, and their wise use. The population structure of plant species was important for determining the regeneration status of forest patches based on reproduction patterns and recruitment states using DBH classes. Various agroecological plant species are involved. But these species are being extincting due to selective cutting for the purposes of firewood, construction, dry fences, and house utensils, and which agrees with the study of (Lulekal et al., 2008a).

In the categories of community types, plant species were identified from the hierarchical cluster analysis. Species with the highest synoptic values in the group were used to name the corresponding communities. From the whole five communities *Syzygium guineense*, *Juniperus procera*, *Agarista salicifolia*, *Allophylus abyssinicus*, and *Afrocarpus gracilior* were reported some of the dominant tree species, including shrub species of *Erica arborea* as the Gennemar dry Afromontane forest, southern Ethiopia (Ahmed et al., 2022). The forest patches of Soro District were comparable with dry Afromontabne montane forests in Ethiopia. Some comparison was done among preferred dry montane forest patches in different areas of Ethiopia. For example, Dodolla dry Afromontane forest patch in the northern part of Bale Mountains (2400 m.a.s.l to 3600 masl) (Hundera, 2003), Jibat dry Afromontane forest patch (2000 masl to 3000 masl) (Bekele, 1993) which have higher altitudinal range than the present study of Soro District dry Afromontane (DAF) forest patches in central Ethiopia, with altitudinal range of 2836 m.a.s.l to 1935 m.a.s.l.

In Soro District Forest patches, some common woody species are identified from four forest sites; nine trees and five shrubs. Unique species in each forest site only in Shonkola alone like *Erica arborea, Hagenia abyssinica, Juniperus procera, Lobelia giberroa, Solanecio mannii;* in share (*e.g.* *Gymnosporia senegalensis)*; in 2nd Hankota *(Oncoba spinosa); Commiphora kua,* *Vachellia bussei,* and *Vachellia seyal* var. *fistula* in 2nd Oda. Most of these species were valuable, and dominant vascular higher plant species in the current study; similarly, the same species, *H. abyssinica*, *J. procera*, and *G. arbutifolia* as well as, *B. abyssinica*, *M. lanceolata*, *O.* subsp. *cuspidata*, and *P.abyssinica* were also reported as having the most visitors species all over the world (Bekele, 1993).

In each forest patches, woody plant species, medicinal plants, wild edible plant species, and neither medicinal nor wild edible plants were identified. A total of 181 (64.64%) medicinal plants, 23 (8.21%) wild edibles, and 76 (27.14%) were neither medicinal plants nor wild edible species were reported. Out of the total documented plant species, 64.64% were found to have medicinal uses by the local people in Soro District, which is greater than the study reported by Yineger et al. (2008), which reported about 63 plant species (35.8%), and similarly, other ethnomedicinal details were also described by other reports elsewhere in Ethiopia (Yineger et al., 2007).

In this research, the results show that Soro District is rich in 264 (70%) ethnomedicinal plant species diversity for treating various ailments belonging to 210 genera, and 83 families were newly documented, including 27 (10.23%) endemic plant species in the 16 families, which is comparable with 27 (10.97%) endemic plants in human medicinal plants in 15 families. The highest number of medicinal plant species are predominantly reported by the Asteraceae family of 26 (9.85%) species, Lamiaceae 19 (7.20%), Fabaceae 18 (6.82%), Solanaceae 13 (4.92%), Euphorbiaceae, and Poaceae 10 (3.79%) species each. This most respective six families, including Rutaceae nine (3.41%) species, Rubiaceae eight (3.03%) species, both Cucurbitaceae, and Myrtaceae six (2.27% each) species, could contribute to their wider distribution and abundance in the flora area, which agreed according to Belayneh and Bussa (2014), Lulekal et al.(2013), and Molla (2014). A number of ethnomedicinal plants harvested in Soro District are found to be far higher than those of other study areas collected in the country that were investigated for their medicinal wealth (Yineger et al., 2008; Bekalo et al., 2009; Giday et al., 2009; Giday et al., 2010; Lulekal et al., 2013). However, in the District, cultural, traditional, economic capacity, medicinal efficacy, availability, and other related cultural factors might have played major roles in relying on herbal ethnomedicine.

Among the whole medicinal documentation of human and livestock traditional medicinal plants of Soro people, 114 (30.16%) were used in common for both human and livestock traditional medicine belonging to 105 genera and 60 families for treating various ailments. A total of 13 (11.40%) plants in the 10 families are endemic, recorded as human and livestock medicinal plant species, and relatively comparable with the livestock medicinal endemic plants reported as 13 (9.85%) endemic plants in 11 families. Family Asteraceae, Fabaceae, and Lamiaceae recorded eight (7.02% each) species; Solanaceae six (5.26% alone) species; Euphorbiaceae and Poaceae five (4.39% each) species; and Rubiaceae recorded four (3.51% alone) species. Whereas four families, Acanthaceae, Cucurbitaceae, Ranunculaceae, and Rutaceae, recorded three (2.63% each), while other nine families, such as Amaranthaceae, Amaryllidaceae, Apiaceae, Cupressaceae, Myrtaceae, Polygonaceae, Rosaceae, Vitaceae, and Zingiberaceae, accounted for two (1.75% each) species with the same or different number of genera, and the dominant 40 families recorded the least number of species (0.88%) with the same number of (0.95%) genera.

In Soro District, indigenous utilization of traditional medicinal plants by a vast number of families might also be related to and explained in other study areas (Gazzaneo et al., 2005), and which indicated that the presence of bioactive effective components to against different human ailments. Moreover, some of the documented human traditional medicinal plants were also reported to be used as sources of herbal medicine in other parts of Ethiopia with potential healing efficacy. From Seharti Samre District, the indigenous people reported *Cucumis ficifolius* to treat cough, gastritis, ear infection, asthma, and tetanus (Araya et al., 2015), and this plant species similarly reported to treat gastritis in Soro District. *Vachellia abyssinica* in the present study was used for the treatment of tooth pain and was also similarly used in the Hawassa Zuria District, southern Ethiopia (Tefera and Kim, 2019). *Allium sativum* was the most frequently used plant in the present study to treat typhoid fever, yellow fever, malaria, haemorrhoids, tumor, asthma, headaches, gastritis, digestion problems, bloating, cold, common cold, and michi by the indigenous people in the area. Similarly, malaria, abdominal pain, and michi were reported by (Mesfin et al., 2009; Giday et al., 2010; Maryo et al., 2015; Temam, 2016; Getu, 2017; Tefera and Kim, 2019;). But, in Amaro and Sheko Districts, it was used for the treatment of headache (Giday et al., 2010; Mesfin et al., 2014) and also its product for upper respiratory system ailments (Temam, 2016).

In Soro District, indigenous people reported the highest medical proportion of medicinal herbs used for human ailments, which are easily available from the nearby natural habitats in the community, compared to shrubs and trees, which are often accessed from forest patches far from human dwellings. The dominance of herbaceous medicinal plant species agrees with many studies in Ethiopia and other countries (Giday et al., 2003, Tabuti et al., 2003; Muthu et al., 2006; Kassa, 2009; Giday et al., 2010; Lulekal et al., 2013; Belayneh and Bussa, 2014).

The natural habitats of Soro District were one of the major sources of human ethnomedicinal plants that could be conserved, accounting for about 75.61% of all reported medicinal plant species, whereas 23.98% harbouring in from cultivated crop lands, and 0.41% from semi-wild and these also categorized in various specific localities. Various anthropogenic factors influence woody medicinal plant species more than herbaceous, and as a consequence, the size of natural habitats and many medicinal species naturally growing in wild habitats are decreasing and being lost due to humans. This agrees with other reports, in which most human medicinal plant preparations come from wild habitats (Lulekal et al., 2008; Yineger, et al., 2008; Zenebe et al., 2012). Various human medicinal preparations are frequently done by leaves, which have a higher overexploitation rate than plant parts, followed by roots. The findings agreed with the study of Alemayehu et al. (2015a) but disagreed with many others (Addis et al., 2001; Lulekal et al., 2008; Flatie et al., 2009; Teklehaymanot, 2009; Belayneh and Bussa, 2014), in which roots are dominantly used for medicinal purposes. Utilization of growing buds and roots is the main part of remedy preparation, which may contribute less flowering and photosynthesis as the consequence decreases medicinal fruits as well as natural potential vegetation; finally contribute for eradicating forest patches from the area.

Human traditional medicines by Soro people were preferentially used in fresh conditions rather than fresh or dry and dry alone for traditional medical preparations to treat different specific human ailments. This finding agrees with many studies in Ethiopia (Teklehaymanot and Giday, 2007; Yineger and Yewhalaw, 2007; Lulekal et al., 2008; Mesfin etal., 2009; Belayneh et al., 2012; Megersa et al., 2013; Mesfin et al., 2013; Kassa et al., 2020) as well as worldwide investigators, for example (Johnson, 2006; Lewu and Afolayan, 2009; Teklehaymanot, 2009; Giday et al., 2010). These practices also strongly agree with scientific facts because fresh plant parts are more effective for curing various human ailments due to the high chemical ingredients in fresh parts than in dry parts because their active, volatile secondary metabolites can disappear or degrade in dry matter (Kalra, 1998).

The ethnomedicinal study of locally reported methods of application and their use routes in the different study sites varied for different types of human ailment treatment. The oral route is the most common application over dermal and dental; thus, it might tell us that most human ailments affect internal body parts more than external parts or organs. These findings of the recent study support the agreement in Ethiopia (Teklehaymanot and Giday, 2007; Yineger and Yewhalaw, 2007; Lulekal et al., 2008; Flatie et al., 2009; Ragunathan and Abay, 2009; Lulekal, 2013; Megersa et al., 2013).

Most local and indigenous people in the study communities prefer herbal medicine in the area over modern medicine due to traditional beliefs based on the efficacy of traditional medicine, economic capacity, accessibility of medicinal plants, and the cost of modern drugs. The findings of this information were also similarly reported by Bekalo et al. (2009) and Lulekal et al. (2013). The symptoms of various common ailments of the patients are locally described by all herbal practitioners (*e.g.* michi and tonsillitis) and visual prescriptions of all ailments of the patients are frequently identified by the diagnoses. But for chronic ailments, patients go to key traditional practitioners (Kassa, 2009). Also, traditional healers gave traditional medicine for a specific ailment by observing the physical appearances of the body parts, for instance, skin and eye colors, the tongue, as well as appetite. Also similarly reported by other authors (Giday et al., 2003; Lulekal et al., 2013). Medicinal doses are not measured using standardized tools, and the lack of precise measurement tools has been described as a global drawback in traditional healthcare (Abebe, 2001), but in the study area doses were traditionally determined by locally available household materials depending on the types of ailment conditions, ages and other patient informations. Measuring with the middle finger next to the index finger, a mug or water glass, and a can and giving them varied numbers were some of the most common examples. The finding of these and other inconsistencies was also reported elsewhere in Ethiopia (Giday et al., 2003; Lulekal et al., 2008; Belayneh and Bussa, 2014), which is considered a serious drawback in the treatment of traditional herbals. Locally available antidotes are given for patients during bad side effects of traditional medicine like excess water, milk and milk products, **basso**, **bord'e**, **keneto**, **tella**, and a few plant parts (Ensete products, like **bu'o**. Similar findings were reported in the studies (Mesfin et al., 2009; Belayneh et al., 2012), and the same pattern also using different or/and the same antidotes were reported for the same purpose to stabilizing disorders/adverse effects according to Giday et al. (2010) and Lulekal et al. (2013). Most of the traditional medicinal plant use is performed by concoction for various human ailments. The addition of two or more traditional medicinal plants as well as additives was preferred to decrease the side effects of medicines in addition to their efficacy in curing ailments. However, in another studies decoction the most dominant and proven effectiveness (Lulekal et al., 2013).

Some of the results of human ethnomedicinal plants recorded from key informant ranking are also prioritized for conservation in the communities of the area for specific ailments and other use values. In the direct ranking matrix, *Cordia africana* has been most important in its various utility values with respect to *C. molle*, *H. abyssinica*, *A. gracilior*, and *P. africana*, which is similar to the findings of Lulekal et al. (2008). The outputs of the PR exercise could indicate the most effective traditional plant species, their potential to be bioactive in the local context, and their responsibility for protecting against human ailments caused by foreign particles. They might also be promising plant species to be screened more for future scientific activities and pharmacological tests. However, these plants were also highly exploited for various purposes and they also severely caused species depletion in the District. Some authors similarly reported the highest exploitation exposed to the loss of multipurpose medicinal plant species in Ethiopia (Yineger et al., 2007; Lulekal et al., 2013). The highest herbal medical recorded ICF values tell us the agreement on the use of remedy plants reported for treatment of the most frequently reported ailments categories and medicinal curing ability in the area. This finding disagrees with the study results (Kassa, 2009). In the FL, the highest value (100%) was reported for potential plant species used to treat various specific human ailments. Among them *Afrocarpus gracilior, Rosmarinus officinalis, Coleus abyssinicus*, *Olinia rochetiana*, and *Moringa stenopetala* for treatment of respective human ailments: rabies, hypertension, diarrhoea, tooth pain, and *diabetes mellitus*. These plant species are also important for further phytochemical testing to show secondary bioactive metabolites that might have high curative potential (Heinrich et al., 1998; Lulekal et al., 2013).

In the survey of market observations, dominant human medicinal plants were sold in the markets for other purposes, mainly as the sources of spices and condiments; few used both medicine and spices, food, and food additives; however, very few plants were sold only for medicinal use, for example, **Dashshi maracca**-Hadiyissa (Had.), **Mukke'e-Had. Hundufaanna-Had.**

Suunfa/shuunfa-Had., **Annaamura-Had**, and **Suuxo-Had.** were recorded from the four major markets in three agroclimatic zones. In addition, in other ways, the majority of human medicinal plants—95%—are collected during remedy preparations alone when they are required. But the eleven mentioned medicinal species were available on the market during the market survey, which were sold and purchased by the market people for medicinal purposes in the area with varied market values and price ranges (one to 100 EthBirr) and using different measurement tools like finger tips or pinches, feasts (**ciibix**-Had.), spoons, bottle lids, tea and coffee cups, mugs, and also numbers of plant buds and leaves. The marketability of some plant roots also leads to threats of human pressure because people purposefully harvest their roots for medicinal purposes and as a source of income. (*e.g. Securidaca longepedunculata*, *Asparagus africanus)*, whereas other wild edibles (*e.g. A. africanus* (Hankiso et al., 2023), for timber production (*e.g. H. abyssinica*), firewood and construction purposes used many plants. During the observation of the market survey, Other potential marketable medicinal plants were used for the purpose of domestic trade (*e.g.* timber production of *Afrocarpus gracilior, Cordia africana*), like other parts of Ethiopian cultural groups (Mander et al., 2006).

Threats to some HMPs are reported by local people of the District due to various factors and some threatened are listed in the IUCN red list (Vivero et al., 2005). *Kalanchoe petitiana, Lippia adoensis, Millettia ferruginea, Solanecio gigas*, and *Thymus schimperi* are endemic and least concern (LC); *Erythrina brucei* is highly vulnerable species. The other HMPs recorded in Soro District, including indigenous species of *Vachellia abyssinica* and *Urtica simensis* (endemic) species (Vivero et al., 2005; Hedberg et al., 2006) are common threatened MPs in the District. *A. africanus*, *J. procera*, *Olea.*subsp. *cuspidata*, and *Trichocladus ellipticus* were reported to be locally threatened medicinal plant species and need conservation priority. In this study, some of the novel traditional medicinal species might be potential plants for future pharmacological tests for various specific human ailments. These plant species were recorded from comparisons of other studies in Ethiopia, and they were novel plant species and new findings in the study area. *A. gracilior*, *A. houstonianum, A. gilbertii*, *B. abyssinica*, *C. molle*, *D. stramonium*, *H. abyssinica*, *M. clematoides*, *S. gigas,* and *S. oxyacantha* are potentially novel plant species to treat specific human ailments in the study District, and they were never reported in other similar investigations for some specific ailments.

In Soro District, a rich number of ethnoveterinary plant species were collected, identified, and documented from different altitudinal ranges. The District has a rich diversity of ethnoveterinary herbal medicinal plants, with indigenous knowledge associated with each traditionally used species. Of these, 10% of the species are endemic medicinal plants. The majority of livestock medicinal plants are angiosperms (98%), and three are gymnosperms (2.3%). These plants are used by the community primarily as first-aid plant materials to handle various health problems in livestock. In the results, herbs contributed the highest species proportion (39%), trees (27%), hemiparasites accounted for the least proportion (0.8%). In Soro District, higher utilization habits are herbs for ethnoveterinary remedies, followed by trees and shrubs. The finding of herbaceous dominance over trees (27.3%) and shrubs (25%) was also reported by other ethnomedicinal investigators (Yineger et al., 2007; Tekle, 2015; Birhan et al., 2018), and this information might be important for the survival of tree and shrub species from excessive harvesting. In contrast, other inventories reported dominance of shurbs species for ethnoveterinary remedy preparations like in Ethiopia and elsewhere (Hunde et al., 2006; Lulekal et al., 2008; Lulekal et al., 2014; Asfaw et al., 2022).

In Soro District, the comparison of the number and diversity of livestock medicinal plant species used in the area with other ethnoveterinary investigation outputs of various Ethiopian cultural communities (Giday and Teklehaymanot, 2013; Lulekal et al., 2014; Assefa and Bahiru, 2018; Abera and Mulate, 2019; Abebe, 2022; Asfaw et al., 2022; Dinbiso et al., 2022) and other countries (McGaw and Eloff, 2008; Shen et al., 2010; Selvaraju et al., 2011; Sharma et al., 2012; Dzoyem et al., 2020) were recorded rich diversity of the ethnoveterinary plant species.

In addition, leaves were the most frequently utilized, preferable, easily available, and simplicity in remedy preparation, and dominant harvesting plant parts in the current study for livestock medicinal use, and which agrees with many other studies in Ethiopia (Lulekal et al., 2014; Yigezu et al., 2014; Tekle, 2015a, 2015b; Feyera et al., 2017; Shimels et al., 2017; Assefa and Bahiru, 2018; Abera and Mulate, 2019; Abebe, 2022) and South Africa (Chakale et al., 2022). Moreover medicinal practitioners use this highly available leaf part rather than root and bark parts to decrease the loss of plants from natural habitats (Yineger et al., 2007; Getnet et al., 2016; Moges and Moges, 2019). Family Asteraceae, Lamiaceae, and Euphorbiaceae were dominant families in the study area, like Ethiopia, studied by another investigators (Yineger et al., 2007;

Lulekal et al., 2013; Yigezu et al., 2014; Tekle, 2015a; Birhan et al., 2018; Asfaw et al., 2022), Asteraceae, Fabaceae and Solanaceae used in large and share potential ethnoveterinary plant species more (Abebe, 2022; Dinbiso et al., 2022). Whereas, Asteraceae was the most commonly used and diversified medicinal plant family, which is in line with the findings of (Mesfin et al., 2009; Lulekal et al., 2014; Abera and Mulate, 2019; Dinbiso et al., 2022;), and it was one of the world's leading largest families, however, next to the family Fabaceae in Ethiopia.

The majority of the rich livestock ethnomedicinal plants were collected and reported from wild habitats, which relatively agreed with the findings of the wild plants reported (Lulekal et al., 2014; Yigezu et al., 2014; Abebe, 2022), and this can increase anthropogenic pressure on wild plant resources. Some were also collected from agricultural croplands, and a few plant species, such as *Antherica sp*., *A africanus*, and *S. longepedunculata*, were reported from the market survey in Soro District and highly sold for the purpose of livestock medicines and human ailments. In addition, a few others, indirectly from other ethnobotanical uses, like *Artemisia absinthium*, mainly sold by women for herbal medicine, and *Nicotiana tabacum*, sold from other social drug smoking in the market by men. The results of gender differences showed that males have rich information, inherited knowledge, and healing practices on the use of livestock herbal medicinal plants on average compared with females. This agrees with the findings reported from different parts of Ethiopia (Lulekal et al., 2014; Yigezu et al.,2014; Birhan et al., 2018; Abebe, 2022) .

Some of the ethnobotanical plant species were widely used and popular in Soro District to treat various specific livestock ailments. For example, *Momordica foetida* was used to treat and manage diarrhoea, blackleg, anthrax, actinobacillosis (wooden tongue), and *Withinia somnifera* was used to treat and manage blackleg, and arthritis (mondy-morning ailment). *Cucumis ficifolius* was the other important recommended plant species used against anthrax, rabies, babesiosis, and blackleg. It agrees with the findings of other ethnoveterinary surveys conducted in different parts of Ethiopia, which witnessed the common use of *C. ficifolius* for the treatment of blackleg Yigezu et al.(2014), and rabies by Tadesse and Dereje (2015). Moreover, *Nicotiana tabacum* was used in the management of nasal bote, snake bite and insects’ infection infestations in Soro District. Similarly, in Libo Kemkem District, Amhara Chekole et al. (2015), suggested in a similar way the use of *N. tabacum* to treat leech, which agrees with (Teklay et al., 2013) in Kilte Awulaelo District, Tigray.

In the current study most herbal medicine preparations were done mainly by decoction, concoction, and crushing; many livestock medicinal local practitioners used fresh plant parts to heal effectively and efficiently, mainly in the form of decoction using a single species followed concoction using two or more medicinal plant species to treat a single ailment, and this was disagreed by Yineger et al. (2007) and Abera and Mulate (2019), and agreed with study of (Wondimu et al., 2007). In addition, those dominantly useable medicinal fresh organs might be retained secondary bioactive metabolites that occurred more in fresh parts than in dry matters (Gazzaneo et al., 2005; Njoroge and Bussmann, 2006; Yineger et al., 2007; Lulekal et al., 2014; Tekle, 2015a). In the current study most herbal medicine preparations were done mainly by mixing a single, with two and more medicinal plant parts to treat a single ailment with cold and warm water, and using other locally available types of additives or without additives; which were similarly reported in other study parts (Maryo et al., 2015; Kidane et al., 2018). The oral treatment route is the main route of remedy administration in the study area and agrees with the findings of others in Ethiopia (Yineger et al., 2007; Giday and Woldu, 2009; Giday and Teklehaymanot, 2013; Maryo et al., 2015; Tekle, 2015b; Assefa and Bahiru, 2018; Birhan et al., 2018; Temeche and Asnakew, 2020), followed with dermal treatment which also agreed with (Yineger et al., 2007; Birhan et al., 2018; Temeche and Asnakew, 2020) in common.

The result of informant consensus factor values between 0.70-0.72 showed the most prevalent ailments in each category in the study area, and the least prevalent ailments with smaller ICF values had effective healing potential plant species. Lulekal et al.(2014) reported a high ICF to treat gastrointestinal ailments with popular curative plants and Sharma et al. (2012) also shared for dermatological ailments. Likewise in Soro District, curative potential plants were used to treat the most prevalent livestock dermatological ailments for instance Foot and Mouth Disease and Lumpy Skin Disease were treated using *C. macrostachyus,* blackleg treated by *Cyathula uncinulata* and ailment of bat urine by *M.foetida*; among gastro-intestinal potential ailment, diarrhoea, abdominal pain, acidiosis, anthrax, actinobacillosis (wooden tongue), telleriosis, and New Castle Disease (NCD) were treated by different healing effective plants discussed on preference ranking and FL values as well as a series respiratory infection like *aspiration pneumonia*, pasteurellosis (livestock TB) treated by *Pentanema confertiflorum* and

*Stephania abyssin*ica. According to Lulekal et al. (2014) plants with higher informant consensus values are thought to have more secondary bioactive metabolites for frequently occurring livestock ailments. The highest FL values among curative medicinal plants were accounted for *D.stramonium* is highly effective to treat rabies from the neurological ailment, *Dodonaea viscosa* subsp. *angustifolia* in treating gastrointestinal PPR, *A.africanus* to treat evil eye/spirit; *C. macrostachyus* for FMD among dermatological ailments, and which is in line with the studies (Kloos, 1977; Lulekal et al., 2014; Yigezu et al., 2014). Different ethnobotanical tools (for example, ICF, FL, and PR) were important to determine the efficacy medicinal plant species in various aspects and for future antimicrobial and phytochemical tests. The index of FL is an important botanical tool to measure potential medicinal plants with the healing ability of the individual plant species and provide good information for future pharmacological investigation techniques, and it supported (Trotter and Logan, 2019). In preference ranking exercise, *C. macrostachyus* also reported the highest and most efficacious to treatment LSD followed *X. americana* and *A. sativum*. In the study area, there were significant knowledge differences in ethnotherapeutic practices to protect livestock health between males and females, key and general participants, rural and urban inhabitants, and different age groups of informants.

In the current study, WEPs were collected from various localities. Most of them are used by the people in the study area for various purposes in addition to wild food sources, contributing to food security in a similar way to other parts of Ethiopia and Africa. A higher number of wild edible plant species were recoded, which is higher than the findings reported by some of the studies made in Ethiopia (Fentahun and Hager, 2009; Ashagre et al., 2016; Amente, 2017; Tebkew et al., 2018; Demise, 2020; Bhatia et al., 2018) and Uganda (Ojelel and Kakudidi, 2015). The abundance of WEPs observed in the present study is shared by the distribution ranges in different agroecological zones of Ethiopia (Balemie and Kebebew, 2006; Mengistu and Hager, 2008; Tebkew et al., 2014). Tree habits provide more edible fruits, which strongly agree (Fentahun and Hager, 2009; Teklehaymanot and Giday, 2010; Kidane et al., 2015; Tebkew et al., 2018). This habit proportion disagree with Lulekal et al. (2011) in southern Ethiopia, and Agea et al. (2011) in Uganda reported that shrubs and herbs were the dominant habits contrasting trees found in the current study of Soro District (Amente, 2017). Similarly, trees and herbs were reported to have the highest parts consumed than shrubs, in agreement with Kidane et al. (2015)

pointed out that trees were consumed more by the Maale and Ari ethnic groups in southern Ethiopia.

Plants with edible fruits contributed the largest proportion and were mostly used as the source of food, which agrees with the findings of other works (Fentahun and Hager, 2009; Addis et al., 2013; Alemayehu et al., 2015b; Seyoum et al., 2015; Dejene et al., 2020; Demise, 2020); followed leaves with shoots (Addis et al., 2013; Amente, 2017). Among edible fruits, the stem latex is used as chewing gum and sipped or sucked by children (*e.g. L. buchananii)* and is also used for attachment purposes. As the index of FL, *F. sycomorus, A. torturous* (synonym of *A. dubius*), *C. spinarum, S.* var.*guineense,* and *S.*subsp. *afromontanum* were potential wild edibles in the study area; similarly, the latter two species shared in Burji District, (Ashagre et al., 2016), as the source of income generation sources in a few rural sites (Kebede et al., 2017).

Socio-demographic and cultural attributes of the current study showed that variations with different indigenous knowledge and traditional practices in the use of human and livestock medicinal plants as well as wild edible plants. Adults cited a higher number of WEPs than youngsters, which may be due differences in experience and knowledge gap on WEPs in the current study, which came up with non-significant difference ($P > 0.05$); similarly, adults cited more WEPs than youngsters in another study (Tebkew et al., 2018); still in another study, youngsters reported more than adults (Wondimu et al., 2006) this may be due to less attention from adults as a result of being dependent on modern food system. The average number of male interviewees were more knowledgeable, quoted the highest proportion of WEPs than females ($P < 0.05$) in contrast with (Regassa et al., 2015) that showed women reported more plant species than men. Key informants reported significantly higher mean average number of wild edible species than general informants ($P < 0.05$) which agrees with one study (Regassa et al., 2015).

Overall, three nutraceutical WEPs were selected from the formerly collected plants present to investigate the nutritional uses of proximate compositions, minerals, anti-nutrient and anti-oxidant properties, as well as vitamin C content. Of these, *O. spinosa* fruit can resist decay micro-organisms due to the hard, thick exocarp, thus assuming fit for rural areas with less or no facilities for fruit preservation technologies (Doyle, 2009). The total ash content in the two fruits ; while the content in the leaves and shoots, which was significantly higher amount than in the fruits. Adamu et al. (2022) reported a high amount of ash in *Amaranthus hybridus* leaf. Similarly, the crude protein content of *A. tortuosus* was significantly higher than that of fruit samples. A lower crude protein content in the leaf of *A. hybridus* was reported by Adamu et al. (2022). Relatively higher crude protein content in the leaves of Ethiopian was reported by Adamu et al. (2022b). These groups of plants might contribute to protein intake in areas with the lowest intake. In fact, the WEPs in this study offer relatively higher protein contents than cultivated vegetable crops (Getachew et al., 2013). Similarly, Adamu et al. (2022b) reported crude fiber content in the leaves. The carbohydrate content of the two fruit samples was comparable with the content in WEPs harvested from southern Ethiopia (Uyoh et al., 2013). The total carbohydrate content in the WEPs in this study is greater than the value in cultivated fruits including mango, banana, guava, pineapple, and papaya (Afolayan and Mbaebie, 2010; Blessing et al., 2011). Diets with greater energy densities may contribute to adequate energy intake in children during meals (Mahapatra et al., 2012).

The calcium (Ca) content of *L. buchananii* is closely comparable with the content of other related WEP plant species (Ibourki et al., 2022). The zinc (Zn) content in *A. tortuosus*, *L. buchananii,* and *O. spinosa* was respectively differ and it was nutraceutical important. Adamu et al. (2022b) reported higher zinc concentration from dried leaf of *A. hybridus*. The oxalate content in the leaves of *A. tortuosus* was observed in low yield whereas the phytate contents in the three WEPs were higher than the values of phytate contents in the leaves of other six WEPs collected in Ethiopia region Lasta District (Adamu et al., 2022a). The high phenolic content in WEPs has been shown to be valuable in the prevention of various chronic diseases (Asami et al., 2003). The total flavonoid content in the leaves and young shoot of six WEPs collected from northeastern Ethiopia was within the range of comparable amount (Adamu et al., 2022a).

The DPPH free radical scavenging activity of the WEPs was estimated by comparison with an ascorbic acid standard. The highest percentage of inhibition was observed for ascorbic acid, followed by *L. buchananii*, and the rest two species. In one of the WEPs in northeastern Ethiopia, *Rumex nervosus* young shoots, Adamu et al. (2022) reported a highest inhibition percent of DPPH. The IC50 of *L. buchananii* extract had an IC50 value comparable to that of an ascorbic acid. The results indicated that the fruit of *L. buchananii* had the highest vitamin C content followed by *A. tortuosus* and *O. spinosa*. Adamu et al. (2022) also reported vitamin C content of in leaves of the WEP *E. abyssinicum*. The highest vitamin C content of *L. buchananii* was comparable to that in cultivated fruits such as *Carica papaya* (Minuye, 2021). Thus, one can assume that the WEPs under investigation are potential sources of vitamin C in Soro District to play a role in prevent of vitamin C deficiency-related diseases (Santos et al., 2016). Generally, based on the results, the three WEPs are good sources of human food with good amounts of the main nutrients, a good supply of antioxidant capacities, and negligible antinutrients.

7.2. General conclusion

In this research study, floristic compositions of forest patches have a high diversity of plant species, a reservoir home for human and ethnoveterinary plant species that encompasses rich sources of nutraceutical plants, including significant bioactive compounds and other multipurpose plant species. The study also shows the diversity of human and livestock ailments treated with various traditional plant remedies and the depth of indigenous and local knowledge applications using plant medicines. A new path for ethnobotanical investigation that links local and indigenous traditional practices of medicinal use of the plant is identified or laid down for phytochemical and pharmacological evaluations for future investigations. Our findings provide a wider support for research questions set for dissertation research. An investigation that occurred in the remnant forests of Soro District indicates that the forest patches are the main reservoirs of natural resources for numerous medicinal plants, wild edibles that enhance food and nutritional security, and other ethnobotanical uses of plants by the people of the District. The hierarchical cluster analysis of forest vegetation exhibits five clusters' values to indicate five community types in overall forest patches, which also consist of traditionally used various ecological and economically important plants. Of the five community types, type two consists of the richest diversity of plant species with varied aspects, including nutraceutical plant species (*Afrocarpus gracilior*-*Apodytes dimidiata*-*Olinia rochetiana* community), community four also relatively consists of second diverse species with varied aspects (*i.e*., *Combretum molle*-*Combretum aculeatum* community type), which are the most potential locally protected forest patches and conservation priority sites for dega and kola herbal medicinal plant species in the study area. However, these forest patches are recently being exploited by the people of the indigenous community for the sake of agricultural expansion and cutting woody plant constructions, fences, and local fuels. And thus, due to these activities, serious investigation attention should be applied for in-situ conservation with the action of sustainable management of floristic and ethnomedicinal plant species in the sites with different stakeholders. As seen, the overall results show that Soro District is very rich in potential traditional medicine, biochemical compositions, important antioxidant wild edible plants, traditional local and indigenous knowledge, and other multifunctional plant diversity that triangulates a rich potential for plant diversity and richness in the community and in each vegetation site. Also, it reveals that there are significant human and livestock-native traditional medicinal plant species, while the whole local inhabitants also hold vast, deep-rooted indigenous traditional ethnomedicinal knowledge in assisting with the primary healthcare requirements for human and livestock ailments in Soro District. It was shown that there has been a closely related culture to plant use for future generations in the study area, which led the descendant community of medical traditions to be widely implemented to address or use for a number of ailments. Moreover, it was identified that economical, efficacy, and ease of availability influencing factors related to the use of ethnomedicinal plants play important roles in the dependence of local people in the area on traditional medicine for various uses.

Most human and livestock herbal ethnomedicinal plants in Soro District were reported to be about 85% sources of various multipurpose uses. However, they are facing more anthropogenic pressures in addition to natural impacts, and in fact, they have faced serious challenges in their existence. The natural habitats of the most human and livestock medicinal sources of plants in Soro District are the main growing pools and are decreasing because of exponential population growth. In addition, the remnant natural forest patches in the study area are facing excessive use and exploitation as sources of construction, fuels, and material serves, resulting in the extinction of numerous ethnomedical species from the natural environments. Recorded high use value indices of multipurpose medicinal plant species in the area are signals of high use pressure and hence can be used as keys to design and implement a focused and well-coordinated complementary in-situ and ex-situ conservation to save plant diversity.

This current study also indicated that traditional healers used leaf parts more for medicinal purposes to prepare various traditional remedies than root and bark parts, which reduces the loss of mother plants from their extinction in natural habitats. Thus, conservation attention was given to the area first to give prior attention to protecting plants targeted for their remedial uses. The pattern of traditional identification methods for specific ailment types and local prescriptions of herbal medicine indicated that Soro District is based on indigenous knowledge on signs and symptoms for corresponding different specific potential common ailments and their illnesses, as well as therapeutic remedial plant species that are held in their memories of local people in the various study residents. This warrants community health education that involves providing learning experiences to help individuals and communities improve their healthcare, the root causes of the most common human and livestock ailments, transmission routes that were assisted to prevent causative agents by traditional healers, and community communicable ailments including non-communicable ailments, in addition to the modern system of healthcare. Whereas the members of the local community in the study area observed that different degrees of traditional medicinal plant knowledge were used based on the categories of age, gender, experience, level of literacy, education, and distance. More ethnobotanical knowledge, such as ethnomedicinal and wild edible knowledge, and other traditional knowledge were observed more in elderly or senior members of the community than in younger groups, except for wild edible plants; experienced key informants and some general informants were more relevant than the whole general informants in the study area and more with the illiterate than the literate. It was also found that both male and female members of the community in the study area are knowledgeable on medicinal plant use, despite the relative dominance of medicinal plant tradition at the male level, which could be associated with the traditional knowledge flow of information along the male line in Ethiopia.

We found that in the study communities, the respondents gained local and indigenous knowledge on human and livestock medicinal plants from parents who had relative knowledge from other family members and from other knowledgeable colleagues somewhere they go and discuss with them. Mode of traditional knowledge is transmitted from generation to generation mainly via oral means, predominantly from parents to children's (*i.e.*, more from father/in some extent, from mother to son/daughter). Degree of secrecy and way of modernization in transmitting local and indigenous knowledge on ethnomedicinal plant species within the family members, mainly for elder secrecy sons and, in rare cases, for daughters, and lack of attention towards traditional herbal medicine by some young or younger generations might also describe the decrease of those traditional knowledge, which could go down for new generations in the study area.

The data analysis of the market survey for this current inquiry shows some potential marketable medicinal plants that address human and livestock ailments, in addition to other non-medicinal purposes like spices and condiments, as well as other traditional uses. It also indicated that there were income-generating potential medicinal plants in the area.

The highest informant consensus, preference ranking, and fidelity values based on the survey of wild edible plants; selected three wild edible plants of Soro District show useful and promising nutritional values with the highest crud protein and higher antioxidant content than common crops, and the non-food values were laid within the safe limit; these might be used for making more healthy and nutritious foods. We also found the highest inhibition percent of DPPH that was obtained for ascorbic acid, and higher percent for *Landolphia buchananii* at a concentration of 200 µg/ mL. Thus, the three plant species are the most promising nutritional plant species for fighting hunger.

The nutraceutical values, antioxidants, and vitamin C contents of three wild edible plants, *Amaranthus tortuosus*, *Landolphia buchananii*, and *Oncoba spinosa*, are important and promising WEPs, and the study calls for further investigation in the District. Also, it was the most promising plant for nutraceutical nutritional values, antioxidants, and vitamin C content. Therefore, in Soro District, a rich source of human and livestock ethnomedicinal plant species diversity to treat various ailments, indigenous traditional knowledge, and the effort to conserve remedial plant species with their associated indigenous knowledge have been documented for future requirements. In addition, few efforts were also made by some home-grown traditional practitioners to cultivate herbal medicinal plants in the area. This situation can help to provide information for further research investigation and a range of governmental support to promote overall complementary conservation priorities through in-situ as well as ex-situ strategies for human and livestock remedial ethnomedicine, wild edibles, and other multi-purpose plants in the District. Indices of high use values for most plant species were recorded as key important plant species for the purposes of in-situ and ex-situ conservation implementation in the sites of protected forest patches and in the natural habitats of people living environments.

7.3. General recommendations

Based on the results and findings of the current research, the following recommendations were proposed for each study component:

- Promote in-situ conservation and establish nurseries for ex-situ conservation of threatened and unique plants at the Mountainous sites (Mount Shonkola), the plain and hilly forest patches of the Share-Haba, and 2nd Oda Forest patches to enhance agroecologically varied plant species;

- Establish action of in-situ conservation to avoid anthropogenic pressures (like local charcoal, firewood, and overgrazing) for those locally protected forest patches against deforestation for various purposes; and take action the reserve of the high-land site of Shonkola Forest patch sites and the low-land forest patches of 2nd Hankota/Haba and 2nd Oda Forest patches as a reservoir area to conserve and enrich the forest patches to conserve multipurpose plant species being seriously exploited by human interference as well as the expansion of agricultural activities towards the forest patches;
- Taking legal measurement actions on illegal entrances and selective cutting activities of plant species by the nearby and far communities and giving awareness for the communities by giving education to enhance reforestation is a solution for deforestation and maintaining the protected forest patches and potential plant wealth in the study area, including endemic and locally extincting indigenous plant species;
- Advise the herders of domestic animals overgrazing in the forest patches to the pressure in the locally protected forest patches, which will allow the regeneration status seedling and sapling of different potential native plant species towards mature mother woody plant species that can serve for many environmental influences and human as well as wild life services. For instance, some species: *A. gracilior, O.* subsp. *cuspidata, O. rochetiana, J. procera, Combretum molle, C. macrostachyus, A. schimperi, S. var. guineense, B. aegyptiaca, M. kummel,* and *W. ugandensis;*
- Increase indigenous dwellers conservation strategies with the cooperative coordination of the study District traditional healers, Offices of Culture and Tourism, Agriculture and Rural Development, and Education to take responsibility for and sustainable utilization of plants. Focusing on those species with high use preferences to maintain ethnomedicinal as well as culturally valueable plant species in the community, which creates new attractive ecotourism sites in the area and encourages the local people around the forest paches to be more involved in conservation activities with sharing benefits;
- Develop participatory forest management programmes and implementation goals for eco-plant diversity projects for conserving the rapidly, locally extinct, or lost human and livestock medicinal plants, wild edibles, and other multipurpose endemic and indigenous plant species of Soro District and from the remnant forest patches;

- Carry out more investigations on the key promising species for pharmacological testing activates for the most-preferred and claimed medicinal plant species by local and indigenous informants.
- More studies are needed on pharmacological testing activities for those plant species for human ailments (*e.g. Afrocarpus gracilior*, *Ageratum houstonianum*, *Aloe gilbertii*, *Artemisia abyssinica, Combretum molle*, and *Cucumis ficifolius*) and livestock ailments (*e.g. Balanites aegyptiaca, Brugmansia suaveolens, Grevillea robusta, Hagenia abyssinica, Juniperus procera, Maesa lanceolata, Millettia ferruginea, Schrebera alata, Spiniluma oxyacantha, Vepris nobilis, Zanthoxylum asiaticum,* and *Ximenia american*a) to treat various specific ailments of each.
- Herbal practitioners depended on medicinal plants to treat various human and livestock ailments, even if the dose of the medicine did not necessarily indicate its accuracy to treat specific ailments and modes of disease transmission; thus, it was recommended that the District Health Offices implement a continuous community health education programme for the major and common human and livestock ailments.
- Taking account for long-term market surveys and investigating indigenous marketable ethnomedicinal plants as part of the study area through successive longitudinal market surveys over a number of years, together with value chain analyses of potential plants, to come up with the real economic potential of medicinal plants for the future;
- Create permanent nurseries by coordinating different head offices of the District in human and veterinary healthcare, culture and tourism, agriculture and rural development, forest and climate change, environmental merits, and biodiversity to propagate seedlings of the most preferred potential ethnomedicinal plants, locally extinct plant species, and distribute seedlings to farmers as a means to conserve important traditional medicinal plants;
- Give attention for nutritional compositions of those selected WEPs were comparable to those of other fruit and leaf eating cultivated crops. Thus, the leaves of wild edible plants with shoots might also contain higher concentrations of crude protein, ash, and essential minerals;
- Domestication of nutritional and antioxidant beneficials are essential in local communities;

- Conservation training actions against anthropogenic activities for this multipurpose indigenous use diversity and giving priorities for disappearing or extincting plant species should be required;
- Encourage the community people for saving these indigenous plants with other wildlife that giving environmental advantages with multipurpose values;
- Giving educational training workshops for responsible bodies in the communities should require for better solution with collaboration of the agricultural sector, plant biodiversity and management office create mutualistic relationship of plants with people.

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Appendices

Appendix 1. Floristic list of forest vegetation in Soro District, central Ethiopia.

No.	Scientific Name	Family Name	Local/vernacular name (Hadiyissa)	Growth Form	Voucher Coll.No. MH:
1	*Acanthus eminens* C.B. Clarke	Acanthaceae	Wobil fiit yoo uttaamo	S	MH-287
2	*Acanthus sennii* Chiov*	Acanthaceae	Ashwaala (Wo'o xuuxakkam kaashar fiita)	S	MH-102
3	*Achyranthes aspera* L.	Amaranthaceae	Hoffi qaccabba	H	MH-75
4	*Acmella caulirhiza* Del.	Asteraceae	Bish bisha	H	MH-42
5	*Acokanthera schimperi (*A. DC.) Schweinf.	Apocynaceae	Illilli qubba	T	MH-265
6	*Afrocarpus gracilior* (Pilg.) C.N.Page (syn. *Afrcapus falcatus* in FEE)	Podocarpaceae	Digiba	T	MH-34
7	*Agarista salicifolia* (Comm. ex Lam.) Don.	Ericaceae	Sotira	T	MH-236
8	*Agelanthus heteromorphus* (A. Rich.) Polh. & Wiens.	Loranthaceae	Habulle'i xanqo'o	Hemp	MH-386
9	*Ageratum houstonianum* Mill. *(*synonym of*: Ageratum conyzoides*)	Asteraceae	Wobil fiit yoo jule'i qaraare	H	MH-286
10	*Ajuga integrifolia* Buch. -Ham. Ex D. Don. **	Lamiaceae	Annaamura	H	MH-51
11	*Albizia schimperiana,* Oliv.	Fabaceae	Maande'e	T	MH-26
12	*Allophylus abyssinicus* (Hochst.) Radlk.	Sapindaceae	Abbara	T	MH-264
13	*Aloe gilbertii* Sebsebe & Brandham. *	Asphodelaceae	Geneeno'o te'im Ireetta	S	MH-377
14	*Aloe* sp.	Asphodelaceae	Geneeno'o	S	MH-184
15	*Aningeria altissima* (A. Chev.) Aubrév. & Pellegr. (synonyms of *Pouteria altissima*).	Sapotaceae	Qabarbuyya laba (Odecho laba)	T	MH-299
16	*Apodytes dimidiata* E. Mey.ex Arn.	Metteniusaceae	Mewwa	T	MH-253
17	*Arisaema schimperianum* Schott. **	Araceae	Got tuma (Daagee'l weesa)/Baco'o	H	MH-319

18	*Artemisia abyssinica* Sch. Bip. ex A. Rich.	Asteraceae	Aguffa	H	MH-163
19	*Asparagus africanus* Lam.	Asparagaceae	Hundufaanna	H	MH-198
20	*Astropanax abyssinicus* (Hochst. ex A. Rich.) Seem. (synonym of *Schefflera abyssinica*)	Araliaceae	Gatama (Xee'n haqqa)	T	MH-275
21	*Baccharoides hymenolepis* (A. Rich.) Isawumi, El-Ghazaly & B. Nord.	Asteraceae	Barawwa laba	S	MH-346
22	*Baccharoides lasiopus* (O. Hoffm.) H. Rob.	Asteraceae	Sotte’e (Aggagga laba mine baxximin haqqa)	S	MH-154
23	*Balanites aegyptiaca* (L.) Delile	Zygophyllaceae	Baddanno'o	T	MH-16
24	*Bersama abyssinica* Fresen.	Francoaceae	Koraqqa	S	MH-80
25	*Bidens pachyloma* (Oliv. & Hiern) Cufod. *	Asteraceae	Kashar jeela	H	MH-63
26	*Bidens pilosa* L.**	Asteraceae	Meent alabo	H	MH-82
27	*Boscia mossambicensis* Klotzsch.	Capparidaceae	Heessi beeto	T	MH-368
28	*Bridelia* sp.	Euphorbiaceae	Qaala'i biishsho'o	T	MH-373
29	*Brucea antidysenterica* J.F. Mill.	Simaroubaceae	Ciiroonta	S	MH-30
30	*Buddleja polystachya* Fresen.	Scrophulariaceae	Bulshaana	T	MH-197
31	*Biancaea decapetala* (Roth) O.Deg. **	Fabaceae	Koronte’e (Amma’i qaapha)	S	MH-204
32	*Bullockia pseudosetiflora* (Bridson) Razafim., Lantz & B. Bremer.	Rubiaceae	Hexxihaqqa	S	MH-394
33	*Calpurnia aurea* (Ait). Benth.	Fabaceae	Senna	S	MH-27
34	*Canthium oligocarpum* Hiern.	Rubiaceae	Googaame lab uttaam	T	MH-293
35	*Capparis tomentosa* Lam.	Capparidaceae	Amade	S	MH-366
36	*Carduus schimperi* SchBip.ex A. Rich.	Asteraceae	Hallutta	S	MH-24
37	*Carissa spinarum* L.	Apocynaceae	Qoqombe'e	S	MH-328
38	*Cassipourea malosana* (Baker) Alston.	Rhizophoraceae	Ximira	T	MH-36
39	*Caylusea abyssinica* (Fresen.) Fisch. &Mey.	Resedaceae	Cii'ishana laba	H	MH-137
40	*Celtis africana* Burm.	Ulmaceae (Cannabaceae-as	Qama'laqqa	T	MH-107

		https://powo.science.kew.org/.)			
41	*Cenchrus setaceus* (Forssk.) Morrone	Poaceae	Sadda	G	MH-256
42	*Cenchrus sphacelatus* (Nees) Morrone (synonyms of *Pennisetum sphacelatum*).	Poaceae	Guffa	G	MH-246
43	*Cenchrus violaceus* (Lam.) Morrone	Poaceae	Wish migira	G	MH-257
44	*Centella asiatica (*L.) Urban.	Apiaceae	Dabayyi macce	H	MH-185
45	*Clausena anisata* (Willd.) Benth.	Rutaceae	Bahixxi haqqa	T	MH-29
46	*Clematis hirsuta* Perr. & Guill. *	Ranunculaceae	Hoffi fiida	Cl	MH-44
47	*Clematis longicauda* Steud. ex A. Rich. *	Ranunuclaceae	Lob fiida	Cl	MH-43
48	*Clutia abyssinica* Jaub. & Spach.	Euphorbiaceae	Shum xiigeeshsho	S	MH-40
49	*Combretum aculeatum* Vent.	Combretaceae	Meentichchi habulle'e	T	MH-362
50	*Combretum collinum* Fresen.	Combretaceae	Qaala'i baalli habulle'e	T	MH-361
51	*Combretum molle* R. Br. ex G. Don.	Combretaceae	Goonchi habulle'e	T	MH-193
52	*Combretum sp*	Combretaceae	Gereebbi qashsha	T	MH-335
53	*Commelina benghalensis* L.	Commelinaceae	Lob gu'ma	H	MH-81
54	*Commiphora kua* (R.Br. ex Royle) Vollesen.	Burseraceae	Uttaam adurusa (Garce'e)	T	MH-333
55	*Cordia africana* L.	Boraginaceae	Weddeeshsha	T	MH-115
56	*Crassocephalum sarcobasis* (DC)S. Moor.	Asteraceae	Horooraam shaano'i lab fiita	H	MH-278
57	*Crassocephalum vitellinum (*Benth).**	Asteraceae	Horooraam baar fiit yoo doba	H	MH-267
58	*Crepis rueppellii* Sch. Bip.	Asteraceae	Gundi baar adi yoo fiita (Fella'i ado)	H	MH-391
59	*Crinum abyssinicum* Hochst ex A. Rich.	Amaryllidaceae	Buchchi unkurubba (Goti tuma)	H	MH-274
60	*Crotalaria cleomifolia* Bak.	Fabaceae	Wic buyya (Senna laba)	S	MH-357
61	*Crotalaria lachnophora* Hochst. ex A. Rich.	Fabaceae	Senna laba	S	MH-369
62	*Crotalaria spinosa* Hochst. ex Benth.	Fabaceae	Qaadalli utti yoo gundi doba	H	MH-156

63	*Croton macrostachyus* Hochst.	Euphorbiaceae	Masana	T	MH-01
64	*Cucumis ficifolius* A. Rich.	Cucurbitaceae	Uulli gereechcho	Cl	MH-14
65	*Cussonia holstii* Harms ex Engl.	Araliaceae	Daagee'l qobbo'o	T	MH-355
66	*Cyathula uncinulata* (Schrad.) Schinz.	Amaranthaceae	Onno'i qaccabba (Gonje'e)	H	MH-199
67	*Cynodon aethiopicus* Clayton and Harlan.	Poaceae	Qorxo'o	G	MH-255
68	*Cynoglossum amplifolium* Hochst. ex A. DC.	Boraginaceae	Ajaar amado'o qaccabba	H	MH-145
69	*Cyphostemma adenocaule* (Steud. ex A. Rich.) Desc. ex Wild & R.B. Drumm.	Vitaceae	Dodoobba (Jaanjeechcho)	Cl	MH-339
70	*Cyphostemma pannosum* Vollesen. *	Vitaceae	Gidiidoola	H	MH-330
71	*Cyphostemma serpens* (Hochst. ex A. Rich.) Descoings.	Vitaceae	Laalo'o laba	Cl	MH-302
72	*Datura stramonium* L. **	Solanaceae	Machaa'l haqqa	H	MH-69
73	*Dicliptera foetida* (Forssk.) Blatter	Acanthaceae	Omoro'o laba	H	MH-136
74	*Dicliptera magaliesbergensis* K. Balkwill	Acanthaceae	Baxaaxursa/Omoro lab. jule'i/Mani illi qaraare)	H	MH-158
75	*Dicrocephala chrysanthemifolia* (Bl.) DC.	Asteraceae	Ginxi/Idoxxi qaraare/Subba'a (Meesso'o)	H	MH-155
76	*Diospyros abyssinica* (Hiern) F. White	Ebenaceae	Miqqe'e laba	T	MH-314
77	*Diospyros mespiliformis* Hochst. ex A. DC.	Ebenaceae	Fuga'i leega (Miqqe'e)	T	MH-352
78	*Discopodium penninervium* Hochst.	Solanaceae	Maraaro'o	T	MH-203
79	*Dodonaea viscosa* subsp. *angustifolia* (L.f.) J.G. West.	Sapindaceae	Kitkiita	S	MH-19
80	*Dombeya torrida* (J. F. Gmel.) P. Bamps.	Sterculiaceae	Booraara/Jaanna	T	MH-235
81	*Dovyalis abyssinica* (A. Rich.) Warb.	Salicaceae	Haqqi wo'l/Doo'm kooshshima	T	MH-170
82	*Dracaena afromontana* Mildbr.	Dracaenaceae	Hoffi caca'a	S	MH-326
83	*Dracaena steudneri* Engl.	Dracaenaceae	Lob caca'a	T	MH-247
84	*Duranta erecta* L.	Verbenaceae	Buuge'i jonge'e	S	MH-374
85	*Echinops amplexicaulis* Oliv.	Asteraceae	Hallutta laba	S	MH-394

86	*Ehretia cymosa* Thonn.	Boraginaceae	Ulaaga	T	MH-32
87	*Ekebergia capensis* Sparrm.	Meliaceae	Oloola	T	MH-248
88	*Embelia schimperi* Vatke	Myrsinaceae	Qaanqa (Xuda laba)	S	MH-304
89	*Entada leptostachya* Harms.	Fabaceae	Qaala'i maande'e	T	MH-367
90	*Erica arborea* L.	Ericaceae	Saate'e	S	MH-233
91	*Erythrina abyssinica* Lam.	Fabaceae	Qaala’i wora’a	T	MH-332
92	*Erythrina brucei* Schweinf. *	Fabaceae	Wora’a	T	MH-55
93	*Euclea divinorum* Hiern.	Ebenaceae	Meegaara	T	MH-15
94	*Euphorbia abyssinica* Gmel.	Euphorbiaceae	Adaamma	T	MH-200
95	*Euphorbia depauperata* A. Rich.	Euphorbiaceae	Gendeella	H	MH-47
96	*Euphoribia* sp.	Euphorbiaceae	Kabee'l xuranqa	T	MH-313
97	*Faurea rochetiana* (A. Rich.) Chiov. ex Pic.Serm.	Proteaceae	Aduruusa (Habuyye)	T	MH-310
98	*Ficus sur* Forssk.	Moraceae	Qodde’i oda’a	T	MH-289
99	*Ficus sycomorus* L.	Moraceae	Oda'a	T	MH-98
100	*Ficus thonningii* Blume	Moraceae	Qaal'i odechcho	T	MH-376
101	*Ficus vasta* Forssk	Moraceae	Qilxo'o	T	MH-177
102	*Flacourtia indica* (Burm.f.) Merr.	Salicaceae	Hagala	T	MH-128
103	*Galiniera saxifraga* (Hochst.) Bridson.	Rubiaceae	Gandi haqqa	S	MH-244
104	*Galinsoga parviflora* Cav.	Asteraceae	No name	H	MH-279
105	*Galium aparinoides* Forssk.	Rubiaceae	Ashkitta	H	MH-263
106	*Gardenia ternifolia* Schumach. & Thonn.	Rubiaceae	Ankuluusa	T	MH-329
107	*Gloriosa superba* L.	Colchicaceae	Kashar fiit yoo lam qaf xuda	H	MH-325
108	*Gmnosporia senegalensis* (Lam.) Loes.	Celastraceae	Qaala'i haabo’o (Qashsha)	T	MH-354
109	*Lasiosiphon glaucus* Fresen.	Thymelaeaceae	Ollawwa	S	MH-37

110	*Grewia bicolor* Juss.	Malvaceae	Dabuubeeshsho	S	MH-337
111	*Grewia* sp.	Malvaceae	Dabuubeeshsho	S	MH-393
112	*Grewia velutina* (Forssk.) Vahl.	Malvaceae	Xogane'e/Monnooqo'o (Qama'l haqqa laba)	S	MH-360
113	*Guizotia scabra* (Vis.) Chiov.	Asteraceae	Ajaar jeela	H	MH-116
114	*Gymnanthemum amygdalinum* (Delile) Sch.Bip	Asteraceae	Heebbaa	T	MH-07
115	*Gymnanthemum auriculiferum* (Hiern) Isawumi.	Asteraceae	Baarawwa	S	MH-03
116	*Gymnosporia addat (*Loes.) * Sebsebe (synonym *Maytenus addat*).	Celastraceae	Anxaaxa (Jonge'e laba)	T	MH-266
117	*Gymnosporia arbutifolia* (Hochst.ex. A. Rich.) Loes.	Celastraceae	Jonge'e	T	MH-126
118	*Gymnosporia obscura* (A. Rich.) Loes.	Celastraceae	Jonge'e (Geejji jonge'e laba)	T	MH-283
119	*Habenaria decumbens* Thomas & Cribb *	Orchidaceae	Shillo'o	Orch	MH-271
120	*Hagenia abyssinica* (Bruce) J. F. Gmel.	Rosaceae	Suuxo	T	MH-173
121	*Halleria lucida* L.	Scrophulariaceae	Garamba	T	MH-344
122	*Helichrysum splendidum* Less.	Asteraceae	Qeeraa'l naatira lab baar fiit yoo doba	H	MH-291
123	*Helichrysum traversii* Chiov.	Asteraceae	Gundi naatira labi hoffi baar fiit yoo doba	H	MH-290
124	*Hemionitis calomelanos* (Sw.) Christenh.	Pteridaceae	Haqqi wo'l farna	Fn	MH-254
125	*Hibiscus calyphyllus* Cavan.	Malvaceae	No name	H	MH-303
126	*Hymenodictyon floribundum* (Hochst. & Steud.) B.L. Rob.	Rubiaceae	Odeera (Wo'l qobbo'o)	S	MH-334
127	*Hypericum quartinianum* A. Rich.	Hypericaceae	Amja'a	S	MH-234
128	*Ilex mitis* (L.) Radlk.	Aquifoliaceae	Ashmiinqa	T	MH-241
129	*Ipomoea tenuirostris* Choisy.	Convolvulaceae	Dabayyi xuda/haraanja/Wiciibbi(boronshi) qaraare	Cl	MH-229
130	*Jasminum abyssinicum* Hochets. Ex DC.	Oleaceae	Fella'i xuda (xoonsa/Moora kara)	Cl	MH-342
131	*Jasminum grandiflorum* L.	Oleaceae	Xamballalla	Cl	MH-385
132	*Juniperus procera* L.	Cupressaceae	Abash hooma	T	MH-60

133	*Kalanchoe hypseloleuce* Friis & M.G. Gilbert. *	Crassulaceae	Hancuura	H	MH-127
134	*Kalanchoe petitiana* A. Rich. *	Crassulaceae	Qaala'i hancuura	H	MH-353
135	*Kosteletzkya adoensis* (Hochst. ex A. Rich.) Mast.	Malvaceae	Maliva	H	MH-384
136	*Laggera crispata* (Vahl) Hepper & Wood.	Asteraceae	Qadaalli horooraam gotichchi lab doba	H	MH-297
137	*Landolphia buchananii* (Hall.f.) Stapf	Apocynaceae	Hoomba	Li	MH-147
138	*Lannea fruticosa* (Hochst. ex A. Rich.) Engl.	Anacardiaceae	Ado di'ishisaancho	T	MH-371
139	*Lantana trifolia* L.**	Verbenaceae	Axxada laba	S	MH-294
140	*Launaea cornuta* (Hochst. ex Oliv. & Hiern) C. Jeffrey.	Asteraceae	No name given	H	MH-382
141	*Ledebouria revoluta* (L.f.) Jessop.	Hyacinthaceae	Alge'e laba	H	MH-372
142	*Leucas martinicensis* (Jacq.) R. Br.	Lamiaceae	Tombosanna (Raas kimmira)	H	MH-187
143	*Lippia adoensis* var *adoensis* Hochst. ex walp *	Verbenaceaae	Axxada	S	MH-35
144	*Lobelia giberroa* Hemsl.	Lobeliaceae	Booyye'e	S	MH-239
145	*Lupinus* sp.	Fabaceae	Got atara	H	MH-140
146	*Maesa lanceolata* Forssk.	Myrsinaceae	Kowwaada	T	MH-02
147	*Malva verticillata* L.	Malvaceae	No name	S	MH-231
148	*Maytenus undata* (Thunb.) Blakelock	Celastraceae	Kin baca (Ximira)	T	MH-312
149	*Microglossa pyrifolia* (Lam.) O. Kuntze.	Asteraceae	Sa'a (Zaldaamma/Macci bobaanqa)	S	MH-143
150	*Mikaniopsis clematoides* (Sch.Bip. ex A. Rich.) Milne-Redh. *	Asteraceae	Ludda (Xaxgoora)	Cl	MH-135
151	*Millettia ferruginea* (Hochst.) Hochst. ex Baker. *	Fabaceae	Billawwaqqa	T	MH-97
152	*Mimusops kummel* A. DC. Kumel	Sapotaceae	Dogoo'na	T	MH-131
153	*Momordica foetida* Schumach.	Cucurbitaceae	Hamash waasa	Cl	MH-06
154	*Myrsine africana* L.	Primulaceae	Gexeema	S	MH-132
155	*Myrsine melanophloeos* (L.) R.Br. ex Sweet	Primulaceae	Ansha	T	MH-321
156	*Rapanea melanophloeos* (L.) Mez.	Primulaceae	Tuulla	T	MH-250

157	*Myrtus communis* L.	Myrtaceae	Goonchi qasha'a	S	MH-169
158	*Neonotonia wightii* (Wight & Arn.) J.A. Lackey (synonmy of: *Glycine wightii* (Wight & Arn.) Verdc.).	Fabaceae	Sas buyyi yoo fella'i xuda	Cl	MH-282
159	*Nuxia congesta* R.Br. ex Fresen.	Stilbaceae	Biixxanna (Bulshaana laba)	T	MH-320
160	*Ochna holstii* Engl.	Ochnaceae	-	T	MH-322
161	*Ochna inermis* (Forssk.) Schweinf.	Ochnaceae	Ooxxi haqqa	S	MH-375
162	*Ocimium* sp.	Lamiaceae	Xago'o laba/Xago'o/Wo'l shilgokki qaraare	H	MH-196
163	*Ocimum gratissimum* L	Lamiaceae	Geejji gimmenja laba (Chacho'o)	S	MH-149
164	*Ocimum lamiifolium* Hochst.ex Benth.	Lamiaceae	Minaantoofa	S	MH-23
165	*Ocimum spicatum* Deflers.	Lamiaceae	Buubayye (Angaambiisha)	S	MH-67
166	*Olea europaea* L. subsp. *cuspidata* Wall. ex G. Don.	Oleaceae	Weera	T	MH-111
167	*Olea welwitschii* (Knobl.) Gilg & G. Schellenb. (a new record in the new study area from MAF).	Oleaceae	Siigeeda	T	MH-261
168	*Olinia rochetiana* A. Juss.	Penaeaceae	Guna	T	MH-39
169	*Oncoba spinosa* Forssk.	Salicaceae	Itakkam kuukka	T	MH-351
170	*Osyris quadripartite* Decn. (synonym of *Osyris lanceolata*).	Santalaceae	Kaaro'o	T	MH-76
171	*Oxalis corniculata* L.**	Oxalidaceae	Goro'ama (cii'i mixmimixo'o)	H	MH-150
172	*Ozoroa insignis* Delile	Anacardiaceae	Debaqa	T	MH-387
173	*Panicum maximum* Jacq.	Poaceae	Biishsho'i hixe	G	MH-338
174	*Pavetta abyssinica* Fresen. var. *abyssinica.*	Rubiaceae	Meentichchi qasha'a	T	MH-314
175	*Pavetta oliveriana* Hiern.	Rubiaceae	Gaarawwa laba (Meentichchi gaarawwa)	T	MH-228
176	*Pavonia urens* Cav. var. *urens*.	Malvaceae	Doba	H	MH-70
177	*Pelargonium* sp.	Geraniaceae	Inqi qaraare	H	MH-240
178	*Phyllopentas schimperi* (Hochst.) Y.D. Zhou & Q.F. Wang (synonym of *Pentas schimperiana)* *)*	Rubiaceae	Wo'l oda'a	H	MH-232

179	*Pentanema confertiflorum* (A. Rich.) D.Gut.Larr., Santos-Vicente, Anderb., E. Rico & M.M. Mart.Ort. *	Asteraceae	Anca (qadaalli haagallo'o/Bulshaana laba)	S	MH-300
180	*Peponium vogelii* (Hook.f.) Engl.	Cucurbitaceae	Humbusha (Danguruulla)	Cl	MH-242
181	*Periploca linearifolia* Quart. -Dill. & A. Rich.	Apocynaceae	Azullala	Li	MH-10
182	*Phaulopsis imbricata* (Forssk.) Sweet.	Acanthaceae	Qadaalli hoffi horooraam fiita	H	MH-276
183	*Phoenix reclinata* acq.	Arecaceae	Sale'e (Dimbaaba)	T	MH-110
184	*Physalis peruviana* L.	Solanaceae	Onjooro'o	H	MH-114
185	*Phytolacca dodecandra* L'Her.	Phytolaccaceae	Haanja	S	MH-161
186	*Piliostigma thonningii* (Schumach.) Milne-Redh.	Fabaceae	Maccoqaara (Qaala'i weddeeshsha)	T	MH-323
187	*Plantago lanceolata* L.	Plantaginaceae	Gereebbi sheerimo	H	MH-285
188	*Platostoma africanum* P. Beauv.	Lamiaceae	Heedoo'l maaxa	H	MH-25
189	*Plectranthus barbatus* Andrews.	Lamiaceae	No. name given	H	MH-138
190	*Plectranthus hadiensis* (Forssk.) Schweinf. ex Sprenger.	Lamiaceae	Qibatoora	S	MH-388
191	*Polyscias fulva* (Hiern) *Harms.*	Araliaceae	Bolfe'e (Daagee'l barcuma)	T	MH-245
192	*Polysphaeria parvifolia* Hiern	Rubiaceae	Miqqe'e	T	MH-350
193	*Polystachya caduca* Rchb.f.*	Orchidaceae	Orkaada	Orch	MH-268
194	*Premna schimperii* Engl.	Lamiaceae	Xooxanqe'e	S	MH-04
195	*Protea gaguedi* J.F. Gmel.	Proteaceae	Haabo'o	T	MH-262
196	*Prunus africana* (Hook.f. Kalkm.)	Rosaceae	Araara	T	MH-57
197	*Psydrax parviflora* (Afz.) Bridson.	Rubiaceae	Gaarawwa laba	S	MH-295
198	*Psydrax schimperiana* (A. Rich.)	Rubiaceae	Googaame	T	MH-71
199	*Pteridium aquilinum* (L.) Kuhn.	Dennstaedtiaceae	Onxooxxo'o	Fn	MH-109
200	*Pterolobium stellatum* (Forssk.) Brenan.	Fabaceae	Cargosa	S	MH-383

201	*Rhamnus prinoides* L. Her.	Rhamnaceae	Geesho'o	S	MH-120
202	*Rhamnus staddo* A. Rich.	Rhamnaceae	Waato'o	S	MH-249
203	*Rhoicissus tridentata* (L. f.) Wild & Drum.	Vitaceae	Wo'l laalo'o	Cl	MH-324
204	*Rhus glutinosa* A. Rich. * (synonmy of: *Searsia glutinosa*).	Anacardiaceae	Qamo'o laba	S	MH-237
205	*Rhus natalensis* Krauss. (synonym of *Searsia crenulata* (A. Rich.) Moffett.). **	Anacardiaceae	Qadaalli dabuubeeshsho	S	MH-340
206	*Rhus vulgaris* Meikle (synonym of *Searsia pyroides* var. *pyroides)*	Anacardiaceae	Qamo'o	T	MH-08
207	*Ricinus communis* L.	Euphorbiaceae	Qobbo'o	S	MH-125
208	*Ritchiea albersii* Gilg.	Capparidaceae	Qama'i barbaro'o	S	MH-281
209	*Rosa x richardii* Rehd.	Rosaceae	Doo'm landaayye	S	MH-288
210	*Rotheca myricoides* (Hochst.) Steane & Mabb.	Lamiaceae	Haniga	S	MH-186
211	*Rubia cordifolia* L.	Rubiaceae	Haaro'o (Baarxusha)	Cl	MH-68
212	*Rubus apetalus* Poir.	Rosaceae	Dabayyyi gora	S	MH-11
213	*Rubus steudneri* Schweinf	Rosaceae	Daane'i gora	S	MH-41
214	*Rumex abyssinicus* Jacq.	Polygonaceae	Shiisho'o	H	MH-22
215	*Rumex nepalensis* Spreng.	Polygonaceae	Go'ichcho	H	MH-21
216	*Rumex nervosus* Vahl.	Polygonaceae	Imbocca	S	MH-307
217	*Rytigynia neglecta* (Hiern.) Robyns.	Rubiaceae	Gaarawwa	S	MH-48
218	*Salvia nilotica* Jacq.	Lamiaceae	Okote'e	H	MH-153
219	*Satureja simensis* (Benth.) Briq.	Lamiaceae	Daaxa	H	MH-270
220	*Scadoxus multiflorus* (Martyn) Raf.	Amaryllidaceae	Got tuma (Hamashshi weesa)	H	MH-238
221	*Schrebera alata* (Hochst.) Welw.	Oleaceae	Lob haqqa	T	MH-284
222	*Securidaca longepedunculata* Fresen.	Polygalaceae	Mukke'e	T	MH-206
223	*Senegalia brevispica (*Harms) Seigler & Ebinger	Fabaceae	Worsaameessa	S	MH-364

224	*Senna didymobotrya* (Fresen.) Irwin & Barneby.	Fabaceae	Senna laba	S	MH-258
225	*Senna petersiana* (Bolle) Lock.	Fabaceae	Chachayyeencho	S	MH-50
226	*Senna singueana* (Del.) Lock	Fabaceae	Senna laba	S	MH-389
227	*Sesbania sesban* (L.) Merr.	Fabaceae	Sasbaana	S	MH-259
228	*Shirakiopsis elliptica* (Hochst.) Esser	Euphorbiaceae	Shaqama	T	MH-33
229	*Sida rhombifolia* L.	Malvaceae	Qarxaffa	S	MH-134
230	*Sida schimperiana* Hochst.ex.A. Rich.	Malvaceae	Jajjo'i goda/Xuraza	S	MH-46
231	*Spiniluma oxyacantha* (Baill.) Aubrév.	Sapotaceae	Faraxxi qasa	T	MH-28
232	*Smilax aspera* L.	Smilacaceae	Hobba amada	Cl	MH-260
233	*Solanecio gigas* (Vatke) C. Jeffrey. *	Asteraceae	Ayibaabba (Halaaphphi bobaanqa)	S	MH-123
234	*Solanecio mannii* (Hook. f.) C. Jeffrey.	Asteraceae	No name	S	MH-363
235	*Solanum incanum* L.	Solanaceae	Heemachchi looraawwa	S	MH-38
236	*Solanum indicum L.*	Solanaceae	Wish (Wiiddi looraawwa)	H	MH-74
237	*Solanum marginatum* L.f.*	Solanaceae	Lob loorraawwa	S	MH-379
238	*Solanum villosum* Mill.	Solanaceae	Ajaar migillo'o	H	MH-336
239	*Steganotaenia araliacea* Hochst. ex A. Rich.	Araliaceae	Ado di'ishisaancho laba	H	MH-280
240	*Stellaria media* (L.) Vill.	Caryophyllaceae	Daqacaaca (Bishbisha laba)	H	MH-157
241	*Stephania abyssinica* (Dellon &A. Rich.) Walp. var. *abyssinica.*	Menispermaceae	Huma	Cl	MH-49
242	*Stephanotis schimperi* (Decne.) S. Reuss, Liede & Meve	Apocynaceae	Doo'l muunca	Cl	MH-341
243	*Stereospermum kunthianum* Cham.	Bignoniaceae	Sha'ma'a	T	MH-349
244	*Stomatanthes africanus* (Oliv. & Hiern) R.M. King & H. Rob.	Asteraceae	Basso'i bila lab manni illi qaraare	H	MH-141
245	*Syzygium guineense* var. (Wild.) DC.*guineense*.	Myrtaceae	Duubaana	T	MH-317
246	*Syzygium guineense* (Willd.) DC. subsp. *afromontanum* F. White	Myrtaceae	Gooto'i duubaana	T	MH-171

247	*Tacazzea apiculata* Oliv	Apocynaceae	Diishshi maraphphi haqqa	Li	MH-243
248	*Tagetes minuta* L.	Asteraceae	Hallenjja (Lata'i enja)	H	MH-129
249	*Tapinanthus globiferus* (A. Rich.) Tieghem	Loranthaceae	Gexee'm xanqo'o	Hemp	MH-301
250	*Tapinanthus heteromorphus* (A. Rich.) Danser	Loranthaceae	Qaala'i qashsha xanqo'o	Hemp	MH-390
251	*Terminalia brownii* Fresen.	Combretaceae	Dibi'n haqqa	T	MH-327
252	*Terminalia* sp.	Combretaceae	-	T	MH-277
253	*Terminalia schimperiana* Hochst.	Combretaceae	Dabaqa	T	MH-331
254	*Thalictrum rhynchocarpum* Dill. & A. Rich. **	Ranunculaceae	Manni illi qaraare	H	MH-345
255	*Thunbergia ruspolii* Lindau *	Acanthaceae	Guffi haata	H	MH-308
256	*Thymus schimperi* Ronniger. *	Lamiaceae	Ishina	H	MH-85
257	*Tragia cinerea* (Pax) Gilbert & Radcl. -Smith.	Euphorbiaceae	Hoffi doobba	Cl	MH-108
258	*Trichocladus ellipticus* Eckl. & Zeyh.	Hamamelidaceae	Qabarbuyya	S	M
259	*Trifolium semipilosum* Fresen.	Fabaceae	Jule'i qaraare	H	MH-272
260	*Urera hypselodendron* (A. Rich.) Willd.	Urticaceae	Hariira (Dooqa)	Cl	MH-130
261	*Urtica simensis* Hochst. ex A. Rich. *	Urticaceae	Amaa'l doobba (Cimcima)	H	MH-194
262	*Uvaria leptocladon* Oliv.	Annonaceae	Illi do'a	S	MH-370
263	*Vachellia abyssinica* (Hochst. ex Benth.) Kyal. & Boatwr.	Fabaceae	Giraara	T	MH-176
264	*Vachellia bussei* (Harms ex Y. Sjöstedt) Kyal. & Boatwr.	Fabaceae	Qadaalli waaco'o	T	MH-347
265	*Vachellia seyal* var. *fistula* (Schweinf.) Kyal. & Boatwr	Fabaceae	Kashar waaco'o	T	MH-356
266	*Vachellia tortilis* (Forssk.) Galasso & Banfi **	Fabaceae	Gundi giraara	T	MH-348
267	*Vangueria apiculata* K. Schum	Rubiaceae	Kuukka	T	MH-164
268	*Vangueria volkensii* K. Schum. **	Rubiaceae	Loqe'e	S	MH-311
269	*Verbascum sinaiticum* Benth.	Scrophulariaceae	Got buyya	H	MH-316
270	*Vepris nobilis* (Delile) Mziray.	Rutaceae	Xaa'a	T	MH-73

271	*Gymnanthemum* sp	Asteraceae	Aggagga	S	MH-309
272	*Gymnanthemum* spp	Asteraceae	Ajaar doba	H	MH-296
273	*Vicia sativa* L.	Fabaceae	Doo'm chachayye'e	S	MH-358
274	*Viscum congolense* De Wild.	Viscaceae	Lob masa'n xanqo'o	Hemp	MH-188
275	*Viscum tuberculatum* A. Rich.	Viscaceae	Hoffi masa'n xanqo'o	Hemp	MH-146
276	*Warburgia ugandensis* Sprague. (a new record in this new study area)	Canellaceae	Leega	T	MH-269
277	*Xanthium strumarium* L.**	Asteraceae	Jaatiroofa laba	H	MH-230
278	*Ximenia americana* L.	Olacaceae	Qaala'i kooshshaama	S	MH-273
279	*Zanthoxylum asiaticum* (L.) Appelhans, Groppo & J. Wen (synonym of *Toddalia asiatica*).	Rutaceae	Seego'o	S	MH-09
280	*Ziziphus spina-christi* (L.) Desf.	Rhamnaceae	Gaaq xuranqa	T	MH-359

Key: MH = Mulatu Hankiso, * = Endemic plant to Ethiopia, ** = Introduced, T=Tree, S = Shrub, H = Herb, Li = Liana, Cl = Climber, Fn= Fern, G= grass, Orch = Orchid, Hemp = Hemiparasites, FEE= Flora of Ethiopia and Eritrea.

Appendix 2. Number of plots with the corresponding altitude, latitude, and longitude of the forest patches

Quadrat	Altitude(masl)	Latitude (UTM)	Longitude	Quadrat	Altitude(masl)	Latitude (UTM)	Longitude
1	2466	UTM0823215	37N0363129	50	1903	UTM0821904	37N0341978
2	2457	UTM0823220	37N0363214	51	1976	UTM0821342	37N0342282
3	2423	UTM0823152	37N0363168	52	1970	UTM0821489	37N0342213
4	2417	UTM0823237	37N0363199	53	1964	UTM0821396	37N0342279
5	2371	UTM0823375	37N0363326	54	1954	UTM0821639	37N0342084
6	2343	UTM0823375	37N0363398	55	1947	UTM0821357	37N0342311
7	2487	UTM0823734	37N0322793	56	1946	UTM0821150	37N0311979
8	2450	UTM0823805	37N0362701	57	1903	UTM0821359	37N0342369
9	2409	UTM0823876	37N0362666	58	1933	UTM0821720	37N0341915
10	2383	UTM0823915	37N0362658	59	1935	UTM0821778	37N0341969
11	2329	UTM0823965	37N0362685	60	1990	UTM0822926	37N0341614
12	2582	UTM0823648	37N0362719	61	1868	UTM0822440	37N0341559

13	2632	UTM0822254	37N0363019	62	1860	UTM0822457	37N0341559
14	2626	UTM0822556	37N0363207	63	1842	UTM0822536	37N0341438
15	2621	UTM0822685	37N0363298	64	1809	UTM0822648	37N0341263
16	2628	UTM0821932	37N0362891	65	1808	UTM0822721	37N0341088
17	2572	UTM0822781	37N0363345	66	1801	UTM0822709	37N0341235
18	2551	UTM0822798	37N0363280	67	1781	UTM0822707	37N0341350
19	2507	UTM0822962	37N0363224	68	1780	UTM0822892	37N0341485
20	2464	UTM0823020	37N0363287	69	1774	UTM0822774	37N0341403
21	2421	UTM0823104	37N0363240	70	1863	UTM0822401	37N00341481
22	2365	UTM0823298	37N0363309	71	1841	UTM0822370	37N0341453
23	2608	UTM0822324	37N0363145	72	1821	UTM0822404	37N0341363
24	2538	UTM0822583	37N0363379	73	1811	UTM0822703	37N0341176
25	2453	UTM 0822595	37N0363534	74	1783	UTM0822763	37N0341261
26	2334	UTM0822975	37N0363653	75	1797	UTM0822616	37N0341172
27	2287	UTM0823171	37N0363448	76	1750	UTM0822648	37N034098
28	2581	UTM0820541	37N0361298	77	1739	UTM0822849	37N0340926
29	2508	UTM820091	37N0361151	78	1730	UTM0822715	37N0340892
30	2482	UTM0820785	37N0361203	79	1696	UTM0822924	37N0340847
31	2494	UTM0820812	37N0361475	80	1672	UTM0822894	37N0340741
32	2520	UTM0820875	37N0361542	81	1762	UTM0826812	37N0338126
33	2818	UTM0822209	37N0362759	82	1599	UTM0826953	37N0338041
34	2766	UTM0822382	37N0362825	83	1608	UTM0827005	37N0337937
35	2720	UTM0822280	37N0362880	84	1576	UTM0826882	37N0337607
36	2695	UTM0822251	37N0362903	85	1597	UTM0826879	37N0337223
37	2626	UTM0822001	37N0362916	86	1585	UTM0826808	37N0336958
38	2678	UTM0821427	37N0362878	87	1583	UTM0826852	37N0336232
39	2830	UTM0821585	37N0362493	88	1567	UTM0826822	37N0333768
40	2813	UTM0821618	37N0362481	89	1559	UTM0826835	37N0336700
41	2806	UTM0821616	37N0362460	90	1562	UTM0826829	37N0336636

42	2725	UTM0821359	37N0362372	91	1558	UTM0826797	37N0336450
43	2667	UTM0821162	37N0362183	92	1556	UTM0826625	37N0336387
44	2600	UTM0821782	37N0362085	93	1546	UTM0826621	37N0335887
45	2548	UTM0823096	37N0362676	94	1518	UTM0826700	37N0335351
46	1959	UTM0821724	37N0341956	95	1495	UTM0826512	37N0335019
47	1864	UTM0822048	37N0341956	96	1497	UTM0826504	37N0334603
48	1867	UTM0822132	37NN0341557	97	1479	UTM0826262	37N00334547
49	1895	UTM0821932	37N0341963	98	1530	UTM0826210	37N0335003

Appendix 3. Density of important value index of some dominant species in mount Shonkola Forest patch

No	Species	Habit	Density
1	*Erica arborea*	S	67.22
2	*Calpurnia aurea*	S	32.22
3	*Croton macrostachyus*	T	26.67
4	*Ilex mitis*	T	23.33
5	*Apodytes dimidiata*	T	18.89
6	*Bersama abyssinica*	S	15.56
7	*Dodonaea viscosa* subsp. *angustifolia*	S	13.89
8	*Agarista salicifolia*	T	13.33
9	*Lasiosiphon glaucus*	S	10.00
10	*Ekebergia capensis*	T	8.89
11	*Brucea antidysenterica*	S	7.78
12	*Hagenia abyssinica*	T	6.67
13	*Albizia schimperiana*	T	5.56
14	*Buddleja polystachya*	T	3.89
15	*Vachellia abyssinica*	T	3.33
16	*Ficus sur*	T	2.78
17	*Celtis africana*	T	2.22
18	*Euphorbia abyssinica*	T	1.67
19	*Cordia africana*	T	1.11
20	*Ehretia cymosa*	T	0.56

Appendix 4. Relative density of some dominant species in Shonkola Forest patch

No	*Species*	Habit	Relative density
1	*Erica arborea*	S	8.05
2	*Lobelia giberroa*	S	6.59
3	*Olinia rochetiana*	T	5.46
4	*Juniperus procera*	T	5.0
5	*Afrocarpus gracilior*	T	4.6
6	*Osyris quadripartita*	s	4.13
7	*Calpurnia aurea*	S	3.86
8	*Maesa lanceolata*	T	3.59
9	*Maytenus arbutifolia*	T	3.33
10	*Croton macrostachyus*	T	3.19
11	*Olea europaea* subsp. *cuspidata*	T	3.0
12	*Syzygium guineense.* subsp. *afromontanum*	T	2.86

13	*Ilex mitis*	T	2.8
14	*Myrtus communis*	S	2.5
15	*Spiniluma oxyacantha*	T	2.40
16	*Apodytes dimidiata*	T	2.3
17	*Bersama abyssinica*	S	1.86
18	*Dracaena steudneri*	T	1.7
19	*Pavetta abyssinica* var. *abyssinica*	T	1.66
20	*Agarista salicifolia*	T	1.60

Appendix 5. Frequency and relative frequency of trees and shrub species of dominant abundance in mount Shonkola Forest patch

N0	Species	Habit	No. of plots a species occurred	Frequency	Relative frequency
1	*Myrsine africana*	S	37	82.22	6.17
2	*Olinia rochetiana*	T	32	71.11	5.33
3	*Erica arborea*	S	29	64.44	4.83
4	*Maesa lanceolata*	T	26	57.78	4.33
5	*Apodytes dimidiata*	T	25	55.56	4.17
6	*Juniperus procera*	T	24	53.33	4.00
8	*Afrocarpus gracilior*	T	21	46.67	3.50
9	*Gymnosporia obscura*	T	18	40.00	3.00
10	*Hypericum quartinianum*	S	16	35.56	2.67
11	*Ilex mitis*	T	15	33.33	2.50
12	*Agarista salicifolia*	T	14	31.11	2.33
13	*Spiniluma oxyacantha*	T	13	28.89	2.17
14	*Gymnanthemum auriculiferum*	S	12	26.67	2.00
15	*Calpurnia aurea*	S	11	24.44	1.83
16	*Lasiosiphon glaucus*	S	10	22.22	1.67
17	*Ekebergia capensis*	T	8	17.78	1.33

Appendix 6. Dominance and relative dominance of trees and shrub species of dominant abundance in Shonkola Forest patch

No	*Species*	Habit	Dominance	Relative dominance
1	*Gymnosporia arbutifolia*	T	1.21	5.96
2	*Afrocarpus gracilior*	T	1.17	5.76
3	*Ilex mitis*	T	1.00	4.89
4	*Juniperus procera*	T	0.79	3.90
5	*Syzygium guineense* subsp. *afromontanum*	T	0.56	2.76
6	*Myrsine melanophloeos*	T	0.50	2.47

7	*Apodytes dimidiata*	T	0.50	2.46
8	*Schefflera abyssinica*	T	0.49	2.38
9	*Croton macrostachyus*	T	0.45	2.19
10	*Hagenia abyssinica*	T	0.42	2.05
11	*Prunus africanus*	T	0.36	1.75
12	*Ekebergia capensis*	T	0.32	1.58
13	*Olinia rochetiana*	T	0.27	1.31
14	*Lobelia giberroa*	S	0.25	1.24
15	*Erythrina brucei*	T	0.20	0.99
16	*Erica arborea*	S	0.19	0.96
17	*Maesa lanceolata*	T	0.18	0.89
18	*Pavetta abyssinica* var. *abyssinica*	T	0.18	0.86
19	*Albizia schimperiana*	T	0.17	0.84
20	*Olea europaea* subsp. *cuspidata*	T	0.15	0.75

Appendix 7. Important value index of some species in Shonkola Forest patch with relative frequency and relative dominance and relative density

No	Species	RF	RDo	RDe	IVI: RF+RDo+RDe
1	*Afrocarpus gracilior*	3.50	5.76	4.59	13.85
2	*Erica arborea*	4.83	0.96	8.05	13.84
3	*Juniperus procera*	4.00	3.90	4.99	12.89
4	*Olinia rochetiana*	5.33	1.31	5.46	12.10
5	*Maytenus arbutifolia*	2.17	5.96	3.33	11.45
6	*Ilex mitis*	2.50	4.89	2.79	10.18
8	*Croton macrostachyus*	3.50	2.19	3.19	8.89
9	*Maesa lanceolata*	4.33	0.89	3.59	8.81
10	*Myrsine africana*	6.17	0.02	2.46	8.65
11	*Lobelia giberroa*	0.67	1.24	6.59	8.49
12	*Syzygium guineense* subsp. *afromontanum*	1.00	2.76	2.86	6.62
13	*Osyris quadripartita*	0.67	0.41	4.13	5.21
14	*Spiniluma oxyacantha*	2.17	0.44	2.40	5.00
15	*Bersama abyssinica*	2.33	0.66	1.86	4.86
16	*Prunus africanus*	1.67	1.75	1.33	4.75
17	*Olea europaea* subsp. *cuspidata*	1.00	0.75	2.99	4.74
18	*Hagenia abyssinica*	0.83	2.05	0.80	3.68
19	*Teclea nobilis*	1.17	0.16	1.20	2.52
20	*Olea welwitschii*	1.17	0.28	0.47	1.91
21	*Carissa spinarum*	1.17	0.01	0.67	1.85

Appendix 8. Some woody plant species total DBH distribution in Mount Shonkola Forest patch

Plant species	Habit	Total DBH (cm)	Plant species	Habit	Total DBH (cm)
Afrocarpus gracilior	T	1219.43	*Bersama abyssinica*	S	260.15
Erica arborea	S	1072.67	*Agarista salicifolia*	T	259.55
Gymnosporia arbutifolia	T	1066.56	*Spiniluma oxyacantha*	T	235.09
Juniperus procera	T	1064.01	*Myrtus communis*	S	217.12
Ilex mitis	T	884.71	*Albizia schimperiana*	T	181.85
Lobelia giberroa	S	741.01	*Myrsine africana*	S	124.36
Croton macrostachyus	T	647.13	*Lasiosiphon glaucus*	S	117.67
Syzygium guineense. subsp. *afromontanum*	T	624.27	*Maytenus undata*	T	115.6
Olinia rochetiana	T	613.47	*Vepris nobilis*	T	102.55
Apodytes dimidiata	T	530.25	*Hypericum quartinianum*	S	99.01
Maesa lanceolata	T	416.4	*Erythrina brucei*	T	95.866
Calpurnia aurea	S	403.72	*Olea welwitschii*	T	85.03
Prunus africanus	T	363.69	*Vachellia abyssinica*	T	84.39
Schefflera abyssinica	T	362.1	*Buddleja polystachya*	T	82.48
Myrsine melanophloeos	T	357.96	*Millettia ferruginea*	T	80.57
Olea europaea subsp. *cuspidata*	T	335.03	*Brucea antidysenterica*	S	70.92
Hagenia abyssinica	T	333.12	*Gymnosporia obscura*	T	70.25
Osyris quadripartita	T	310.29	*Dracaena steudneri*	T	58.92
Pavetta abyssinica var. abyssinica	T	299.04	*Euphorbia abyssinica*	T	54.14
Ekebergia capensis	T	290.44	*Dovyalis abyssinica*	T	46.88

Appendix 9. Figure of forest patch of 2nd Hankota/Haba (*Combretum-Terminalia* vegetation type)

Appendix 10. Figures of Riverine and *Acacia-Commiphora* wood land vegetation type

Appendix 11. List of medicinal plants for treating human ailments in Soro District; with mode of preparations and applications

Scientific name	Family	Local name: Hadiyissa	Disease treated: Hadiyissa (Had.) and /or Amharic (Amh.)	Ha	CP	Medicinal plants and applications (MPAP) include FP (preparation form), MT (means of treatment), and RA (root of administration).	UR	CN: MH:
Achyranthes aspera L.	Amaranthaceae	Hoffi qaccabba	Michi (Michcha-Had.)	H	F/D	Crushed leaf is powdered and mixed with water, and the decoction is administered orally.	4	MH-75
			Constipation (Godaphphi gonga-Had.)	H	F	Root is crushed and mixed with water for oral administration.	1	MH-42
Acmella caulirhiza Delile	Asteraceae	Bish bisha	Tonsillitis (Leella'i luwwa-Had.)	H	F	Chewed flower or leaf and spitting the juice into the mouth and swallowing orally.	25	
			Tooth pain	H	F	Three flowers chewed and wrabbed with fibre; hold on the ached or pained tooth dentally.	12	
			Eczemab (Jenje'na-Had.)	H	F	Three flowers or leaves are crushed, pounded in water, pasted, and tied over the wound.	2	
			Bat urine (Cii'i jabbo-Had.)	H	F	Whole part crushed with *P. africanus* bark mixed in cold or warm water, smear the concoction.	1	

Aframomum corrorima (A. Braun) P.C.M. Jansen*	Zingiberaceae	Wokkaashsha	Bloat (Duubimma-Had.)	H	D	Chewed the seeds and swallowed the juice.	4	MH-88
			Tonsillitis	H	D	Chewed with NaCl and swallow the juice.	3	
			COPD (Siniqa-Had.)	H	D	Leaves with leaves of *C. citratus*, NaCl, and swallowed.		
Afrocarpus gracilior (Pilg.) C.N.Page	Podocarpaceae	Digiba	Rabies, diarrhoea	T	F	Leaves crushed, pounded with water for oral administration.	10	MH-34
			Rabies, impotence, wound	T	F	Seven fresh buds/ the leaves together with a leaves of *Z. asiaticum,* crushed with stem bark of *S. oxyacantha* and *E. capensis,* pounded in water and drunk; the resin is mixed with water, and drunk for diarrhoea, drunk with butter for impotence; paste, tied.	3	
Agarista salicifolia (Comm.ex Lam.) Don.	Ericaceae	Sotira	Eczema	T	F	Stem bark, leaves or buds are crushed with leaves /buds of *O. rochetiana*, paste and tied with *E. ventricosum* dry pseudo stem/Hofe'e-Had. /	1	MH-236
Ageratum houstonianum Mill. ***(*synonym of *Ageratum conyzoides*)	Asteraceae	Zeeqisse	Worm stinging ('Jule'i jabbo-Had.)	H	F	Leaves crushed, pasted, and tied over the painful area.	2	MH-286
			Abdominal pain, stomach ache (Godaphphi jabbo-Had.)	H	F	Leaf soaked in boiled water and drunk as tea orally.	2	
			Diarrhoea (Aadite-Had.)	H	F	Leaf soaked in boiled water and drunk as tea orally	1	
Ajuga integrifolia Buch. -Ham. Ex D. Don.	Lamiaceae	Annamura	Abdominal pain, stomach ache	H	F	Leaf or whole part, pounded in water, drunk; chewed swallow the juice via mouth.	3	MH-51
			Hypertension (Xiiqqi gafechcha Had.)	H	D	Powdered drunk the solution by beverages: coffee, tella, arekie, and drunk	1	
			Cold/myalgia (Qiixxi jabbo-Had.)	H	F/D	Whole or leaf parts are powdered, mixed within local beverages of coffee, black fresh honey, tella, and arekie, and taken orally	40	
			Malaria (Huxiisa/Kachchisa-Had)	H	F/D	Crushed, powdered local beverages: coffee, tella, arekie, drunk via mouth	2	
			Boils/folliculitis (Bikkiraata-Had.)	H	F/D	Leaf powdered, pounded in water and drunk, and it burst the swelling.	1	
			Dingetegna (Qasimmi jabbo-Had.)	H	F	Leaf chewed and swallowed the juice	1	
			Muscle stress (Mudaajjimma (Had.)	H	F/D	Leaves crushed, pounded with cold or warm water, and drunk	2	
			Diarrhoea	H	F	Leaves are crushed, pounded with cold or warm water, and drunk	3	
Albizia schimperiana, Oliv.	Fabaceae	Maande	COPD (Siniqa-Had.)	T	F	Stem barks removed from the sunrise are chewed and swallowed, spitted to the nose, mixed with butter, and drunk or sniffed into the two nostrils.	3	MH-26
Allium cepa L.**	Amaryllidaceae	Kaashar shunkuruta	Common cold (Gansha-Had.), headache (Damuuma-Had), asthma (Shiinqa-Had.), dingetegna	H	F	Buds chewed with the bulb of *A. sativum* and eating the mixture concoction.	30	MH-92

Allium sativum L. **	Amaryllidaceae	Tuma	Typhoid fever (Taayfooda-Had.), yellow fever (Shekkeere'i jabbo-Had.), malaria	H	F/D	Buds crushed with buds of *A. cepa* flower of *C. aurantiifolia* and *C. aurantium* with epicarp and mesocarp, and rhizome *Z. officinale* and *C. frutescens* pod and charcoal then drunk with hen soup, and eat with cheese	186	MH-90
			Hemorrhoids, tumor (Kintaaroota)	H	F	Buds crushed with rhizome of *Z. officinale* and root of *R. nepalensis* and drunk.	10	
			Asthma, headache	H	F/D	Buds crushed with rhizome of *Z. officinale,* bulbs of *A. cepa*, fruit of *C. aurantiifolia* and add fresh egg in warm water, mixed the solutions and drunk	11	
			Gastritis (Qiirimma-Had.), digestion problem	H	F	Crushed its buds with the rhizome of Z. *officinale*, bulbs of *A. cepa*, mixed with water or sugar and drunk via mouth	26	
			Bloat	H	F	Buds crushed with seeds of *A. cororima*, *N. sativa* seeds and leaves of *R. chalepensis* and rhizome of *Z. officinale* and drunk orally	6	
			Cold (myalgia)	H		Bulbs crushed with fresh leaf of *A. integrifolia,* fruit of *R. chalepensis*, with powdered of *N. sativa* seed, mixed with fresh butter and eat 2-3 spoons at morning; drunk the solutions with honey	60	
			Common cold, michi	H		Bulbs pounded in boiled water and inhale the steam/smoke by enclosed in the blanket; chewed and swallow; smear on the body	24	
Aloe gilbertii T. Reynolds ex Sebsebe & Brandham. *	Asphodelaceae	Geneeno'o te'im Ireetta	Ascariasis (Hensheeshsha-Had.), gastritis, typhoid fever,	S	F	Leaves boiled/burned upon a fire and crushed squeezed the liquid or jelly sap for oral use	4	MH-377
			Tinea capitis (Boronsha-Had.)	S	F	Crushed fresh leaf, cream on the infected part skin derm	1	
Aloe sp.	Asphodelaceae	Geneeno'o laba	Digestion disease (gastric problem	S	F	Leaves are crushed, pounded, mixed with water for oral use.	7	MH-184
			Malaria	S	F	Leaves crushed, pounded with water and drunk via oral route	2	
			Hypertension	S	F	Leaves crushed, pounded, mixed with water and drunk 1 coffee cup	1	
			Swelling (Orachchi dashshimma/Haab dashsha-Had.)	S	D	Dry roots are crushed, powdered and mix with water for oral route	1	
			Body burning-1st, 2nd and 3rd degree burns (Orachchi babimma-Had.)	S	F	Crushed dry roots are, pounded wrap/smear the sap on the burned wound skin derm	3	
			Ear disease/otitis-media-infection (Macci xisso-Had.)	S	F	Fresh squeezed leaf juice and add the drops with the squeezed bulbs of *A. sativum* to add the drops in to the ear.	1	
			Diarrhoea, obesity (Hig	S	F	Heated/boiled the fresh leaves upon fire, crushed and	3	

			geejjooma-Had.), sore, abdominal pain			squeeze the juice to give orally.		
			Typhoid fever, ascariasis	S	F	Crushed fresh leaves squeeze the juice/sap; mix with arekie or yoghurt to take oral route	2	
Alysicarpus rugosus (Willd.) DC.	Fabaceae	Haraanja	Worm stinging (Jule'i-Had.), snake bite (Hamashshi qaraare-Had.)	H	F	Fresh leaves crushed, pounded and paste, tied on the stinged / infected skin	1	MH-165
Amaranthus caudatus L. **	Amaranthaceae	Haliba	External and internal cancer (Suqqo'i jabbo-Had.)	H	F	Leaves crushed with leaves of C. *benghalensis, A. dubius, B. pachyloma, P. peruviana, S. nigrum, E. arabicum, A. caulirhiza, C. pepo, C. aurantiifolia*, and *C. sinensis*, mixed with water for oral use	6	M-77
Amaranthus tortuosus Hornem (synonym of *Amaranthus dubius*) **	Amaranthaceae	Gude'e	External and internal cancer	H	F	Fresh buds crushed with buds of *P. africanus*, pounded and drunk orally	6	MH-65
Annona senegalensis Pers.	Annonaceae	Gishxa'a	Internal cancer	S	F	Crushed fresh leaves are mixed with fruits of *L. esculentum* and buds of *C. benghalensis* squeezed, drunk the juice	1	MH-117
Antherica sp.**	Anthericaceae	Dashsha maracca	Swelling (Dashshimma/Haab dashsha)	H	F/D	Powdered rhizome, mix with water for oral use	5	MH-380
Apodytes dimidiata E. Mey.ex Arn.	Icacinaceae	Mewwaa	Tooth pain	T	F	Fresh stem bark is boiled within closed fibre and hold on place of pained tooth by spitting water; not swallowed the fluid from dental use	1	MH-253
Artemisia absinthium L. **	Asteraceae	Naatira	Hypertension, kidney disease, Tonsillitis	H	F	Fresh leaves mixed in water for oral administration, and chewed with NaCl and swallow or spitting the decoct juice to mouth of children	93	MH-87
			Abdominal pain, stomach ache, COPD (Siniqa-Had.), impotence (Godaphphisa ihimma-Had.)	H	F	Leaf chewed and swallow/spit the juice, crushed odd number of leaves for impotence (Mango'i xiggo-Had.), boiled and drunk on Friday and Wednesday	2	
			Malaria, cold (myalgia)	H	F	Leaves of C. *citratus, R. chalepensis*, pod of *C. frutescens* and bulb of *A. sativum* are crushed, pounded and mixed with pure honey and butter for eating 2-3 spoons at morning before food and sleep within blanket	2	
Artemisia abyssinica Sch.Bip. ex Oliv. & Hiern	Asteraceae	Aguffa	Hypertension	H	F	Concoction of crushed leaves with the *A. absinthium* leaves, mixed with water for oral administration; chewed, swallowed the juice until heal	5	MH-163
			Bloat, sever coughing, whooping cough	H	F	Leaves are pounded with the leaves of *R. chalepensis* and drunk the concoction, leaves chewed and fruit then swallow the juice	2	

			Whooping cough (Qakke'e-Had.), sever coughing	H	F	The leaf is boiled, mixed fresh butter alone or boiled wasp honey or fresh bee honey	1	
			Insect repellents (Tikaayyuwwi qaraare-Had.)	H	F	Leaf crushed, pounded and spraying the decocted liquid on physical environments	1	
Asparagus africanus Lam.	Asparagaceae	Hundufaanna	Evileye/evil spirit (Manni ille/Goromota-Had., diarrhoea, clitoris/vaginal infection), Michcha/Cabala-Had.), swelling	H	F/D	Crushed roots, pounded, mixed with water and drunk decoction, washing with leaf and root	30	MH-198
			Cold (myalgia), coughing (Kuxxichcha)	H	F/D	Roots are powedered with leaves of *A. integrifolia*, roots of *R. cordifolia*, bulb of *A. sativum*, seed of *N. sativa* powdered mixed with pure honey, in local beverage coffee or tella, 'borde', arekie, and use the decoct orally	8	
Baccharoides adoensis (Sch.Bip. ex Walp.) H. Rob.	Asteraceae	Baarawwa laba (Jarde'e qarraare)	Gardiasis	S	F	Leaves crushed, mixed with water for oral administration	1	MH-152
Balanites aegyptiaca (L.) Delile.	Zygophyllaceae	Baddanno'o	Sever head ache (Sambaca-Had.), epistaxis/nasalbleeding (Sanguuga Had.)	T	D	Resin is boiled or melt with warm water sniffing with fresh butter/inhale	14	MH-16
			Epilepsy (Xafanna-Had.)	T	F	Crushed stem bark is pounded in water and drunk 1 coffee cup; sweep with alive Owl	2	
Bersama abyssinica Fresen.	Francoaceae	Koraqqa	Rabies	S	F	Laves /stem bark are crushed, pounded in cold/warm water to oral administration, avoid to eat meat, eggs and to drunk milk	6	MH-80
			Pyelonephritis (Waa damuuncho)	S	F	Stem bark is crushed, pounded in cold or warm water for oral administration	1	
			Tooth pain	S	F	Leaves are chewed and hold on dental pain	1	
			Eczema	S	D	Powdered seeds are mixed with water and paste then tied over the skin wound	1	
Beta vulgaris L.**	Amaranthaceae	Kasharilugumo	Anaemia (Xiiqqi hoffechcha), blood loss	H	F	Vegetable roots boiled, cooked with eggs, eat	1	MH-218
Bidens pachyloma (Oliv. & Hiern) Cufod. *	Asteraceae	Kashar jella/Ede'e	Internal and external cancer	H	F	Buds with buds of S. *nigrum*, *A. tortuosus*, *E. arabicum*, *B. pilosa*, *P. peruviana*, *A. caulirhiza*, and leaves of *C. pepo* and *L. sativa* and *P. africanus* freshly crushed concoction all for oral administration	6	MH-63
Bidens pilosa L. ** b	Asteraceae	Meent alabo	Malaria, internal cancer, constipation	H	F	Leaves /above ground boiled with boiled stem/roasted and eat the cooked vegetable	6	MH-82
			Michi, tooth pain	H	F	Crushed the leaves with *O. spicatum* crushed, pounded in water and drunk with coffee; antidote caused diarrhoea	1	

Brassica oleracea L var. capitata. **	Brassicaceae	Xaxami-shaana/Xigiili shaana	Cancer (external and busted)	H	F	Un processed *B. oleracea* var. *capitata* leaf alone wrapped one side until water produce then tied over the dermal wound for one night then washed with warm water and changed again	2	MH-187
Brassica oleracea L var. oleracea.	Brassicaceae	Wonge'i shaana	Malaria, typhoid fever	H	D	Roasted the seeds, powdered mixed with boiled water for oral administration	3	MH-118
Brassica carinata A. Braun. *	Brassicaceae	Fiishsho'i shaana/Asussa	COPD (Siniqa)	H	F	Leaves are chewed and swallow the juice	2	119
			Mumps	H	F	Leaf is crushed with bulbs of *A. sativum* and mixed with fresh butter then eating	1	
			Wound	H	F	Leaves crushed with the leaves of *G. auriculiferum*, paste on the pained and tied.	1	
Brucea antidysenterica J.F. Mill.	Simaroubaceae	Ciiroonta	Diarrhoea, bacillary dysentery (Aadite-Had.)	S	F	Buds/ root barks are crushed, pounded in water filter for oral administration	50	MH-30
			Dingetegna, abdominal pain, COPD	S	F	Root bark is chewed with NaCl salt and swallow the juice	4	
			Bat disease, bat urine	S	F	Buds are wrapped eagle meat and eagle feace with powdered *B. antidysenterica* leaf in cloth and put around the neck of pained mother and child as kitab (amulet); eat cooked meat	2	
Biancaea decapetala (Roth) O. Deg. **	Fabaceae	Koronte'e (Amma'l qapha)	Tonsillitis	S	F	Three buds chewed and swallow the juice	1	MH-204
Calpurnia aurea (Aiton) Benth.	Fabaceae	Senna	Amoebiasis	S	F	Leaves powdered with seeds of *C. arabica* and filtered oral use	7	MH-27
			External cancer but not busted	S	F	Leaves with *E. globulus* and *H. lusitanica,* with buds of *A. sativum, A. cepa,* fruits of *E. esculentum*, root of *D. carota,* are crushed and mixed with pure honey, add and tied on the pained area, the squeezed juice is use for oral route.	3	
Capsicum annuum L.	Solanaceae	Saadam barbaro'o	Amoebiasis	H	F	Pods of the vegetable crushed, eat with red meat.	1	MH-215
Capsicum frutescens L. **	Solanaceae	Mixmixo'o	Cold (myalgia), tooth disease, headache, gingivitis (gum bleeding)	H	F	Pods of vegetable/spice are chewed and eat; crushed, pounded and eat for gum bleeding.	35	MH-91
			Malaria, typhoid fiber, cancer	H	F	Crushed pods with bulbs of *A. cepa, A. sativum,* whole fruits of *C. aurantiifolia* and *C. aurantium* with exocarp, rhizomes of *Z. officinale* and a pod of C. *frutescens* and two spoon powder of charcoal, mixed with water and drunk.	4	
			Hemorrhoids, tumor	H	F	Crushed a pod with of *A. cepa* and *A. sativum,* rhizome *of Z. officinale* and mixed with water, the concocted solutions.	2	

Carduus schimperi Sch.Bip.	Asteraceae	Hallutta	Michi	S	F	Roots crushed with the leaves of *R. chalepensis*, pounded with water and drunk on Wednesday and Friday.	43	MH-24
Carica papaya L. **	Caricaceae	Paapaayya	Malaria	S	F	Stembark/leaves/seeds crushed, powdered mixed in cold water for oral administration; young goat digestion system soup with butter, filter and drunk; eat black, red goat meat, soup, milk and butter	105	MH-59
			Tumor	S	F	Cutted fresh fruit and smear/ontiment the fruit latex on the pained anal area.	1	
Carissa spinarum L.	Apocynaceae	Qoqombe'e	Amoebiasis (Ameeba-Had.)	S	F	Stem bark crushed, pounded, boiled for oral administration.	3	MH-328
			Body swelling (Facita-Had.)	S	F	Roots/fruits crushed, boiled, pounded and mixed with water use the decoction for oral administration.	1	
Catha edulis (Vahl) Endl.	Celastraceae	Caata	Tonsillitis	S	F	Buds are chewed and swallow juice	4	MH-122
				S	F	Buds are crushed, pounded with the flowers of A. *caulirhiza*, buds of *C. africana* and buds of *R. prinoides* spitting to the mouth.	1	
Celtis africana Burm.f.	Cannabaceae	Qama'laqqa	Diarrhoea	T	F	Leaves pounded with black cow fresh milk and drunk oral.	3	MH-107
*Cenchrus setaceus (*Forssk.) Morrone	Poaceae	Sadda	Nasal bleeding, abdominal pain, stomachache	G	F	Whole parts/roots are crushed with root bark of *S. indicum*, the juice sniffed by nose; root chewed with NaCl and swallowed the juice, and drunk orally	1	MH-256
Centella asiatica (L.) Urb.	Apiaceae	Dabayyi macce	COPD (Siniqa-Had.)	H	F	Leaves chewing and swallow the juice.	2	MH-185
Citrus x *aurantiifolia* (Christm.) Swingle. **	Rutaceae	Loome'e	Common cold, headache	S	F	A fruit crushed and squeezed the juice and drunk with pure honey for three days.	26	MH-208
			Malaria	S	F	A fruit is crushed with bulb of *A. sativum* and black pure honey and drunk the concoction	1	
Citrus × *aurantium* L.**	Rutaceae	Komxaaxx e'e	Liver disease/jaundice (Afa'l jabbo-Had.)	S	F	Fruits are crushed one fruit of *C. aurantiifolia* with epicarp and pure honey, drunk for 3 days.	1	MH-318
			Hypertension	S	F	Fruits *C. aurantiifolia* with epicarp is crushed, pounded with water and drunk; *A. absinthium* leaves are crushed, squeezed the juice and drunk always a coffee cup until cure	2	
			Asthma, common cold, head ache	S	F	Fruit is crushed with bulbs of *A. sativum*, rhizome of *Z. officinale, C. aurantiifolia*, bulb of *A. cepa*, mixed egg in warm water and drunk the decoction. Fruit is crushed, boiled and drunk with tea; chewed and eat the fruit for common cold.	1	
Citrus × limon (L.) Osbeck **	Rutaceae	Faranj loome'e	Common cold, asmata	S	F	Fruits with epicarp crushed and boiled with pure black honey drunk the boiled solution	1	MH-100
Citrus × *aurantium* f. aurantium. **	Rutaceae	Burtukaana	Asmata	S	F	Fruits of *C. sinensis* with epicarp crushed and boiled with water drunk the solution	12	MH-101

Clausena anisata (Willd.) Hook.f. ex Benth.	Rutaceae	Bahixxi haqqa	Diarrhoea, liver cirrhosis	T	F	Leaves are crushed, mixed in water, drunk with local 'tella' of te concoction	22	MH-29
			Malaria, typhoid fever, cold/myalgia	T	F	Leaves with the leaf and fruits of *R. chalepensis* and leaves of *A. integrifolia* cooked together and drunk	5	
			Skin disease (Omachchi jabbo-Had.)	T	F	Leaf boiled and taken the bath	1	
			Tooth pain, common cold headache	T	F	Leaves chewed and hold on pained tooth; soaked in boiled water, inhale the steam, drunk the infusion for child; washing body	3	
			Hypertension/blood pressure, Asmatic, gastritis/digestion problem	T	F	Leaves crushed, pounded, mixed with water for oral administration.	7	
			Michi	T	F	Leaves crushed and pounded, boiled and drunk, inhale the steam via oral and nasal	30	
Clematis hirsuta Perr. & Guill. *	Ranunuclaceae	Hofi-fiida	Venign tumor (external tumor on toe (Xenxirra-Had.)	Cl	F	Buds of *Clematis longicauda* crushed, pounded and wrapped and tied on the tumor for 1-3 days.	2	MH-44
Clematis longicauda Steud. ex A. Rich. *	Ranunuclaceae	Lob fiida	Pyelonephritis (Waa damuuncho), bloat	Cl	F	Roots are crushed, mixed with milk and stay for one night for oral route, Buds crushed, pounded and drunk 1 glass for bloat; tied 1-3 day for venign tumor.	13	MH-43
			Bat urine disease (Cii'i jabbo-Had.)		F	Buds crushed, pounded, mixed with water with buds of *C. macrostachyus, M. lanceolata, O. rochetiana, M. foetida, G. auriculiferum* and *P. schimperi* and paste, tied over the pained area.	6	
Clutia abyssinica Jaub. & Spach.	Euphorbiaceae	Shum xiigeeshsho	Diarrhoea	S		Buds crushed, pounded, mixed in water and drunk through mouth	1	MH-40
Coffea arabica L.	Rubiaceae	Buna	Amoebiasis	S	F	Leave crushed, mixed with roasted and powdered and filtered to drunk; antidote: cause bloody or none diarrhoea.	4	MH-52
Coleus abyssinicus (Fresen.) A.J. Paton. *	Lamiaceae	Bobaanqa	Hypertension	S	F	Crushed leaves, powdered, mixed with water filtered to drunk with arekie; removed disease with diarrhoea	113	MH-56
			Ascariasis, taeninsis, diabetes, gardiasis, asmatic, malaria, abdominal pain, stomache ache, constipation	S	F	Leaf or root crushed, pounded in water and drunk the juice at morning.	73	
			Cancer (external brusted)	S	F	Bud crushed together with buds of *C. aurea,* leaf of *C. macrostachyus, B. oleracea* var. *capitata,* leaf and fruit of *S. indicum, S. marginatum,* and powdered charcoal of *Combretum* sp. and mixed all with unplugged soil from 50 cm depth, with pure honey, cream over wound for 2 h, tied then removed and washed the body.	3	
			Hemorrhoids, tumor, wound,	S	F	Leaves crushed, pounded with water and drunk;	3	

			heart disease			crushed leaves paste, tied; smear on the itching skin		
			Cold (myalgia)	S	F	Buds together with buds of *D. laxata, C. anisata, C. macrostachyus* and *G. amygdalinum,* boiled the concoction for oral use	4	
			Scabies (skin itching disease)			Leaf is soaked together with the leaf of C. *macrostachyus, G. auriculiferum, C. africana, S. gigas, G. amygdalinum, J. chimperiana,* and *M. lanceolata,* boiled in warm water and washed the skin	5	
			Conjunctivitis (eye disease), michi			Leaf with leaf of *D. laxata* boiled in water, inhale and wash, brush face for michi; drunk	6	
			Diarrhoea	S	F	Leaf is crushed with the leaf of *G. amygdalinum*, boiled in warm water and drunk	12	
			Typhoid fever	S	F	Leaf is crushed, pounded, drunk for 3 days.	1	
Coleus hadiensis (Forssk.) A.J. Paton.	Lamiaceae	Qibatoora	Cold (myalgia), muscle stress, dingetegna, michi, abdominal pain, stomach ache	S	F	Leaves crushed, pounded with water, drunk Monday and Wednesday; chewed and swallowed the juice	13	MH-388
			Ascariasis	S	F	*C. hadiensis* buds or leaves are crushed with the leaves of *P. abyssinica* and leaves of *A. integrifolia* pounded in water for oral administration	2	
				S	F	Leaves together with the leaves of *R. abyssinica*, *P. africanum* and fresh or dry whole parts of *A. integrifolia* boiled and drunk the concoction	2	
Coleus cylindraceus (Hochst. ex Benth.) A.J. Paton.	Lamiaceae	Dubbi hancuura	Worm stinging, swelling ('Jule'i jabbo')	S	F	Leaves pounded in water, paste and tied; boiled leaves in water and steam it, touch and wrab the swelling	15	MH-162
			Ear pain (Otitis-media infection)	S	F	Crushed leaves boiled in water, filtered the fluid	1	
			Michi	S	F	Leaves together with the leaves of *M. pyrifolia* crushed, pounded with water and concoction	2	
			Common cold, headache, diarrhoea, bloat, dingetegna	S	F	Fresh leaves are boiled in water and inhale the steam for oral administration	9	
			Michi and kwashiorkor, tumor, cold/myaligia, hemorrhoids	S	F	Leaves crushed, pounded, squeezed and drunk; soaked fresh plant, boiled and touch pained area	3	
			Ascariasis	S	F	Leaves rushed, pounded, boiled in warm water; drunk	2	
			Diabetes	S	F	Leaves are crushed, pounded and squeezed; drunk	1	
			Breast (Anuu'n miqiica-Had.), skin cancer	H	F	Crushed, fluid pounded in water and powdered hyena liver and hen faece smear on wound and tied, insert leaf of *C. benghalensis* in small part of body wound	2	
Colocasia esculenta L.	Araceae	Gabija	Abdominal pain, diarrhoea	H	D	Dry rhizome is cooked /roasted and eaten with milk	1	MH-191
Combretum molle R. Br. ex G. Don.	Combretaceae	Goonich-habulle'e	Epistaxis (nasal bleeding), headache	T	D	Powdered the resin and melt with butter, inhale the steam or take in by nose.	1	MH-193

Combretum sp.	Combretaceae	No given name	Abdominal pain, bloody diarrhoea (Xiiga aadissimma-Had.)	T	F/ D	Stem bark crushed, pounded and powdered with stem bark of *S. longepedunculata*, *X. americana*, *Combretum* sp and mixed with water and drunk half of coffee cup with coffee.	3	MH-361
			Digestion problem	T	D	Stem charcoal powdered, mixed in water, drunk 1-2 glass for 3 days.	2	
Commelina benghalensis L.	Commelinaceae	Lobi guma	Evil eye /spirit	H	F	Leaves crushed and homogenized with cold water, drunk 1-2 cups of the infusion for child and adult.	21	MH-81
			Bat urine disease	H	F	The leaf crushed with the leaf of *Ageratum conyzoides* and Oxalis corniculata, mixed with water and paste in the pained area.	3	
			Worm stinging ('Jule'i qasimma'-Had.), body swelling	H	F	Crushed, paste, enclosed with neat cloth and tied as kitab (amulet).	1	
			Breast (Anuu'n miqiica-Had.), skin cancer	H	F	Crushed, fluid pounded in water and powdered hyena liver and hen faece smear on wound and tied, insert leaf of *C. benghalensis* in small part of body wound	2	
Commiphora kua (R.Br. ex Royle) Vollesen.	Burseraceae	Garce'e (Uttaam adurusa)	Depression (Mujunuunimma-Had.)	T	D	Resin is burnt/heated upon fire and inhale the smoke	1	MH-333
Cordia africana Lam.	Boraginaceae	Weddeeshs ha	Tooth pain	T		Leaves/ stem bark crushed, pounded and closed with fibre and hold on the place of pained dental tooth	7	MH-115
			Tonsillitis	T		Buds chewed and swallow, spit to mouth	10	
			Hypertension	T		Crushed stem bark, pounded and mixed with water for oral administration	5	
Coriandrum sativum L. **	Apiaceae	Woldimaa ma	Stomachache	H		Leaves/fruits and /or fruits together with the leaves of *R. officinalis*, *O. basilicum* var. *cinnamon* crushed, poundeded and drunk; chewed with salt and swallowed.	16	MH-172
			Bloat	H	F/ D	Fruits and leaves are crushed and pounded with leaves of *C. cylindraceus,* mixed with water/ milk, and drunk	11	
			Common cold, headache	H	F/ D	Leaves/fruits boiled with leaves or fruits of *R. chalepensis* and drunk the decoction	4	
Corrigiola capensis Willd.	Caryophyllaceae	Adiila	Bat disease	H	F	Leaves/whole parts crushed, pounded, paste and concoction is tied on the pained area	1	MH-144
Crepis rueppellii Sch. Bip.	Asteraceae	Axibacco'o/ Guffi go'ichcho	Impotence (for infected fetus), diarrhoea, tonsillitis	H	F	Roots are crushed, pounded with water and drunk the decoction; chewed and swallow the juice.	5	MH-391
Crotalaria cleomifolia Welw. ex Baker	Fabaceae	Wic buyya (Senna laba)	Scabies or skin itching (Hankaratta-Had.), eczema	S	F	Crushed leaves, powdered and mixed with butter and ontiment over the pained area; seeds powdered and homogenized in cold water then tied on wound with neat cloth for every day till heal.	2	MH-357

Crotalaria spinosa Hochst. ex Benth.	Fabaceae	Qaadalli utti yoo gundi doba	Diarrhoea, evil eye, pyelonephritis (Waa damuuncho)	S	F	Crushed above ground parts/leaves, pounded and mixed with water and given the concoction for oral administration	1	MH-156
Croton macrostachyus Hochst. ex Delile.	Euphorbiaceae	Masana	Impotence, liver cirrhosis (Damtokke'e- Had.), abdominal pain	T		Root bark/leaves crushed and mixed with cold/warm water, infusion with crushed buds of *R. chalepensis*, pounded in water and drunk concoction; spit small amount for less 3 years child.	226	MH-01
			Amoebiasis, taeninsis, bloat, abdominal pain (Kurtimat-Amh.), diarrhoea, malaria, asthma, typhoid fever, gardiasis, dengetagn, hemorrhoids	T	F	Buds/leaves crushed, pounded with water, boiled, add butter and drunk; fresh root bark chewing and swallow until heal for asmatic disease.	13	
			Gastritis	T	D	Charcoal powdered, mixed with water, and given orally.	12	
			Snake bite (Hamashshi qasa-Had.)		F	Buds crushed, boiled in fire, rubbed bite are with addition of mice soil and tied.	1	
Cucumis ficifolius A. Rich.	Cucurbitaceae	Uulli gereechcho	Wound	Cl	F	Leaves and latex with leaves of *G. auriculiferum* crushed and tied on infected part. Charcoal of *C. macrostachyus* or *Combretum* sp powdered and mixed with honey then cream with cloth on wound and tied with neat cloth over wound	25	MH-14
			Eczema (atopic dermatitis)	Cl	F	Crushed, homogenized in water and cream, then tied on infected part	1	
			Stomachache, abdominal pain, anthrax (Hix xisso-Had.), dingetegna, sever coughing, malaria, gastritis, COPD, ascariasis	Cl		Roots/leaves are chewed with NaCl or without the root bark of *S. longepedunculata* and swallow to heal; leaf is chewed and swallow the juice for COPD; root is chewed with the seed of *L. sativum* and swallow for ascariasis.	26	
			Pyelonephritis, kidney inflammation (Mu'l jabbo-Had.)	Cl	F	Roots crushed, pounded and homogenized with water or fresh butter for oral administration	2	
			Diarrhoea	Cl	F	Roots are crushed, pounded and drunk via mouth	4	
Cucurbita maxima Duchesne. **	Cucurbitaceae	Dabaaqula	Gardiasis (Jaarde'e-Had.), taeniasis (Suuxiincho- Had.), gastric/digestion disease, diabetes (Sukkaa'l jabbo-Had), obesity	Cl	D	Vegetable seeds are roasted in fire, chewed then eaten; powdered is mixed with water for oral administration.	4	MH-220
Cucurbita pepo L.**	Cucurbitaceae	Dabaaqula	Taeniasis and other worms, sleeping disorder (Diriiro hoora-Had.), obesity, for heart and bone health (Woda'nanee miq fayya'oomaa)	Cl	D	Roastetd vegetable seeds, chewed and swallowed through oral means.	11	MH-53
Cyathula uncinulata (Schrad.) Schinz.	Amaranthaceae	Onno'i qaccabba	Michi, COPD (Siniqa-Had.)	H	F	Leaves are crushed with the *R. nepalensis*, pounded and sniff the filtered liquid by nose; drunk, and wash	3	MH-199

		(Gonje'e)				face, mouth, brush face; root is crushed for nasal use.		
			Liver cirrhosis (Dami-tokke-Had.)	H	F	Roots with the leaves of *R. communis*, *P. vogelii*, and buds of *R. steudneri, M. foetida, C. macrostachyus, B. antidysenterica* buds with roots of *A. africanus, R. nepalensis, R. abyssinica, P. dodecandra, C. amplifolium, S. abyssinia* and *C. longicauda* are crushed, pounded with water and yougghurt for oral administration.	1	
Cymbopogon citratus (DC.) Stapf.	Poaceae	Hixaana	Hypertension	H	D	Powdered with the *L. adoensis* var. koseret and *T. schimperi* leaves, mix in warm water, drunk infusion on Wednesday and Friday.	62	MH-86
			Impotence (infected fetus), stomach ache	H	F	Roots crushed, pounded with water and drunk decoction via oral administration.	21	
			Cold (myalgia)	H	F	Roots with *A. sativum* bulb, fruit of *L. esculentum*, fruit of *C. aurantiifolia* and *C. aurantium* with epicarp crushed, pounded and mixed all and drunk, and wash	3	
Cynoglossum amplifolium Hochst. ex A.DC.	Boraginaceae	Ajaar amado'o qaccabba	*Tinea capitis* (Forefor-Amh.)	H	F	Roots crushed, pounded with in water and paste, creamed/ontiment on the head.	2	MH-145
Cyperus atronervatus Boeckeler	Cyperaceae	Leenda	Stomach ache	G	F	Roots are chewed and swallowed for two days	1	MH-251
Cyperus rotundus L.	Cyperaceae	Naaqa	Boat, stomach ache, dingetegna, COPD, give better flavour for women delivery	G	F	Roots are crushed, pounded with water and drunk, and inhale the gas through the nose for COPD (siniqqa-Hadiyissa); smoke roots and stem and fumigate the house during child delivery	10	MH-168
Cyphostemma adenocaule (Steud. ex A. Rich.) Desc. ex Wild & R.B. Drumm.	Vitaceae	Dodoobba (Jaanjeechcho)	Bloat, swelling, snake bite	Cl	F	Root is crushed, pounded and mixed with water; decoction for oral administration.	2	MH-339
Cyphostemma pannosum Vollesen*	Vitaceae	Gidiidoola	Dingetegn, bloat	S	F	The root crushed with the fresh or dry root bark of *S. longepedunculata*, pounded and drunk, chewing with salt and swallow the juice orally.	2	MH-330
Datura stramonium L.**	Solanaceae	Machaa'il haqqa	Tooth pain	S	D	Seeds are boiled/warmed putting on hot metal (e.g., axle) with by pounded with spices mixed with butter and inhale the smoke by placed on aching tooth.	8	MH-69
			Tinea capitis (Boronsha-Had.)	S	F	Crushed fresh leaves, paste with residue and cream.	6	
			Rabies (Machchaaru wish jabbo-Had.)	S	F	Leaves crushed alone or with the roots of *S. abyssinica* and drunk via mouth	2	
Daucus carota L.	Apiaceae	Caaroota	Conjunctivitis/eye pain (Illi xisso-Had.)	H	F	Washing and eating fresh raw root vegetable via mouth.	2	MH-213
Dicliptera foetida (Forssk.) Blatter	Acanthaceae	Omoro'o laba	Bat disease	H	F	Leaves crushed, paste and tied on pained skin part	3	MH-136
Dicliptera laxata C.B.	Acanthaceae	Omoro'o	Michi	H	F	Boiled fresh plant in water and inhale distillation	2	MH-

Clarke						steam and drunk 1 tea-coffee cup; used as tea spices.		79
Dicliptera magaliesbergensis K. Balkwill	Acanthaceae	Baxaaxurs, Jule'i/Manilli qaraare	Worm stinging ('Julle'-Had.)	H	F	Leaves crushed with the leaves of *D. chrysanthemifolia*, mixed with water and tied on the pained area for two days	2	MH-158
Dicrocephala chrysanthemifolia (Bl.) DC.	Asteraceae	Ginxi/Idoxxi qarrare, Subba/Messo	Spider infection (Idootichchi marza-Had.), Snake bite (injection of venom)	H	F	Leaves/roots crushed, pounded and drunk three days	7	MH-155
Dioscorea schimperiana Hochst. ex Kunth	Dioscoreaceae	Qoxino'o	Digestion/gastric problem	H	F	Tubers are cooked or roasted and eat with milk	1	MH-315
Discopodium penninervium Hochst.	Solanaceae	Maraaro'o	Cold (myalgia), common cold headache	S	F	Fruit boiled with the leaf of *A. gracilior*, *C. macrostachyus*, *E. globulus* and *J. chimperiana* in water and inhale the steam; wash the body by soaking all plants and sta a nigh with metals	3	MH-203
Dodonaea viscosa subsp. *angustifolia* (L.f.) J.G. West	Sapindaceae	Kitkiita	Diarrhoea, taeniasis	S	F	Crushed, pounded and cooked and mixed with butter or local alcohols and drunk 1-2 coffee cup child, 1-2 glass for adult.	17	MH-19
			Eczema	S	F	Leaf powdered with leaf of *S. schimperiana,* mixed with baseline and paste on the paining area	2	
			Wound, burned skin, bat disease, swelling (Mushshaa-maqqina)	S	F	Leaves crushed, pasted and tied over the pained part; wrapped in cloth and put around the neck as kitab (amulet).	7	
			Tooth pain	S	F	Leaves /buds chewed *B. abyssinica* leaf and hold on the pained dental tooth	3	
			Malaria, placental remain (Ami gatimmi jabbo-Had.), taeniasis	S	F	Leaves crushed with or without the leaves of *C. anisata*, mixed with water and drunk the concoction	3	
Dombeya torrida (J.F. Gmel.) Bamps	Malvaceae	Booraara/Jaanna	Wound	T	F	Crushed the leaves and homogenized with cold water, paste and tied on the pained area.	1	MH-235
Dovyalis abyssinica (A. Rich.) Warb.	Salicaceae	Haqqi wo'ill/Doo'im koshimma	Ascariasis	T	F	Raw ripe yellow fruit crushed and eaten at morning before breakfast.	1	MH-170
Dovyalis caffra (Hook.f. & Harv.) Warb.**	Salicaceae	Ooxxi kooshshaama	Tooth pain	T	F	Chewed buds with NaCl-salt and hold on the pained tooth, not swallow the juice; spit too outside	3	MH-17
			Tonsillitis, stomachache	T	F	Three buds chewed with NaCl and swallow the juice; stem bark or leaf chewed and swallow for tonsillitis	2	
Echinops kebericho Mesfin*	Asteraceae	Toosa	Abdominal pain, dingetegna	S	F	Crushed, pounded in water and drunk 1 coffee cup child,1glass adult; chewed and swallow the juice.	13	MH-195
Echinops longisetus A. Rich. *	Asteraceae	Lob hallutta	Michi	S	F	Root crushed, mixed with water and drunk orally	1	MH-305

Ehretia cymosa Thonn.	Boraginaceae	Ulaagaa	Epilepsy (Xafanna-Had.)	T	F	Seven buds, left side stem bark, ripe orange raw fruits crushed and boiled/warmed or cooked, and dink at morning before human moving, bird song; wash the body; may cause diarrhoea to heal and remove diseases	2	MH-32
		Ulaagaa	Pyelonephritis (Waa damuuncho)	T	F	Three buds of crushed with three buds of *C. macrostachyus* and *J. chimperiana,* pounded with water and drunk 1 coffee cup then drunk 'tella'.	1	
Ensete ventricosum (Welw.) Cheesman. *	Musaceae	Weesa	Diarrhoea, constipation (Godaphphi gonga-Had.)	H	F	Roasted or cooked with *Ensete* ‘bula or kocho’ porridge (ganfo) eats with milk (Irigo), uncooked drunk bula orally	19	MH-20
		Weesa/Oniyya	Amoebiasis, trauma (Broken bones) /Aphphixximma-Had.	H	F	Pseudopodia is crushed, squeezed fluid and wash the body; cooked/roasted corm is eaten with ‘irigo’.	4	
		Weesi waasa	Mumps, sever head ache (Zawura /Anku’lichcho-Had.)	H	D	Ensete product ('kocho') is cooked, with its hot cooked 'Kocho' touch with small pieces around neck	2	
Eragrostis tef (Zucc.) Trotter. *	Poaceae	Xaafe’e	Boils/folliculitis (Bekiratta-Had.), digestion problem	H	D	Rhizome of *Antherica* sp is crushed, powdered and cooked with porridge(‘ganfo’) of teff and eat	2	MH-223
Erucastrum arabicum Fisch. & C.A. Mey.	Brassicaceae	Ciishaana	Heart disease	H	F	Above ground cooked with the whole parts of *S. nigrum* and mixed with butter, drunk or eating	5	MH-190
Erythrina brucei Schweinf. *	Fabaceae	Wora’a	COPD	T	F	Stem bark is crushed, pounded and drunk with keneto, yougghurt, also buds use.	8	MH-55
			Stomach ache, tonsillitis	T	F	Buds are chewed and swallow the juice; spit to mouth for tonsillitis in children.	2	
			Eczema	T	F	Stem bark crushed with leaves and NaCl, pounded and tied by enclosed neat cloth, bath on light or fire, add these before this ontiment using baseline	1	
Eucalyptus camaldulensis Dehnh.	Myrtaceae	Kaashar baarzafa	Pityriasis (Bacaro’o-Had.)	T	D	Resin from stem is powdered and add to the pained area.	1	MH-104
Eucalyptus globulus Labill.	Myrtaceae	Qadaalli baarzaafa	Common cold, michi, dingetegn, headache, malaria, vomiting (Uwwiisimma-Had.)	T	F	Bioled fresh plant leaves in water and inhale distillation/the steam; crushed/rubbed fresh buds on palm and inhale the volatile gas; and drunk in a small	69	MH-54
			Wound, ants	T	F	Buds crushed, paste, tied; to move away	1	
			Hypertension, ascariasis, diarrhoea, bloat, gastritis	T	D	Stem charcoal of *E. globulus* and *C. macrostachyus* powdered, mixed with water for oral use	27	
			Conjunctivitis	T	D	Powdered stem charcoal mixed with water, close eye with neat white cloth and cream the mixture on the surfaces of eyelids	13	
Euclea divinorum Hiern.	Ebenaceae	Meegaara	Cold (myalgia)	T	F	Leaves crushed, mixed with water and drunk through mouth	1	MH-15
			Conjunctivitis	T	F	Crushed the leaves and squeezed with water and add 1-2 drops by syringe	1	

Euphorbia abyssinica J.F. Gmel.	Euphorbiaceae	Adaamma	Liver cirrhosis	T	F	Latex or crushed roots are cooked with *E. ventricosum* 'bula' or 'kocho' porridge (ganfo) and eat with milk mixture or cooked goat cerebellum and add butterand drunk soup; latex added to the venign tumor (external tumor on the leg-(xenxirra-Had.).	10	MH-200
			Swelling (Haab dashsha-Had.)	T	F	Extract juice of latex added/smear with NaCl on the swelled skin derm	1	
Euphorbia bicompacta Bruyns	Euphoribiaceae	Kashar fiita	Pityriasis (Bacaro'o-Had.)	S	F	Cutted the stem or leaf, smear latex on the pained skin	1	MH-365
Euphorbia cotinifolia L. **	Euphorbiaceae	Kashar buyi fiita	Pityriasis (Bacaro'o-Had. /Qoaquchcha-Amh.)	S	F	Crushed leaf /smear the extract of the latex on the pain started place of the skin	2	MH-192
Euphorbia depauperata Hochst. ex A. Rich.	Euphorbiaceae	Gendeella	Venign (skin tumor)	H	F	Latex is smeared on the pained area until heal; add powdered eagle faece	8	MH-47
			Michi	H	F	Root is crushed, pounded with milk and drunk	1	
			Liver cirrhosis, diarrhoea, vomiting, stomach ache	H	F	The leaf is crushed with the leaf of *C. macrostachyus*, pounded with water and drunk; child is drunk leaf alone for diarrhoea; chewed with NaCl and swallow	3	
			Carbuncles/boils-skin problem (Hombobbimma-Had.)	H	F	Three buds crushed with three buds of *C. macrostachyus* and *R. communis and given* orally for adult only, not for children	1	
			Malaria	H	F	Buds crushed with buds of *C. macrostachyus* or chewed; mixed with ale or yoghurt given orally; swallow the juice	1	
Ficus sur Forssk.	Moraceae	Qodde'i oda'a	Wound	T	F	The extract of latex smeared on wound	1	MH-289
Ficus sycomorus L.	Moraceae	Oda'a	Bat disease, eagle urine disease/jaundice, hepatitis/Afa'l jabbo	T	F	Leaves powdered, pound with water and smear on the wound or pained part, drunk sap of latex, chewed and swallow the juice	5	MH-98
			Wound	T	F	Drops of the latex are added	1	
			Epistaxis (nasal bleeding)	T	F	Crushed buds squeezed; used fluids via nose	1	
			Pyelonephritis	T	F	Leaves crushed, pounded for oral use	1	
Ficus thonningii Blume	Moraceae	Qaal'i odechcho	Wound	T	F	Fresh stem latex extracted and smear on wound	1	MH-376
Ficus vasta Forssk	Moraceae	Qilxo'o	Tonsillitis, wound	T	F	The stem bark crushed with inflorescences of *A. caulirhiza* and swallows; chewed and swallow. Extract of stem latex smeared over the wound	1	MH-177
Foeniculum vulgare Mill.	Apiaceae	Wollanga (Ashbe'e (Had.)	Heart disease	H	F	Buds are chewed with buds of *A. absinthium* chewed and swallow; buds crushed mixed with butter, drunk	16	MH-66
			Common cold, headache, michi, stomach ache, COPD	H	F	Boil fresh fruits/leaves with warm water and pure butter; with sugar and drunk via mouth.	6	
			TB, pneumonia, diarrhoea, typhoid fever	H	D/F	Fresh/dry leaves crushed and powdered, mixed with water for oral route.	5	

			Hypertension	H		Leaves crushed, powdered with the *T. schimperi* and drunk the decoction through oral administration	2	
Gloriosa superba L.	Colchicaceae	Kashar fiit yoo'i lami-qaffi xuda	Pyelonephritis	H	F	Chewed leaves with salt, and the juice is swallowed	1	MH-325
Guizotia abyssinica (L.f.) Cass.	Asteraceae	Nuuga	Gout/arthritis disease (Iico'o-Had., rih-Amh.)	H	D	Seeds powdered with the bulbs of *A. sativum* and mix with pure honey and eat	1	MH-160
Guizotia scabra (Vis.) Chiov.	Asteraceae	Ajar jella	Wound	H	F	Its crushed leaves with leaves of *G. auriculiferum, C. macrostachyus* and *P. abyssinica* are pounded, past, and tied over the pained area for 1-7 days or for 2-3 days.	12	MH-116
Gymnanthemum amygdalinum (Delile) Sch.Bip	Asteraceae	Heebbaa	Abdominalpain, stomachache, swelling, back pain (Afa'l qaso'o-Had.), chest pain	T	F	Leaves are crushed, pounded, and mixed with water given the decoction for oral administration	19	MH-07
			Cold (myalgia)	T	F	Leaves with the buds of *P. abyssinica*, *D. laxata*, *C. anisata*, *C. macrostachyus* and *G. amygdalinum,* boiled and drunk, no human shade needed	2	
			Scabies (skin itching disease)	T	F	Leaves together with the leaves of *C. macrostachyus, P. abyssinica, C. africana, S. gigas, J. chimperiana* and *M. lanceolata* leaf boiled freshly in water and washing thoroughly	3	
			Trauma (blood accumulation)	T		Leaves crushed, pounded in water for oral administration	10	
Gymnanthemum auriculiferum (Hiern) Isawumi.	Asteraceae	Baarawwa	Freshly cutted wound, sore	S	F/D	Crushed leaves alone or with leaves of *C. macrostachyus* with latex or its stem charcoal, *G. scabra* leaves, pounded in water, paste and tied over pained area; Leaves are crushed with leaves of *C. arabica/*powdered of its seeds, mixed with monkey faeces, paste on the wound and tied.	105	MH-03
			Eye disease	T	F	Water with crushed and squeezed buds, 1–2 drops on the eye	4	
			Worm stinging, swelling ('Jule'i jabbo-Had.)	T	F	Crushed the leaf, squeezed and add liquid; crushed paste tied with it until cure	7	
			External cancer, eczema, scabies, *tinea capitis,* epistaxis/nasal bleeding, bat disease	S	F	The bud with the buds of *C. macrostachyus* fluid of *C. benghalensis* leaves of *P. abyssinica,* fruit fluid of *S. indicum/S. marginatum* mixed together, creamed on the pained area in 3^{rd} ,4^{th} alternative days for each day until one year	9	
			Tooth pain	S	F	Fresh leaves or buds chewed with NaCl and hold on the pained area dental	5	
			Pyelonephritis (Waa	S	F	Leaves crushed, pounded in water, mixed for oral	8	

			damuuncho), diarrhoea			administration		
			Abdominal pain, stomach ache	S	F	One buds with one bud of *C. macrostachyus*, *E. globulus, B. antidysenterica,* crushed all these fresh parts, pounded mixed with water and drunk, and take the bath with concoction	5	
Gymnosporia arbutifolia (Hochst.ex. A. Rich.) Loes.	Celastraceae	Jonge	Tonsillitis (Sammaagga-Had.), uvalitis (Leella'i luwwi jabbo)	S	F	Leaf chewed and swallow the juice through mouth	2	MH-126
Gymnosporia senegalensis (Lam.) Loes.	Celastraceae	Qaala'i haabo'o (Qashsha)	Cancer (Miqiica (Had.), diarrhoea	T	F	Leaf crushed, pounded in water and drunk ing orally	1	MH-354
Habenaria decumbens Thomas & Cribb *	Orchidaceae	Shillo'o	Malaria	H	F	Tuber is crushed, mixed with water the decoction is taken orally	1	MH-271
Hagenia abyssinica (Bruce) J. F. Gmel.	Rosaceae	Suuxo	Taeninsis, gardiasis, ascariasis, amoebiasis, gastritis, myalgia, kidney disease, michi, COPD	T	D	Fruits with inflorescences and seeds powdered, homogenized in cold water or warm water with stem bark of *C. macrostachyus* drunk at morning; mixed with butter and drunk half of coffee cup for michi and COPD	35	MH-173
Helianthus annuus L.**	Asteraceae	Faaranj nuuga	Michi	H	F	Leaves boiled with the leaves of *O. lamiifolium, D. laxata* and *C. anisata* or only with seed of *A. caudatus*, drunk	12	MH-183
			Swelling	H	F	Powdered, mixed with milky or coffee and drunk	1	
Hesperocyparis lusitanica (Mill.) Bartel. **	Cupressaceae	Faaranj hoomaa	Cold (myalgia), tumor, dingetegna	T	D	Crushed leaves with the leaves *E. globulus* are boiled for four minutes and insert rhumantic pained leg then remove and stay in cold water and drunk.	11	MH-61
Hordeum vulgare L.**	Poaceae	So'o	Gastric problem	H	D	Drunk roasted poweder 'basso; burned seed mixed with water for oral route	11	M-222
			Tinea capitis (Boronsha)	H	F	Germinated seedling leaves crushed, smeared on the pained area	1	
			Pyelonephritis (Waadamuuncho)	H	D	Roasted seeds are powdered and cooked with *A. porrum* porridge with bulbs and eat decoction	1	
Ilex mitis (L.) Radlk.	Aquifoliaceae	Ashmiinqa	Tooth pain	T	F	Chewed the leaves and hold with pained dental	1	MH-241
Ipomoea batatas (L.) Lam.**	Convulvulaceae	Sukkaare'i dinnichcho	Diabetes mellitus (DM), decrease stress (Orbachcha gabbaa'imma-Had.)	C	F	Vegetables roots are cooked and eat with milk	2	MH-219
Ipomoea tenuirostris Choisy.	Convolvulaceae	Dabayyi xuda/haraa nja/Wiciibb i(boronshi) qaraare	*Tinea capitis* (Boronsha-Had.), sever iching/ cellulitis (Tachiqosha-Had.)	Cl	F	Crushed leaves with the leaves of *O. corniculata,* pounded and paste on the pained area for 1-2 days on pained derm	5	MH-229
			Eczema, bat disease	Cl	F	Leaves crushed, paste on the pained skin a dermal area	1	
Jatropha curcas L.**	Euphorbiaceae	Jatroffa	Pityriasis (Bacaro'o.)	S	F	Leaves are crushed and smear on the infected area	1	MH-151

Juniperus procera Hochst. ex Endl.	Cupressaceae	Abash hooma	Common cold, headache	T	F	Buds/leaves boiled with the leaves of *E. globulus* and inhale and wash, bath the body.	9	MH-60
			Tonsillitis	T	F	Stem bark is chewed and swallow or pit to nose	1	
			Malaria, typhoid fever, abdominal pain, stomachache	T	F	Leaves crushed, pounded with water and drunk for 1-2 days.	1	
			Wound	T	D	Stem charcoal powdered and mixed with water and drunk; powdered, winnowing, close the wound by neat cloth and sprinkle over the wound.	1	
Justicia chimperiana (Hochst.ex. Nees) T. Andres.	Acanthaceae	Xummunga	Malaria	S	F	Crushed leaves, mixed with warm water and drunk at morning before food.	16	MH-31
			Cold (myalgia), muscle stress	S	F	Touch with warmed leaf and water.	1	
			Scabies (skin itching disease)	S	F	Leaves boiled with the leaves of *C. macrostachyus, G. auriculiferum, S. gigas, P. abyssinica, C. africana, G. amygdalinum, M. lanceolata* and wash the body thoroughly.	1	
			Gonorrheae (Cophxo'o-Had.)	S	F	Leaves crushed squeezed the fluid insert in to penis by syringe.	1	
Kalanchoe hypseloleuce Friis & M.G. Gilbert. *	Crassulaceae	Hancuura	Swelling (Mushsha-maqqina-Had.)	H	F	Leaves with the leaves of *K. petitiana* and *S. incanum* crushed pounded and tied on swelled part.	1	MH-127
Kalanchoe petitiana A. Rich. *	Crassulaceae	Qaal'i' i qadaalli haniccura	Ear disease or otitis-media	H	F	Leaves boiled, crushed mixed with water and add filtered fluid 2-3 drops by syringe.	2	MH-353
Kosteletzkya adoensis (Hochst. ex A. Rich.) Mast.	Malvaceae	Maaliva	Impotence	H	F	Leaves crushed, mixed with water and drunk orally.	1	MH-384
Lactuca sativa L.**	Asteraceae	Salaaxa	Cancer, constipation	H	F	Leaves crushed and mixed with water, filtered and drunk the decoction for one week	2	MH-178
Lagenaria siceraria (Molina) Standl.	Cucurbitaceae	Qooma	TB/tuberculosis (Qadafa'l jabbo-Had.)	Cl	F	Roots crushed with the roots of C. *ficifolius* and mixed with water for oral administration	3	MH-159
Landolphia buchananii (Hall.f.) Stapf	Apocynaceae	Hoomba	Diarrhoea	Li	F	Raw ripen fruits pelled and eaten with milk	3	MH-147
Lasiosiphon glaucus Fresen.	Thymelaeaceae	Ollawwaa	Abdominal pain, stomachache, anthrax	S	F	Leaves are crushed and pounded with water for oral administration; crushed roots are pounded with water, and drunk anthrax	1	MH-37
Lathyrus oleraceus Lam. **	Fabaceae	Gite'e	Digestion problem, trauma	H	D	The roasted seed is powdered with the seeds of *H. vulgare*, *E.tef**, *P. sativum*, *V. fava*, and *S. bicolor* pounded, cooked 'atimit' and mix with water and drunk; cooked and eat or drunk soup	2	MH-227
Lavandula dentata var. *candicans* Batt.	Lamiaceae	Qadaalli wereeggi fiita (Naatira laba)	Swelling, impotence	H	F	Roots crushed with the leaves of *P. africanum*, pounded in water and drunk orally	2	MH-167
			Abdominal pain, stomach ache	H	F	Roots crushed on palm, add NaCl, pounded and mixed with water and drunk the decoction through oral administration	1	

			Womens delivery/Meenti qarimmina hara'moo	H	F	Chewed the leaves with NaCl and swallowed the decocted juice; facilitate infant delivery	4	
Lepidium sativum L.**	Brassicaceae	Suunfa (Shu unfa)	Michi, blood pressure, tooth pain	H	D	Chewed seeds and swallow or hold on pained tooth; burn and inhale the smoke	23	MH-05
			Ascariasis	H	D	The seeds are powdered with the crushed roots of C. *ficifolius*, drunk; chewed and swallowed its juice	3	
			Evil eye (evil spirit)	H	D	The seed powdered and mixed with the crushed leaf of *O. lamiifolium* and root of *C. schimperi*, homogenized with water and drunk orally	7	
Leucas martinicensis (Jacq.) R. Br.	Lamiaceae	Tombosanna (Raas kimmira)	Tonsillitis	H	F	One to three leaves/flowers inflorescence heads or leaf chewed and spit to nose or mouth	6	MH-187
			Diarrhoea, hemorrhoids, jaundice	H	F	Leaves crushed with the roots of *R. nepalensis*, pounded with water and drunk the solution.	4	
Linum usitatissimum L.**	Brassicaceae	Talba	Gastritis, impotence, amoebiasis, michi	H	D	Seed is roasted, powdered mix with or without pure honey drunk at morning before breakfast; mixed with NaCl, drunk for amoeba; cooked with porridge(ganfo) eat for michi.	10	MH-05
			Goiter (Kico'o/Loomme'e-Had.)	H	D	Roasted seeds, powdered, mixed with water, stay for one night, remove water and again mixed with pure water and drunk at morning	1	
Lippia adoensis var adoensis Hochst. ex walp*	Verbenaceaae	Axxada	Bloat	S	F	Leaf is crushed, mixed with water oral intake.	2	MH-35
Lippia adoensis var. koseret Sebsebe*	Verbenaceaae	Kosarata	Hypertension	S	F/D	Leaves with leaves with of *T. schimperi* crushed together, pounded in water and drunk; chewed and swallow the juice.	2	MH-84
Lycopersicon esculentum Mill. **	Solanaceae	Timaatima	Internal cancer	H	F	Fruits crushed; drunk squeezed the juice at morning	3	MH-214
			Impotence	H	F	Fruits crushed with the bulbs of *A. sativum* and one whole fruit of *C. aurantiifolia* and *C. aurantium*, mixed in water for oral intake.	1	
Lysimachia ruhmeriana Vatke.	Primulaceae	Uulli saratichcho (Guffi saratichcho)	Asthma, rhinitis/runny nose	H	F	Root/leaf crushed, mixed with water for oral administration	28	MH-139
			Epistaxis/nasalbleeding (Sanguuga Had.), swelling around neck/head/throat and other parts, tumor-swelling around anus	H	F	Root crushed, pounded, mixed and oral administered for 1-5 days.	2	
			COPD (siniqa-Had.)	H	F	Chewed with NaCl and sniffed to nose/swallow the juiced	6	
			Boils/Folliculitis (Bikkiraata-Had.), skin cancer (Omachchi miqiica)	H	F	Crushed leaves are pounded and creamed; and drunk orally	2	
					D	Powdered and mixed with water for oral administered at morning and chewed with NaCl and swallow the	4	

				H		juice		
				H	D	Root bark powdered, mixed with water and taked orally at morning; chewed and swallow the juice	5	
			Tonsillitis, TB, common cold, severe headache	H	F	Roots /seeds powdered mixed with water for drinking at morning; chewed NaCl and swallow the juice	3	
			Diarrhoea, malnutrition/kwashiorkor, (Wonannada-Had.), Dingetegna	H	F	Root poweder mixed with water and drunk at morning; chewed fruit or leaf and swallow its juice, might be used as protein.	1	
Maesa lanceolata Forssk.	Myrsinaceae	Kowwaada	Bat disease, scabies (itching skin)	T	F	Buds crushed together with the buds of *C. macrostachyus, M. foetida, C. longicauda, G. auriculiferum* and *P. schimperi,* pounded and paste over the pained area and tied; wash the body	7	MH-02
			Evil eye/evil sprit	T	F	Leaf together with *A. gracilior* leaf, crushed with root of *A. africanus*, pounded in water and stays a night with insertion of any metal, wash the body at morning before any sounds hearing	1	
			Impotence (missed women)			Buds are crushed with hand and add NaCl, closed with fibre and swallow the juice	1	
			Breast cancer, *tinea capitis*, epistaxis (nasal bleeding)			Buds crushed with buds of *C. macrostachyus, G. auriculiferum, C. longicauda*, *O. rochetiana* and mixed with water; pasted on the wound; take by nose	6	
Mangifera indica L. **	Anacardiaceae	Mango'o	Typhoid fever	T	F	Leaves are crushed, pounded in cold water and drunk the filtrate	10	MH-124
Megathyrsus maximus (Jacq.) B.K. Simon & S.W.L. Jacobs	Poaceae	Biishsho'i hixe	Pyelonephritis/kidney disease	G	F	Leaves crushed, pounded and boiled, add butter drunk for 2 days, don't drunk and eat animal products, cause vomiting, diarrhoea, bloody urine for cure	1	MH-338
Microglossa pyrifolia (Lam.) Kuntze	Asteraceae	Sa'a (Zaldaamma/Macci bobaanqa)	Diarrhoea	S	F	Fresh leaf crushed, pounded with water and drunk	11	MH-143
			Michi	S	F	Leaves are crushed with the leaves of *O. lamiifolium,* pounded in water and drunk	5	
			Evil eye/evil spirit/ rabies	S	F	Leaves are crushed, pounded with leaves/buds *S. indicum,* mixed with water for drinking concoction	2	
			Conjunctivitis	S	F	Leaf is crushed, pounded and add 2-3 drops by syringe, inhale boiled smoke	1	
Mikaniopsis clematoides (Sch.Bip. ex A. Rich.) Milne-Redh. *	Asteraceae	Ludda (Xaxgoora)	Taeninsis	Cl	F	Crushed, pounded with water drunk 1 cup child,1glass adult at morning	2	MH-135
			Diarrhoea		F	Root crushed with in closed in fibre, pounded, mixed with milk for drinking it	1	
Millettia ferruginea (Hochst.) Hochst. ex Baker. *	Fabaceae	Billawwaqqa	TB/tuberculosis, COPD	T	F	Stem bark is crushed, pounded drunk; chewed and swallow /spit the juice for child	4	MH-97
			Common cold, head ache	T	F	Stem bark is chewed and swallow the juice, spit to	1	

						child		
Momordica foetida Schumach.	Cucurbitaceae	Hamash waasa	Bat disease, jaundice, eczema, sore	Cl	F	Leaf is crushed, homogenize, paint the solution	51	MH-06
			Tonsillitis, uvalitis, TB, dingetegna, malaria	Cl	F	Three buds chewed with NaCl and swallow, spit the juice infusion for 2-4 days until heal, root is chewed and swallow for TB and dingetegna	15	
			Hemorrhoids, tumor	Cl	F	Leaf crushed with the stem bark of *C. macrostachyus* and eat with porridge of 'bula'	7	
			Michi, liver cirrhosis	Cl	F	Laef is crushed with the root or leaf of *P. vogelii*, pounded and the infusion for oral route	13	
			Pityriasis (Bacaro'o-Had.)	Cl	F	Ripened fruit is divided into two halves, crushed, wrabbed and smear on the pained	1	
			Abdominalpain, stomachache	Cl	F	Crushed, pounded in water for drinking	6	
			Worm stinging (Jule'i jabbo-Had.)	Cl	F	Root is crushed, pounded and paste then tied cotton cloth on the wound	3	
Moringa stenopetala (Baker f.) Cufod.	Moringaceae	Haqqi shaana (Moringa)	Malaria	T	F	Leaf crushed for oral intake of the solution for 3 days	11	MH-62
			Hypertension, mumps	T	F	The leaf crushed, pounded and dunk as a tea	1	
			Diabetes mellitus (DM)	T	F	Leaf is crushed, pounded and drunk as a tea	1	
			Abdominal pain, stomach ache	T	F	Leaf is crushed with the bulb of *A. sativum* and one fruit of *C. aurantiifolia*, pounded, mixed with water for oral use as a tea.	1	
Musa x paradisiaca L.	Musaceae	Muuza	Dandruff (Forefor-Amh.)	H	F	Fruit mesocarp is crushed with the fruit mesocarp of *P. americana*, mixed with fresh egg and creamed on the pained area	18	MH-18
			Diarrhoea (due to banana eat)	H	F	Root is chewed with NaCl and swallowed it	1	
			Heart health bone, hypertension, digestion ulcer (Satti mada-Had.), depression (dibert-Amh.), menstrual pain (Aga'n xu'l xisso-Had.), decrease cigarrite smoking (Sujaara agimmi hasano hoffiisookko-Had.)	H	F	Raw ripe fruit eaten; eating the raw ripen form after smoking before food, decrease smoking addiction	5	
			Wound, fire burn/Gii'l shokka	H	F	Latex of from freshly cutted pseudo fruit is painted on the freshly cutted skin wound	7	
			Wound	H	F	Leaf/bud is crushed with the leaf on *C. macrostachyus* with bud latex and *G. auriculiferum* pounded, paste then tied the skin	1	
			Pityriasis (Bacaro-Had.)	H	F	Latex of psuedo fruit is crushed with the fruit of *R. prinoides* and root of *R. abyssinica,* pounded, smear on the area.	1	
			Cold(myalgia), cough (Kuxxichcha-Had.)	H	F	Ripen pseudo fruit is crushed with the bulb of *A. sativum* and powdered *N. sativa*, mixed with pure	1	

						honey and eat 1-2 spoon with butter at morning unto heal		
Myrtus communis L.	Myrtaceae	Goonchi qasha'a	Asmatic	S	F	Stem bark is chewed and swallow the decocted juice	1	MH-169
Nicotiana tabacum L.**.	Solanaceae	Tambaa'i koshsho'o	Dingetegna, stomachache, gardiasis	S	F/D	Fresh or dry leaf is chewed with the fresh or dry root bark of *S. longepedunculata* and swallow; dry leaf is chewed for giardiasis;	21	MH-103
			Bloat	S	F	Leaf crushed with the leaf of *Vepris nobilis*, pounded with water and 'tella' drunk; chewed and swallow	3	
			Abdominal pain, stomach ache	S	D	Leaf product of 'kosho'o' crushed with the powdered of rhizome of Z. *officinale*, mix with 'arekie', for oral administration	7	
			Conjunctivitis, trachoma	S	D	Leaf 'koshsho'o chewed/crushed with the fresh leaf of C. *citratus* and *O. urticifolium* add 1-2 drops by syringe; or spit to the eye.	5	
			Sore, snake bite (injection of venom)	S	D	Leaf crushed, powdered, after wash the sore; add the juice on bitted area	2	
Nigella sativa L. **	Ranunculaceae	Heemachchi enja	Typhoid fever, typhus (Taayfasa-Had.), michi, malaria	S	D	Powdered seed mixed with the crushed bulbs of *A. sativum*, and mixed with cheese, butter, and eat 1-3 spoons at morning and night for 3-7 days; mixed with milk; drunk the concoction.	52	MH-93
			Cold (myalgia), sever cough, abdominal pain, stomach ache, TB	S	F/D	The powdered seed mixed with the crushed three bulbs of *A. sativum,* one rhizome of *Z. officinale* leaf or fruits of *R. chalepensis* and leaf of *A. integrifolia*, mixed with black pure honey, butter, milk, stay for 1-3 days and eat one spoon at morning.	10	
			Ascariasis, cold (myalgia)	S	D	Powdered seed (pinch of finger) mixed with the crushed leaf or buds of *Z. asiaticum,* drunk the concoction	1	
			Tooth pain	S	D	The seed boiled/hotted metal (axle) with spices contained butter and inhale the smoke with the seed of *D. stramonium.* It releases out germs	1	
			Mumps	S	D	Seed mixed with crushed bulb of *A. sativum,* mixed wasp honey, boiled and drunk, with milk /irgo/, stay 3-4 days and drunk before food	1	
Nuxia congesta R.Br. ex Fresen.	Stilbaceae	Biixxanna (Bulshaana laba)	Tooth pain	T	F	Stem bark crushed, boiled and hold on pained dental tooth.	1	MH-320
Ochna holstii Engl.	Ochnaceae	Hasso	Malaria	T	F	Leaf crushed, mixed with water and drunk the decoction	1	MH-322
Ocimum basilicum L.var. *cinnamon* Basil sweet. **	Lamiaceae	Gimenja/Basso'i bila laba	Diarrhoea, constipation, stomach ache	H	F	Leaf crushed with leaf of *M. pyrifolia*, mixed with water for drunk via mouth.	27	MH-148
			Gastric problem	H	F	Roots are crushed, mixed and drunk orally	1	

			Abdominal pain, stomach ache, common cold, head ache	H		Leaf crushed with the leaf of *R. officinalis* and dry or fresh fruit of *C. sativum* and *R. chalepensis,* pod of *C. frutescens* and bulb of *A. sativum* mixed with water and drunk for 3 times until cure orally.	2	
Ocimum gratissimum L.	Lamiaceae	Chacho'o	Michi, tooth pain	S		Chewed the leaves and hold on the pained area; taken by nose the squeezed fluid	7	MH-149
			Bat urine disease	S		Leaf is crushed with leaf of C. *longicauda* ***, pounded with water; wash the child; cream on the scabies	1	
Ocimum lamiifolium Hochst.ex Benth.	Lamiaceae	Minaantoofa	Michi, conjunctivitis, tooth pain, cough, head ache	S	F	Leaf boiled with the leaf of *Clausena anisata*, *D. laxata,* root of *R. cordifolia,* leaf of *M. pyrifolia,* and inhale distillation, washing and hold in mouth, taken by nose; add 2-3 drops	132	MH-23
			Evil eye, michi, cold (myalgia), gastric disease, malaria, bloat	S	F	Leaf mixed with the leaf of *D. laxata,* seed of *A. caudatus*, *C. anisata,* root of *C. schimperi,* leaf *V. officinalis,* powdered of seed *L. sativum*, pounded and drunk	1	
			Michi (Cabala-Hadiyissa), sore, scabies, tinea capitis	S	F	Leaf alone is crushed with fresh or dry root of *A. africanus* and *R. cordifolia*, pounded drunk; wash with boiled/warm fesh plants, paste and tied	1	
Ocimum tenuiflorum L.**	Lamiaceae	Qadaalli enja	Mumps	H	D	Seeds powdered mixed with the honey of wasp stay 3-4 days and drunk 1 mug/glass before food	1	MH-207
Ocimum spicatum Deflers.	Lamiaceae	Buubayye (Angaambiisha)	Mechi, head ache	S	F	Soaked in cold or warm water, boiled in warm water and drunk 1 coffee cup adult, ½ cup child; crushed, pounded with water and sniff by nose, smear on leg/body it causes diarrhoea to heal	22	MH-67
			Conjunctivitis	S	F	Crushed, squeezed and add 1-2 drops by syringe	4	
			Tooth pain	S	F	Chewed leaf with *O. lamiifolium* leaf and hold on the aching tooth	2	
Oldeania alpina (K. Schum.) Stapleton.	Poaceae	Leema	Mumps (Anku'lichcho-Had.), syphilis (Qixxinna-Had.)	H	F/D	Soaked, boiled false pseudo fruits and mixed with wasp honey or pure fresh butter ('Qaalimma'-Had.) and drunk oral	9	MH-174
Olea europaea L. subsp. *cuspidata* Wall. ex G. Don.	Oleaceae	Weera	Swelling (Musha/maqina/ Had.	T	F	Leaves/stem bark crushed, pounded, in water cooked and filter the fluid and drunk	21	MH-111
			Tonsillitis		F	Buds are chewed and spit/sniff fluid	3	
			Tooth pain		F	Leaves/buds are chewed and hold on the pained tooth, spit out the water with saliva, the branch/stem bark of *O. europaea* subsp. *cuspidata*, *E. globulus* is boiled/heated in fire, closed with fibre and hold on pained area; one *C. aurantiifolia* with epicarp and mesocarp crushed in half and brush the tooth; fresh butter closed in fibre and hold it to cool the pain	6	
			Asmata, dingetegna	T	F	Chewed with salt and swallow the juice	3	

			Abdominal pain, stomach ache, ascariasis, amoebiasis, gardiasis	T		Buds crushed together with buds of *C. macrostachyus* and buds of *R. chalepensis*, mixed with water and drunk until heal	7	
Olinia rochetiana A. Juss.	Penaeaceae	Guna	Tooth pain /toothache, amoebiasis	T	F	Leaf/bud chewed and hold on pained tooth by spitting out the water, brush the tooth, drunk through oral route	35	MH-39
			Gardiasis	T	F	Leaf is crushed, mixed with water and drunk	1	
			Bat disease/jaundice, eczema, wound, breast cancer, tinea *capitis,* epistaxis/nasal bleeding	T	F	Buds crushed with buds of *C. macrostachyus, M. lanceolata, C. longicauda* and *G. auriculiferum* and paste on the pained area then wrabbed on the wound, tied on the area, take the fluid by nose	4	
			Diarrhoea	T		Buds crushed with buds of C. *macrostachyus*, boiled these fresh plants in fire, crushed and drunk via mouth	3	
Oncoba spinosa Forssk.	Salicaceae	Itakkam kuukka	Ring worm/buuqaashshi jabbo, skin infections	T	F	Fruits crushed, pounded and mix with water, smear on the infected area	1	MH-351
Oncocalyx glabratus (Engl.) M. Gilbert	Loranthaceae	Caaxi xanqo'o	Tumor-anal swelling, hemorrhoids	He mp	D	Crushed, leaves powdered, mixed with one spoon of it with 2 cups of roasted and powdered coffee in a glass and drunk	1	MH-381
Oxalis corniculata L.**	Oxalidaceae	Goro'ama (cii'imixmi mixo'o)	Bat disease, worm stinging (Jule'i jabbo), thorn infection (Utti tuttuchcha-Had.), wound	H	F	Whole parts crushed, pounded, paste and tied on the pained area; with ear wax for thorn infection	20	MH-150
			Abdominal pain, stomach ache, bloody diarrhoea, snake bite	H	F	Leaves crushed, pounded with water, squeezed and drunk	8	
			Tooth pain	H	F	Whole parts chewed with the leaves of *P. abyssinica* hold on the pained tooth	2	
Pavetta oliveriana Hiern.	Rubiaceae	Gaarawwa laba	Evil eye (evil spirit)	S	F	Leaves with branches crushed, pounded in cold water then add metal stay for a night and washing at morning at 12 h.	3	MH-288
Pavonia urens Cav. var. *urens*	Malvaceae	Doba	Diarrhoea, evil eye (Evil spirit)	H	F	Roots crushed, mixed with water and drunk	2	MH-70
Pelargonium sp.	Geraniaceae	Inqi qaraare	Tooth pain	H	F	Whole parts are chewed and hold on the pained tooth	1	MH-240
Phyllopentas schimperi (Hochst.) Y.D. Zhou & Q.F. Wang (synonym of *Pentas schimperiana)*)	Rubiaceae	Wo'l oda'a	Dingetegna	H	F	Root crushed, mixed with fresh milk, drunk	5	MH-232
			Diarrhoea, abdominal pain	H	F	Roots, crushed, mixed with cold water and drunk	1	
			External cancer/Ha'n miqiica	H	D	The leaves are dried, powdered sprinkled on wound	1	
			Impotence	H	F	Leave crushed and drunk the solution	1	
			Pyelonephritis	H	F	Root crushed, pounded with black cow fresh milk and drunk orally	1	
Peponium vogelii (Hook.f.) Engl.	Cucurbitaceae	Humbusha (Dunguruul la)	Michi, liver cirrhosis	Cl	F	Roots/leaves crushed, pounded with water and drunk	2	MH-242

Persea americana Mill.**	Lauraceae	Avokaato'o	Gastritis, digestion problem, goiter, michi	T	F/ D	Dry seeds/ fruits powdered, mixed with pure honey or tea, squeeze the juice, drunk before sleep at night; fresh juice is drunk during pain; smear on the skin for michi	14	MH-121
			Dandruff	T	F	Fruit mesocarp is crushed, mixed with fresh egg and creamed the solution	5	
			Tooth pain	T	F	Buds are chewed and hold on pained tooth	1	
Persicaria glabra (Willd.) M.Gómez	Polygonaceae	Uulli saratichcho laba	COPD	H	F	Roots chewed and drunk with coffee or tea, sniff by nose	1	MH-298
Phaseolus lunatus L. **	Fabaceae	Boloqe'e (Lob otongora)	Trauma	H	D	Cooked /rooted seeds are eaten, and drunk the soup with fresh butter	1	MH-216
Phoenix reclinata acq.	Arecaceae	Sale'e (Dimbaaba)	Tonsillitis	T	F	Leaves chewed and swallowed the juice	1	M-110
Physalis peruviana L.	Solanaceae	Onjooro'o	Dingetegna	H	F	Roots pounded within water drunk	37	MH-114
		Tonsillitis, COPD		H	F	Roots chewed with NaCl and swallow the its juice	1	
Phytolacca dodecandra L'Her.	Phytolaccaceae	Haanja	Liver cirrhosis, COPD	S	F	Leaves crushed, pounded in water and drunk; caused vomiting, diarrhoea to cure disease; spit liquid of crushed leaves or roots to mouth for COPD	11	MH-161
			Eczema, worm stinging/'Jule'i' jabbo-Had	S	F	Leaves and root bark crushed, pounded together and tied on pained area	1	
			Mumps	S	F	Roots are crushed, pounded in water drunk	1	
			Swelling (Musha/maqin)	S	F	Leaves crushed with NaCl, pounded with the stem bark of *E. brucei*, roots of *M. foetida,* leaves *of P. dodecandra*, *J. chimperiana*, *G. auriculiferum, G. amygdalinum, C. macrostachyus, S. nilotica,* wrapped neat cloth and tied over pained area; bath the body	2	
				S	D	Dry roots are crushed, pounded with youghurt and drunk the decoction	1	
			Abdominal pain, stomach ache	S	F	Roots are chewed and swallowed the juice	1	
Plantago lanceolata L.	Plantaginaceae	Gereebbi sheerimo	*Tinea capitis,* eczema	H	F	Whole parts/leaves are crushed, pounded together with the leaves of *O. corniculata* and buds of *C. benghalensis;* washed the wound with soup then paste and tied over the pained area	6	MH-285
			Tooth pain	H	F	Whole parts or leaves alone are chewed and hold on the pained tooth	1	
Platostoma africanum P. Beauv.	Lamiaceae	Heedoo'l maaxa	Common cold, head ache	H	F	Leaves are crushed together with the leaves of *E. globulus*, *O. lamiifolium*, *J. procera* pounded, mixed in water and boiled and inhale steam through nasal and oral route; sniff by nose or drunk orally	14	MH-25

			Swelling, gastritis, impotence, diarrhoea	H	F	Leaves crushed, pounded, mixed with water for oral administration drunk	4 2	
			Cough	H	F	Leaves are pounded together with the leaves of *E. globulus, J. procera, C. anisata* pounded in boiled water then inhaled through nose		
			Sinusitis or rhino sinusitis	H	F	Leaves crushed and sniff juice by nose	2	
			Ascariasis	H	F	Leaves are crushed together with the leaves of *P. abyssinica*, *C. hadiensis*, S. *oxyacantha* with the fresh or dry leaves of *A. integrifolia* boiled the concoction for oral administration	1	
Premna schimperi Engl.	Lamiaceae	Xooxanqe'e	Tooth pain	S	F	Fresh leaves are chewed and holds on pained tooth by spitting saliva, chewed three buds of *T. asiatica* and hold on pained tooth.	16	MH-04
			Headache, sever head ache	S	F	Leaves crushed with *C. macrostachyus* leaves, squeezed and sniffing/inhale filtrate by nose; smear/ brush nose by crushed leaves of *P. schimperii*		
			Common cold, head ache	S		Buds boiled with buds of *E. globulus*, *inhale* for dinking drunk		
			Michi	S	F	Leaf soaked and boiled with leaf of *O. lamiifolium, C. anisata,* leaf and fruit *of R. chalepensis*, leaf of *H. annuus* for oral administration		
			Pneumonia head ache, common cold, cough	S	F	Crushed leaves with *S. oxyacantha*, pounded and boiled concoction until heal	3	
			Kidney's disease	S	F	Three buds with buds of *T. ellipticus*, *O.* subsp. *cuspidata, C. anisata* and ripen mesocarp of *C. papaya* is roasted, crushed, pounded, mixed with water and drunk the concoction	1	
Protea gaguedi J.F. Gmel.	Proteaceae	Haabo'o	Sore (Maraam omara-Had.)-	T	F	Leaf /stem bark is crushed, pounded with water and paste on sore wound of the leg	2	MH-262
			Pyelonephritis (Waadamuuncho)	T	F	Stem bark crushed, pounded with water, filtered and drunk via mouth	1	
Prunus africana (Hook.f.) Kalkman	Rosaceae	Araara	Tooth pain	T	F	Stem bark/leaf is boiled, crushed and wrabbed with white cloth /fiber and hold on pained tooth	9	MH-57
			Hepatitis (liver disease)	T	F	Stem bark is crushed, pounded and homogenized in cold or warm water and drunk	1	
			Diarrhoea	T	F	Leaf is crushed, mixed with water and drunk	1	
			Bat urine	T	F	Stem bark from sun rise crushed with whole parts of *A. caulirhiza*, pounded and homogenized in cold/warm water and smear on the pained area at the morning	1	
Psidium guajava L.	Myrtaceae	Zayituuna	Tooth pain	S	F	Fresh leaf is chewed and hold on the pained tooth	3	MH-179
Psydrax schimperiana (A.	Rubiaceae	Googaame	Anthrax	T	F	Root is crushed, pounded mixed with water for oral	1	MH-

Rich.)						administration		71
Pteridium aquilinum (L.) Kuhn.	Dennstaedtiaceae	Onxooxxo'o	Eczema	S	D	Leaf is crushed, dry, roasted and powdered then mix with butter and creamed/smear the skin wound	1	MH-109
Rhamnus prinoides L'Hér.	Rhamnaceae	Geesho'o	Scabies (skin itching disease), pityriasis (Bacaro'o-Had.)	S	F	Crushed fruit/bud crushed, and mixed with butter ointment or smear/cream the solution	7	MH-120
			Malaria	S	F	Branch and leaf crushed, pounded with water and filtered, and drunk the decoct	2	
			Tonsillitis	S	F	Buds together with buds *of C. africana* 3 flowers of *A. caulirhiza,* buds of *C. edulis,* crushed and spit to mouth	2	
Rhus vulgaris Meikle. (*synonym of. Searsia pyroides var. pyroides*)	Anacardiaceae	Qamo'o	Jaundice, kidney disease	T	D, F	Powdered the dry leaf/fresh stem bark, pounded in water and drunk the decoction by oral administration	2	MH-08
Ricinus communis L.	Euphorbiaceae	Qobbo'o	Carbuncles, (boils-skin problem-Bikkiraata-Had.), wound	S	F	Buds together with buds of *C. macrostachyus* and buds of *E. depauperata,* crushed, pounded with water and drunk, not given for child; smear bud latex on wound for 2-3 days.	4	MH-125
Rosmarinus officinalis L**	Lamiaceae	Maa'lenjja	Blood pressure, diabetes, gastritis/digestion problem, abdominal pain, stomach ache, COPD	S	F	Leaf together with the leaf of *A. abysinthium*, *C. citratus* crushed, pounded and drunk; chewed and swallowed juice	55	MH-12
			Hemorrhoids, tumor, dingetegna	S	F	Leaf is crushed, boiled with water and drunk, boiled and touch pained area	4	
			Cold (myalgia) and stress	S	F	Leaf crushed and boiled with chicken/hen soup and add fresh butter drunk a decoction solution until heal at morning	3	
			Tooth pain	S	F	Leaf or root is chewed with NaCl and hold on the ached dental	2	
Rotheca myricoides (Hochst.) Steane & Mabb. (synonym of *Clerodendrum myricoides*).	Lamiaceae	Haniga	Pneumonia (Kuxxichcha-Had.), jaundice	S	F	Leaves or roots crushed, pounded, mixed with water for oral administration. Its stem is boiled and burned pained area	18	MH-186
			Toothache, COPD, severe headache (Zawore/Sambaca-Had.)	S	F	Stem bark is chewed with in enclosed fibre and hold on pained tooth Leaf is chewed and swallow the juice or sniff to nose	6	
			Epilepsy (Xafanna-Had.), anaemia (Xiiqqi hoffechcha/ Jawwisa-Had.)	S	F	Stem bark is crushed, pounded and drunk the decoction	2	
			Gonorrhea (Cophxo'o-Had.)	S	F	The leaves are crushed, pounded then drunk via mouth	2	

			Pityriasis	Cl	F	Leaf crushed, pound, smeared /creamed	3	
			Pyelonephritis	Cl	F	Crushed fresh root bark, pounded and drunk on the Wednesday and Friday	1	
Rubia cordifolia L.	Rubiaceae	Haro'o/Baarxusha	Hemorrhoids tumor, cancer, michi, heart disease, jaundice, tooth disease, abdominal pain	Cl	F	Leaves or roots crushed, pounded with water drunk 1 cup-1glass the squeezed for three alternative days; root bark chewed and swallow. Chewed and wrapped with Ensete fibre and hold on ached tooth.	40	MH-68
			Evil eye/sprit	Cl	F	Leaves and roots/root bark crushed, boiled, inhaled the steam, drunk 1 coffee cup on Wednesday and Friday; pounded the decoction in cold water, stay a night and wash the body at morning.	3	
			Body swelling (Habidasha-Had.)	Cl	F	Leaves crushed, paste on swelled part.	1	
			Pityriasis	Cl	F	Leaves crushed, pounded, smeared /creamed on the pained area.	3	
			Pyelonephritis	Cl	F	Crushed fresh root bark, pounded and drunk one glass on the Wednesday and Friday	1	
Rubus steudneri Schweinf	Rosaceae	Daane'i gora	Liver cirrhosis, pyelonephritis cancer, impotence-infected fetus	S	F/D	With leaves/buds of *R. communis, M. foetida,* C. *macrostachyus, Peponium vogelii, B. antidysenterica* with root of *A. africanus*, *R. nepalensis, R. abyssinica, C. uncinulata*, *P. dodecandra*, *C. amplifolium*, *S. abyssinica* and *C. longicauda* are crushed, pounded with water, yougghurt and drunk orally	5	M-11
Rumex abyssinicus Jacq.	Polygonaceae	Shiisho'o	Venign (external tumor on toe or thumb), pyelonephritis, stomach ache	H	F	Root is crushed, pounded with water and drunk squeezed juice, and roasted the leaf and touch over the pained area and tied there.	16	MH-22
			Pityriasis	S	F	Root crushed and creamed on pained area	1	
Rumex nepalensis Spreng.	Polygonaceae	Go'ichcho	Pyelonephritis	S	F	Boiled the root or leaf is crushed, pounded in water and drunk for 2 days Wednesday and Friday until heal	91	M-21
			Hypertension, dingetegna	S		Root or leaf crushed, drunk, and mixed in cold or warm water drunk the infusion	9	
			Hemorrhoids, tumor, ascariasis, tonsillitis	S		Root or leaf crushed, pounded with 1 glass milk, add NaCl and drunk; mixed in cold or warm water drunk the solution and touch anal tumor by warmed leaf in fire; root chewed and swallowed or spit the juice; cooked with porridge (genfo) and eat	53	
Rumex nervosus Vahl.	Polygonaceae	Imbocca	Abdominal pain, stomach ache, michi	S	F	Root chewed with or without bud of *B. antidysenterica* and NaCl, swallowed the juice, and drunk orally	10	MH-307
			Gastric problem	S	F	Crushed leaf is pounded in water and drunk	2	
			Ear pain	S	F	Leaf warm and crushed, squeezed and add 2-3 drops	2	

						in the ear		
			Venign tumor, external tumor	S	F	Leaf with the leaf of *C. longicauda* is wrapped with leaf of *E. ventricosum* warmed in fire and tied for 3 days, cut and remove	4	
			Diarrhoea, heart disease	S	F	Root is crushed, pound in water drunk the squeezed decoction	5	
			Worm stinging ('Jule'i jabbo-Had.')	S	F	Boiled the fresh leaf and root, crushed and tied on the pained area	1	
			Evil eye, evil sprit	S	F	Leaf crushed, mixed decoction for oral route	1	
Ruta chalepensis L. **	Rutaceae	Qantalaama	Abdominal pain, stomachache Bloat, michi, dingetegna	H	F/ D	Chewed stem bark of *S. longepedunculata* and seed of *N. sativa* chewed and swallow the juice, and fruit or leaf fruit of *C. sativum*, rhizome of *Z. officinal* and root of *C. citratus*, pounded in water or honey and drunk	159	MH-83
			Tooth pain	H		Chewed and hold on the pained area	5	
			Common cold, headache	H	F/ D	Leaf crushed together with leaf of *A. absinthium*, leaf/fruit of *C. sativum* and drunk; chewed and swallow the juice or all part; crushed leaf or fruit together with the leaf of *O. basilicum* var. *cinnamon,* bud of *A. sativum* mixed in water, drunk for 3 times	4	
			Diabetes mellitus (DM)	H	F	Leaf with the fruits crushed for oral administration	10	
			Malaria	H	F	Crushed leaf is drunk alone or crushed together with leaf of *C. citratus*, leaf of *T. schimperi*, *A. absinthium,* and *with pod of C. frutescens*, bulb of *A. sativum*, seed powdered of N. *sativa,* all pounded with black honey and fresh butter, eat the concoction at morning before food and sleep in blanket	6	
			Cold (myalgia)	H	F/ D	Fresh fruit crushed together with leaf of *A. integrifolia*, powdered roasted *B. oleracea* var. *oleracea* and *N. sativa* with black honey/milk and drunk at morning before breakfast; fruit with rhizome of *Z. officinal,* bulbs of *A. sativum;* with the leaf of *T. schimperi, C. citratus*, pod of *C. frutescens* and drunk; 2-3 spoons at morning before breakfast and sleep in blanket	30	
			Hypertension, evil eye, evil sprit	H	F	Chewed and swallow the juice; drunk the decoction; inhale volatile the gas from crushed	9	
			Typhoid fever, diarrhoea	H	F	Fresh leaf crushed with bulbs *A. sativum*, powered, pounded in milk or coffee or with cheese and drunk decocted fresh fruit	5	
Rytigynia neglecta (Hiern.) Robyns.	Rubiaceae	Garawwa	Evil eye (evil spirit), bat disease, jaundice	S	F	Leaf crushed with the leaf of *S. ellipticum*, pounded, drunk the extract, don't drunk milk, paste and tied, or smear until 14 days on pained skin	3	MH-48

			Tooth pain / tooth ache	S	F	Chewed stem bark or buds and hold on pained tooth by spitting water with saliva	1	
Salvia nilotica Juss. ex Jacq.	Lamiaceae	Okote'e	Tonsillitis	H	F	Leaf crushed, mixed in water and drunk, chewed and spit for infant	11	M-153
			Itching (skin), michi, wound	H	F	Leaf crushed, pounded with fresh cattle urine or water alone, washed like soup; pasted and smear the pained skin	7	
			Gastric problem	H	F	Crushed leaf is pounded in water, squeezed then drunk	1	
			Dingetegna, conjunctivitis	H	F	Leaf is Crushed, squeezed fluid and add 2-3 drops in the ear	1	
			Tooth pain	H	F	Leaf together with the leaf of *O. spicatum,* buds of *G. auriculiferum* crushed or chewed these plants, wrapped *Ensete* fibre and NaCl, hold on pained tooth by spitting saliva with water	1	
Shirakiopsis elliptica (Hochst.) Esser	Euphorbiaceae	Shaqama	Bat disease, jaundice	T	F	Crushed leaf is ointment on the pained area on; and tied on infected area.	5	MH-33
Clinopodium simense (Benth.) Kuntze.	Lamiaceae	Daaxa	Diarrhoea, abdominal pain	H	F	Whole parts crushed with leaf of *B. pilosa*, mixed with water and drunk.	1	M-270
Securidaca longepedunculata Fresen.	Polygalaceae	Mukke'e	Dingetegn, abdominal pain, stomach ache, bloat, swelling	T	F/D	Chewed with salt and swallow the juice; crushed buds boiled and add butter and drunk by oral route	27	MH-206
			Diarrhoea, gardiasis	T	F/D	Root bark is crushed, squeezed and drunk.	13	
Senna petersiana (Bolle) Lock.	Fabaceae	Chachayye encho	Evil eye, evil sprit	S	F	Buds crushed together with a bud of *C. macrostachyus* and *B. abyssinica*, pounded in water drunk and washing body at morning.	5	MH-50
			Bat disease, swelling (Habi-dashsha-Had, cancer	S	F	Crushed, pounded in water and drunk; smear on the wound	2	
Sida rhombifolia L.	Malvaceae	Qarxaffa	Snake bite (injection of venom)	S	F	Leaf crushed, squeezed and drunk	7	MH-134
			Diarrhoea	S	F	Root is crushed, pounded and drunk	2	
Sida schimperiana Hochst.ex.A. Rich.	Malvaceae	Jajjo'i goda/Xuraza	Eczema, wound, bat disease, worm stinging	S	D/F	The dried powdered pounded, homogenized with cold water, paste and tied on the infected area for three times; change daily; crushed is creamed on the washed wound with baseline	18	MH-46
			Diarrhoea, evil eye	S	F	Crushed and homogenized with cold water and drunk	4	
			Digestion problem		F	Root is crushed, pounded and drunk	1	
Spiniluma oxyacantha (Baill.) Aubrév.	Sapotaceae	Faraxxi qasa	Mumps	T	F	Stem bark crushed, pounded, boiled and drunk the decoction	11	MH-28
			Common cold, head ache, pneumonia	T	F	Leaves crushed with leaves of *P. schimperi*, pounded, boiled, and drunk decoction of until heal	2	
			TB	T	F	The leaf is crushed, pounded and drunk with butter; buds chewed and swallow the juice	6	

			Rabies	T	F	The stem bark together with buds of *A. gracilior*, stem bark of *E. capensis* and leaf of *Z. asiaticum* are crushed, pounded in water, filtered and drunk	2	
Snowdenia polystachya (Frensen.) Pilg.	Poaceae	Mujja	Epistaxis (nasal bleeding)	H	F	Leaf crushed, pounded with water and sniffed juice during bleeding time	2	MH-112
			Vomiting	H	F	Leaf crushed, mixed with water and drunk the juice	1	
Solanecio gigas (Vatke) C. Jeffrey. *	Solanaceae	Ayibaabba (Halaaphphi bobaanqa)	Cold (myalgia), muscule stress	S	F	The leaf is boiled with the leaf of *J. chimperiana* and *C. macrostachyus*, touch the body with the boiled concoction	9	MH-123
			Pyelonephritis, diarrhoea	S	F	Leaf is crushed with the root of *R. abyssinicus*, crushed, pounded with water for oral administration	3	
			Scabies (skin itching disease)	S	F	Leaf together with leaf of *C. macrostachyus*, G. auriculiferum, *P. abyssinica*, *C. africana*, and G. amygdalinum leaf boiled together and wash.	2	
			Cancer	S	F	Fresh leaf with leaf of *C. macrostachyus, P. abyssinica, and J. chimperiana* leaf boiled and touch the pained area.	1	
			Boils/folliculitis (Bekiratta-Had.), cold, swelling	S	F	Leaf with leaf of *C. macrostachyus*, *P. abyssinica*, *J. chimperiana*, *H. lucitanica* leaf boiled and touch	2	
Solanum incanum L.	Solanaceae	Heemachchi-lorawwa	Abdominal pain, stomach ache, dingetegna, cancer (external and brusted)	S S	F F	Root is chewed and swallowed the juice orally Leaves with *C. macrostachyus* or *Combretum* sp charcoal powdered mixed with honey cream on neat white cloth and tied on wound; remove after 12 h.	24 3	MH-38
			Cancer (external and brusted)	S	F	Leaf and fruit with *S. marginatum* glowed/ burnt in fire until burst, bud *P. abyssinica, leaves* of *S. indicum and C. aurea* crushed all in neat way and add on the wound until 2 h then removed and washed, soil from not ploughed land 50 cm, not insecticide, powdered, boil all fresh plants in water and crushed then mixed with powdered soil, cold water, add honey stay 20min-30min then add on wound and tightly tied for 2 h, remove and wash with warm water, not eat meat.	3	
			Diarrhoea	S	F	Root crushed, pounded for oral administration	1	
Solanum indicum L.	Solanaceae	Wish/wiiddi looraawwa	Asmata, TB, syphilis, diarrhoea, malaria	H	F	Crushed, pounded and drunk; one mug a day for diarrhoea and malaria with fresh milk	23	MH-74
			Abdominal pain, stomach ache, gastric problem, dingetegna	H	F	Buds crushed pounded, mixed and filter them and drunk concoction; chewed and swallow	8	
			Epistaxis (nasal bleeding)	H	F	Root bark with *C. setaceus* whole parts crushed together the squeezed juice sniffed by nose	2	
			Hemorrhoids, tumor	H	F	Root crushed with *R. nepalensis* root, pounded and drunk the decoction	1	

			Cold (myalgia), kidney disease	H	F	Buds crushed with buds *T. ellipticus* and its infusion mixed with soup of C. *arabica*, add fresh butter and drunk concoction	2	
			Evil eye, evil spirit, rabies	H	F	Buds crushed, pounded with water and drunk	1	
			Cancer	H		Bud with buds of C. *benghalensis* and bulbs A. sativum, rhizome *of Z. officinale* crushed together, pounded, pasted and tied	2	
Solanum marginatum L.f.*	Solanaceae	Lob loorraawwa	Cancer	S	F	Fruits fluid and leaves with fruits fluid of *S. indicum*, buds of C. *benghalensis,* C. macrostachyus, G. auriculiferum and *P. abyssinica* crushed and mixed together then creamed on the pained area in 3rd, 4th alternative days until one year.	2	MH-379
Solanum nigrum L.	Solanaceae	Heemachchi migillo'o ,	Constipation, malaria, ascariasis, syphilis, abdominal pain, stomache ache, conjunctivitis, michi, TB	H	F	Above ground or whole part cooked NaCl, boiled with butter drunk 1glass; eat as cabbage	29	MH-13
			Heart disease (cardiovascular disease)	H	F	Whole parts with the above ground parts of *E. arabicum* cooked with butter, drunk or eating as cabbage	9	
			Pityriasis	H	F	Fresh leaf crushed, pounded and smeared	1	
			Breast and skin cancer	H	F	Leaf with leaf of *C. aurea*, buds of *C. macrostachyus* and yellow ripened fruit of *S. incanum* crushed, paste, tied with white neat cloth on the wound	4	
				H	F/D	Fresh or dry Hyena liver powdered with dry hen faece spiked on the wound	1	
			External and internal cancer/Ha'nanee woro'l miqiicaa	H	F	Buds with 2 buds of *A. tortuosus*, *B. pachylom, A. caulirhiza, C. benghalensis, P. peruviana* with 1 leaf of *C. pepo* and *P. africanus* crushed, pounded and drunk 1 glass concoction	2	
			Snake bite	H	F	Buds or leaf crushed, pounded in water, pasted and tied on the cut or bite place	1	
Solanum sp.	Solanaceae	Bulo'o	Common cold, head ache, pneumonia, measles (Shifita-Had	S	F	Leaf cooked or roasted drunk the infusion; eat warmed foods and drinks were used	2	MH-182
Sorghum bicolor (L.) Moench	Poaceae	Sarata	Wound	H	D	Chewed dry seed and spit to the wound	4	MH-175
			Urticaria (Xasho'o-Had.)	H	D	Powdered, mixed with human faeces and smear on it	1	
			Diarrhoea	H		The seed is powdered and cooked porridge; ' atimit' and with water and drunk orally	2	
Stephania abyssinica (Quart. -Dill. & A. Rich.) Walp.	Menispermaceae	Huma	Malaria, typhoid fever	Cl	F	Root crushed, pounded and drunk	8	MH-49
		Huma	Hepatitis, COPD, dingetegna, pyelonephritis	Cl	F	Fresh root crushed, pounded for oral route; chewed with NaCl and swallow	4	
		Huma	Rabies	Cl	F	Fresh root crushed together with leaf of D. *stramonium*, pounded and drunk 1 coffee cup	1	

						concoction		
Stephanotis schimperi (Decne.) S. Reuss, Liede & Meve	Apocynaceae	Doo'l muunca	Pyelonephritis (Wa'i damuncho)	Cl	F	Root buds chewed with NaCl and swallowed the juice; buds crushed, pounded, and added metal, and any metal took a bath in the morning	1	MH-341
Stomatanthes africanus (Oliv. & Hiern) R.M. King & H. Rob.	Asteraceae	Basso'i bila lab manni illi qaraare	Michi, evil eye (evil spirit)	H	F	Leaf with the leaf of *A. integrifolia* crushed together, pounded with water and sugar drunk 1 coffee cup	1	MH-141
Syzygium guineense var. (Wild.) DC.guineense	Myrtaceae	Duubaana	Taeniasis	T	F	Fruit or leaf/bud is chewed and swallow the juice	1	MH-317
Syzygium guineense (Willd.) DC. subsp. *afromontanum* F. White	Myrtaceae	Gooto'i duubaana	Taeniasis	T	F	Fruit or leaf/bud is chewed and orally swallow the juice	1	MH-171
Tagetes minuta L. **	Asteraceae	Hallenjja (Lata'i enja)	Cancer	H	F	Powdered leaf with leaf of *C. macrostachyus*, *S. gigas* and *P. abyssinica* crushed, powdered mixed with honey for 10 days; boiled four fresh plants leaves and touch the area	4	MH-129
			Ants, repellents to against formic acid, mange (mite bite, tick infections (Ko'lanee baalqaanc ga'mimmi jabbo-Had	H	F	Crushed, pounded and spray on them or to the physical environment to killed and move away	2	
Tapinanthus sp.	Loranthaceae	Buni-xanqo	TB, pneumonia	He mp	F	Leaf with leaf of *V. tuberculatum* pounded, mixed with water and drunk orally for 2-3 times	3	MH-202
Terminalia schimperiana Hochst.		Dabaqqa	Wound	T	F	Buds or leaves crushed, pounded and paste then tied on the infected area	1	MH-331
Thalictrum rhynchocarpum Dill. & A. Rich.**		Manni illi qaraare	Evil eye, evil spirit	H	F	Whole parts are crushed, mixed with water for oral administered	1	MH-345
Thunbergia ruspolii Lindau .*	Acanthaceae	Guffi haata	Ascariasis, abdominal pain, stomach ache, diarrhoea, and constipation	H	F	Whole parts/leaves are washed and crushed, pounded in water for oral administration	4	MH-308
Thymus schimperi Ronniger. *	Lamiaceae	Ishina	Hypertension, COPD	H	F/D	Soak fresh leaves or powdered mixed in warm water and drunk infusion as tea 1-3 times on Wednesday and Friday morning; leaves chewed with buds; drunk	28	MH-85
			Hemorrhoids, tumor		F	Leaves are boiled and drunk	2	
			Diabetes mellitus (DM)	H	F/D	Leaves crushed, pounded boiled and drunk orally	2	
			Cold (myaligia)	H	F	Leaves with leaves of *C. papaya*, fruits of *R. chalepensis, A, absinthium* leaves and *G. amygdalinum*, leaves crushed, and drunk at morning	3	
			Goiter	H	D	Leaves crushed, powdered and drunk	2	
Tragia cinerea (Pax)	Euphorbiaceae	Hoffi	Malaria, pyelonephritis	Cl	F	Root crushed, pounded, mixed with water for oral	2	MH-

M.G. Gilbert & Radcl. - Sm.		doobba				administration		108
Trichocladus ellipticus Eckl. & Zeyh.	Hamamelidaceae	Qabarbuyya	Worm stinging and swelling ('Jule'i jabbo-Had.)	S	F	Leaves crushed, mixed in water and butter, paste then tied over the wound	14	MH-78
			Kidney disease, pyelonephritis	S	F	Leaves crushed, pounded and mix with butter drunk the decoction	7	
Trifolium semipilosum Fresen.	Fabaceae	Jule'i qaraare	Worm stinging ('Jule'i jabbo-Had.)	H	F	Whole parts crushed, paste and tied over the pained	1	MH-272
Trigonella foenum-graecum L. **	Fabaceae	Shuqoota	Scabies (skin itching disease)	H	D	Dry seed powdered, homogenized with butter and ontiment or smear at night	10	MH-94
			Amoebiasis	H	D	One cup of dry seed, roasted and powered, pounded in fresh milk, stay 3 days and drunk	2	
			Cold (myalgia), chest pain (Biq xisso/Qaso'o-Had.)	H	D	Powdered seeds mixed with hen eggs and bee honey, butter, and drunk; powdered and crushed *A. sativum* bulbs and butter, eat in the morning.	5	
			Trauma (back bone pain), hepatitis (liver disease)	H	D	Seeds crushed, powdered, pounded and mixed with water and drunk	1	
Triticum aestivum L.**	Poaceae	Arasa	Eczema	H	D	Seeds poweder and mixed together with the stem charcoal of *E. globulus* or *C. macrostachyus*, and others, pounded in water, painted/creamed/smear on thick white cloth and tied until four days, wash with warm water every remove	1	MH-224
Urtica simensis Hochst. ex A. Rich. *	Urticaceae	Amaa'il doobba/Cimcima	Scabies/skin itching disease	H	F	Leaves crushed, pounded in water stay on sun light and washing Wednesday and Friday	2	MH-194
			Gonorrheae (Cophxo'o-Had.)	H	F	Leaves crushed with *C. macrostachyus*, boiled and washing the body daily until heal	1	
Urtica urens L.	Urticaceae	Lob doobba	Cystitis/bladder inflammation, urine irritation (Fuguuqqi dashshimmanee/Shum shokkiisimmi jabboo-Had.), kideny disease, impotence, spider stinging, anaemia, snake bite, and gonorrheae (Cophxo'o-Hadiyissa)	H	F	Leaves crushed, pounded in and drunk as tea of a tea cup/coffee cup/mug; roasted eat as vegetable	10	MH-58
			Heart disease	H	F	Roots crushed, pounded in water, boiled and drunk	1	
			Menstrual pain/disturbed or irregular, heart and bone health, menstrual cycle	H	F	Fresh roots crushed, pounded in water and drunk	2	
			Hypertension	H	F	Leaves soak in water, boiled and drunk orally	1	
Vachellia abyssinica (Hochst. ex Benth.) Kyal. & Boatwr.	Fabaceae	Giraara	Tooth pain (Inqi xisso-Had.	T	F	Stem bark is chewed and swallow the juice through mouth; and hold on the pained dental	1	MH-176
Vepris nobilis (Delile)	Rutaceae	Xaa'a	Diarrhoea (digestion problem),	T	F	Leaf crushed, pounded in water and 'tella' drunk the	39	MH-

Mziray.			bloody diarrhoea			decoction via mouth		73
			Abdominal pain, stomachache, bloat	T	F	Leaf is crushed, pounded with water and 'tella' given orally	6	
			Diarrhoea, abdominal pain, stomach ache	T	F	Crushed leaf with the leaf of *G. amygdalinum*, *C. anisata*, *P. abyssinica* and *R. nepalensis* root, mixed with water and taked orally	3	
			Michi	T	F	Crushed leaf with the leaf of *O. lamiifolium*, *H. annuus*, *D. laxata*, *C. anisata*, and poweder *B. oleracea* var. *oleracea* seed of pounded in cold /water, homogenized for oral administration	1	
			Amoebiasis	T	F	Crushed buds with buds of *C. macrostachyus, C. anisata*, *C. aurea*, boiled and drunk	1	
			Hemorrhoids, tumor	T	F	Buds crushed with the buds of C. *macrostachyus* with NaCl, pounded in water and 'tella' drunk via mouth	1	
Verbascum sinaiticum Benth.	Scrophulariaceae	Got buyya	Wound (Xiige'oo mada/omara)	T	D	Powdered stem charcoal and sprinkled on the skin wounded surface	5	MH-316
Verbena officinalis L.	Verbenaceae	Qisqisa (Modollo'o)	Michi	H	F	Leaves crushed, pounded in milk and drunk	15	MH-166
			Diarrhoea, dingetegna, malaria	H	F	Fresh roots/leaves crushed, pounded in water and drunk; not give for 1–2-year child.	5	
			Abdominal pain, stomach ache	H	F	Roots with the buds of *B. antidysenterica* crushed, pounded and drunk; chewed with salt; swallowed	3	
			Kideny disease, bloat, heart disease	H	F	Fresh root crushed, pounded and drunk 1glass adult 1 tea cup child.	2	
Vicia fava L.**	Fabaceae	Baaqeela	Worm stinging ('Jule'i jabbo-Had.), swelling	H	D	Seeds powdered and pounded in water smear or ontiment on the swollen or painful area, tied over the area with cloth until burst.	3	MH-226
			Digestion problem	H	D	Seeds powdered and mixed with the powdered seeds of *H. vulgare, E. tef*, *P. sativum* and *S. bicolor* *all* cooked' atimit' and drunk orally.	1	
Vigna unguiculata L. Walp.	Fabaceae	Hoffi otongora	Digestion problem	H	D	Seeds are cooked and its soup is used orally.	1	MH-181
Viscum congolense De Wild. & T. Durand	Viscaceae	Lob masa'n xanqo'o	Tooth pain	Hemp	F	Leaves are glowed/ burnt /heated to warm; stem part in fire and the warmed is then hold on the pained tooth.	1	MH-188
Viscum tuberculatum A. Rich.	Viscaceae	Hoffi masa'n xanqo'o	Cold (myalgia)	Hemp	D	Crushed, powdered mixed with water oral administration. .	2	MH-1466
		Hoffi masa'n xanqo'o	Tooth pain	Hemp	D	Boiled the stem part in hot fire and warmed then hold the boiled part on pained tooth.	1	
Withania somnifera (L.) Dunal.	Solanaceae	Ajaar buyya	Stomach ache, dingetegna, cancer, chest pain	S	F	Crushed leaves/stem bark, pounded in water squeezed decoction for oral administration.	1	MH-378

Xanthium strumarium L.	Asteraceae	Jaatiroofa laba	Pityriasis (Bacaro'o.), ring worm	H	F	Leaves are crushed and smeared /ontiment on the infected area skins surface.	1	MH-230
Ximenia americana L.	Olacaceae	Qaal'i kooshimma /Shisho'o	Diarrhoea	S	F	Roots or leaves/fruits or stem bark are crushed, pounded, mixed in water and drunk the decoction	6	MH-273
			Abdominal pain, stomach ache	S	F	Fruits are chewed and eat oral means.	2	
			Tooth pain	S	F	Fruits chewed and add on the pained tooth.	2	
			Pyelonephritis (Waa damuuncho-Had.)		F	Stem bark crushed, pounded in water and drunk orally until cure.	1	
Zanthoxylum asiaticum (L.) Appelhans, Groppo & J. Wen	Rutaceae	Seego'o	Ascariasis, amoebiasis, rabies, taeninsis (taenia saginata), gardiasis, abdominal pain, stomach ache, common cold, head ache	Cl (S)	F	Raw ripe yellow fruit eaten or leaves crushed alone and add pinch of *N. sativa* poweder added and the concoction juice is used via oral administration	21	MH-09
			Tooth pain (tooth ache)	Cl	F	Buds are chewed and hold on pained tooth; leaves crushed and drunk its juice	3	
Zea mays L.**	Poaceae	Boqqolla	Tooth pain (tooth ache)	H	F	Buds are chewed and hold on pained tooth; leaves crushed and drunk its juice	3	
			Abdominal pain/stomach ache	H	F	Crushed roots drunk water	1	
Zingiber officinale Roscoe.**	Zingiberaceae	Giingibella	Typhoid fever	H	F	Rhizomes with bulbs of *A. sativum,* bulbs of *A. cepa*, pods of *C. frutescens*, fruits of *C. aurantiifolia* (epicarp and mesocarp), one fruit of *C. aurantium* (epicarp and mesocarp) crushed together, add two spoon charcoal and stay few minutes in closed glass for mixation/homogeneity then add half spoon in a glass water for oral administration in different time intervals.	20	MH-64
			Malaria	H	F	Rhizomes crushed with bulbs of *A. sativum, a* pod of *C. frutescens*, a whole parts of *C. aurantium* fruits and *C. aurantiifolia* fruits and add two spoon powdered charcoal stay for five minutes in closed glass, pounded its prepared half spoon in a glass water, and black honey larvae the mixed together, and eat a spoon child, drunk half glass adult at 12 h, 6 h and 12 h.	5	
			Bloat, COPD	H	F	Rhizomes with dry seed of *A. corrorima* and *N. sativa*, *A. sativum* bulb, *R, chalepensis* leaves and fruits crushed together, mixed in water and drunk half of coffee cup; rhizomes is chewed with seeds and swallowed the juice for COPD.	3	
			Bacterial infection	H	F	Rhizomes crushed with dry leaves of *N. tabacum,* powdered and mixed with 'arekie', drunk.	1	

			Esophagus/throat and, swelling (Leella'anee qoonqa'i dashshimmaa-Had.)	H	F	Crushed and powdered and mixed with black honey and eat 1 spoon for all.	1	
			Tooth pain	H	F	Rhizomes with *A. sativum* chewed with NaCl and hold on the pained tooth	1	
			External cancer	H	F	Half of rhizome with two bubs of *A. sativum,* bulbs of *A. cepa* crushed together smear on cloth washed soap and tied on the pained area.	1	
			Hemorrhoids, tumor	H	F	Rhizome with buds of *A. sativum,* root of *R. nepalensis* crushed and touch until a few after wash anus with water and soap; drunk.	1	
			Asthma	H	F	Rhizomes with the bulbs *A. sativum,* bulbs of *A. cepa, a* fruit C. *aurantiifolia* and 1 fruit of *C. aurantium* add egg in warm water, mixed with all crushed and drunk.	1	
			Gastritis, digestion problem	H	F	Half rhizome with a bulb of *A. sativum*, one bulb *A. cepa* crushed together pounded in water or sugar squeezed and drunk.	1	
			Gardiasis	H	F	Half rhizome with bulbs of *A. sativum,* 1 bulb *A. cepa*, 1 pod of *C. frutescens,* fruits of *C. aurantiifolia*, fruits of *C. aurantium* crushed, pounded, mixed water and drunk.	1	
Ziziphus spina-christi (L.) Desf.	Rhamnaceae	Gaaq xuranqa	Taeniasis	T	F	Eaten raw ripe fruits/leaves crushed squeezed concoction for oral administration.	1	MH-359

Keywords: Growth form: Habit : Hàb=habit; H=herb, S=Shrub, T=Tree, Cl=Climber, and Hemp=Hemi-parasite; Part used=PU; Conditions of the preparation=CP (Fresh-F; Dry-D; Fresh or Dried- F/D); Preparation Forms (PF), MT, and Ra are used, Endemic to Ethiopia (*), Introduced into Ethiopia (**), Native not used asterisks, Total number of informants who cited the medicinal plants for treating the major aliments = UR (use report); VN: = Vernacular name, and MH = Mulatu Hankis

Appendix 12. Market survey of ethnobotanical plants in Soro District

In the open markets of the study sites, some human medicinal plants were selling as the form of edible cultivated fruits, and seeds of spices and condiments as well as medicinal herbs for herbal medicine.

№	*Scientific name*	Family name	Vernacular name (Hadiyissa)	Growth form	Functional group to be used	Coll.No
1.	*Aframomum corrorima* *	Zingiberaceae	Wokkaashsha	Herb	Spice and condiment	MH-88
2.	*Allium cepa* **	Amaryllidaceae	Kashar shunkurutta	Herb	Spice and condiment	MH-92
3.	*Allium porrum*	Amaryllidaceae	Habashichi shunkurutta	Herb	Spice and condiment	MH-205
4.	*Allium sativum* **	Amaryllidaceae	Tuma	Herb	Spice and condiment	MH-90
5.	*Amaranthus caudatus* **	Amaranthaceae	Haliba	Herb	Medicinal, Vegetable(food)	MH-77
6.	*Annona senegalensis*	Annonaceae	Gishxa'a	Shrub	Fruit	MH-117
7.	*Antherica sp.***	Anthericaceae	Dashshi maracca	Herb	Rhizome (Medicinal use)	MH-380
8.	*Artemisia absinthium***	Asteraceae	Naatira	Herb	Leaf (Medicinal and ritual)	MH-87
9.	*Artemisia abyssinica*	Asteraceae	Aguffa	Herb	Leaf (Medicinal and ritual)	MH-163
10.	*Asparagus africanus*	Asparagaceae	Hundufaanna	Herb	Root&leaf (Medicinal use)	MH-198
11.	*Beta vulgaris* **	Amaranthaceae	Kashar lugumo	Herb	Vegetable(food)	MH-218
12.	*Brassica carinata**	Brassicaceae	Fiishsho'i shaana/Asuss a	Herb	Vegetable(food)	MH-119
13.	*Brassica oleracea* var. *capitata* **	Brassicaceae	Xaaxammi shaana	Herb	Vegetable (food)	MH-189
14.	*Brassica oleracea* var. *oleracea*	Brassicaceae	Wonge'i shaana	Herb	Vegetable(food)	MH-118
15.	*Brassica rapa***	Brassicaceae	Qosxa'a	Herb	Vegetable(food)	MH-105

16.	*Capsicum annuum*	Solanaceae	Fiigosichoo te'im Saadam baribaro'o	Herb	Spice and condiment	MH-215
17.	*Capsicum frutescens* **	Solanaceae	Mixmixo'o	Herb	Spice and condiment	MH-9
18.	*Carica papaya* **	Caricaceae	Paapaayya	Tree	Fruit	MH-59
19.	*Casimiroa edulis***	Rutaceae	Kaazmira	Shrub	Fruit	MH-99
20.	*Cicer arietinum* subsp. *reticulatum* **	Fabaceae	Shunbura	Herb	Pulse	MH-306
21.	*Citrus x aurantiifolia* **	Rutaceae	Loome'e	Shrub	Fruit	MH-208
22.	*Citrus × limon***	Rutaceae	Faranj loome'e	Shrub	Fruit	MH-100
23.	*Citrus × aurantium***	Rutaceae	Burtukaana	Shrub	Fruit	MH-101
24.	*Coffea arabica*	Rubiaceae	Buna	Shrub	Stimulant	MH-52
25.	*Colocasia esculenta*	Araceae	Gabija	Herb	Root/tuber (food)	MH-191
26.	*Coriandrum sativum* **	Apiaceae	Woldimaama	Herb	Spice and condiment	MH-172
27.	*Cucurbita maxima* **	Cucurbitaceae	Dabaaqula	Herb	Fruit	MH-220
28.	*Cucurbita pepo* **	Cucurbitaceae	Dabaaqula	Herb	Vegetable(food)	MH-53
29.	*Cymbopogon citratus***	Poaceae	Hixaana	Herb	Spice and condiment	MH-86
30.	*Daucus carota* **	Apiaceae	Caaroota	Herb	Root/tuber (food)	MH-213
31.	*Ensete ventricosum**	Musaceae	Weesa	Herb	Corm/Pseudostem-product: 'Kocho, Bula' (food)	MH-20
32.	*Eragrostis tef* *	Poaceae	Xaafe'e	Grass	Cereal crop (food)	MH-223
33.	*Foeniculum vulgare*	Apiaceae	Wollanga (Ashbe'e)	Herb	Spice and condiment	MH-6
34.	*Helianthus annuus***	Asteraceae	Faaranj nuuga	Herb	Oil crop(food)	MH- 183
35.	*Hordeum vulgare***	Poaceae	So'o	Grass	Cereal crop (food)	MH-222
36.	*Ipomoea batatas* **	Convolvulaceae	Sukkaare'i dinnichcho	Herb	Root/tuber (food)	MH-219
37.	*Lactuca sativa* **	Asteraceae	Salaaxa	Herb	Vegetable(food)	MH-178

38.	*Vicia lens***	Fabaceae	Mishira	Herb	Pulse(food)	MH-221
39.	*Linum usitatissimum* **	Linaceae	Talba	Herb	Oil crop (food additive)	MH-96
40.	*Lippia adoensis* var. *koseret* *	Verbenaceaae	Kosarata	Shrub	Spice and condiment	MH-84
41.	*Lycopersicon esculentum* **	Solanaceae	Timaatima	Herb	Vegetable(food)	MH-214
42.	*Malus sylvestris***	Rosaceae	Appila	Shrub	Fruit	MH-210
43.	*Mangifera indica* **	Anacardiaceae	Mango'o	Tree	Fruit	MH-124
44.	*Mentha spicata subsp. spicata***	Lamiaceae	Naana'a	Herb	Spice and condiment	MH-89
45.	*Musa x paradisiaca***	Musaceae	Muuza	Herb	Fruit	MH-18
46.	*Nicotiana tabacum* **	Solanaceae	Tambaa'i koshsho'o	Shrub	Stimulant	MH-103
47.	*Nigella sativa* **	Ranunuclaceae	Heemachchi enja	Herb	Spice and condiment	MH-93
48.	*Ocimum tenuiflorum* **	Lamiaceae	Qadaalli enja	Herb	Spice and condiment	MH-207
49.	*Persea americana* **	Lauraceae	Avokaato'o	Tree	Fruit	MH-121
50.	*Phaseolus lunatus* **	Fabaceae	Boloqe'e (Lob otongora)	Climber	Pulse(food)	MH-216
51.	*Lathyrus oleraceus* **	Fabaceae	Gite'e	Herb	Pulse (food)	MH-227
52.	*Prunus persica* **	Rosaceae	Kooka	Tree	Fruit	MH-212
53.	*Prunus x doemstica* **	Rosaceae	Briima	Tree	Fruit	MH-211
54.	*Psidium guajava***	Myrtaceae	Zayituuna	Shrub	Fruit	MH-179
55.	*Rosmarinus officinalis***	Lamiaceae	Maa'lenjja	Shrub	Spice and condiment	MH-12
56.	*Rhamnus prinoides*	Rhamnaceae	Geesho'o	Shrub	Stimulant	MH-120
57.	*Saccharum officinarum* **	Poaceae	Shonkoora	Grass	Sugar	MH-180
58.	*Solanum tuberosum* **	Solanaceae	Dinnichcho	Herb	Root/tuber (food)	MH-217
59.	*Sorghum bicolor*	Poaceae	Sarata	Herb	Cereal crop (food)	MH-175
60.	*Thymus schimperi* *	Lamiaceae	Ishina	Herb	Spice and condiment	MH-85

61.	*Trigonella foenum-graecum***	Fabaceae	Shuqoota	Herb	Spice and condiment	MH-94
62.	*Triticum aestivum***	Poaceae	Arasa	Grass	Cereal crop (food)	MH-224
63.	*Vicia fava***	Fabaceae	Baaqeela	Herb	Pulse (food)	MH-226
64.	*Vigna unguiculata*	Fabaceae	Hoffi otongora	Herb	Pulse(food)	MH-181
65.	*Zea mays* **	Poaceae	Boqqolla	Grass	Cereal crop (food)	MH-225
66.	*Zingiber officinale* **	Zingiberaceae	Jaanjibeela	Herb	Spice and condiment (Food additives)	MH-64

* Endemic and cultivated plant species to Ethiopia, ** introduced and cultivated to Ethiopia, and native and cultivated/semi cultivated plant species (not used asterisks).

Appendix 13.Livestock ailments recorded in the study area (Soro District)

No.	Identified livestock aliments by veterinary experts (*e.g.* Dr. Sisaye Haile and Dr. Birhanu Erimias)	Vernacular name (Hadiyissa/Had.)/Few in Amharic (Amh.)	Affected Livestock Type	Ailment Category
1.	Foot and Mouth Disease/Ailment, FMD/FMA (it removes hooves from cattle)	Anjichcho/nidifa	Infects bovines (cattle)	Dermatological inflammation
2.	Lumpy Skin Disease/Ailment (LSD/A)	Loophphi jabbo, ye qoda gurubiribita (Amh.)	Infects bovines	
3.	Blackleg (inflammation of skeletal and cardiac muscles, severe toxemia and high mortality)	Moggolle'i/hafachchi jabbo	Infects bovines	
4.	PPR (Peste des petits ruminants- ailment of goats which creates wound infection around the mouth).; shoat pox	Fanxaaxa/kurkusso'o	Mostly attacks both sheep and goats	
5.	Epizootic lymphangitis	Gammaam tusha	Equines (large numbers of livestock of horses, donkeys and mules)	
6.	Bat urine ailment (cause skin ulceration)	Cii'i xisso, yewof beshita (Amh.)	Attacks all livestock	
7.	Mastitis (breast-dermatologicao)	Anuu'n jabbo, ye desta bashita (Amh.)	Bovines	
8.	Actinomycosis	Korossa/gergeeda	Bovines	
9.	Skin wound (fresh skin cutting)	Xiige'oo mada/omara	Attacks all livestock	
10.	Sore-with pus	Maraam omara	Attacks all livestock	
11.	Skin ailment	Omachchi jabbo	Attacks all livestock	
12.	Back sore	Afa'l gambaxa	Attacks equines: horses, donkeys and mules	
13.	Livestock tumor (venign tumor/external tumor)	La'l xeenxira	Infects bovines, equines	
14.	Swelling body	Orachchi dashshimma	Bovines	
15.	Anthrax	Xiinxichcho, abassanga (Amh.)	Infects bovines, equines, sheep	Gastro-intestinal
16.	Livestock trypanomiasis (due to bite of tsetse fly)	Sute'e, gandi (Amh.)	Infects both bovines and equines	

17.	Coccidiosis	Xiiga edaakkoo aadora	Infects poultry	
18.	*Fowl typhoid*	Cii'i soko'i gaayyo'o	Infects poultry/cholera	
19.	Livestock hepatitis/jaundice (liver ailment cause yellow skin (Ectruse).	Afa'l jabo	Attacks all livestock	
20.	Diarrhoea	Alooyya te'im godaphphi aadite	Attacks all livestock	
21.	NCD/A (New Castle Disease/Ailment)	Kembesha, feangil (Amh.)	Poultry ailment	
22.	Acidiosis (bloat)	Godabduubimma/quruuro'o	Attacks all livestock	
23.	Faciolosis	Mure'e, loomme/ wocwoca	Bovines, sheep and goats	
24.	Actinobacillosis (wooden tongue)	Soorgassa/allabo mooradisoo jabbo	Bovines	
25.	Telleriosis/Anaplasmiosis (spleen enlargement)-tick borne ailment)	Hilleeffi jabbo/suruulli-jabbo	Bovines and sheep	
26.	Toxicity (poisonous)	Marzi yoo mutaano itimmi jabbo	Poisonous bovines, sheep and goats	
27.	Abdominal pain/abdominal ache	Bashsha'na	Bovines and sheep	
28.	Constipation	Shilli gokka	Bovines, sheep, goats	
29.	Nasal bote (parasitic leech)	Urulla	Attacks all livestock	Respiratory
30.	Asthma (stenosis of respiratory organ)	Saallaaqa/shiinqa	Equines	
31.	Pasteurellosis (livestock TB)	Suqqo'i/qadafa'l jabbo	Attacks bovines	
32.	*Aspiration pneumonia*	Siniqa	Bovines, sheep and goats	
33.	Insects' infection	Sa'n kochcha'na	Bovines, sheep, goats	
34.	Livestock mites, flea and lices (mange mite/otitis)	Baalqaanca, ibiiba, cibe'e	Attacks all livestock	Ecto-parasitic
35.	Babesiosis (liver ailment)	Waadamuuncho	Attacks all livestock	Endo-parasitic) (protozoan)
36.	Cysticercus (bovis, ovis/livestock ascariasis)	Hensheeshsha	Bovines, goat, sheep	Endo-parasitic
37.	Rabies (dogs, cats, foxes, wolves, insectivorous and fruit-eating bats)	Machchaaru wish jabbo,	Attacks all livestock	Neurologic
38.	Snake bite	Hamash qasimma	Attacks all livestock	
39.	Listeriosis	Horoore jawwaa'aa do'isimma, azurit (Amh.)	Attacks all livestock	
40.	Tetanus	Teetaanoosa	Attacks all livestock	
41.	Conjunctivitis (eye pain)	Illi xisso	Attacks all livestock	Orbital
42.	African horse sickness (para-orbital eye lob enlargement/inflammation (AHS)	Ille fugoo jabbo	Infects equines	
43.	Trauma (injury, fracture, broken bones, muscles deformities, blood accumulation in the body)	Aphphixximma/madimma	All forcefully heated livestock that cause blood accumulation	Orthopedics
44.	Arthritis (gouge or mondy-morning ailment)	Luquc/hoong jabbo	Mostly attacks equines/horses, donkeys and mules.	Musculo skeletal
45.	Reproduction problem	____	Bovines	Infertility, fertility or unable to fertility
46.	Retained placenta (fetal placenta membrane remain)	Maqqeer gatimmi jabbo	Bovines, sheep, goats, horses and donkeys	Placental
47.	Michi	Michcha	Attacks all livestock	Fibril illness
48.	Dingetegn	Xokka/qasimmi jabbo	Attacks all livestock	Any aliment

49.	Evil eye	Manni ille	Attacks all livestock	Other
50	Evil spirit	Goromota	Attacks all livestock	Other

Appendix 14. List of medicinal plants for treating livestock ailments in Soro District with the mode of preparations and applications

Scientific name	Family	Local name (Hadiyissa)	Ailment treated (Hadiyissa/Had. /Amharic/Amh.)	Ha	PU	CP	Medicinal plants and applications include FP (preparation form), MT (means of treatment), and RA (root of administration).	UR	VN: MH:
Achyranthes aspera L.	Amaranthaceae	Hoffi qaccabba	*Aspiration pneumonia*	H	L	F	Crushed, squeezed, and spitted the decoction juice to the nose via nasal administration	2	MH-75
Acmella caulirhiza Delile	Asteraceae	Bishibisha	Perganency (fertility)	H	Fl	F	Crushed with leaves of *C. macrostachyus* and *O. rochetiana*, enclosed with fibre, and inserted in the reproduction organ for six hours after copulationin in three days.	2	MH-42
			Bat urine ailment (jaundice)		Fl, R, Wh	F	Crushed either part, mixed in water, and washed the body skin.	1	
Aframomum corrorima (A. Braun) P.C.M. Jansen*	Zingiberaceae	Wokkaashsha	Abdominal pain	H	Se	D	Fresh or dry leaf or fruit of *C. sativum* and *R. chalepensis*, crushed with a bulb of *Z. officinale* and NaCl salt, homogenized in cold water, and drunk in a one-liter concoction via mouth or anus; oral or anal.	14	MH-88
			Acidiasis (bloat)	H	Se	D	Seed of *N. sativa* with leaf and fruit of *C. sativum* and *R. chalepensis* crushed with bulb of *Z. officinale* and *A. sativum* with common salt or NaCl, homogenized in cold water, and drunk one liter concoction via mouth and anus; burning or glowing with hot metal or iron in fire.	6	
							Crush the leaf of *S. hypselodendron* and the leaf of *G. robusta,* mix with water, and drunk one liter.	1	
							Powdered with *E. globulus* leaf and *C. macrostachyus*, mix with water, and drunk one liter.	1	
			Aspiration pneumonia	H	Se	D	Seed is chewing with NaCl and spitting to the nose.	2	
			Trauma (blood accumulation in the body)	H	Se	D	*A. corrorima* seed with *G. amygdalinum* fresh leaf crushed or fresh or dry leaf or fruit of *C. sativum and R. chalepensis*, squeezed, and drunk one liter of concoct.	1	
			LSD/A	H	Se	D	Crushed with a dry leaf of *N. tabacum*, a bulb of *A. sativum*, a rhizome of *Z. officinale*, and a fresh pod of *C. frutescens*, pounded it in water and drunk a one-	1	

							liter.		
Afrocarpus gracilior (Pilg.) C.N.Page	Podocarpaceae	Digiba	Rabies	T	L	F	Seven buds, crushed with fresh leaves of *Z. asiaticum,* fresh stem bark of *S. oxyacantha*, and *E. capensis*, are mixed with water and drunk in three coffee cups orally.	7	MH-34
Agave sisalana Perrine. **	Asparagaceae	Aanci haqqa	Swelling	S	L	F	Boiled or heated in fire and touch on the painful part; dermal.	4	MH-95
			NCD/A	S	L	F	Heated/boiled in fire and squeezed the sap, added fresh or spicy butter, and gave it to eat alone or drunk mixed with a syringe by opening the beak; drunk decoction	2	
Ajuga integrifolia Buch. -Ham. Ex D. Don.	Lamiaceae	Annaamura	Evil eye (evil spirt)	H	L	F/D	Crushed or powdered, mixed with water, and drunk one liter or jug decoction through the mouth; oral route.	1	MH-51
Albizia schimperiana, Oliv.	Fabaceae	Maande'e	*Aspiration pneumonia*	H	Sb	F	Stem bark is chewing and spitting or sniffing at the nose.	56	MH-26
Allium cepa L.**	Amaryllidaceae	Kashar shunkurutta	Pasteurellosis/livestock TB	H	2Bu	F	Leaf of *C. arabica*, fresh or dry two bulbs of *A. sativum,* one rhizome of *Z. officinale*, and pods of *C. frutescens* drunk one liter of concoction given orally.	2	MH-92
			Actinomycosis (Ankulicho-Had.)				Three to four bulbs *of A. sativum* crushed with one bulb of *A. cepa*, half of rhizome of *Z. officinale,* and one fruit of *C. aurantiifolia*, and drunk one liter.	2	
Allium sativum L. **	Amaryllidaceae	Tuma	Lumpy Skin Disease/Ailment (LSD/A)	H	Bu	F/D	*N. tabacum* dry leaf, mixed with fresh *Z. officinale* rhizome, fresh leaf or root of *M. foetida*, drunk one liter for three, three, or four times in three-day intervals or until healed; burn with hot metal or heated or glowed iron in fire.	42	MH-90
			Swelling	H	Bu	F/D	Fresh leaves of *C. macrostachyus* are crushed with dry leaves of *N. tabacum*; one whole bulb of *A. sativum* is mixed in water; it then stays for one to two days and drunk one liter concoction through the mouth; oral.	3	
							Ground the dry leaf of *N. tabacum* with NaCl salt together with the leaf or fruit of *R. chalepensis* and *C. sativum*, the seed of *A. corrorima*, the bulb of *A. sativum*, and *Z. officinale* mixed together with butter, and then one liter of the solution is drunk via mouth and anus.	4	
							Seed of *A. corrorima* and *N. sativa* with leaf and fruit of *C. sativum and R. chalepensis* crushed with rhizome of *Z. officinale* with common salt, homogenized in cold water, and drunk one liter concoction; burn with hot or glowing metal or iron in fire; drunk one cup petroleum.	2	

							Fresh or dry bulbs are mixed with dry *N. tabacum,* pounded, and drunk one liter concoction via mouth; oral		
			Coughing	H	Bu	F/D	Crushed with dry leaves of *N. tabacum* and *Z. officinale* rhizome, then mixed the powdered with water and drunk a liter concoction orally given.	2	
			New Castle Disease/Ailment (NCD/A)	H	Bu	F/D	Fresh *Z. officinale* is crushed, pounded with two to three fresh pods of *C. frutescens*, and drunk in three to four drops by syringe.	2	
			Aspiration pneumonia	H	Bu	F/D	Three to four bulbs are crushed and inhaled through the nose.	1	
			Telleriosis/anaplasmiosis	H	Bu	F/D	Crushed with fresh rhizome of *Z. officinale*, mixed with arekie, and drunk one liter of concoct; oral.	1	
			Constipation	H	Bu	F/D	Three to six bulbs crushed with fresh/dry leaf/fruit of *C. sativum*, and drunk one liter concoction.	1	
Aloe sp.	Asphodelaceae	Geneeno'o	Swelling, wound	S	L	F	Boiled in fire, warmed, and touched/wrabbing the swollen area; crushed, pounded, and drunk one liter	8	MH-184
			Diarrhoea	S	L	F	Leaf is crushed, pounded, and drunk one-liter infusion.	1	
Antherica sp.**	Anthericaceae	Dashshi maracca	Body swelling	H	Rh	F/D	Freshly crushed, pounded with water, and drunk one liter	2	MH-380
Apodytes dimidiata E. Mey.ex Arn.	Metteniusaceae	Mewwa	Bat urine ailment	T	L	F	Crushed *U. simensis*, mixed it with water, and drunk one-liter infusion through the mouth.	2	MH-253
Artemisia absinthium L. **	Asteraceae	Naatira	Livestock trypanomiasis	H	L	F	Leaves and buds are crushed, pounded with water, and given half a liter by oral and anal administration.	2	MH-87
			Aspiration pneumonia	H	L	F	Chewed with fresh leaves of *C. citratus* and *R. cordifolia*, bud of *P. dodecandra*, and seed of *A. corrorima*, spit the juice to the nose.	1	
Asparagus africanus Lam.	Asparagaceae	Hundufaanna	Evil eye (evil spirit)	H	R, Wh	F/D	Its parts are crushed, pounded in water, and drunk from one water glass to one liter.	20	MH-198
						F/D	Whole parts are crushed and washed with the pounded infusion in the morning.	3	
			Coughing	H	R, Wh	F/D	Crushed and pounded in water, drunk one liter or glass.	1	
Balanites aegyptiaca (L.) Delile.	Zygophyllaceae	Baddanno'o	Arthritis (gouge)	T	L	F	Crushed fresh leaf, pounded, and given one liter of anal and oral administration.	1	MH-16
Bersama abyssinica Fresen.	Francoaceae	Koraqqa	Anthrax	S	L	F	Crushed, pounded in cold or warm water, and drunk one glass or mug.	5	MH-80
			Swelling	S	R	F	Crushed, pasted, and tied to the painful area.	1	
Brucea antidysenterica J.F.	*Simaroubaceae*	Ciiroonta	Blackleg	S	R	F	Crushed and pounded it in water and eaten the solution.	1	MH-30

Mill.									
Brugmansia suaveolens (Humb. & Bonpl. ex Willd.) Sweet. **	Solanaceae	Qadaalli fiita	Diarrhoea	S	R	F	Crushed with leaves of *E. divinorum*, drunk one liter concoction by mouth.	8	MH-201
			Acidiosis (bloat)	S			Crushed with leaves of *E. divinorum*, drunk one liter concoction by mouth.	2	
Calpurnia aurea (Aiton) Benth.	Fabaceae	Senna	Livestock mites, flea and lices (skin ailments /mange mite)	S	L	F	Crushed, pounded with water, wash the skin by tiding mouth to treat dermatophytes; fata if it swallowed to mouth.	14	MH-27
Capsicum frutescens L. **	Solanaceae	Mixmixo'o	Coccidiosis	H	Pd	F	Crushed mixed with penicillin; added water and mixed butter; swallowed the bolus through the beak of the hen.	7	M-91
							Fesh pods with the rhizome of *Z. officinale* crushed together, mixed water, squeezed the juice, and drunk the drops by syringe through the beak.	1	MH-24
			Spleen enlargement	H	Pd	F	Crushed and drunk one glass to half of liter with water.	1	
			LSD	H	Pd	F	Fresh pods with dry *N. tabacum*, fresh or dry bulb of *A. sativum*, fresh rhizome of *Z. officinale*, and dry seeds of *A. corrorima* crushed, drunk one liter orally.	1	
			NCD	H	Pd	F	Two to three fresh pods with two full fresh or dry bulbs of *A. sativum* and one rhizome of *Z. officinale*, crushed, and drunk by syringe through the beak or mouth.	1	
			Pasteurellosis (livestock TB)	H	Pd	F	Drunk one liter with crushed or roasted *C. arabica* leaf, *A. sativum* two bulbs, *A. cepa* one bulb, and *Z. officinale* one rhizome.	1	
Carduus schimperi Sch.Bip.	Asteraceae	Hallutta	Perganency (fertility)	S	R	F	Crushed with fresh three buds of *C. macrostachyus* and three buds or flowers of *R. abyssinica* crushed enclosed fibre and inserted in the female sex organ by tying the lower tip of the enclosed at the tail for 30 min. to occur perganency.	5	MH-328
							Three fresh buds of *C. macrostachyus* crushed with fresh roots or fruits of *O. rochetiana* were enclosed, pounded, or wrapped in fibre, and inserted into the female sex organ by tying the other tip on the tail for 30 min.	1	
			Poisonous/toxicity by eating plants	S	R	F	Crushed, mixed with water, and drunk one liter of infusion; or drunk one liter of milk alone and soil imedetely for eating fresh leaves of *A. salicifolia,* and germinating two-three leaves contain *S. bicolor*; cause body fatness.	3	
Carissa spinarum L.	Apocynaceae	Qoqombe'e	Swelling	S	R	F	Fresh roots were crushed, boiled, and drunk in one glass.	2	MH-328

Citrus x aurantiifolia (Christm.) Swingle. **	Rutaceae	Loome'e	Actinomycosis	S	Fr	F	One whole fruit with three to four bulbs of *A. sativum* crushed with half a rhizome of *Z. officinale*, one bulb of *A. cepa*, and drunk one liter concoction, oral administration.	1	MH-208
Clematis hirsuta Perr. & Guill. *	Ranunculaceae	Hoffi fiida	Livestock hepatitis /jaundice	Cl	L	F	Crushed with fresh leaves of *C. macrostachyus* and drunk one liter concoction via oral.	2	MH-44
Clematis longicauda Steud. ex A. Rich. *	Ranunculaceae	Lob fiida	Babesiosis	Cl	L	F	Boiled, crushed, and mixed soil salt ('Borra'-Had.,), and drunk one-liter infusion.	4	MH-43
			Acidiosis (bloat)	Cl	R	F	Roots are crushed, pounded and drunk one liter.	2	
			Perganency (fertility)	Cl	Bd		Crushed with buds of *C. macrostachyus* and buds of *O. rochetiana,* enclosed fibre and insert in female reproduction organ for 30min. or occurrence of perganency or three days.	2	
Clutia abyssinica Jaub. & Spach.	Peraceae	Shum xiigeeshsho	Toxicity/poisonous plant eating livestock	S	L	F	Crush and drunk a one to two-liter infusion for the treatment of poisonous plants (*A. salicifolia*) eaten by livestock. Uses for livestock's fatness.	4	MH-40
			Aspiration pneumonia	S	R, Bd	F	Crushed it, mixed with water, and drunk one liter of squeezed liquid.	2	
			Actinomycosis	S	R	F	Crushed, mixed with water and drunk one liter.	1	
Coffea arabica L.	Rubiaceae	Buna	Abdominal pain, livestock TB	S	L	F	Crushed with one whole rhizome of *Z. officinale* and drunk one liter concocted.	4	MH-52
			Aspiration pneumonia	S	Se	D	Chewed with NaCl and spited the juice to nose.	1	
Coleus abyssinicus (Fresen.) A.J. Paton. *	Lamiaceae	Bobaanqa	Cysticercus, bovis, ovis (ascariasis), diarrhoea	S	Bd	F	Crushed, mixed with water, and drunk one mug of two liter; decoction of orally calf to adult.	7	MH-56
Colocasia esculenta (L.) Schott	Araceae	Gabija	Nasal bote (parasitic leech)	H	Rh	F	Crushed the fresh leaves of *E. globulus* and drunk the concoction.	1	MH-191
Combretum molle R. Br. ex G. Don.	Combretaceae	Goonchi habulle'e	Diarrhoea	T	R, Rb	F	Crushed, powedered, and mixed in cold or warm water, and drunk a one to two liter decoction via oral.	1	MH-193
Commelina benghalensis L.	Commelinaceae	Lob gu'ma	Constipation	H	L	F	Crushed, mixed with water, decoct, and drunk three liter or two liter *Lagenaria siceraria* drinking material (Bulle'e'-Had.); oral	4	MH-81
Cordia africana L.	Boraginaceae	Weddeeshsha	*Aspiration pneumonia*	T	L, Sb		Crushed, decocted and closed with fibre and spited to nose; nasal route	3	MH-115
			Acidiosis	T	L		Fresh leaves are crushed, mixed with water, and drunk one liter decoction via mouth.	1	
Coriandrum sativum L. **	Apiaceae	Woldimaama	Acidiosis abdominal pain, body swelling	H	L, Fr	F/ D	Crushed alone or with or without NaCl, fresh leaves or dry fruits of *R. chalepensis*, fresh rhizomes of *Z. officinale*, and bulbs of *A. sativum* are drunk in a one-to-two-liter concoction through oral administration.	14	MH-172
			Blackleg	H	L, Fr	F/ D	Crushed with fresh buds of *C. macrostachyus* and *F. vulgare*, mixed with cold or warm water, drunk a one-liter concoction through oral administration.	1	

Crepis rueppellii Sch. Bip.	Asteraceae	Gundi baar adi yoo fiita (fella'i ado)	*Aspiration pneumonia*	H	R	F	Measured with a finger index of the root, chewed and swallowed the juice, spited to the nose.	1	MH-277
Crinum abyssinicum Hochst ex A. Rich.	Amaryllidaceae	Buchchi unkurubba (Goti tuma)	Skin wound	H	R	F	Crushed and pasted on the wound on the dermal.	1	MH-274
Croton macrostachyus Hochst. ex Delile.	Euphorbiaceae	Masana	Actinobacillosis-wooden tongue, FMA	T	Bd	F	Crushed with fresh leaves of *J. procera*, *E. divinorum*, and dry dungs; eat them with warmed *C. macrostachyus* buds with butter; eat their heated or boiled parts, inhaling the mixture smoke; wrap the patient tongue with two to three pieces of dry livestock cattle dung and human hair alive.	167	MH-01
			Actinobacillosis-wooden tongue, FMA	T	L		Fresh leaves or buds warmed or heated with leaves of *E. divinorum* and dry dung, then inhaled the smoke (nasal, oral).	1	
			Skin wound	T	La		Fresh buds with buds of *G. auriculiferum*, dry leaf prod uct of *N. tabacum,* and NaCl are pasted on the infected.	9	
			Livestock mites, flea and lices (skin ailments /mange mite)	T	L		Crushed with fresh leaves of *C. aurea* and washed the body skin with its concoction.	1	
			Anthrax, acidiosis, pasteurellosis	T	Sb, L/ Bd		The parts are crushed with fresh root of *S. abyssinica* and dry prepared leaves of *N. tabacum*, mixed with water and butter, and drunk two-three-liter concoct via oral administration.	25	
			Acidiosis	T	Sc	D	Powdered with stem charcoal from *E. globulus* and drunk via oral means of administration.	1	
			Pasteurellosis, FMD	T	L	F	Fresh leaves crushed, pounded and drunk one liter, and inhale the smoke.	2	
			Jaundice	T	L	F	Fresh leaves with fresh leaves of *C. hirsuta* crushed and drunk a one liter concoction via mouth.	3	
			Dingetegna	T	L, Bd	F	Fresh leaves or buds alone or crushed with fresh leaves of *G. amygdalinum* and *E. divinorum* mixed with water and drunk one to two liters; inhale their smoke.	7	
			Placenta remain	T	L	F	Fresh leaves with fresh leaves of *G. amygdalinum*, mixed with water, and drunk one-liter concoction.	3	
			NCD/A	T	L/ Bd	F	Three buds are crushed, pounded with arekie or water, and butter given to the drunk or drunk by syringe.	2	
			LSD	T	L, Sb	F	Crushed with dry prepared black *N. tabacum* mixed with NaCl and water drunk one liter concoction via oral.	5	
			Swelling eye, body swelling (Fuxxe'i gana)	T	L, Bd	F	Touch body skin of pained area with warmed boiled/heated fresh leaves/ buds without processed.	4	

			Blackleg	T	L, Bd	F	Eat fresh leaves or only three buds with butter; crushed with fresh roots of *M. foetida* and fresh leaves of *H. lusitanica* and *E. divinorum*, drunk one liter concoct.	10	
			Perganency (fertility)	T	L	F	Crushed enclosed in fiber; add sex organ for three days.	4	
			Abdominal pain	T	Bd	F	Fresh buds crushed and ate with butter.	3	
			Snake bite (venom injection)	T	L		Crushed, pounded with water and drunk one liter decoction.	2	
			Diarrhoea	T	Sb	F	Crushed fresh leaves of *V. nobilis* and drunk one liter concoction through oral administration.	5	
			Evil eye, evil spirit	T	Rb	F	Crushed, washed the body and drunk one liter decoction.	1	
			Coccidiasis	T	Bd	F	Crushed with fresh two to three pods of *C. frutescens*, mixed with butter, and eaten or drunk via oral.	3	
			Body swelling	T	Sb	F	Crushed, drunk one liter decoct; touch the swelled by boiled.	2	
Cucumis ficifolius A. Rich.	Cucurbitaceae	Uulli gereechcho	Rabies, babesiosis, anthrax, blackleg, dinegetegna	Cl	R	F	Crushed fresh roots with or without NaCl or livestock soil salt ('Borra'), mixed in water, and drunk one glass to one liter; also given for dogs and cats, oral and anal.	9	MH-14
			Venign external livestock tumor	Cl			Fresh roots are crushed and drunk one liter decoction via anal or oral administration.	2	
Cyathula uncinulata (Schrad.) Schinz.	Amaranthaceae	Onno'i qaccabba (Gonje'e)	*Aspiration pneumonia*	H	R	F	Crushed, mixed with water, squeezed, and drunk half a liter through the mouth, sniffing or spitting the juice to the nose.	9	MH-199
			Blackleg	H	R	F	Crushed, mixed with water and drunk one liter decoction for every morning for four days.	3	
Cymbopogon citratus (DC.) Stapf. **	Poaceae	Hixaana	Conjunctivitis/eye pain	H	R, L	F	Chewed and spited; crushed and squeezed; add two up to three drops by syringe in the morning and night.	39	MH-86
			Aspiration pneumonia	H	L	F	Crushed, mixed with water, drunk one liter, inhale, chewed, and swallowed the juices by oral means.	2	
			Bloat	H	L	F	Crushed and drunk one liter decoction through mouth.	1	
Cyperus rotundus L.	Cyperaceae	Naaqa	Acidiosis	G	R	F	Crushed, mixed with water and drunk one coffee cup or one glass one liter of decoction via mouth.	2	MH-168
Cyphostemma adenocaule (Steud. ex A. Rich.) Desc. ex Wild & R.B. Drumm.	Vitaceae	Dodoobba (Jaanjeechcho)	Acidiosis body swelling, snake bite	Cl	R	F	Crushed and drunk half a coffee cup to one liter of the decoct.	1	MH-339
Cyphostemma pannosum Vollesen.	Vitaceae	Gidiidoola	Skin wound	H	R	F	Roots are crushed, mixed with water, and pasted on the wound.	9	MH-330

			Acidiosis blackleg, telleriosis (anaplasmiosis), spleen enlargement-tick borne ailment, retained placenta, anthrax	H	R	F	Crushed and drunk one glass to two liters of decoction through oral and anal administration.	4	
Datura stramonium L.**	Solanaceae	Machaa'l haqqa	Rabies	H	R	F	Crushed with *S. abyssinica* roots or only mixed with water and drunk one glass or mug to two liters to one 'Bulle'e'/equal to one Pepsi bottle'(Had.) immediately via mouth or anus.	10	MH-69
Dicliptera foetida (Forssk.) Blatt.	Acanthaceae	Omoro'o laba	Bat urine ailment	H	L	F	Crushed, mixed with water, and drunk one liter, washing the body with the decoction.	1	MH-136
Dicliptera magaliesbergensis K. Balkwill.	Acanthaceae	Baxaaxursa/Omoro labi jule'i/maniilli qaraare)	Pasteurellosis, evil eye (evil spirit)	H	R, L	F	Crushed, mixed with water, and drunk one liter of decoction via mouth while washing the body skin.	1	MH-158
Dodonaea viscosa subsp. *angustifolia* (L.f.) J.G. West.	Sapindaceae	Kitkiita	PPR (Peste des petits ruminants), diarrhoea	S	Bd	F	Fresh leaves with buds of *G. amygdalinum*, buds of *C. macrostachyus*, *E. depauperata*, *B. antidysenterica*, *R. cordifolia, J. chimperiana, S. elliptica*, and *P. dodecandr*a, mixed with water, and drunk half a glass for young calf and two glasses for adults.	17	MH-19
			Bat urine, back sore	S	L	F	Crushed, pasted on the painful area or wound, and tied.	2	
			Bloat	S	L	F	Crushed and drunk one liter decoction.	1	
Echinops kebericho Mesfin. *	Asteraceae	Toosa	Abdominal pain Acidiosis	H	R	F	Crushed, mixed with water, and drunk one glass up to one liter of oral and anal administration.	2	MH-195
Ekebergia capensis Sparrm.	Meliaceae	Oloola	Rabies	H	Sb	F	Crushed the fresh leaves of *Z. asiaticum*, the fresh stem bark of *S. oxyacantha*, and *A. gracilior*, mixed them with water, and drunk three coffee cups of the concoction.	4	MH-248
Ensete ventricosum (Welw.) Cheesman. *	Musaceae	Weesa	Placental remain, trauma (broken bones)	H	L, Ps, Cm	F	Fresh red leaf/pseudo stem/corm ('Hamicho'-Had.) roasted and eaten until healed or removed from the remained placenta orally.	21	MH-20
			Acidiosis, diarrhoea	H	R	F	Crushed or 'Bu'o-Had', 'Hamicho-Had.', mixed with water, and drunk one liter of corm ('Hamicho'-Hadiyissa) eaten livestock, eaten roasted/cooked corm.	9	
			Toxicity	H	Ps	F	Freshly crush, squeeze water, and drunk two liters of oral	1	
Eragrostis tef (Zucc.) Trotter. *	Poaceae	Xaafe'e	Sore	H	Se	D	Unprocessed seeds are mixed with donkey faeces and pasted on the sore wound.	1	MH-223
Erica arborea L.	Ericaceae	Saate'e	Constipation	S	Bd	F	Fresh buds or leaves are crushed; drunk one liter orally.	1	MH-233
Erythrina abyssinica Lam.	Fabaceae	Qaala'i wora'a	Acidiosis	T	Sb	F	Crushed, mixed with water, and drunk one liter of the decoction and given oral administration.	2	MH-332

Erythrina brucei Schweinf. *	Fabaceae	Wora'a	*Aspiration pneumonia,* acidiosis, constipation, abdominal pain	T	Sb	F	Chewed with fresh stem bark of *D. schimperiana* and/or with dry leaves of *N. tabacum* spitted to the nose, drunk one liter of concoction by oral and nasal route.	15	MH-55
Eucalyptus globulus Labill. **	Myrtaceae	Qadaalli baarzaafa	Bloat	T	Sc	D	Drunk one liter of charcoal from *C. macrostachyus* and *H. lusitanica* mixed with water, and drunk one liter of concoct.	11	MH-54
			Dingetegna	T	Bd	F	Boiled, mixed with butter, and eaten; inhaled the smoke.	2	
			Parasitic leech	T	L	F	Crushed with fresh *C. esculenta* rhizome and drunk.	2	
			Coughing, infection of grass hopper entrance, listeriosis	T	L	F	Crushed with dry prepared leaves of *N. tabacum*, mixed with water, and drunk one liter in three alternative days until healed.	4	
Euclea divinorum Hiern.	Ebenaceae	Meegaara	Actinobacillosis, blackleg, dingetegna	T	Bd	F	Crushed with fresh buds of *C. macrostachyus*, boiled and eaten; burned with dry livestock dungs inhaled the smoke through the nose, oral, and nasal.	16	MH-15
			Bloat	T	L	F	Fresh buds are crushed with fresh buds of *R. neglecta* and *J. procera*, mixed with water, and drunk one liter.	1	
			Diarrhoea, acidiosis	T	L	F	Crushed alone or with fresh root of *B. suaveolens,* mixed with water, and drunk one liter.	2	
			Conjunctivitis/eye ailment	T	Bd	F	Chewed and spitted to the eye.	2	
Euphorbia abyssinica J.F. Gmel.	Euphorbiaceae	Adaamma	Asthma (stenosis, respiratory organ)	T	St-Br	D	Dry stem branch burning and inhaling the smoking gas, nasal and oral administration.	15	MH-200
			Body swelling, wound, livestock tumor	T	La	F	Milky latex juice extract and NaCl are added, then smeared on the cutted skin wound and swollen part; it burst the swell and released out as pus.	6	
Euphorbia depauperata Hochst. ex A. Rich.	*Euphorbiaceae*	Gendeella	PPR (Peste des petits ruminants)	H	Bd /L	F	Crushed, mixed with water, and drunk one glass of young calf, two glasses of adults, orally.	1	MH-47
			LSD	H	Bd /L		Crushed, mixed with water, and drunk one liter of decoction oral administration.	4	
Foeniculum vulgare Mill.	Apiaceae	Wollanga (Ashbe'e)	*Aspiration pneumonia*	H	L, Fr	F	Fresh leaves and fruits are chewed and spitted into the nose.	4	MH-66
			Blackleg, pasteurellosis	H	L, Fr	F	Crushed, powdered, mixed with water, and drunk one liter of decoction, oral	1	
Grevillea robusta A. Cunn. ex R.Br. **	Proteaceae	Giraar shuwwishuwwa	Constipation, diarrhoea, LSD, Acidiosis	T	L	F	Crushed alone or with fresh leaves of *S. hypselodendron,* mixed with water, drunk one liter.	5	MH-106
Gymnanthemum amygdalinum (Delile) Sch.Bip.	Asteraceae	Heebbaa	Actinobacillosis, trauma/blood accumulation, PPR (Peste des petits ruminants), diarrhoea, babesiosis (liver ailment),	T	L, Bd	F	Crushed and mixed with water, and drunk one liter of decoction for adults and half a liter for young people via oral administration.	19	MH-07

			dinegetegna, acidiosis, placenta remain						
			Conjunctivitis/eye pain	T	L	F	Mixed with water, squeezed, filtered, and added three drops to the eyes.	3	
Gymnanthemum auriculiferum (Hiern) Isawumi.	Asteraceae	Baarawwa	Wound	S	L, Bd	F	Crushed with fresh/dry leaves of *N. tabacum*, pasted and tied; added the juice until cure	11	MH-03
			Fowl typhoid	S	L, Bd	F	Crushed the fresh or dry leaves of *N. tabacum* and drunk the juice through the beak via the oral route.	5	
Gymnanthemum sp.	Asteraceae	Aggagga	Dingetegna, diarrhoea, trypanomiasis	S	R	F	Crushed, mixed with water, and drunk two-liter infusion of decoctions by oral administration.	3	MH-309
Gymnosporia arbutifolia (Hochst.ex. A. Rich.) Loes.	Celastraceae	Jonge'e	Conjunctivitis (eye pain)	T	R	F	Crushed, mixed with water, filtered by a neat white cloth, and added two to three drops to the eyes.	1	MH-126
			Aspiration pneumonia	T	R	F	Chewed fresh roots spitted to the nose, nasal route	1	
Hagenia abyssinica (Bruce) J. F. Gmel.	Rosaceae	Suuxo	Bat urine ailment	T	Fl, Se	D	Crushed and mixed with water and drunk one coffee cup 1st by nose and ear; 2nd one liter by anus at morning	1	MH-173
Helianthus annuus L.**	Asteraceae	Faaranj nuuga	Body swelling	H	Se	D	Powedered and mixed in water, and drunk one liter	1	MH-183
Hesperocyparis lusitanica (Mill.) Bartel. **	Cupressaceae	Faaranj hooma	Livestock trypanosomiasis, blackleg, dingetegna	T	L	F	Crushed fresh leaves NaCl, mixed with water and drunk one liter via mouth or anus.	6	MH-61
Hordeum vulgare L.**	Poaceae	So'o	Acidiosis	H	Se	D	Powedered burned seeds, mixed them with water, and drunk one-liter solution of decoction orally.	1	MH-222
Hymenodictyon floribundum (Hochst. & Steud.) B.L. Rob.	Rubiaceae	Odeera (Wo'l qobbo'o)	Cysticercus: bovis, ovis (livestock ascariasis)	S	L	F	Leaves are crushed, mixed in water, and drunk. half-liter decoction given orally.	1	MH-334
Ilex mitis (L.) Radlk.	Aquifoliaceae	Ashmiinqa	Acidiosis	T	L	F	Crushed with fresh leaves or fruits of *C. sativum*, bulbs of *A. sativum,* and NaCl, drunk one liter and drunk one liter.	2	MH-241
Juniperus procera Hochst. ex Endl.	Cupressaceae	Abash hooma	Actinobacillosis (wooden tongue)	T	L	F	Fresh leaves boiled or burned in the fire with *C. macrostachyus* and smoked with the steam or gas.	1	MH-60
Justicia schimperiana (Hochst.ex. Nees) T. Anderson.	Acanthaceae	Xummunga	FMD, diarrhoea	S	Bd		Fresh buds were boiled with fresh buds of *C. macrostachyus*, breathing or inhaling the smoke through the nose or mouth, crushed, and drunk one mug for calf and two mugs for adults with water.	2	MH-31
Kalanchoe	Crassulaceae	Hancuura	Body swelling	H	L	F	Boiled fresh leaves or stems in fire, crushed, and	1	MH-

hypseloleuce Friis & M.G. Gilbert. *							inserted in the painful area by cutting the painful place.		127
Lasiosiphon glaucus Fresen.	Thymelaeaceae	Ollawwa	FMD	S	Sb	F	Stem bark is pressed, tied to the head and legs, and crushed water infusions of decoctions via oral route.	46	MH-37
			Rabies	S	Sb	F	Crushed stems from sunrise and drunk one liter of decoction.	5	
Lathyrus oleraceus Lam. **	Fabaceae	Gite'e	Nasal bote	H	Wh	D	Crushed dry straw with dry *N. tabacum* leaves, mixed in their drinking water, and killed them in the water.	1	MH-227
Lavandula dentata var. *candicans* Batt.	Lamiaceae	Qadaalli wereeggi fiita (Naatira laba)	Abdominal pain/ache	H	L	F	Crushed with NaCl, mixed with water, and drunk one liter.	1	MH-167
Lysimachia ruhmeriana Vatke.	Primulaceae	Uulli saratichcho (Guffi saratichcho)	*Aspiration pneumonia*	H	R	F	Roots chewed with NaCl and spitted to the nose.	1	MH-139
Maesa lanceolata Forssk.	Primulaceae	Kowwaada	Babesiosis, diarrhoea, aspiration pneumonia	T	Sb	F	Crushed from sunrise, mixed in cold or warm water, juice add to nose; drunk one mug-one liter; spitted to the nose; oral and nasal administration	5	MH-02
Melia azedarach L. **	Meliaceae	Niima laba	Dingetegna	T	L	F	Crushed, mixed with water, and drunk in one liter of decoction; orally.	4	MH-209
Millettia ferruginea (Hochst.) Hochst. ex Baker. *	Fabaceae	Billawwaqqa	Coughing, *aspiration pneumonia*	T	Sb, L	F	Crushed the fresh leaves of *D. viscosa* subsp. *angustifolia*, mixed them with water, and drunk one-liter of the concoct; orally.	3	MH-97
							Chewed and spitted to the nose or mouth	2	
Momordica foetida Schumach.	Cucurbitaceae	Hamash waasa	Diarrhoea	Cl	R	F	Crushed, mixed with charcoal powedered with *C. molle* in cold or warmed water; drunk one to two liters, young to adults.	48	MH-06
			Abdominal pain, abdominal ache	Cl	R	F	Crushed fresh roots and leaves of *S. hypselodendron*, mixed in cold or warmed water, drunk one liter or powedered mixed in water and drunk one liter separately.	3	
			Bat urine ailment, *aspiration pneumonia*, acidiosis	Cl	L, R	F	Crushed, mixed cold or heated water, added the juice to the urine-injured area, and drunk one liter with fruits or leaves of *C. sativum* for bloating via anal administration.	13	
			Blackleg, dingetegna, anthrax	Cl	R	F	Cushed roots alone or with leaves of *C. macrostachyus* mixed with cold or warmed water, and drunk one-two liters of oral.	16	
			Telleriosis/anaplasmiosis (sp leen enlargement-tick borne ailment)	Cl	R	F	Crushed with dry prepared leaves of *M. foetida*, mixed with two cups local arekie, and drunk one liter of concoction.	3	
			LSD	Cl	L	F	Crushed with dry leaves of *N. tabacum* and bulbs of *A. sativum*, drunk one liter until healed via mouth.	3	
			Swelling oxen head area due	Cl	L	F	Fresh leaves crushing and rubbed on the pained area.	1	

			to fraction of yoke						
			Epizootic lymphangitis	Cl	L	F	Fresh leaves are crushed and drunk in one liter via anal administration; orally.	1	
			Actino bacillosis (cause wooden tongue)	Cl	L	F	Crushed with fresh leaves or buds of *C. macrostachyus*, drunk one liter; eat boiled buds of it; and inhale the smoke with dry dung.	2	
			Evil eye (evil spirit)	Cl	R, L	F	Crushed freshly and drunk one liter immediately, oral.	1	
Myrtus communis L.	Myrtaceae	Goonchi qasha'a	Diarrhoea	S	Sb	F	Crushed from sunrise; drunk one liter until cured, oral	1	MH-169
Nicotiana tabacum L.**	*Solanaceae*	Tambaa'i koshsho'o	LSD, acidiosis, coughing, livestock TB, body swelling	S	L	FD	Crushed, fresh, or dry black product by *E. depauperata* fresh leaves alone or with a bulb of *A. sativum*, rhizome of *Z. officinale* fresh leaves of *C. macrostachyus*, mixing with water, and drinking one to two liters for two days via mouth and anus.	162	
			Aspiration pneumonia	S	L	D	Dry prepared leaves with sunrise stem bark of *E. brucei* and *A. schimperiana* chewed and spitted the fluid to the nose; closed with fibre chewing and spitting juice.	17	
			Skin wound	S	L	D	Dry leaves crushed with NaCl, powedered with fresh buds with latex of *C. macrostachyus* and *G. auriculiferum*, mixed with water, paste; tied.	22	
			Back sore	S	L	D	Crushed, powedered and sprinkled on the painful area.	12	
			Nasal bote, snake bite, insects' infection	S	L	D	Crushed with a bulb of *A. sativum* and a rhizome of *Z. officinale*, covered with ensete fibre, held in the mouth and spitted to the nose or mouth, crushed, and sprayed to protect the snake from a bite on the physical environment.	28	
			Body swelling, telleriosis	S	L	D	Crushed with rhizome of *Z. officinale*, mixed with local arekie, and drunk one liter, rubbed swollen area	11	
			Conjunctivitis (eye pain)	S	L	D	Crushed, squeezed, and added three drops of the filtrate, then added two-three drops by syringe.	6	
			Livestock tumor	S	L	D	Crushed dry prepared leaves, mixed with water paste and tied on wounded area; drunk one liter charcoal.	2	
			PPR (Peste des petits ruminants)	S	L	D	Crushed and pasted the decoction on the sore mouth.	3	
			NCD	S	L	D	Crushed and mixed with arekie and drunk by using a syringe through the beak, oral means.	4	
Nigella sativa L.**	Ranunculaceae	Heemachchi enja	Acidiosis	H	Se	D	Crushed with dry or fresh leaves and dry of *C. sativum*, *A. corrorima*, and *R. chalepensis*, rhizome of *Z. officinale*, and *A. sativum*, powedered, mixed with	5	MH-03

							water, and drunk one liter through the mouth and anus.		
Ocimum basilicum L var. *cinnamon* Basil sweet. **	Lamiaceae	Gimmenja (Basso 'i bila laba)	Constipation	H	L	F	Crushed and drunk one liter of decoction via oral administration.	1	MH-148
Ocimum lamiifolium Hochst.ex Benth.	Lamiaceae	Minaantoofa	Acidiosis (bloat)	H	L, Ag	F	Crushed with livestock salt ('Borra') and fresh or dry bulbs of *A. sativum*, *Z. officinale*, and *R. chalepensis*, drunk one liter of concoction via mouth.	4	MH-23
Ocimum spicatum Deflers.	Lamiaceae	Buubayye (Angaambiisha)	Conjunctivitis (eye pain)	S	L	F	Cushed and added two-three drops by syringe.	5	MH-67
			LSD, michi, African horse sickness/AHS	S	L	F	Crushed alone or with fresh leaves of *N. tabacum*, mix and drunk one glass of concoction by oral route.	1	
Oldeania alpina (K. Schum.) Stapleton.	Poaceae	Leema	Trauma (broken bone)	H	St	D	Dry stems are chopped or pressed and tied to the broken bone for proper attachment.	1	MH-174
Olea europaea L. subsp. *cuspidata* Wall. ex G. Don.	Oleaceae	Weera	Livestock tumor	T	Bd	F	Fresh buds are crushed and drunk one-liter concoction through oral administration.	2	MH-111
Olea welwitschii (Knobl.) Gilg & G. Schellenb.	Oleaceae	Siigeeda	*Aspiration pneumonia*	T	Sb, L	F	Fresh stem bark from sunrise, fresh leaves crushed and spitted to the nose.	2	MH-261
Olinia rochetiana A. Juss.	Penaeaceae	Guna	*Aspiration pneumonia*	T	Bd	F	Fresh buds are crushed and spitted into the nose.	2	MH-39
			Perganency (fertility)	T	Bd	F	Crushed with fresh buds of *C. macrostachyus* and *C. longicauda* enclosed fibre and inserted in the female sex organ for 30 min.	1	
Oncoba spinosa Forssk.	Salicaceae	Itakkam kuukka	Abdominal pain	T	L, Fr	F	Fresh leaves or ripe raw fruits crushed and drunk one liter	1	MH-351
Oxalis corniculata L.**	Oxalidaceae	Goro'ama (cii'i mixmimixo'o)	Snake bite (venom injection)	H	L	F	Crushed, and drink one mug, jug, or liter of the solution decoction through the mouth.	1	MH-350
Pavetta oliveriana Hiern.	Rubiaceae	Gaarawwa laba (Meentichchi gaarawwa)	Bat urine ailment	S	L	F	Crushed and drunk one liter; dry faeces of eagle powdered and drink one liter decoction.	1	MH-228
Pentanema confertiflorum (A. Rich.) D.Gut.Larr., Santos-Vicente, Anderb., E. Rico & M.M. Mart.Ort. *	Asteraceae	Anca (qadaalli haagallo'o/Bulsha ana laba)	Coughing, pasteurellosis	S	L	F	Fresh leaves are crushed, pounded in water, and drunk one liter; NaCl and livestock soil salt ('Borra') are drinking one liter orally.	2	MH-300
Peponium vogelii (Hook.f.) Engl.	Cucurbitaceae	Humbusha (Dunguruulla)	Anaplasmiosis (spleen enlargement)	H	L	F	Crushed, fresh leaves and drunk half liter of water mixed decoction via mouth.	1	MH-242
Phaseolus lunatus L.	Fabaceae	Boloqe'e (Lob	Dingetegna	Cl	R	F	Crushed, mixed in cold or warm water, and drunk one-	2	MH-

		otongora)	Diarrhoea				two liter solution for equines (mule, donkey, and horse)		216
Phoenix reclinata Jacq.	Arecaceae	Sale'e (Dimbaaba)	Conjunctivitis (eye pain)	T	Se, Bd , Tw		Chewed either the parts and spitted a drop; add two-three drops into the painful eye.	4	MH-110
Phyllopentas schimperi (Hochst.) Y.D. Zhou & Q.F. Wang.	Rubiaceae	Wo'l oda'a	Cysticercus, bovis, ovis/asca riasis	H	L	F	Crushed, mixed with milk, and drunk one liter of decoction through oral administration.	1	MH-232
Physalis peruviana L.	Solanaceae	Onjooro'o	Dingetegna	H	R	F	Crushed, mixed with water, and drunk one liter via mouth.	2	MH-114
Phytolacca dodecandra L'Her.	Phytolaccaceae	Haanja	*Aspiration pneumonia*	S	L, R	F	Chewed three leaves, buds, and roots, squeezed, and spitted the filtered water to the nose.	10	MH-161
			Diarrhoea	S	Bd	F	Crushed and drunk two mugs for adults, half for calves.	6	
Piliostigma thonningii (Schumach.) Milne-Redh.	Fabaceae	Maccoqaara (Qaala'i weddeeshsha)	Bloat	T	L	F	Fresh leaves are crushed and drunk in one-liter decoction by oral administration.	1	MH-323
Platostoma africanum P. Beauv.	Lamiaceae	Heedoo'l maaxa	Diarrhoea	H	L	F	Crushed and mixed it with water and drunk one-liter decoction through oral means.	2	MH-25
Prunus africana (Hook.f. Kalkm.)	Rosaceae	Araara	Body swelling, bloat	T	Sb	F	Fresh stem bark from sunrise was crushed, mixed with cold water, and drunk one-liter solution.	3	MH-57
			Back sore	T	Sb	F	Crushed from sunrise, paste on the wound	1	
Ricinus communis L.	Euphorbiaceae	Qobbo'o	Swelling eye, body swelling	S	L	F	Boiled or warm and touch the painful body skin.	1	MH-125
Rotheca myricoides (Hochst.) Steane & Mabb.	Lamiaceae	Haniga	*Aspiration pneumonia,* evil sprit	S	Sb , L. Bd	F	Chewed sunrise-stem bark or buds or leaves and spitted the juice to the nose.; stem bark or either part is amulated. on the head or on the hind leg of cattle to against evil eye/sprit.	4	MH-186
Rubia cordifolia L.	Rubiaceae	Haaro'o (Baarxusha)	Michi, diarrhoea, *aspiration pneumonia,* bat urine ailment	Cl	L, R	F	Crushed roots alone or with buds of fresh *D. viscosa* subsp. *angustifolia* leaves, mixed with water, and drunk one liter; spitted to nose the decoction via mouth.	8	MH-68
Rumex abyssinicus Jacq.	Polygonaceae	Shiisho'o	Babesiosis, dinegetegna, abdominal pain	H	R	F	Crushed, pounded in water, homogenized in cold water, and drunk a liter of decoction via oral route.	19	MH-22
			Perganency (fertility)	H	Bd	F	Crushed with three fresh buds of *C. macrostachyus*, fresh *C. schimperi* roots, enclosed fibre and insert in female sex organ, and tied lower tip at the tail.	3	
			Livestock tumor (skin wart/venign-external tumor)	H	R	F	Crushed, pasted, and then tied to the painful area.	5	

Rumex nepalensis Spreng.	Polygonaceae	Go'ichcho	Rabies	H	R, L	F	Crushed it, mixed it with water, and drunk one glass or mug decoction via mouth.	3	MH-21
Ruta chalepensis L. **	Rutaceae	Qantalaama	Abdominal pain, acidiosis (bloat)	H	L, Fr	F/D	Crushed with fresh or dry leaves or fruits of *C. sativum*, seeds of *A. corrorima*, rhizome of *Z. officinale*, and bulbs of *A. sativum* mixed with NaCl or salt soil of livestock ('Borra'), soil in cold water, and drunk one-two liters.	99	MH-83
			Blackleg	H	L, Fr	F/D	Fresh leaves and fresh or dry fruits are crushed and drunk one liter decoction by oral or anal administration.	5	
Rytigynia neglecta (Hiern.) Robyns.	Rubiaceae	Garawwa	Acidiosis	S	Bd	F	Crushed together with the fresh buds of *E. divinorum* and fresh buds of *J. procera*, mixed and drunk.	1	MH-48
Scadoxus multiflorus (Martyn) Raf.	Amaryllidaceae	Got tuma (Hamashshi weesa)	Acidiosis	H	R, L	F	Crushed the dry-prepared *N. tabacum* leaf and drunk a liter of concocted solution.	3	MH-238
			Shoat pox	H	R	F	Crushed, mixed with water, and drunk one coffee cup decoction via mouth.	2	
Scepocarpus hypselodendron (*Hochst*. ex A. Rich.) T. Wells & A.K. Monro. (synonym of Urera hypselodendron).	Urticaceae	Hariira (Dooqa)	Cysticercus, bovis, ovis (ascariasis), acidiosis, constipation,	Cl	L	F	Crushed alone or with fresh leaves of *G. robusta*, mixed with water, and drunk one liter of water solution, oral	13	MH-130
Schrebera alata (Hochst.) Welw.	Oleaceae	Lob haqqa	Conjunctivitis (eye pain)	T	L	F	Squeezed the crushed, mixed with water, filtered, and added three drops to the eyes or spitted to the nose.	1	MH-284
Securidaca longepedunculata Fresen.	Polygalaceae	Mukke'e	Dinegetegn acidiosis, babesiosis. anthrax, body swelling abdominal pain, actinomycosis	T	Rb	F, D	Crushed its part from sunrise, mixed with water, and drunk one liter of decoction oral and anal administration.	25	MH-206
			Diarrhoea	T	Rb	F, D	Crushed, with root bark of *X. americana* and stem bark of *C. molle*, mixed water, and drunk one liter of concoct.	7	
Shirakiopsis elliptica (Hochst.) Esser.	Euphorbiaceae	Shaqama	Bat urine ailment, diarrhoea	T	L	F	Crush fresh leaves and apply cream or ointment to the wound.	1	MH-33
Sida rhombifolia L.	Malvaceae	Qarxaffa	Snake bite (venom injection), acidiosis, constipation abdominal pain	S	L	F	Crushed and mixed it with water and drunk a mug to one liter decoct via mouth.	5	MH-134
Spiniluma oxyacantha (Baill.) Aubrév.	Sapotaceae	Faraxxi qasa	Rabies	T	Sb	F	Crushed and drunk three coffee cups of decoction for one day via mouth or anus.	4	M-28
Solanum incanum L.	Solanaceae	Heemachchi	Actinomycosis	S	Fr	F	Ripe fresh fruits, crush, decoct, and drunk half liter.	3	MH-

		looraawwa	Conjunctivitis (eye pain)	S	Fr	F	Ripe fruit was crushed, squeezed, mixed with water, and added to the eyes with two-three drops.	1	38
			Bloat	S	R	F	Crushing fresh roots and drunk one mug/a glass orally.	2	
			Actinobacillosis (wooden tongue)	S	Fr	F	Fresh, ripe fruits are crushed and given with butter.	2	
Stephania abyssinica (Quart. -Dill. & A. Rich.) Walp.	Menispermaceae	Huma	Diarrhoea, acidiosis, anthrax, pasteurellosis, dingetegna	Cl	R	F	Crushed with fresh stem bark from the sunrise of *C. macrostachyus* and drunk one mug of concoct via mouth.	30	MH-49
			Rabies	Cl	R	F	Crushed fresh leaves of *D. stramonium* and drunk one liter of concoction through the mouth and anus.	7	
Tapinanthus sp.	Loranthaceae	Buni xanqo	LSD	Hemp	L	F	Crushed fresh whole parts and drunk one liter of decoction by means of oral route.	1	MH-202
Terminalia brownii Fresen.	Combretaceae	Dibi'n haqqa	Constipation	T	Sb	F	Fresh stems are crushed and drunk in one liter of decoction by mouth.	1	MH-327
Thymus schimperi Ronniger. *	Lamiaceae	Ishina	*Aspiration pneumonia*	H	L	F/D	Chewed and spitted at the nose or mouth of sick livestock through the oral or nasal route.	1	MH-85
Trigonella foenum-graecum L. **	Fabaceae	Shuqoota	Faciolosis	H	Se	D	Mix poweder seeds with water and drunk one liter for bovines, sheep, and goats via mouth.	1	MH-94
Urtica simensis Hochst. ex A. Rich. *	Urticaceae	Amaa'l doobba (Cimcima)	Evil eye (evil spirit)	H	L, Bd	F	Crushed with fresh roots of *A. africanus*, mixed with water, and drunk one liter, concoction, oral mean.	3	MH-194
			Bat urine ailment	H	L	F	Crushed, mixed with *A. dimidiata*, and drunk three mug infusion concoction.	3	
Vepris nobilis (Delile) Mziray.	Rutaceae	Xaa'a	Acidiosis	T	L	F	Crushed, mixed with water, and drunk one liter of decoction via mouth.	2	MH-73
			Diarrhoea, constipation	T	Sb	F	Crushed from sunrise both with *C. macrostachyus* and drunk one liter of concoct via mouth.	2	
Verbascum sinaiticum Benth.	Scrophulariaceae	Got buyya	*Aspiration pneumonia*	H	R	F	Chewing and spitting at the nose decoction.	4	MH-316
			Constipation	H	L	F	Crushed, mixed with water, drunk one to two liters decoct.	5	
Verbena officinalis L.	Verbenaceae	Qisqisa (Modollo'o)	Abdominal pain	H	R, L	F	Roots or leaves are rushed, and a liter of decoction is drunk via mouth.	5	MH-166
Withania somnifera (L.) Dunal.	Solanaceae	Ajaar buyya	Arthritis (gouge or mondy-morning ailment), acidiosis	S	L, R	F	crushed fresh leaves or roots, mixed them with water, and drunk a one-liter decoction for bovines and equines via oral and anal administration.	4	MH-378
Ximenia americana L.	Olacaceae	Qaala'i kooshshaama	LSD, diarrhoea, *aspiration pneumonia*	S	L, Sb	F	Crushed, mixed with water, and drunk one liter until healed; spitted the decoction to the nose via oral and nasal means.	4	MH-273
Zanthoxylum asiaticum (L.) Appelhans, Groppo & J. Wen. (synonym of *Toddalia asiatica*).	Rutaceae	Seego'o	Rabies	Cl (S)	L	F	Crushed fresh leaves, mixed with water, and drunk one mug until cure.	2	MH-09
			Dingetegna	Cl	Fr	F	Crushed with fresh leaves of *C. macrostachyus* and *E. divinorum*, drunk one liter of the infusion of concoct.	2	

Zea mays L.**	Poaceae	Boqqolla	Dingetegna	Cl	Fr	F	Crushed with fresh leaves of *C. macrostachyus* and *E. divinorum*, drunk one liter of the infusion of concoct.	2	MH-225
Zingiber officinale Roscoe. **	Zingiberaceae	Jaanjibeela	Actinomycosis, acidiosis, abdominal pain, diarrhoea	H	Rh	F	Crushed the bulbs of *A. sativum,* dry or fresh leaves or fruits of *C. sativum*, *R. chalepensis,* and dry seeds of *A. corrorima* and drunk the concoction.	64	MH-64

Keywords: Growth form: Habit : Hàb=habit; H=herb, S=Shrub, T=Tree, Cl=Climber, and Hemp=Hemi-parasite**;** Part used= **PU** (Whole part =Wh; above ground=Ag or if below ground=Bg); Leaf=L; Root=R; Stem=St; Flower=Fl; Fruit=Fr; Pod=Pd; Seed=Se; Rhizome=Rh; Bulb=Bu; Bark=Ba, Stem bark=Sb, Stem charcoal=Sc, Root bark=Rb; Latex=La, Buds=Bd, Bula=Bl, Pseudo stem=Ps, Corm-Cm); Conditions of the Preparation**=CP (**Fresh-F; Dry-D; Fresh or Dried- F/D); Preparation Forms (PF), MT, and Ra are used symbols or as it **=PF** (Burning=Bn, Chewing=Ch, Concoction=Co, Decoction=De, pounded=Pu, powdered=Po, or Grinding=Gr, Crushing=C, Warming/Boiling/Heating =Wa/Bo/He, Roasted/Cooked =Ro/Ck, Infusion=Inf, Squeezing=Sq, Cutting=Cu, Chopping=Cp); Means of Treatment**=MT**(Drinking=Dk, Smoking=Smo, Eating=Et, Fumigating=Fum, Ho=Holding on pained tooth, Touch the pained area=Tu, Inhaling/sniffing=In/Sn, Inserting=Ins, Pasting=Pa, Painting/Creaming/Smearing=Pt/Cr/Sm, Dermal/External=Dr/Ex, Spitting to the mouth or eye=Sp, Sprinkled=Spr, Rubbing=Ru, Dropping=Dp, Eye=Ey, Swallowing the chewed juice=Sw, Amulet = Am a plant part which is tied at legs or on the horn/head of cattle and legs, Spraying,=Spy, Tie around the pained area=Td,Wrapped=Wr, Without process=Wp; Smelling through nose/mouth=Sme, Washing=W); Physical=Ph; and Route of Administration**=RA** (Oral=O; Nasal=N; Eye (Optical) =Ey/Op; Dental=Dt; Dermal=Dr, Ear (Auricular) = (E/Au), Anal=An, and, Endemic to Ethiopia (*), Introduced into Ethiopia (**), Native not used asterisks, Total number of informants who cited the medicinal plants for treating the major aliments = **UR** (use report); VN: = Vernacular name, and MH = Mulatu Hankiso

Appendix 15. Ethnobotanical wild edible plants diversity collected in Soro District, central Ethiopia

Vernacular name, Scientific name, Family name, Habit = Hab, Diversity, Function of wild edible plant = FWEP, reported medicinal and wild edible part used; Voucher No/VNº: MH-XY/XYZ [2-3 digital number; MH = Mulatu Hankiso; XY= two digital number, XYZ = three digital nº].

No	**Vernacular Name**	**Scientific Name**	**Family Name**	**Diversity**		**Reported wild edible part used**	**FWEP**	**Reported medicinal p art used**	**VNº**
1.	Ashwaala [Wo'o xuuxakkam fiita]	*Acanthus sennii* Chiov*	Acanthaceae	S	W, GL, D, WD, Co	Sipping/sucking sweet liquid nectar sap	F, Hb, Fin	X	MH-102
2.	Hoffi qaccabba	*Achyranthes aspera* L.	Amaranthaceae	H	W, HG, D, WD, Co	Leaf with young shoot cooked	Veg, M, Fo	Leaf or whole parts	MH-75
3.	Illilli qubba	*Acokanthera schimperi* (A. DC.) Schweinf.	Apocynaceae	T	W, FP, WD, Co	Raw ripe dark-red fruit	F, Fw, Pn, Sha	X: Stem; leaf latex poisonous	MH-265
4.	Zeqisse [Ajaar jeela laba]	*Ageratum conyzoides* L.	Asteraceae	H	W, HG, D, WD, K, Co	Leaves with young shoot cooked	F, M, Fo, Hb	Leaf or whole parts	MH-286
5.	Abbara	*Allophylus abyssinicus* (Hochst.) Radlkofer.	Sapindaceae	T	W, FP, WD, Ra	Raw ripe orange fruit	F, Fw, Ft, Hb	X	MH-264
6.	Haliba	*Amaranthus caudatus* L.	Amaranthaceae	H	W, HG, D, WD, Co	Leaf, young shoot, seed cooked	Veg, M, Hb	Leaf, seed	MH-77
7.	Gude'e	*Amaranthus tortuosus* Hornem (synonym of Amaranthus *dubius*)	Amaranthaceae	H	W, HG, D, WD, K. Co	Leaf with young shoot cooked	Veg, M, Fo, Hb	Leaf, young shoot	MH-65
8.	Hundufaanna	*Asparagus africanus* Lam.	Asparagaceae	H	W, FP, D, K, Ra	Raw ripe orange fruit	F, M	Leaf and root	MH-198
9.	Baddanno'o	*Balanites aegyptiaca* (L.) Delile	Zygophyllaceae	T	W, FP, WD, K, Co	Raw ripe yellow fruit	M, Fo, Df, Fw, Ch, Res	Stem-charcoal, Resin	MH-16
10.	Kashar jeela	*Bidens pachyloma* (Oliv. & Hiern) Cufod.*	Asteraceae	H	W, HG, WD, K, Co	Young shoot, bud and leaf cooked	Veg, M, Fo	Leaf, young shoot, bud	MH-63

No	Vernacular Name	Scientific Name	Family Name	Diversity		Reported wild edible part used	FWEP	Reported medicinal p art used	VN⁰
11.	Meent alabo	*Bidens pilosa* L.	Asteraceae	H	W, HG, D, WD, Co	Leaf with young shoot cooked	Veg, M, Fo	Ag-above ground, leaf	MH-82
12.	Qaala'i biishsho'o	*Bridelia* sp.	Euphorbiaceae	T	W, FP, WD, K, Co	Light-green leaf, young shoot cooked	M, F, Fo, Fw	Leaf	MH-373
13.	Qoqombe'e	*Carissa spinarum* L.	Apocynaceae	S	W, FP, K, Co	Raw ripe dark - black fruit	F, M, Fo, Co	Fruit, stem bark, root	MH-328
14.	Lob gu'ma	*Commelina benghalensis* L.	Commelinaceae	H	W, HG, D, WD, Co	Leaf & young bud	F, M, Fo	Leaf, bud	MH-81
15.	Weddeeshsha	*Cordia africana* L.	Boraginaceae	T	W, AL, D, WD, K, Co	Raw ripe yellow fruit	M, F, TP, Ut, Ff, EI	Leaf, bud &stem bark	MH-115
16.	Gidiidoola	*Cyphostemma pannosum* Vollesen. *	Vitaceae	H	W, GL, WD, K, Co	Dark raw ripe fruit	F, M	Fresh root, Root bark	MH-330
17.	Omoro'o	*Dicliptera laxata* C.B. Clarke.	Acanthaceae	H	W, HG, WD, Co	Leaf, young shoot	F, Tsp, M, Hb	Leaf, Young shoot	MH-79
18.	Qoxino'o	*Dioscorea schimperiana* Kunth.	Dioscoreaceae	Cl	SW, HG, WD, K, Co	Tuber cooked and eaten	F, M	Tuber	MH-315
19.	Fuga'i leega [miqqe'e]	*Diospyros mespiliformis* Hochst. ex A. DC.	Ebenaceae	T	W, FP, K, Co	Raw ripen fruit	F, Fw, Ch, Con, Ft, Ut	X	MH-352
20.	Haqqi wo'l [Doo'm] kooshshima	*Dovyalis abyssinica* (A. Rich.)	Salicaceae	T	W, FP, D, WD, Co	Eaten yellow raw ripen fruit	F, M, Fo, Fw	Raw ripe yellow fruit	MH-170
21.	Ooxxi kooshshaama	*Dovyalis caffra* (Hook. f. & Harv.) Hook. f.	Salicaceae	S	SW, HG, D, WD, Co	Raw ripe yellow fruit is eaten	F, M, Lf	Leaf or bud	MH-17
22.	Qaanqa [Xuda laba]	*Embelia schimperi* Vatke.	Myrsinaceae	S	W, FP, D, WD, K, Co	Eaten raw ripe fruit	F, Fo	X	MH-304

No	Vernacular Name	Scientific Name	Family Name	Diversity		Reported wild edible part used	FWEP	Reported medicinal p art used	VNº
23.	Ciishaana	*Erucastrum arabicum* Fisch & Mey.	Brassicaceae	H	W, HG, D, WD, Co	Leaf & bud cooked	Veg, M, Fo	Above ground, leaf	MH-190
24.	Meegaara	*Euclea divinorum* Hiern.	Ebenaceae	T	W, FP, WD, K, Co	Raw dark-black fruit	F, M, Df, Fw, Hb, Fin	Leaf	MH-15
25.	Qodde'i oda'a	*Ficus sur* Forssk.	Moraceae	T	W, FP, WD, K, Co	Raw ripe orange fruit	F, M, Fo, Am, Gu, Sha, Ut, TP, Fw	Stem bark and latex	MH-289
26.	Oda'a	*Ficus sycomorus* L.	Moraceae	T	W, FP, D, WD, K, Co	Raw ripe orange fruit	F, M, Fo, Ut, Gu, Sha, Ut, TP, Am, Fw	Stem bark and latex	MH-98
27.	Qaal'i odechcho	*Ficus thonningii* Blume	Moraceae	T	W, Riv, K, Co	Raw ripe fruit	F, TP, Ut, Fw, Am	Stem latex	MH-376
28.	Qilxo'o	*Ficus vasta* Forssk	Moraceae	T	W, FP, K, Co	Raw ripe fruit	F, M, Fo, Ut, Gu, Fw, TP, Am	Stem bark and latex	MH-177
29.	Hagala	*Flacourtia indica* (Burm.f.) Merr.	Salicaceae	T	W, FP, D, WD, Ra	Raw ripe dark brown fruit	F, Fw	X	MH-128
30.	Shillo'o	*Habenaria decumbens* Thomas & Cribb *	Orchidaceae	H	W, GL, WD, Co	Red crushed tuber is eaten	F, M	Tuber	MH-271
31.	Hoomba	*Landolphia buchananii* (Hall.f.) Stapf	Apocynaceae	Li	W, AL, WD, Ra	Raw ripe varied colored fruit	F, M, Cul, La, Con, Ut	Raw ripe fruit	MH-147
32.	Qaala'i qashsha	*Gmnosporia senegalensis* (Lam.) Loes. [*Maytenus senegalensis* (Lam.) Ex ell.].	Celastraceae	T	W, FP, K, Co	Raw ripe fruit	F, Fo, Fw	Leaf/bud	MH-354
33.	Dogoo'na	*Mimusops kummel* A. DC. Kumel	Sapotaceae	T	W, FP, D, WD, K, Co	Raw ripe yellow fruit	F, Con, Fw, Ch	X	MH-131

No	Vernacular Name	Scientific Name	Family Name	Diversity		Reported wild edible part used	FWEP	Reported medicinal p art used	VN⁰
34.	Hamashshi waasa	*Momordica foetida* Schumach.	Cucurbitaceae	Cl	W, HG, D, WD, Co	Raw ripe fruit	F, M	Raw ripe fruit, leaf, bud	MH-06
35.	Haqqi shaana [Moringa]	*Moringa stenopetala* (Bak. f.) Cuf.	Moringaceae	T	SW, HG, K, Ra	Leaf with young shoot	Veg, M	Leaf	MH-62
36.	Gexeema	*Myrsine africana* L.	Myrsinaceae	S	W, FP, D, WD, Co	Raw ripe fruit	F, Fo, Tb, Cul	X	MH-132
37.	Itakkam kuukka	*Oncoba spinosa* Forssk.	Salicaceae	T	W, FP, K, Co	Raw ripe dark-brown colored fruit	F, M, Fo, Fw	Leaf, fruit	MH-351
38.	Goro'ama [Cii'i mixmimixo'o]	*Oxalis corniculata* L.	Oxalidaceae	H	W, GL, D, WD, K, Co	Leaf is eaten by cooked	F, M, Hb, Fin	Whole parts, leaf	MH-150
39.	Kookile'e	*Passiflora edulis* Sims.	Passifloraceae	Cl	W, HG, WD, Ra	Raw ripe red-dark fruit	F, Hb, Fin	X	MH-142
40.	Sale'e [Dimbaaba]	*Phoenix reclinata* acq.	Arecaceae	T	W, Riv, D, WD, Co	Raw ripe orange fruit	F, M, Fo, Con, Orn, Hb, Fin	Leaf, bud/twig	MH-110
41.	Onjooro'o	*Physalis peruviana* L.	Solanaceae	H	W, HG, D, WD, Co	Raw ripe orange fruit	F, M, Hb, Fin	Leaf/bud, root	MH-114
42.	Macco'i qarra [Qaal'i weddeeshsha]	*Piliostigma thonningii* (Schumach.) Milne-Redh.	Fabaceae	T	W, FP, WD, K, Co	Leaf cooked roasted; chewed swallow the juice.	F, M, Ch, Fw	Leaf, fruit	MH-323
43.	Qamo'o	*Rhus vulgaris* Meikle.	Anacardiaceae	T	W, FP, D, WD, Co	Light-green raw ripe fruit	F, M, Fo, Fw, Ch	Leaf, stem bark	MH-08
44.	Dabayyi gora	*Rubus apetalus* Poir.	Rosaceae	S	W, RS, D, WD, Co	Black raw ripe fruit,	F, M, Fo, Hb, Fin	Leaf	MH-11
45.	Daane'i gora	*Rubus steudneri* Schweinf.	Rosaceae	S	W, RS, D, WD, Co	Raw ripe fruit	F, M, Fo, Hb, Fin	Bud	MH-41

No	Vernacular Name	Scientific Name	Family Name	Diversity		Reported wild edible part used	FWEP	Reported medicinal p art used	VNº
46.	Shiisho'o	*Rumex abyssinicus* Jacq.	Polygonaceae	H	W, HG, D, WD, Co	Leaf, young shoot roasted	F, M, Fo	Leaf, root	MH-22
47.	Imbocca	*Rumex nervosus* Vahl.	Polygonaceae	S	W, Lf & Df, D, WD, Ra	Roasted leaf, young shoot	F, M, Fo	Leaf, root	MH-307
48.	Gaarawwa	*Rytigynia neglecta* (Hiern.) Robyns.	Rubiaceae	S	W, Lf, D, WD, Co	Raw ripe deep black fruit, sweet tested	F, M, Fo	Leaf, stem bark	MH-48
49.	Faraxxi qasa	*Spiniluma oxyacantha* (Baill.) Aubrév.	Sapotaceae	T	W, FP, D, WD, Ra	Raw ripe fruit	F, M, Fo, Fw, Df	Leaf, bud, stem bark	MH-28
50.	Heemachchi migillo'o	*Solanum nigrum* L.	Solanaceae	H	W, HG, D, WD, Co	Above ground, leaf cooked /raw ripe	F, M, Fo, Hb	Leaf/bud	MH-13
51.	Bulo'o	*Solanum* sp.	Solanaceae	S	W, HG, WD, Ra	Leaf, young shoot cooked	Veg, M, Hb	Leaf	MH-182
52.	Ajaar migillo'o	*Solanum villosum* Mill.	Solanaceae	H	W, AL, D, WD, K, Co	Leaf, bud, ripe fruit	Veg, M, Fo, Hb	Leaf, bud	MH-336
53.	Duubaana	*Syzygium guineense* (Wild.) DC. var. *guineense*	Myrtaceae	T	W, Ria, WD, K, Co	Raw ripe different colored fresh fruit	F, M, Con, Ut, Df, Sha, Hb, Fin	Leaf, bud, fruit	MH-317
54.	Gooto'i duubaana	*Syzygium guineense* (Willd.) DC. subsp. *afromontanum* F. White	Myrtaceae	T	W, D, FP, WD, Co	Raw ripe different colored fruit	F, M, Con, Ut, Df, Sha, Hb, Fin	Leaf, bud, fruit	MH-171
55.	Guff haata	*Thunbergia ruspolii* Lindau *	Acanthaceae	H	W, GL, WD, Co	Leaf with young shoot cooked	M, F, Fo	Whole part, leaf	MH-308
56.	Ishinna	*Thymus schimperi* Ron. *	Lamiaceae	H	SW, HG, D, WD, Co	Leaf, bud as spices	F, Sp, M	Leaf, bud	MH-85

No	Vernacular Name	Scientific Name	Family Name	Diversity		Reported wild edible part used	FWEP	Reported medicinal p art used	VNº
57.	Seego, o	*Toddalia asiatica* (L.) Lam. (synonym of *Zanthoxylum asiaticum* (L.) Appelhans, Groppo & J. Wen)	Rutaceae	S (Cl)	W, RS, D, WD, Co	Raw ripe orange fruit	F, M, Fo	Fruit, leaf, bud	MH-09
58	Qabarbuyya	*Trichocladus ellipticus* Eckl. & Zeyh.	Hamamelidaceae	S	W, Riv, WD, K, Co	Matured raw leaf	F, M, Fo, Fw, Hb, Fin	Leaf, bud	MH-78
59.	Cimcima	*Urtica simensis* Steudel. *	Urticaceae	H	W, Riv, D, WD	Leaf with bud cooked	Veg, M	Leaf/bud	MH-194
60.	Lob doobba	*Urtica urens* L.	Urticaceae	H	W, HG, D, WD, Co	Leaf with bud cooked	Veg, M	Leaf, bud, root	MH-58
61.	Loqe'e	*Vangueria volkensii* K. Schum.	Rubiaceae	S	W, FP, WD, K, Co	Raw ripe dark fruit	F, Fw	X	MH-311
62.	Leega	*Warburgia ugandensis* Sprague.	Canellaceae	T	W, Riv, WD, K, Ra	Raw ripe light-green spherical fruit	F, Con, Ft, Cul, Ut, Po, M	X	MH-269
63.	Qaal'i kooshimma	*Ximenia americana* L.	Olacaceae	S	W, FP, K, Co	Raw ripe yellow fruit is eaten	F, Fo, M, Fw, Con	Fruit, Leaf, Stem bark, Root bark	MH-273
64.	Gaaq xuranqa Desf.	*Ziziphus spina-christi* (L.) Desf.	Rhamnaceae	T	W, FP, WE, K, Co	Raw ripe fruit	M, F, Fo Fw	Leaf, fruit	MH-359

Key words: Wild = W; semi-wild = SW; agro-climatic zone: dega = D; woinadega = WD; kola = K; medicine = M; F = food; fodder/forage = Fo; vegetable = Veg; both medicinal and spice = MSp; Tea spices = Tsp; both medicinal and food=MF (F,M); economic income = EI; cultural = Cul; Fw = fire wood; pole = Po; toothbrush =Tb; timber production = TP; poison = Pn; honeybee = Hb; flower-inflorescence-nectar = Fin or flower = Fl; stem charcoal = St-ch; constructions = Con; utensils = Ut; farming tool = Ft; ornamental = Orn; shade = Sha; fire formation = Ff; live fence/&dry fence = Lf/&Df; attachment = Am); functional part: whole part =Wh (above grand = Ag or below ground = Bg);young shoot = Ysh, leaf/bud = L/Bd; root = R; root&leaf = RL;tuber = Tu; stem = St; fruit = Fr; seed = Se, stem bark = Sb, root bark = Rb; latex = La, sap = Sa; resin = Res); locality: grass/bush land = GL/BL; Riv = riverine; roadsides = RS; forest patch = FP; dominance: common = Co; rare = Ra, endemic plant species(*). Habit = Hab, Diversity, Function of wild edible plant = FWEP, X = not reported for medicinal use.

Appendix 16. Data collection sheet of the floristic composition

- Collector name: ________________________________ Date: _____________________
- Quadrat No: Altitude _____________ Latitude __________ Longitude: ______________
- Vernacular/local name: _______________________Location: _____________________
- Aspect: _________________________________Slope: _________________________
- If any features: ____
  ____

	1.	2.	3.		4.	5.	6.	7.	8.	9.	10.	11.	12.
Species Nº/ Code	Species scientific/ Local name	Growth habit	Height	Cover/cover-abundance	Circumference	DBH	BA	Species density /number	Species relative density	Species dominance	Sp. relative dominance	Species frequency	Sp. relative frequency
1.													
2.													
3.													

Appendix 17. Semi-structured interview items and questions were used for the collection of ethnobotanical indigenous and local knowledge on the plants of the study sites in Soro District

Interview schedule a) **for collection of information on human medicinal plants and their uses**

I. Personal information/Socio-demographic information

1. General information on respondents:

i. Date_________Zone:________Region_________Residence kebele(village):___________; place of residence: Urban:_______________Rural______________

ii. Name of respondent: _____________________________Sex: Male _____Female____ (Mark an "X" on the one of the given alternatives); Age:___________________________________

iii. Occupation/job status: Traditional healer___ Traditional healer as part time___trade___ Farmer (farming, livestock rearing) _____Artecraft_____Retired and others__________________

iv.Religion: Orthodox: __Catholic: __Protestant: __Muslim: ____Wakefata: __Other: __ (Mark X on your choice).

v. Marital status: unmarried/single______ married ______ widowed _______divorced ______ (Mark an "X" on your choice).

vi. Full information on educational back ground (status) of informants:

a) Illiterate (unable to read and write): ____ read only: ____ literate (able to read and write): ____ (Mark an "X" on your choice).

b) Elementary school level: ___c) Secondary school level: ___d) Higher educational institute: __

vii. For how long have you lived in the area?

a. Since birth_____________b. For the last 18 years_________ c. For the last 19 years_________ d. More than 20 years____________ (Mark an "X" on your choice).

e. Ethnicity and language spoken: ____

viii. Locality: Detailed description of locality: District and Kebele

____

II. Ethnobotanical Information

2. What are the main human health problems in your locality?

____

3. How do you identify/diagnose each disease or health problem in the area?

____

4. What are the symptoms and signs of the diseases/health problems in your locality?

____

5. How do you prevent diseases/health problems?

____

6. How do you treat human health problems /diseases?

____

7. Which plant species(s') you use for treating that particular health problem/disease of humans?

8. Harvesting periods? ____

9. What is/are its/their vernacular or local name(s)of plant(s)? ___________________________________

10. Scientific/ botanical name(s) to be written/ filled in by the investigator

____

11. Family name(s) to be completed by the investigator/researcher________________________________

12. Growth habit/form of the plant species such as herb, shrub, tree and liana, epiphytes, parasitic/aquatic and if other features.

____

13. Which plant part(s) used for medicinal value? Root, stem, root bark, stem bark, leaves, small twigs with leaves/ buds, flowers, fruit, seed, underground / above ground part, whole plant parts (Underlined your selection part) and if others__________________________________

14. Used in what way? alone, mixed with water or other materials/spices, concoction (Underlined the selection) and if others____

15. How plant parts are used: fresh only/dried only/ fresh or dried (Underlined your selection)

____

16. Preparation for medicinal use in crushed in form freshy, crushed and powdered in dry form/extracted with water/ boiled (juice/latex) (Underlined your selection) and if other______________________________________

17. Route of administrations: oral, nasal, orbital/eye, dermal or any other are used for remedy? (Underlined)

____

18. Does the dose differ among males, females, children, elders, health condition, pregnant women or any others? (Underlined your selection)

____

19. What are any adverse/side effect(s) of ethnomedicinal use?

____

20. Is /Are there any immediate solution for that adverse side effects?

____

21. Inform if any unpleasant bad side effect(s)

____

22. Are they TMPs marketable/marketed in the area? And what are the other food crops, plant products, and other multipurpose plant materials that are marketable in the sampled markets?____

23. Brief description about plants (by investigator): stem feature, height, color of flower, ripened fruit color, matured seed color and other unique features

____

24. Habitat of wild or cultivated plant species and type of vegetation in the District ___________________________

25. Type of medicinal plant diversity in the communities/protected forest patches exist? What about round the home gardens and agricultural areas?

____

26. How medicinal plant(s) is /are widely spread? Is (are) they obtained easily from surrounding environment/home garden/other distant places (how much it far? ___; or how much purchased __________; if purchased from individual at household/market (indicate name of person/ individual/market place).

____

27. How do you preserve traditional medicine in your locality/environment?

____

28. What major cultural and socio-economic factors affect this TMK in the study site?

____

29. Are there any limiting conditions or taboos in utilization, in collecting traditional medicinal plants/TMPs in the locality?

____

30. Are there any economic groups who mostly or occasionally use different ethnobotanical plants? Yes/ No. If you say yes for question 30, describe them(Q31) ____

31. For what purposes they used? For medicine, food, fodder/forage; honeybee rearing, construction, timber, house hold utensils, building, charcoal, firewood (any other). (Underlined)

____

32. Do the MPs you are using still now, are available, disappeared or available in far places?

____

33.Are they disappeared/extincted medicinal plants? Names of locally disappeared plants are?

____

34. Are there any threats to the TMPs in the District? Please list out the main threats?

____

35. How is the knowledge on traditional medicine passed to a family member/younger generation?

____

36. Describe how do you conserve traditional medicinal plants?

37. Are there any preventive solutions to the plants being extinct from their locality?

____

38. Are there any local traditional important plants conservation practices with management practices by indigenous people in the community?

39. Foreword any suggestions that you have concerning the risks on plants or vegetation resources, indigenous knowledge in the study district of your local community.

____

b) for collection of information on medicinal plants used for the treatment of livestock aliments

I. Personal information/Socio-demographic information

1. General information on respondents:

i. Date__________Zone: ________Region_________Residence kebele(village): ___________; place of residence: Urban: _______________Rural______________

ii. Name of respondent: ___________________________Sex: Male _____Female____ (Mark an "X" on the one of the given alternatives); Age: ___________________________________

iii. Occupation/job status: Traditional healer___ Traditional healer as part time___trade___ Farmer (farming, livestock rearing) _____Artecraft_____Retired and others_________________

iv.Religion: Orthodox: __Catholic: __Protestant: __Muslim: ____Wakefata: __Other: __ (Mark X on your choice).

v. Marital status: unmarried/single______ married ______ widowed _______divorced ______ (Mark an "X" on your choice).

vi. Full information on educational back ground (status) of informants:

a) Illiterate (unable to read and write): ____ read only: ____ literate (able to read and write): ____ (Mark an "X" on your choice).

b) Elementary school level: ___c) Secondary school level: ___d) Higher educational institute: ___

vii. For how long have you lived in the area?

a. Since birth_____________b. For the last 18 years_________ c. For the last 19 years_________ d. More than 20 years____________ (Mark an "X" on your choice).

e. Ethnicity and language spoken: ____ __________________________

viii. Locality: description of locality: Kebele and District

____

II. Ethnobotanical Information

2. What are the main livestock health problems or diseases in your locality?
____

3. How do you identify/diagnose each ailment or health problems in the area?
____

4.What are the symptoms and signs of the diseases/health problems in your locality?
____

5.How do you prevent diseases/health problems?
6. How do you treat livestock health problems/aliments/diseases?
____

7.Which plant species(s') you use for treating that particular health problem/ailment of livestock?
8. Harvesting periods? ____
9.What is/are its/their vernacular / local name(s) of plant(s)? ______________________________________
10. Scientific/ botanical name(s) to be written / filled in by the investigator
____

11. Family name(s) to be completed by the investigator/researcher
12. Growth habit/form of the plant species such as herb, shrub, tree and liana, epiphytes, parasitic/aquatic and if other features ____________________________________

13. Which plant part(s) used for medicinal value? Root, stem, root bark, stem bark, leaves, small twigs with leaves/ buds, flowers, fruit, seed, underground / above ground part, whole plant parts (Underlined your selection part) and if others____
14. Used in what way? alone, mixed with water or other materials/spices, concoction/decoction (Underlined the selection) and if others____________________________________
15. How plant parts are used: fresh only/dried only/ fresh or dried (Underlined your selection)
____

16. Preparation for medicinal use in crushed in form freshy, crushed and powdered in dry form/extracted with water/ boiled (juice/latex) (Underlined your selection) and if other____
17. Route of administrations: oral, nasal, orbital/eye, dermal or any other are used for remedy? (Underlined)
____

18. Does the dose differ among males, females, young, elders, health condition, pregnant livestock or any others? (Underlined your selection)
19. What are any adverse/side effect(s) of ethnomedicinal use?
____

20. Is /Are there any immediate solution for adverse side effects?
21. Inform if any unpleasant bad side effect(s)
22. Are they TMPs marketable / marketed in the area? ____
23. Brief description about plants (by investigator): stem feature, height, color of flower, matured/ripened fruit color, matured seed color and other unique features?
24. Habitat of wild or cultivated plant species and type of vegetation in the District ___________________________
25.Type of medicinal plant diversity in the communities/ protected forest patches/vegetation areas exist? What about round the home gardens and agricultural areas?
____

26. How medicinal plant(s) is (are) widely spread? Is (are) they obtained easily from surrounding environment/ home garden/ other distant places (how much it far? ___; or how much purchased _______; if purchased from individual at household/market (indicate name of person/ individual/market place).
27. How do you preserve traditional medicine in your locality/ environment?
____

28. What major cultural and socio-economic factors affect this TMK in the study site?
____

29. Are there any limiting conditions or taboos in utilization, in collecting traditional medicinal plants/TMPs in the locality?
____

30. Are there any economic groups who mostly or occasionally use different ethnobotanical plants? Yes/ No. If you say yes for question 30, describe them(Q31) ______________________

31. For what purposes they used? For medicine, food, forage/fodder; honeybee rearing, building/construction, lumbering, timber, house hold utensils, firewood, local charcoal (any other) (Underlined) ____

32. Do the MPs plants you are using still now, are available, disappeared or available in far places?

____

33.Are they disappeared/extincted medicinal plants? Names of locally disappeared plants are?

____

34. Are there any threats to the TMPs in the District? Please list out the main threats?

____

35. How is the knowledge on traditional medicine passed to a family member/younger generation?

____

36. Describe how do you conserve traditional medicinal plants?

37. Are there any preventive solutions to the plants being extinct from their locality?

38. Are there any local traditional important plants conservation practices with management practices by indigenous people in the community?

39. Foreword any suggestions that you have concerning the risks on plants or vegetation resources, indigenous knowledge in the study district of your local community. ____

c). Interview questions for collection of wild edible plants (WEPs) in the study sites.

These interview questions will be used for semi-structure interview, key informants and focus group discussions during ethnobotanical WEPs data collection.

I. Personal information (Socio-demographic information)

1. General information on respondents:

i. Date__________Zone: ________Region_________Residence kebele (village):___________; place of residence: Urban: _______________Rural_____________________________________

ii. Name of respondent: ___________________________Sex: Male _____Female____ (Mark an "X" on the one of the given alternatives); Age:____

iii. Occupation/job status: Traditional healer___ Traditional healer as part time___trade___ Farmer (farming, livestock rearing) _____Artecraft_____Retired and others_________________

iv.Religion: Orthodox: __Catholic: __Protestant: __Muslim: ____Wakefata: __Other: __ (Mark X on your choice).

v. Marital status: unmarried/single______ married ______ widowed _______divorced ______ (Mark an "X" on your choice).

vi. Full information on educational back ground (status) of informants:

a) Illiterate (unable to read and write): ____ read only: ____ literate (able to read and write): ____ (Mark an "X" on your choice).

b) Elementary school level: ___c) Secondary school level: __d) Higher educational institute: ___

vii. For how long have you lived in the area?

a. Since birth_____________b. For the last 18 years_________ c. For the last 19 years_________ d. More than 20 years____________ (Mark an "X" on your choice). e. Ethnicity: ____

g. Climate of the area: Dega__ Woina dega___Kola___Semi desert: __ (Mark X)

viii. Locality: description of locality: Kebele and District:

____

II. Ethnobotanical information on wild edible plants (EbIWEPs)

2. Are they wild edible plants in your locality which are consumed by the community as alternative feed, snack (a small quantity of food or a light meal), during farming or herding or as food security for documentation? List out their local names and their agro ecological GPS information (such as Altitude, Latitude and Longitude).

____

3. Scientific/botanical name(s) to be written/filled in by the investigator/researcher.

____

4. Family name(s) to be completed by the investigator/researcher. ____

5. Interview Question for key and FGDs informants. What are the thirteen (13/10) top wild edible plants and plant part that is eaten/consumed (write down the local languages for the names of the medicinal plants in bracket).

____

6. Where do (i.e. habitat of WEPs) these WEPs are growing in the study area? Home gardens, Farm land, Forest patches, Grassland, Riverain (Underlined) and if other: ____

7. Growth habit /form of the plant species such as herb, shrub, tree, liana, epiphyte, parasitic and other features.
8. The collection type of wild edible plants are: wild from forest patches___ cultivated from____?
9. Description about WEPs stem feature, height, color of flower, matured/ripened fruit color, fruit test, thickness of epicarp, thickness of edible part/mesocarp, matured seed colors and other unique features (by investigator)

____

10. Which part(s) of wild edible plants play in food security? Roots, Stem, Bark, Leaves (young leaves), Latex, Sap, Flower, Fruit, Seeds, Whole part? (Underlined) and if others____

1. How edible plant part(s) is/are used: Raw/Cooked or Roasting / Fresh/ Dried, after pilling, washed with water (Underlined) and if other

____

12. Which WEP species (s') you use now in your locality?
13. Stage of the development: Young/Matured (Underline), and other ____
14. Which area/section of the community frequently consume the wild edible plant? Urban/ Rural (Underline), and other specify____
15. Is /Are the wild edible plant(s) marketable and generate income source? (1. Yes, 2. No, 3. Do not know). If you said yes how much cost? ____
16. Is / Are the wild edible plant(s) accessible easily (1. Yes, 2. No, 3. Do not know)
17. When they are available/harvesting season(s)? Rainy/wet season? Dry season? Or Kiremt, Tseday, Belg, Bega and throughout the year (Underline).
18. Period of consumption of wild edible plants? Normal period/ Famine period (Underline)
19. Do eating wild edible plant have any cultural taboos or restriction for certain group of the community by the local community e.g. children, women, etc? (1. Yes, 2. No, 3. Do not know), If the response is "Yes" please also specifying the cultural taboos
20. Do the wild edible plant eating have any unpleasant bad or toxic health effect from the community observation (1. Yes, 2. No, 3. Do not know), If the response is "Yes" please also specifying the undesired health effect of eating WEPs?

____

21.Is /Are there any solution for adverse side effects of eating WEPs?

____

22. Are there members of the community who frequently use will edible plants?

____

23. Are there economic groups who mostly or occasionally use these wild edible plants?

____

24. What are the major uses of cultivated and wild edible plants in the area?

____

25. How WEPs diversity in the communities/protected forest patches exist? What about round the home gardens, agricultural areas and if other habitats?

____

26. Do you list nutritional uses of WEPs? They have role on food security? (1. Yes, 2. No, 3. Do not know) If the response is "Yes" please specifying the time/period for food security.
27. How abundant is the wild edible plant? 1. Very abundant or abundant 2. Occasional 3. Very rare or rare. 4. Other (specify)

____

28. Do the wild edible plant have any medicinal use or health benefit? (1. Yes, 2. No, 3. Do not know), If the response is "Yes" please also specifying the medicinal use or health benefit.

____

29. For what other purposes do you use WEPs? Food? Human and livestock medicine? Fodder? Firewood? Local charcoal? House construction? Forage, etc.
30. Do the WEPs plants you are using still now, are available, disappeared or available in far places from the home?

____

31. Are they disappeared/extincted WEPs? Names of them?
32. Are there threats to the WEPs in the District? 1.Yes, 2. No, 3. Do not know, If the response is "Yes" please also specifying the main problems / threats?
33. Describe how do you conserve WEPs in your locality?
34. Are there any preventive solutions to the WEPs plants being extinct from their locality?

d). I. Market survey for ethnomedicinal plants (WEPs & MPs)

1. Location of market place/kebele____Name of the market________________________collection no______Date____
Collector Name ___

II. Information from vendor if there is.

1. Name of respondent: ___________________________Sex: Male _____Female____ (Mark an "X" on the one of the given alternatives).
2. Religion: Orthodox: ___Catholic: __Protestant: __Muslim: __Wakefata: __ (Mark an "X")
3. Ethnicity and language spoken
4. Address: Urban ______Rural: ______
5. How long you have lived in the area
a. Since birth_____________b. For the last 18 years_________ c. For the last 19 years_________ d. More than 20 years____________ (Mark an "X" on your choice). e. Ethnicity: _____________
6. Marital status: unmarried/single___married ___widowed ____divorced ___ (Mark an "X").
7. Full information on educational back ground (status) of informants:
a) Illiterate (unable to read and write): ____ read only: ____ literate (able to read and write): ____ (Mark an "X" on your choice).
b) Elementary school level: ___ c) Secondary school level: __d) Higher educational institute: __
8. Average income in Birr per month: ____
9. Locality: Detailed description of locality: District and Kebele____
10. Type of vendor if occurred: A/permanent stall B/temporary stall C/ ambulatory
11. Village of vendor if there is____

III. Information on market data collection

1. Is/Are the wild edible plant(s) marketable in the area? Where they obtained? What about medicinal plants? ________________
2. Vernacular/local name(s) of plant(s) and Its/Their habit(s)
3. Which age group sells? ____
4. Which plant species are more common on a market? What are their sources?
5. Is the wild edible plants easily accessible? If not why? ____
6. Which plant species is the most preferred? Why?
7. Are there taboos in the utilization of some wild edible plants in the locality? ---
8. Cultivation status: A/cultivated B/Managed C/wild (Underlined) and if other (specify)
9. Marketing status: A/ gathered by vendors B/Resold
10. Condition of the plant: A/fresh B/dry (underlined) and if other (specify) ____
11. Price/unit_____________brought to market: A/daily B/weekly C/occasionally(underlined), if other (specify) _____________
12. How much sold now compared to in the past: A/ more B/same C/less
13. If less why? A/less available for the market B/less demanded by buyers
14. Use of the plant:
15. Plant part used:
16. Preparation:____________
17. Important notes:________
18. Document with picture: _______

Identification for all questionnaires:

Name of survey area/District:
Farmer association kebele: __________
Village/Community: _______________
Interviewer: ______________________
Date/Month/Year: _______________Time: From____________a.m/p.m.to __________a.m/p.m.