TRADITIONAL MEDICINAL PLANTS IN HADES FOREST, DOBA WEREDA, WEST HARARGHE, ETHIOPIA; LOCAL KNOWLEDGE, CONSERVATION STATUS AND THREATS

MSC THESIS

AYNYIRAD TEWODROS

DECEMBER, 2025

HARAMAYA UNIVERSITY, HARAMAYA

TRADITIONAL MEDICINAL PLANTS IN HADES FOREST, DOBA WEREDA, WEST HARARGHE, ETHIOPIA; LOCAL KNOWLEDGE, CONSERVATION STATUS AND THREATS

A Thesis Submitted to the School of Africa Center of Excellence for Climate Smart Agriculture and Biodiversity Conservation, Post-Graduate Program Directorate

HARAMAYA UNIVERSITY

In Partial Fulfillment of the Requirements for the Degree of Master in BIODIVERSITY AND ECOSYSTEM MANAGEMENT

Aynyirad Tewodros

December 2025
Haramaya University

HARAMAYA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

We hereby certify that we have read and evaluated this Thesis entitled: Traditional Medicinal Plants in Hades Forest, Doba Wereda, West Hararghe, Ethiopia; Local Knowledge, Conservation Status and Threats, prepared under our guidance by Aynyirad Tewodros. We recommend that it be submitted as fulfilling the thesis requirement.

Anteneh Belayneh (PhD.)	_____	_____
Major Advisor	Signature	Date
Kidane G/Meskel (PhD.)	_____	_____
Co-Advisor	Signature	Date

As members of the Examining Board of the M.Sc. Thesis Open Defense Examination. We certify that we have read and evaluated the Thesis prepared by Aynyirad Tewodros and examined the candidate. We recommend that the Thesis be accepted as fulfilling the Thesis requirements for the degree of Master of Science in Biodiversity and Ecosystem Management.

_____	_____	_____
Chairperson	Signature	Date
_____	_____	_____
Internal Examiner	Signature	Date
_____	_____	_____
External Examiner	Signature	Date

Final approval and acceptance of the Thesis is contingent upon the submission of its final copy to the council of post-graduate program directorate (CPGDP) through the candidate's department or school graduate committee (DGC or SGC).

DEDICATION

This thesis manuscript is dedicated to my father, whose unwavering support, guidance, and belief in my potential have formed the foundation of my journey. He has made tremendous efforts to help me reach where I am today, sacrificing his time and everything he had, to raise me. I am incredibly honored to have him as my father and for his constant presence in my life. Thank you for being my greatest mentor and source of strength.

STATEMENT OF THE AUTHOR

By signing below, I affirm that this Thesis represents my original work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this Thesis. Any scholarly matter included in the Thesis has been given recognition through citation.

This Thesis is submitted in partial fulfillment for Master of Science in Biodiversity and Ecosystem Management at Haramaya University. The Thesis is deposited in the Haramaya University Library and is made available to borrowers under the rules of the Library. I solemnly declare that this Thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

Brief quotations from this Thesis may be used without needing special permission, provided that an accurate and complete citation of the source is given. Requests for permission for extended quotations from or reproduction of this Thesis, in whole or in part, may be granted by the Head of the School or Department when they believe the intended use of the material serves scholarly purposes. In all other cases, however, permission must be obtained from the Thesis author.

Name: Aynyirad Tewodros Kabtamu Signature: _____

Date of submission: _____

School/Department: Biodiversity and Ecosystem Management

BIOGRAPHICAL SKECH

The author was born in July 2000 in Areka District, located in the southern part of Ethiopia. She completed her elementary and secondary education at Haramaya University Model School from 2006 to 2017. Aynyirad earned her Bachelor's Degree in Range Ecology and Biodiversity from Haramaya University. Following her graduation, she began her career as a graduate assistant at the College of Agriculture and Environmental Science at Haramaya University in 2021. In 2023, Aynyirad enrolled in the African Center of Excellence to pursue her Master's program in Biodiversity and Ecosystem Management. Outside of her professional endeavors, she enjoys drawing and reading, which provide a balance to her life. Above all, Aynyirad values the time spent with family and friends, drawing inspiration from their love and support. With a commitment to lifelong learning and growth, she looks forward to the future and the opportunities it holds.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my deepest gratitude to Almighty God, for granting me the strength and opportunity to accomplish this work.

I would like to extend my sincere appreciation to my advisors, Dr. Kidane G/Meskel and Dr. Anteneh Belayneh, for their guidance and encouragement throughout the development of this thesis.

My heartfelt thanks go to Haramaya University and the Africa Center of Excellence for Climate Smart Agriculture and Biodiversity Conservation for providing opportunity to pursue my studies. I also sincerely appreciate the Doba District administration for permitting me to conduct fieldwork in the area and for assigning field assistant to assist me during the data collection process.

I am especially grateful to the traditional healers, elders, and farmers who generously shared their knowledge and experiences with me. Their contributions formed the foundation of this research. I would like to give special thanks to Mr. Ashenafi Alemu and his wife Weynitu Derbe, as well as Mr. Musa Adam and Mr Sufiyan for their invaluable support during fieldwork and for kindly hosting me at their home. Their hospitality and assistance made my stay in the field both productive and comfortable.

Finally, I extend my deepest gratitude to my father, Tewodros Kabtamu, and my brother, Misikir Tewodros, as well as to all those who supported me throughout the research process. Your love, patience, and unwavering support have been instrumental in my achievements. I am truly blessed to have such a caring and encouraging family by my side. I sincerely thank you all, and your contributions have been profoundly appreciated.

.

ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
CI	Cultural Importance
DMR	Direct Matrix Ranking
FC	Frequency of Citation
FL	Fidelity Level
HSD	Honest Significance Difference
IBC	Institute of Biodiversity Conservation
ICF	Informant Consunces Factor
MDs	Medicinal Plant
RFC	Relative Frequency of Citation
RI	Relative Importance Index
TK	Traditional Knowledge

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

TRADITIONAL MEDICINAL PLANTS IN HADES FOREST, DOBA WEREDA, WEST HARARGHE, ETHIOPIA; LOCAL KNOWLEDGE, CONSERVATION STATUS AND THREATS

ABSTRACT

Medicinal plants play a vital role in primary healthcare systems in Ethiopia, where access to modern medical services remains limited. This ethnobotanical study was conducted in Hades Forest and the surrounding communities of Doba Woreda, West Hararghe Zone, Ethiopia, to document traditional medicinal plant knowledge, assess patterns of use, and evaluate conservation status and threats. Data were collected from 120 informants, comprising 105 randomly selected general informants and 15 purposively selected key informants, using semi-structured interviews, guided field walks, and direct observations. Quantitative ethnobotanical indices, including preference ranking, Informant Consensus Factor (ICF), Relative Frequency of Citation (RFC), Relative Importance Index (RI), and Cultural Importance Index (CI), were applied to analyze medicinal plant use patterns and cultural significance. A total of 49 medicinal plant species belonging to 32 families were recorded for the treatment of human and livestock ailments. *Ocimum lamiifolium* and *Verbascum sinaiticum* were the most preferred species for medicinal use, while *Echinops kebericho* exhibited the highest RFC (74.1%) for livestock ailments and the highest Cultural Importance Index (0.7). Informant consensus was highest for dermatological disorders in humans and digestive disorders in livestock (ICF = 0.96). Traditional medicinal knowledge was predominantly transmitted orally within families, with elders possessing significantly greater knowledge than younger informants and general community members ($P < 0.05$). However, no significant differences in medicinal plant knowledge were observed across gender or educational levels ($P > 0.05$). Several medicinal plant species, including *Cissampelos mucronata* and *Myrtus communis*, were identified as increasingly threatened due to anthropogenic pressures such as deforestation and agricultural expansion. The study highlights the rich ethnomedicinal knowledge associated with Hades Forest, alongside the vulnerability of both medicinal plant resources and orally transmitted indigenous knowledge, emphasizing the need for locally tailored conservation and sustainable management strategies.

Key words: Local knowledge, Ethnomedicine, Ethnoveternery, Ethnobotany, *Myrtus communis, Ocimum lamiifolium, Verbascum sinaiticum*, Hades Forest

1. INTRODUCTION

The utilization of medicinal plants has a long history and is widely recognized for its value in healthcare systems around the world (Zewdie et al., 2020). Since ancient times, these plants have served as effective and safe sources of medicine. Traditional medicinal plants are the primary means of treating diseases and combating infections globally (Abdela and Sulatn, 2018). Countries such as Thailand, Sri Lanka, China, India, Pakistan, and Japan have a long tradition of practicing traditional medicine. However, the extensive use of these therapeutic plants is especially prominent in developing and resource-poor nations (Kindie, 2023). According to Jeelani *et al.* (2018), between 70% and 95% of people living in developing countries primarily rely on medicinal plants for their healthcare needs. Among these nations, the legacy of African people preferring MPs over modern medicine for their health care is well documented (Desalegn et al., 2022).

Ethiopia is one of biodiversity-rich countries in the world. The country harbors approximately 6,027 species of vascular plants, including about 887 medicinal plants (Sebsebe *et al.*, 2021). Ethnobotanical studies emphasize the important role of medicinal plants in primary healthcare in Ethiopia, where approximately 80% of the human population and 90% of livestock depend on these plants (Fassil and Gashaw, 2019; Husen *et al*., 2022; Damie *et al.*, 2018; Tezera *et al.*, 2020). The high reliance on medicinal plants is due to their cultural acceptance, availability, and affordability compared to modern medicine (Fekensa *et al.,* 2020). The utilization, management, and conservation of medicinal plants are inseparably linked to Local knowledge that has been developed and transmitted across generations. The knowledge system guides plant identification, harvesting methods, preparation techniques, dosage determination, and seasonal use of treating human and livestock ailmnets (Martin, 1995). Local practices also play a key role in regulating sustainable harvestingand conserving plant resources within the local communities.

Despite their importance, medicnal plants and the local knowledge associated with their use and manegemenet are increasingly threatened in Ethiopia. Habitat destruction, defrorestation for timber extraction, agricultural expansion, unbanization and climate chane have significantly reduced the availability of medicnal plant resources (Atinafu *et al.,* 2017; Admasu and Yohannes, 2020; Awoke *et al.,* 2024; Melese, 2019). The lack of systematic conservation, research, and documentation also contributes to the loss of these plants (Admasu and Yohannes, 2020). At the

same time, local knowledge is rapidly eroding due to secrecy surrounding medicinal knowledge transmission, cultural erosion, globalization, industrialization, increased access to modern healthcare, and declining interest among young generations (Abdela and Sulatn, 2018; Merera and Mesfin, 2023; Yihenew *et al.*, 2023). The predominantly oral transmission of knoweldeg, limited documentation, and weak intergenerational transfer further accelerate this loss, posing serious challenges to the sustainability of medicinal knowledge plants and traditional health care systems.

To address these challenges, significant efforts are needed to conserve and sustainably utilize medicinal plants in Ethiopia's primary healthcare systems for both humans and livestock (Desalegn *et al.*, 2022). Global conservation initiatives, including in-situ and ex-situ measures, aim to protect threatened medicinal plants (Chen *et al.*, 2016). In-situ conservation is particularly vital for certain species due to difficulties in domestication and management (Bizuayehu and Assefa, 2017; Zerihun, 2017). Increasingly, there is growing interest in the role of local knowledge in promoting the sustainable utilization and conservation of biodiversity where MPs thrive. While no universal definition exists, Martin (1995) describes local knowledge as the result of generations of experiences and observations. Consequently, local communities have developed specific knowledge regarding the identification, use, management, and conservation of plant resources for disease treatment

Despite its significance, local knowledge is rapidly disappearing, contributing to the loss of medicinal plants in Ethiopia (Abdela and Sulatn, 2018). Factors driving this decline include cultural erosion, industrialization, globalization, urbanization, increased access to modern healthcare, and declining interest among younger generations in traditional practices (Merera and Mesfin, 2023; Yihenew *et al.*, 2023). Oral-based knowledge transfer, inadequate documentation, and limited intergenerational sharing further exacerbate the loss of local knowledge (Tewodros and Worku, 2018). Therefore, documenting and preserving this knowledge is imperative to maintain cultural heritage, support local healthcare solutions, and provide potential resources for drug development (Merera and Mesfin, 2023; Shah *et al.*, 2016). Although, Hades and the surrounding area harbor a rich diversity of medicinal plants used by the local communities, both the medicinal plant species and the local knowledge associated with their identification, medicinal uses, and management remain largely undocumented. Therefore, this study aimed to document medicinal plant species and their traditional uses, examine the

threats affecting these resources, and assess the current availability and conservation practices of locally prioritized medicinal plants.

General Objective

- To identify and document medicinal plants and their associated local knowledge, threats posed to these resources, and their conservation status regarding the top priority MPs in Hades and the surrounding natural vegetation.

Specific Objectives

- To document Medicinal Plant species and associated local knowledge held by the communities.
- To analyze the existing threats to the traditional medicinal plant species in the study area.
- To assess the current availability and conservation practices of the MPs resources identified and prioritized by the local communities.

2. LITERATURE REVIEW

2.1 Ethnobotany

Ethno botany is the study of peoples' classification, management and use of plants available around them (Harshberger, 1895). The relation between plants and human culture is not only limited to the use of plants for food, clothing and shelter but also includes their use for health care (Keneni, 2023). In this regard Ethnobotany is aimed at gathering and documenting local botanical knowledge cultural practice, use and management of botanical resources and discovers benefits from plants. Besides, Ethnobotanical studies are often significant in revealing locally important plant species, especially for the discovery of new drugs (Yihenew *et al.*, 2023).

Globally, in recent years' research on Ethnobotanical information on medicinal plants has gained considerable attention in segments of the scientific community (Jagrati *et al*, 2017). According to Wondimu (2019). Ethno-medicinal survey is one of the reliable sources to natural and synthetic drug discovery. Moreover, Ethnobotanical studies are useful in documenting, analyzing, and communicating knowledge and interaction between biodiversity and human society, how diversity in nature is used and influenced by human activities (Eshete *et al.,* 2021).

2.2 Medicinal Plants and Local Knowledge

A cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations, about the relationship of living beings (including humans) with one another and with their environment (Berkes, 1999). Much of local knowledge system, from the earliest times, is also found linked with the use of traditional medicine in different countries of the world (Saleh *et al.,* 2015). Local knowledge on medicinal plants emerged when humans began learning how to utilize medicinal plants for their health and well-being. Over centuries local people of different localities have developed their own specific knowledge on plant resource use, management and conservation. Local knowledge of medicinal plants (MPs) and their use by traditional healers is valuable for biodiversity conservation, community healthcare, and the development of drugs for local populations (Mesfin *et al*., 2013).

Local knowledge is unique to a given culture. Thus, the local people in different countries and localities have developed their own specific knowledge of plant resource uses, management and

conservation by "trial and error" (Duguma and Mesele, 2019). Many countries in the world have their own traditional or local form of healing, varying from country to country, which is firmly rooted in their culture and history (Junsongduang *et al.,* 2020). Currently, scientists and pharmaceutical companies are looking at local knowledge to identify new drugs by combining it with modern scientific methods and research (Mikias *et al*., 2023). Thus the integration of local knowledge and scientific research holds great potential for identifying new drug sources and advancing medical science; herbal drugs can help the emergence of a new era of the healthcare system to treat human diseases in the future. Hence, the documentation of ethnobotanical knowledge plays a vital role not only in gathering information on medicinal plants (MPs) and associated local knowledge for conservation and sustainable utilization, but also in providing raw materials for the development of important modern drugs.

2.3 Medicinal Plants and Their Role in Ethiopia

Ethiopia is endowed with a rich diversity of flora owing to its heterogeneous agroclimatic conditions. Over 6,500 species of vascular plants, of which about 887 species of MPs were identified and recorded in the country. It is stated that medicinal plants play a significant role in primary health care delivery in Ethiopia, where 70% of the human population and 90% of the livestock population depend on traditional medicine (Admasu and Yohannis, 2021).

MPs are very vital in their uses for medication, besides providing ecological, economic, and cultural services. In Ethiopia, plants have been used as a source of traditional medicine from antiquity to solve different health problems and human suffering (Nigatu, 2018). The country possesses a wide range of potentially useful medicinal plants, more extensive indeed than available in many other parts of the world (Keneni, 2018). Several scholars have confirmed that the relatively low cost of traditional medicine, together with inadequate health facilities and shortages of medicines and health personnel in clinics, are the main factors that drive many Ethiopians particularly low-income and rural communities to rely on traditional healthcare. This, in turn, increases the demand for medicinal plants (Admasu and Yohannes, 2020). However, this is not only the reason, but traditional systems are also more culturally acceptable and meet the psychological needs in a way modern medicine does not (Keneni, 2018).

2.4 Medicinal Plants: Their Growth Forms and Parts Used

2.4.1 Composition and growth forms of medicinal plants

In Ethiopia, most medicinal plants used by herbalists are harvested from wild environments such as forests, wetlands, riverbanks, grazing lands, woodlands, and bushlands (Admasu and Yohannes, 2020; Amare *et al.*, 2022). The growth habits of these plants include trees, shrubs, climbers, and herbs. Among these herbal medicinal plants are primarily utilized for treating various human and animal health issues (Awelachew, 2021).

Different studies conducted across Ethiopia have reported variations in the dominant growth habits of medicinal plants used to treat human and livestock ailments. Muhidin *et al.* (2021) documented that in Adwa District the main growth forms of remedial plants were herbs, shrubs, trees, and climbers, with herbs being dominant (55 species, 43%), followed by shrubs (39 species, 31%), trees (28 species, 22%), and climbers (5 species, 4%). Similarly, Juhar *et al*. (2024) found that in Boreda Abaya District, southern Ethiopia, herbalists primarily used herbaceous species (71 species), followed by shrubs (59 species), trees (35 species), climbers (21 species), and epiphytes (2 species). Consistent with these findings, Zerihun (2023) reported that herbs constituted the largest proportion of medicinal plant growth forms (18 species, 37%), followed by trees (16 species, 32%) and shrubs (15 species, 31%).

2.4.2 Medicinal plant parts used for remedy preparation

Various reviews support the fact that different plant parts are used for medication preparation by traditional healers. According to the study by Getnet *et al.* (2016), healers mostly use fresh specimens from commonly available plants to prepare remedies for their patients. This preference is primarily due to the effectiveness of fresh medicinal plant parts in treatment, as their contents are not lost before use compared to dried ones (Tolosa and Megersa, 2019). As indicated in relevant literature, traditional healers use plant parts such as leaves, roots, barks, seeds, fruits, stems, flowers, or latex of medicinal plants to prepare their traditional medicines. These parts can be used individually or in combinations to prepare traditional remedies.

According to Takele (2017), most remedies were prepared from the leaves (66%) of the claimed medicinal plants, followed by roots (14%) and seeds (10%). Plant species harvested for their fruits (4%), stems (3%), barks (2%), and flowers (1%) were also reported. This finding aligns

with Zerihun *et al.* (2023), who indicated that leaves (35%) are the most widely used plant part, followed by roots (27%), leafy stems (10%), and seeds (12%). The study by Banchiamlak and Young-Dong (2019) also reports that leaves (56%) are the dominant plant part used to prepare remedies, followed by fruits (15%), roots (12%), barks (5%), seeds, stems, and bulbs (4%), shoot tips (2%), and flowers and latex (1%). Similarly, Mersha and Ermias (2021) found that in the Suro Barguda District, a larger proportion (36.2%) of remedy preparations were obtained from leaves, followed by roots (23.8%) and barks (18.6%). Additionally, stems were used for 5.7% of preparations, while latex alone and leaves mixed with other plant parts accounted for 5.2%, respectively. Most remedy preparations (93.7%) were reported as being prepared from freshly collected plant parts, 5.8% from dried parts, and the remaining 0.5% from either fresh or dried plant parts.

2.4.3 Preparation methods and conditions of traditional medicine

Studies conducted across different parts of Ethiopia consistently show that traditional healers use a variety of preparation methods, with crushing and pounding being the most common techniques. Moa and Nigussie (2022) reported that crushing accounted for the largest proportion of preparations (33.9%), followed by pounding and powdering. Similar findings were documented by Asaye *et al.* (2022), who noted that most remedies in the Ensaro District were prepared using fresh plant materials, either alone or mixed with dried parts. This pattern is further supported by Tariku *et al.* (2024), who found that fresh plant parts constituted 87.1% of all preparations, whereas dried and fleshy parts were used less frequently. Overall, the literature demonstrates a strong preference for using fresh plant materials in remedy preparation, with dried or mixed forms used only when fresh materials are unavailable.

2.4.4 Application route of prepared remedies

Several studies report that the application of traditional remedies depends on the type of ailment, with drinking being the most common route. Amare (2022) documented that 32.12% of remedies in Sedie Muja District were administered orally, followed by eating (13.98%) and topical application (9.84%). Kebede (2017) similarly reported that oral administration was dominant, followed by creaming, inhaling, eating, and other methods. Comparable trends were observed in studies by Juhar *et al.* (2024) and Leul *et al.* (2018). These studies indicate that oral routes are

preferred for internal ailments, while topical applications are used primarily for localized conditions.

2.5 Threats to the Transmission of Local Knowledge on Medicinal Plants

Previous studies showed that local knowledge on the usage of MPs as folk remedies is getting lost through various reasons. For instance, according to Asheir *et al.* (2024), in some communities, the decline in the knowledge and utilization of MPs is due to environmental degradation and intense deforestation. In addition, it is stated that most of the local knowledge of medicinal plants is passed mainly orally and secretly from generation to generation in fragile forms without any documentation (Mikias, Firew and Tamene, 2023; Asfaw and Tarekegn, 2017; Meskerem *et al*, 2023; Amare and Meseret, 2022). And hence, such a mode of transmission makes local knowledge vulnerable to distortion, and in most cases some of the knowledge is lost at each point of transfer (Keneni, 2018). In support of this Yibra (2014) stated that in this process valuable information can be lost whenever the medicinal plants are lost or a traditional medical practitioner dies without passing his local knowledge to others.

According to Asfaw and Tarekegn (2017), of all local knowledge, knowledge about plant use, and particularly medicinal plant use, appear to be one of the most vulnerable to loss due to many factors, expansion of markets, globalization and amalgamation of culture and other human activities. Admasu and Yohanse (2021) attributed deforestation for the loss of medicinal plants. The extensive knowledge of medicinal plants and their associated local knowledge is under severe threat due to development activities, deforestation, environmental degradation, and population growth, which not only endanger vital forest ecosystems but also disrupt local communities and their cultural heritage, risking the permanent loss of both MPs and the invaluable traditional practices tied to them (Ashebir *et al.,* 2024)

As a result, all of the scholars mentioned above agreed that unless the MPs are conserved and the associated local knowledge is documented, there is a danger that both the valuable MPs and the knowledge could vanish forever. Moreover, awareness on the contribution of traditional medicinal practice towards fulfilling the primary health care needs should be created among the youth. It is also pointed out that younger generation has no interest to know about MPs and

efforts should be made to incorporate traditional medicine in school curricula so that younger people appreciate its usefulness (Asfaw and Tarekegn, 2017).

2.6 Threats to Medicinal Plant Species

Medicinal plants (MPs) in Ethiopia are extensively used for treating human and livestock ailments, mainly because of communities' trust in their healing properties, cultural importance, affordability, and limited access to modern healthcare. However, the sustainability of traditional medicine faces threats from the loss of medicinal plant species and inadequate quality control of herbal remedies (Admasu and Yohannes, 2020). A review by Helmut (2023) of literature published between 2000 and 2023 identified several major threats to MPs in Ethiopia. Overharvesting near population centers and habitat destruction are the main factors threatening MP sustainability. These issues are worsened by the country's large human and livestock populations, which cause land degradation through deforestation, intensive farming, and grazing on erosion-prone mountainous areas. Helmut (2023) also pointed out possible effects of climate change (CC) on MPs, though limited research has been done in Ethiopia to confirm these impacts. Climate change may affect MPs in four key ways: (1) drought and higher temperatures may decrease their growth and survival; (2) subsistence farmers impacted by CC might increase collection and sale of MPs to boost income; (3) changing environmental conditions can influence the production of secondary metabolites, which affects the medicinal qualities of plants (IPCC, 2023); and (4) the rise of pests, diseases, and invasive species in response to CC could harm plant habitats.

2.7 Conservation of Medicinal Plants

Various literature reveal conservation of medicinal plants is essential for the sustainability of these plants. Different methods of conservation strategies are practiced across Ethiopia. As studies carried out by Zemede (2001) show medicinal plants can be conserved by promoting their growth in special places such as churches, mosques, grave yards, seared grooves, farm margins, river banks, road sides, live fences of gardens and fields. According to the study of Alemayehu *et al*., (2021), Ethiopian Biodiversity Institute is practicing in-situ and ex-situ conservation methods for conservation of medicinal plants. In study carried out in Sidama and across Ethiopia Medicinal plants find refuge in a range of botanical environments such as sacred groves which

provide crucial protection for medicinal plants and some critically threatened native trees (Zerihun, 2017). As the same author stated, the conservation of medicinal plants in other protection areas like farmers' backyards is presented subsequently. In addition to cultivation, measures such as establishing protected areas, promoting sustainable harvesting practices, and conducting research on medicinal plants can contribute to their long-term conservation (Ashebir *et al.,* 2024). Home gardens are being used effectively by traditional practitioners and local people for conservation. Nevertheless, most researchers agree that little attention is given to medicinal plants regardless of their use (Getnet 2017, Atinafu *et al*., 2017; Getenet *et al*., 2015).

3. RESEARCH METHODOLOGY

3.1 Description of the Study Area

3.1.1 Location

This study was conducted in rural kebeles in Doba District, located in the West Hararge Zone of the Oromia Regional State in Ethiopia. The district is 371 kilometers east of Addis Ababa and 45 kilometers from Chiro, the zonal capital. The area has an average elevation ranging from 1600 to 3100 meters above sea level and covers approximately 618 hectares (Amare and Patrick, 2023).

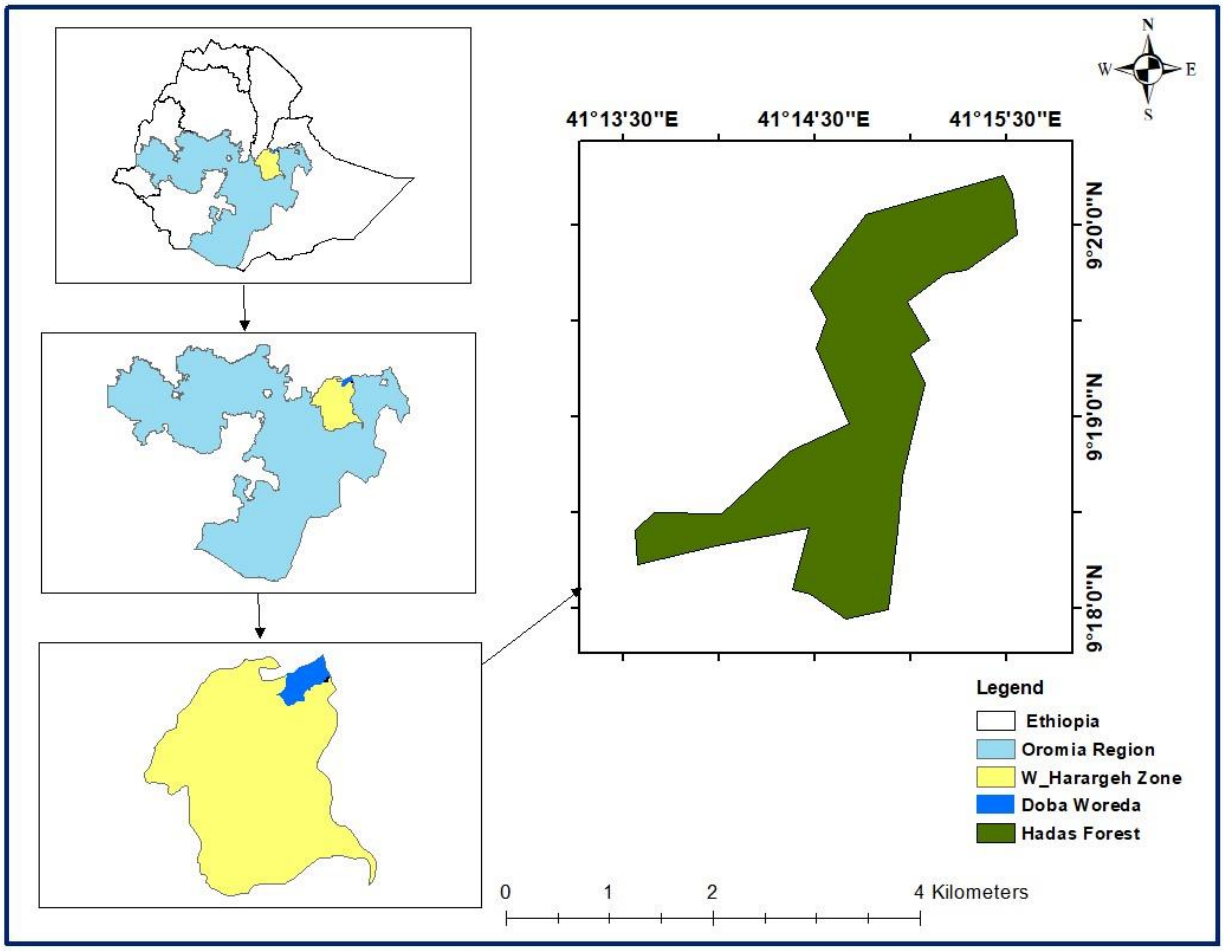

Figure 1. Location map of Hades and surrounding communities in Doba District, Ethiopia

3.1.2 Demographic characteristics of the study area

Based on the 2018 national census conducted by the Central Statistical Agency of Ethiopia, Doba District had a total population of 213,715, out of which 103,802 were men and 109,913 were women. From this, 50,032 (8.46%) of the population were urban dwellers (Gizaw, 2021).

3.1.3 Temperature and rainfall in the study area

The annual rainfall in the study area ranges between 300 and 800 mm, with the highest precipitation occurring from June to September. A shorter rainy season also takes place during the spring months of March, April, and May. The average annual temperature ranges from 16°C to 18°C (Diribe, 2024).

3.1.4 Vegetation

The Doba district is home to a variety of plant species. Among the most common species are *Juniperus procera, Podocarpus falcatus*, *Croton macrostachyus,* and *Maytenus* sp. The vegetation changes with altitude, featuring dense forests dominated by secondary growth of *Podocarpus falcatus* at lower and middle elevations, while higher altitudes are characterized by *Juniperus procera* and *Croton macrostachyus* mixed with other species such as *Mytenus* species and *Gymnosporia obscura* (Atomsa and Dibbisa 2019).

3.1.5 Topography and soil types

The area is characterized by an irregular topography with depressions, numerous chain mountains, flat lands, gorges with scattered trees and dense shrubs of patch natural vegetation. The soils in the study area generally exhibit a texture composed of sand, clay, and silt (Melese and Tessema, 2023)

3.2 Reconnaissance Survey

A reconnaissance survey was conducted in February 2025 in the study area prior to the actual data collection. The purpose of the survey was to gather sufficient preliminary information about the study sites, including the population, the location of traditional healers, and knowledgeable elders. Based on this information, three study sites (kebeles); Bekelecha Biftuu, Ifa Haqaa and Tokuma Jaalalaa were purposively selected among the 44 kebeles in the district. The selection

criteria included the presence of traditional medicine practitioners, the availability of medicinal plants, and density of the natural vegetation and recommendations from knowledgeable elders

3.3 Sampling Design

A total of 120 informants were included in this study from three purposively selected kebeles: Tokkuma Jalala, Ifa Haka, and Bekelecha Biftu, with 40 informants from each kebele. Key informants (n = 15; 5 per kebele), recognized as holders of traditional medicinal knowledge, were selected using snowball sampling. These included 12 males and 3 females, identified as traditional healers, herbalists, or knowledgeable elders with extensive experience in medicinal plant use. Initial key informants were identified through consultations with kebele administrators, development agents, and respected local elders, who subsequently referred other knowledgeable individuals within their social networks. Recruitment of key informants continued until data saturation was reached, i.e., when no new medicinal plant knowledge or practices emerged.

General informants (n = 105; 72 males and 33 females) were randomly selected from the community to provide representative information on knowledge variation across demographic groups. This approach allowed for legitimate comparisons of medicinal plant knowledge across age, gender, and educational levels. Selection aimed to capture demographic diversity, including age categories (young adults, middle-aged, and elders), gender, and education levels (literate vs. non-literate).

3.4 Ethnobotanical Data Collection Techniques

Before data collection, official permission was obtained from Doba District Administrative Ofthe fice. Participants were clearly and honestly briefed about the purpose and scope of the research before interviews were conducted. They were informed that participation was voluntary and that their individual identities would remain confidential. Oral consent was obtained from each participant to provide the information needed for the study.

The ethnobotanical data collection employed several techniques, including semi-structured interviews, group discussions, and guided field walks with key informants to facilitate field observations and accurate identification of medicinal plants (MPs). These methods were used to

gather information related to respondents' socio-demographic status, their local knowledge of medicinal plant utilization, factors threatening medicinal plants, and conservation efforts being made to preserve them. Data collection took place between February and March 2025, following the formal survey procedures described by Cotton (1996) and Cunningham (2001).

3.4.1 Semi-structured interview

Semi-structured interviews were conducted with purposively selected informants using a checklist of questions initially developed in English and translated into Afaan Oromo and Amharic, the local languages. The flexible format allowed additional questions to emerge naturally during discussions. Interviews gathered information on respondents' socio-demographic characteristics (gender, age, education, marital status, religion, occupation, and economic status), human and livestock ailments treated with medicinal plants, vernacular plant names, plant parts used, methods of preparation, routes of administration, conservation status, and other uses of medicinal plants.

Community perceptions of threats and conservation practices were assessed using a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). A total of 30 informants participated, comprising 15 purposively selected elders with local knowledge and 15 randomly selected community members. Higher scores indicated perceptions of greater medicinal plant availability, more effective conservation practices, stronger community involvement, and higher severity and prevalence of threats to medicinal plant resources. Lower scores reflected perceptions of scarce availability, ineffective conservation practices, minimal community participation, negative changes in traditional medicinal plant availability, and weaker perceptions of existing threats.

3.4.2 Focus group discussion

Focus group discussions were conducted with key informants, divided into three groups of five participants from each kebele, to gather additional information on the local uses of medicinal plants (MPs), community traditional practices, and their management, and to ensure the reliability of the information collected. These discussions also explored how knowledge is preserved within the community and transmitted across generations. The discussions were guided by a checklist of questions covering topics such as local names, medicinal uses, disease

treated, major threats, methods of preparation, modes of administration, availability status, and conservation strategies for medicinal plants (MPs).

3.4.3 Guided field walk

Guided field observations were conducted with key informants and field assistants to validate the information obtained from earlier interviews and group discussions. During the field visit, medicinal plant species were systematically collected following standard herbarium protocols, and voucher specimens were prepared and deposited at the Haramaya University Herbarium. Identification was performed by visual comparison with authenticated herbarium specimens and cross-referenced with taxonomic descriptions in the relevant volumes of the *Flora of Ethiopia and Eritrea*.

3.5 Data Analysis

The collected data were initially organized and stored in Microsoft Excel (2010). Then analyzed using R software (version 4.5.1) and Microsoft Excel (2010). Descriptive statistics, including percentages and frequencies, were used to summarize data related to medicinal plant species, plant parts used, methods of preparation, administration routes, disease categories treated.

3.5.1 Informant Consensus Factor

The level of homogeneity among information provided by different informants was calculated by using Informant Consensus Factor (ICF). The data collected from informants were analyzed using the following equation:

$$ICF = \frac{Nur - Nt}{Nur - 1}$$

Where:

Nur, denotes number of use reports from informants for a specific plant use and Nt, denotes number of species (taxa) that are used for that plant use category for all informants. The result of this factor ranges from 0 to 1. A high value (close to 1) indicates that relatively few taxa (usually species) are used by a large proportion of people, while a low value indicates that the informants disagree on the taxa to be used in the treatment within a category of illness (Heinrich *et al.*, 1998).

3.5.2 Fidelity level

Fidelity Level (FL) was calculated to determine the relative importance of each medicinal plant species for the treatment of specific ailments. This index reflects the proportion of informants who reported the use of a plant species for the same major purpose, indicating its potential effectiveness or cultural importance for that particular use. FL was calculated using the formula developed by Friedman *et al.* (1986) and later applied by several ethnobotanical studies (Santosh, 2021):

$$FL\ (\%) = Ip\ /\ Iu * 100$$ Where:

- Ip = Number of informants who independently reported the use of a species for the same specific ailment
- Iu = Total number of informants who mentioned the plant for any ailment

  A higher FL value indicates greater consensus among informants about the specific use of a plant species, suggesting its potential effectiveness in treating that particular condition.

3.5.3 Preference ranking to medicinal plants

In accordance with (1995), nine key informants have been randomly chosen to evaluate the level of efficacy of eight medicinal plants for humans against intestinal parasites and five medicinal plants for livestock against local illness called ‘‘Dengetegna’’. The selected key informants ranked the plants depending on the relative potential of medicinal plants to cure the diseases. Those mentioned plants were then given to individual respondents so as to rank them by giving the highest value (5) to the medicinal plant they believe is most effective and lowest value (1) for least effective one. The assigned values of each plant species were summed and then ranked based on the total score obtained for each medicinal plant.

3.5.4 Relative frequency of citation (RFC)

In this study, the Relative Frequency of Citation (RFC) index was used to assess the local importance of each medicinal plant species, based on how frequently it was mentioned by the informants. The RFC provides an indication of the extent of knowledge or recognition of a given

species among the community. The RFC was calculated using the method proposed by Tardío and Pardo-de-Santayana (2008), using the formula:

$$\text{RFC} = {}^{FC}/_{N}$$

where N is the total number of informants interviewed. The FC for each species was computed as FC = ((Number of times a specific species is cited / Total number of informant}) × 100. After calculating the FC, the RFC index for each species was obtained by dividing its FC value by the overall number of informants involved in the study (N). The RFC value ranges from 0 to 1, where a higher value indicates greater recognition and importance of the species among the community.

3.5.5 Relative importance index (RI)

The Relative Frequency of Citation (RFCs) was used to quantify how frequently each species is mentioned relative to its maximum citation frequency among all species studied. This metric help in understanding which plants are most commonly recognized and utilized within the community. According to Tardío and Pardo-de-Santayana (2008), the index was calculated using the following equation:

$$RI = \frac{\text{RFCs (max)} + \text{RNUs (max)}}{2}$$

Where RFC_{max} represents the relative frequency of citation over the maximum, calculated as:

$$\text{RFCmax} = \frac{\text{FCs}}{\max(FC)}$$

and $RNUs_{max}$ denotes the relative number of use categories over the maximum, calculated as:

$$\text{RNUsmax} = \frac{\text{Nus}}{\max(NU)}$$

The RI index theoretically ranges from 0, when no informant mentions any use of the plant, to 1, when the plant is both the most frequently cited and recorded in the maximum number of use-categories (Tardío and Pardo-De-Santayana, 2008)

3.5.6 Direct matrix ranking (DMR)

To assess the relative importance of multipurpose medicinal plants, a direct matrix ranking technique was employed, following the approach described by Cotton (1996). From the total list of medicinal plants identified in the study area, five tree species were selected due to their wide range of uses. These species were evaluated across six major use categories: soil erosion control, goat feed, timber, edible fruit, firewood, and fencing. Nine knowledgeable key informants participated in scoring the usefulness of each plant within each category using a five-point scale, where a score of 5 represented the highest level of use and 1 indicated the lowest

3.5.7 Cultural importance (CI)

The Cultural Importance Index (CI) was computed as the sum of the proportion of informants who mentioned each use category of a given plant species, relative to the total number of informants According to Tardío and Pardo-De-Santayana (2008), the index was calculated using the following equation:

$$CIs = \sum_{u=1}^{NC} \frac{Nsu}{N}$$

To analyze differences in local knowledge regarding the use of medicinal plants for treating across various informant groups and demographic factors, several statistical methods were employed. The normality of local knowledge scores related to medicinal plants was initially assessed for each group using the Shapiro–Wilk test, and homogeneity of variances was evaluated using Levene's test (Field, 2013). To compare knowledge scores between key informants and general informants, a Welch two-sample t-test was employed, as it accounts for unequal variances and sample sizes (Welch, 1947). Knowledge differences between male and female informants were examined using an independent samples t-test. Similarly, differences in medicinal plant knowledge between educational levels (Non-litrate vs. literate) were analyzed using an independent samples t-test. To evaluate the effect of age group on knowledge depth, a one-way ANOVA was conducted to test for significant differences among young adults, middle-aged, and elder groups (Kirk, 2013). When significant differences were found, Tukey's Honest Significant Difference (HSD) test was applied as a post-hoc analysis to identify specific group

differences while controlling for multiple comparisons (Tukey, 1949). A significance level of $p < 0.05$ was maintained throughout the analysis.

4. RESULTS AND DISCUSSION

4.1 Demographic Status of Informants

A total of 120 informants participated in this study. A large proportion of the informants were male, with females making up a smaller share of the participants. Most participants were above the age of 46, and primarily engaged in farming. The majority were married and non-literate, and all reported a monthly income above 5,000 (Table 1).

Table 1. Sociodemographic characteristics of respondents

Category	Subcategory	Count	Percentage
Occupation	Farmer	46	38.30
	Farmer and trader	7	5.80
	Farmer and traditional healer	13	10.80
	Farmer, Forest guardian	2	1.70
	Housewife	6	5.00
	Police	4	3.30
	Student	14	11.70
	Trader	5	4.20
	Traditional healer	2	1.70
Gender	Female (F)	36	30.00
	Male (M)	84	70.00
Age	>46	69	57.50
	25–35	18	15.00
	36–45	33	27.50
Marital Status	Married	111	92.5
	Single	9	7.50
Education Status	Non-litrate	90	75.00
	Litrate	30	25.00
Income (Monthly	>5000	120	100

The demographic profile indicates that older males, particularly those engaged in farming and traditional healing, are key custodians of ethnomedicinal knowledge. This finding is consistent with previous Ethiopian studies (Zemede *et al.*, 2024), which reported that farmers and herbalists tend to cite more medicinal plants compared to other infromants. The high proportion of non-literate participants suggests that medicinal knowledge is primarily transmitted through experience and oral tradition rather than formal education (Sintayehu *et al.*, 2024).

4.2. Medicinal Plants of the Study Area and Their Use

4.2.1. Medicinal plant resources of the study area used for treating human ailments

A total of 49 medicinal plant species belonging to 47 genera and 31 families were documented in this study. Among the families, Asteraceae was the most represented, comprising 5 species; Lamiaceae followed with 4 species, and Rosaceae and Fabaceae each accounted for 3 species. 5 families, such as Apocynaceae, Primulaceae, Solanaceae, Saliaceae, and Scrophulariaceae, contributed two species each, while the remaining 14 families were represented by a single species. All of these 49 species were used for treating human ailments**,** highlighting the extensive ethnomedicinal knowledge available for human healthcare in the study area. (Table 2).

Table 2. Medicinal plant resources of the study area used to treat human ailments (L- leaf, R-root, B-bark, Sd-seed, St- stem, Ap-all part)

Voucher No	Botanical Name / Habit	Family	Vernacular Name	Disease Treated	PU	PM & AM
AT015	*Afrocarpus falcatus* (Thunb.) C.N. Page / Tree	Podocarpaceae	Birbirsa	Insect repellent, Heart Disease, Fever	L, Sd	Crushed and rubbed on skin; boiled with apple leaf and drunk with coffee; crushed and boiled to drink (Oral/Dermal)
AT012	*Aloe pubescens* Reynolds / Succulent Herb	Asphodelaceae	Ret	Diabetes, Gastric	L	Inner jelly-like part extracted, mixed with Beso and eaten (Oral)

				Dandruff	Sap	Inner jelly-like part extracted and applied to scalp (Topical)
AT011	*Alysicarpus rugosus* (Willd.) Dandy / Herb	Fabaceae	Alii-hanqaa	Gonorrhea, Cough	B, L	Dried, crushed, boiled with water and oil to drink (Oral)
AT009	*Asparagus africanus* Lam. / Climbing Shrub	Asparagaceae	Hiddii saree	Menorrhagia,	L	Crushed, mixed with water, left overnight and drunk
				Tufa	L	pounded and wrapped on wound (Oral/Dermal)
AT044	*Astropanax abyssinicus* (Hochst. ex A. Rich.) Seem / Tree	Araliaceae	Gatama	Skin irritation	L	Pounded and rubbed over affected area (Dermal)
AT026	*Bidens pilosa* L. / Herb	Asteraceae	Xiyyee	Back pain, Stomach disorder, Headache	L	Boiled and drunk (Oral)
AT020	*Caesalpinia decapetala* (Roth) Alston / Shrub	Fabaceae	Qajima	Ascariasis	R	Crushed with leaves of Plectranthus ecklonii and drunk with water (Oral)
AT032	*Calpurnia aurea* (Aiton) Benth. / Shrub	Fabaceae	Ceekaa	Jaundice, Detoxification	L	Crushed with leaves of Verbascum sinaiticum and Plectranthus ecklonii and drunk with water (Oral)
AT017	*Carissa spinarum* L. / Shrub	Apocynaceae	Agamsa	Wound	B	Wrapped on the wound (Dermal)
AT001	*Cissampelos mucronata* A. Rich. / Perennial Climber	Menispermaceae	Bal-Toke	Stomach ache, Cough, Diarrhea	L	Crushed and mixed with water to drink; (Oral)
				Snake bite	R	Pounded and applied to

						affected area (Dermal)
AT045	*Combretum molle* G. Don / Shrub	Combretaceae	Maldhissa	Fever, Constipation	R	Boiled and drunk (Oral)
AT031	*Croton macrostachyus* Hochst. ex Delile / Tree	Euphorbiaceae	Bekenissaa	Bloating, Hemorrhoids, Gonorrhea	L, Sd, St, R	Crushed and drunk with water (Oral)
AT008	*Cucumis ficifolius* A. Rich. / Annual Climber	Cucurbitaceae	Hare goge	Diarrhea, Kidney disease, Bloating, Gonorrhea	L	Crushed and drunk with water (Oral)
AT023	*Cymbopogon citratus* (DC.) Stapf / Grass	Poaceae	Cita fura	Evil spirit, Common cold	Ap	Burned to fumigate the patient (Inhalation)
AT040	*Datura stramonium* L. / Herb	Solanaceae	Qomaxeri	Dhandacha (O)	L	Crushed and squeezed on scalp (Topical)
				Bloating	B	crushed and drunk with water (Oral)
				Toothache	Sd	held on aching tooth (Buccal)
AT043	*Dovyalis abyssinica* (A. Rich.) Warb. / Shrub	Salicaceae	Shimbirkoli	Intestinal parasite	L	Pounded and drunk with water (Oral)
AT038	*Echinops kebericho* Mesfin / Shrub	Asteraceae	Qabariicho	Intestinal worms, Urine retention, Evil eye, Tonsillitis, Fever	R	Pounded, mixed with water and drunk; crushed with oil and drunk (Oral)
AT030	*Embelia schimperi* Vatke. / Shrub	Primulaceae	Hanquu	Tapeworm	F	Dried, pounded and drunk with water (Oral)
AT047	*Ficus sur* Forssk. / Tree	Moraceae	Harbuu	Jaundice, Anemia,	L	Crushed and drunk with water (Oral)
				Ringworms	L	Crushed and applied on the affected body part (Dermal)

AT003	*Foeniculum vulgare* Mill. / Perennial Herb	Apiaceae	Kemona	Kidney disease, Vomiting, Urinary retention	L, R	Roasted, crushed and drunk with milk; crushed and drunk with water (Oral)
AT007	*Hagenia abyssinica* (Bruce) J.F. Gmel. / Tree	Rosaceae	Heexoo	Tapeworm, Back pain	L, R, Sd	Crushed, dried and consumed; root soaked and consumed (Oral)
AT034	*Hoffmannanthus abyssinicus* / Shrub	Asteraceae	Muka adi	Cataracts	L	Crushed and squeezed to extract liquid into eye (Ocular)
AT028	*Jasminum grandiflorum* L. / Shrub	Oleaceae	Bilu	Tufa, Bleeding, Body swelling	L	Crushed and applied to affected body part (Dermal)
AT027	*Juniperus procera* Hochst. ex Endl. / Tree	Cupressaceae	Gatiraa habashaa	Uterus problem,	Sd, L	Pounded and drunk with water (Oral)
				Toothache	Sd	Held by aching teeth (Buccal)
AT046	*Justicia schimperiana* (Hochst. ex Nees) T. Anderson / Shrub	Acanthaceae	Dhummuga	Rabies	L	Dried with leaf of *Phytolacca dodecandra*, crushed and drunk with water (Oral)
AT018	*Kalanchoe marmorata* Baker / Shrub	Crassulaceae	Phiphii	Ear disease	L	Heated and squeezed to extract liquid into ear canal (Otic)
AT013	*Lippia adoensis* Hochst. ex Walp. var. / Shrub	Verbenaceae	Sukee	Fungal skin infection, Body swelling	L	Roasted, powdered and mixed with butter or oil to apply (Dermal)
AT049	*Myrica salicifolia* Hochst. / Shrub	Myricaceae	Macheenssso	Dermatitis	L	Dried, crushed, mixed with water and applied (Dermal)
AT021	*Myrsine africana* L. / Shrub	Primulaceae	Qacuu	Stomach ache, Back pain	R	Crushed, roasted, drunk with goat milk (Oral)
AT036	*Myrtus communis* L. / Shrub	Myrtaceae	Hades	Stomach ache	L	Pounded and drunk with water (Oral)

AT014	*Ocimum lamiifolium* Hochst. ex Benth. / Shrub	Lamiaceae	Anchebi	Mich, Common cold	L	Rubbed by hand and squeezed into coffee to drink (Oral)
AT025	*Olea africana* Mill. / Tree	Oleaceae	Ejersa	Headache, Common cold	L, St	Crushed and burned to fumigate the patient (Inhalation)
AT048	*Oncoba spinosa* Forssk. / Tree	Salicaceae	Garabagosh	Dermatitis	L	Pounded and applied to affected area (Dermal)
AT041	*Osyris quadripartita* Decne. / Shrub	Santalaceae	Wato	Evil eye	L, R	Dried, crushed, powdered, burned and smoke inhaled (Inhalation)
AT022	*Periploca linearifolia* Quart. Dill. & A. Rich. / Perennial Climber	Apocynaceae	Hidda aanaannoo	Eye disease	R	Dried and burned for fumigation (Inhalation)
AT037	*Phytolacca dodecandra* L'Hér. / Shrub	Phytolaccaceae	Handoode	Intestinal parasite	Sd	Pounded and drunk with water (Oral)
				Itching	L	crushed and used for washing(Dermal)
AT035	*Plantago media* L. / Herb	Plantaginaceae	Asandabo	Hemorrhoid	L	Crushed and drunk with water (Oral)
AT033	*Plectranthus ecklonii* Gürke / Shrub	Lamiaceae	Muka ajawa	Mich	L	Crushed and placed in cloth to squeeze into eye (Ocular)
AT024	*Premna schimperi* Engl. / Shrub	Lamiaceae	Urgessa	Body swelling, Toothache	L	Crushed with leaves of Jasminum grandiflorum and Podocarpus falcatus and applied; chewed and held with affected teeth (Dermal/Buccal)
AT042	*Rosa abyssinica* Lindl. / Shrub	Rosaceae	Goraa	Toothache, Wound	R, L	Chewed and held on teeth;

						dried, crushed and applied to wound (Buccal/Dermal)
AT005	*Rubus apetalus* Poir. / Shrub	Rosaceae	Gora gallo	Digestive issues	F, R, L	Unprocessed eaten; dried, boiled, and drunk (Oral)
AT002	*Rumex abyssinicus* Jacq. / Herb	Polygonaceae	Meyemeqo	Gofla (O), Cancer	R	Crushed and boiled to drink (Oral)
AT004	*Salvia merjamie* Forssk. / Herb	Lamiaceae	Muka aroo	Spider poison	L, R	Pounded and applied to affected body part (Dermal)
AT016	*Scolopia theifolia* Gilg. / Tree	Salicaceae	Qillisaa	Ascariasis	R	Crushed and drunk with water (Oral)
AT010	*Solanecio nandensis* Oliv. / Herb	Asteraceae	Jiniirsaas	Spider poison Fungal skin infection	L, Ap	Crushed and applied on the affected body part (Dermal)
				Febrile illness	L	Crushed and mixed with water to drink (Oral)
AT019	*Verbascum schimperi* Skan. / Herb	Scrophulariaceae	Muka Loni	Stomach ache	L	Crushed with Plectranthus ecklonii and apple leaf, mixed with water (Oral)
AT039	*Verbascum sinaiticum* Benth. / Herb	Scrophulariaceae	Gura hare	Gonorrhea, Cancer	R	Crushed and drunk with water or coffee (Oral)
AT029	*Vernonia amygdalina* Del. / Shrub	Asteraceae	Ebicha	Diarrhea, Intestinal parasite	L	Pounded and drunk with water (Oral)
AT006	*Withania somnifera* (L.) Dunal / Shrub	Solanaceae	Hide-budei	Bloating, Evil eye, Heart problem, Diabetes	R, L	Pounded and drunk with water; dried, powdered and eaten or drunk (Oral)

This result indicates that these families are among the top contributors to medicinal plant use in the study area, suggesting that the local community preferentially utilizes species from these groups for healthcare purposes. This finding is in agreement with previous studies in Ethiopia,

which similarly reported Asteraceae and Lamiaceae as the most frequently cited families in ethnomedicinal practices (Haile, 2022; Ashebir *et al.,* 2024; Kasa *et al*., 2020; Awoke *et al*., 2024). The prominence of these families may be attributed to the presence of diverse bioactive phytochemicals commonly found in these taxa, which enhance their therapeutic effectiveness (Reinaldo *et al.*, 2020; Safitr *et al.*, 2024). Kedir *et al*. (2022) also highlighted the importance of Asteraceae in traditional medicine, noting that species within these families often share similar phytochemical compositions that contribute to their medicinal value. Moreover, many species from these families are easy to prepare and administer, often using leaves or aerial parts that require simple processing, which increases their practicality for local healers. This cultural familiarity, combined with a long-standing perception of safety and efficacy, likely contributes to their continued preference within the community. The prominence of these families highlights the cultural and therapeutic significance of key plant families and the importance of understanding and protecting these valuable botanical resources.

4.2.2. Medicinal plant resources of the study area used for treating livestcok ailment

A total of 9 medicinal plant species, belonging to 9 genera and 8 families, were documented for the treatment of livestock ailments. The most represented families were Lamiaceae and Scrophulariaceae, each comprising 2 species, while the remaining families, Apocynaceae, Solanaceae, Myrtaceae, Asteraceae, and Apiaceae, were represented by a single species. These plants were used to address a range of livestock health problems, including bloating, intestinal parasites, mastitis, urine retention, vomiting, wounds, and refusal to breastfeed (Table 3).

Table 3. Medicinal plant resources of the study area used to treat livestock ailments (L- leaf, R-root, B-bark, St- stem, Ap-all part)

Voucher No.	Botanical Name / Habit	Family	Plant ID	Disease Treated	PU	PM & AM	Usage Type
AT001	*Carissa spinarum* L. / Shrub	Apocynaceae	Bal-Toke	Bloating, Dngetegna	R	Unprocessed directly eaten	Goat, cattle
				Viruses	R	Unprocessed directly eaten	Goat, cattle

AT038	*Echinops kebericho* Mesfin / Shrub	Asteraceae	Qabariichoo	Jigo / Gofla (Tooth disease, Breast Cancer, Tonsillitis, Intestinal worms)	St, R	Pounded and drunk with water	Cow
AT003	*Foeniculum vulgare* Mill. / Herb	Apiaceae	kemona	Urine retention	R	Crushed and drunk with water	Donkey
				Vomiting	L	Roasted, crushed, mixed with milk	Livestock
AT036	*Myrtus communis* L. / Shrub	Myrtaceae	Hades	Bloating	L	Crushed and drunk with water	Livestock
AT033	*Plectranthus ecklonii* / Herb	Lamiaceae	Muka ajawa	Dngetegna	L	Crushed and drunk with water	Cattle
AT004	*Salvia merjamie* / Herb	Lamiaceae	Muka aroo	Wound	L	Dried, pounded and spread on affected body part	Livestock
				Dngetegna	R	Pounded and drunk with water	
AT019	*Verbascum schimperi* Skan. / Shrub	Scrophulariaceae	Muka Loni	Dngetegna	L, R	Crushed with leaves of Plectranthus ecklonii and apple leaf and mixed with water to drink	Cattle
AT039	*Verbascum sinaiticum* Benth. / Herb	Scrophulariaceae	Gura hare	Bloating	R	Crushed and drunk with water	Cattle
				Refusal to breastfeed in cattle after giving birth	R	Crushed and drunk with water	Cow

AT006	*Withania somnifera* (L.) / Shrub	Solanaceae	Hide-budei	Intestinal parasite	R	Crushed with leaves of Solanecio nandensis and mixed with water to drink	Cattle
				Itching	R	Pounded and applied on the skin	Cattle
				Mastitis	L	Dried, crushed and drunk with water	Cow

The documentation of these medicinal plant species, drawn from a limited number of families with Lamiaceae and Scrophulariaceae being the most prominent, suggests that the local community has refined its practices to utilize the most efficacious local flora. The application of these plants to address a variety of common ailments, such as bloating, intestinal parasites, and mastitis, underscores the practical utility of this local knowledge in maintaining animal health. These findings are consistent with other ethnobotanical studies conducted in the Ethiopia which frequently highlight the use of plants from the Lamiaceae and Asteraceae families in animal health (Fisseha *et al.* 2009; Tesfaye *et al.* 2009). The high frequency of use of species within these botanical families for treating various ailments suggests that these families contain common bioactive compounds recognized in the study area for their medicinal properties.

4.2.3 Habits of medicinal plants

Various habits of medicinal plants were identified for treating both human and livestock ailments in the study area. Among these, shrubs were the most dominant. Herbs and trees also constituted a significant portion of the recorded species. In contrast, climbers and grasses were the least represented habits, suggesting a more limited use within the medicinal plant repertoire (Figure 2).

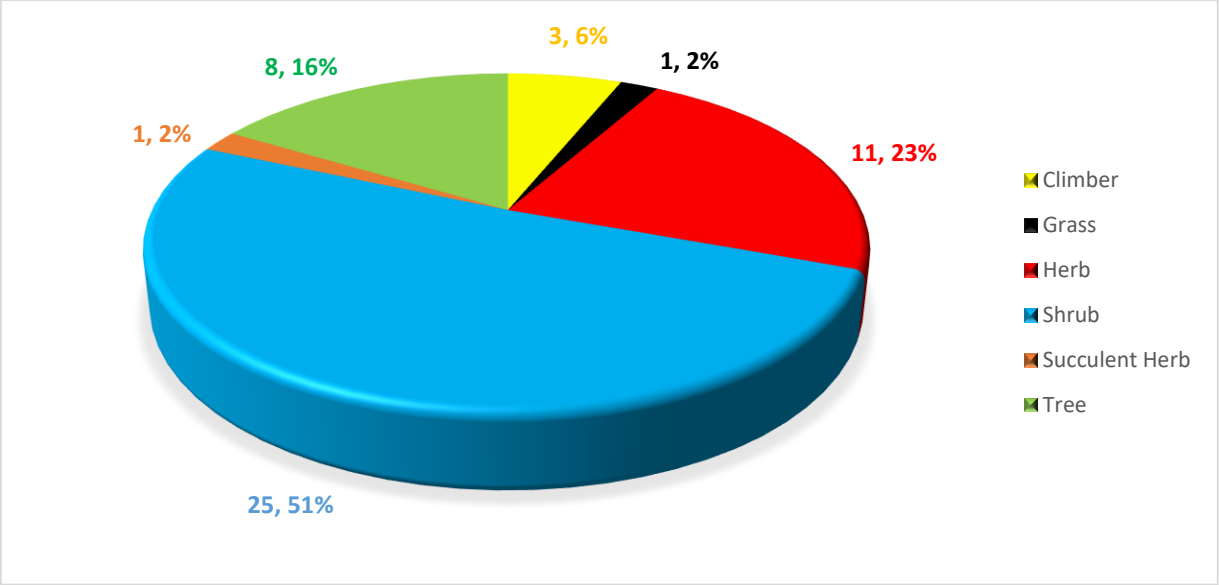

Figure 2. Habits of medicinal plants in the study area

The result indicates that shrubs are the most commonly preferred plant habit for treating human and livestock ailments, suggesting their prominence as widely used medicinal resources in the study area and underscoring their important role in traditional healthcare practices. A similar preference for shrubs has been reported in other relevant studies (Jima and Megersa, 2018; Megenasa *et al.*, 2019; Mutie *et al.*, 2020). Their dominance in the local pharmacopoeia is often attributed to practical factors such as their greater accessibility and ease of harvesting. Unlike many wild herbs which exhibit seasonal availability, shrubs are typically perennial and more resilient to environmental stresses such as drought and competition from invasive species. These characteristics make shrubs a more dependable and continuously available resource for traditional healers (Asheber *et al.*, 2024). The high prevalence of shrubs in this study, alongside significant contributions from herbs and trees, demonstrates that traditional medicinal practices in the study area are closely aligned with the reliability and availability of local plant resources.

4.2.4. Medicinal plant parts used for treating human and livestock ailments

Findings from the study indicated the use of seven different plant parts in preparing remedies for human ailments, while three plant parts were identified as sources for treating livestock ailments. For human healthcare, leaves were the most frequently cited, followed by roots and seeds. Other plant parts such as stems, bark, fruits, the whole plant, and sap were also mentioned, though in smaller proportions (Figure 3).

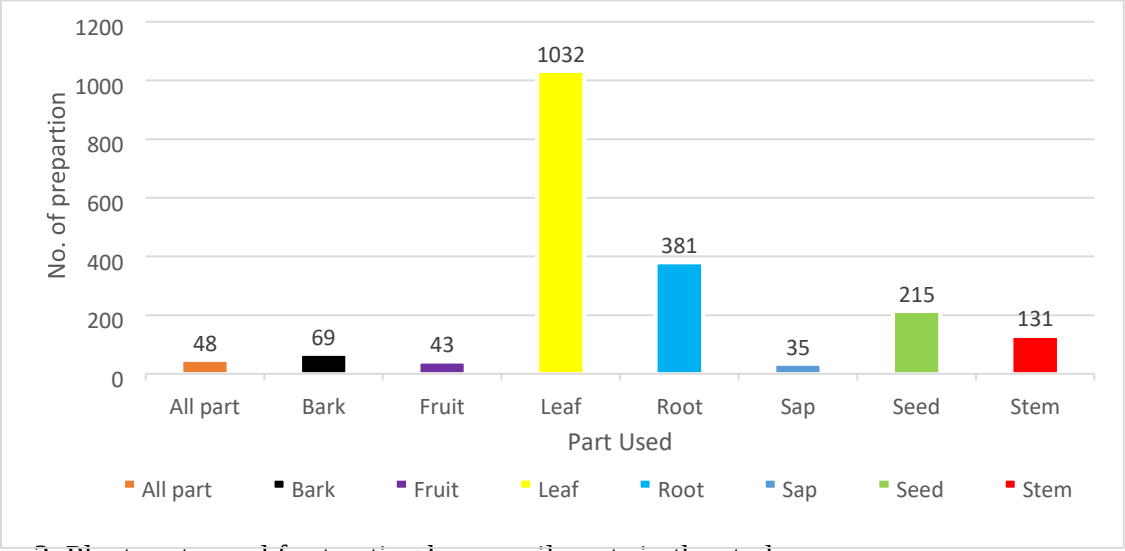

Figure 3. Plant parts used for treating human ailments in the study area

The results indicate that leaves are the most frequently used plant part for treating human ailments, followed by roots. This suggests that the local community prefers plant parts that are effective, abundant, and easily harvested without harming the plant. This usage pattern aligns with findings from other ethnobotanical studies, which commonly report leaves as the dominant plant part used followed by roots in traditional healthcare (Firehun *et al.*, 2025; Bekele and Chala, 2021; Bekele *et al.*, 2021). The widespread use of leaves may be attributed to their abundance, ease of access without destroying the entire plant, and high concentration of medicinally active compounds, making them a preferred choice in remedy preparation by the local communities in the study area. This consistent dominance in human treatments underscores their central role in traditional medicine, reflecting both practical harvesting considerations and therapeutic efficacy. The use of roots as a secondary resource also matches reports from other Ethiopian districts, where roots are valued for their perceived efficacy and year-round availability (Asheber *et al.*, 2020; Fongang *et al.*, 2021).

Concerning livestock treatments, roots were the most frequently used plant part, while stems and leaves were used to a much lesser extent, reflecting the diversity of plant parts employed by the community in ethnoveterinary practices (Figure 4).

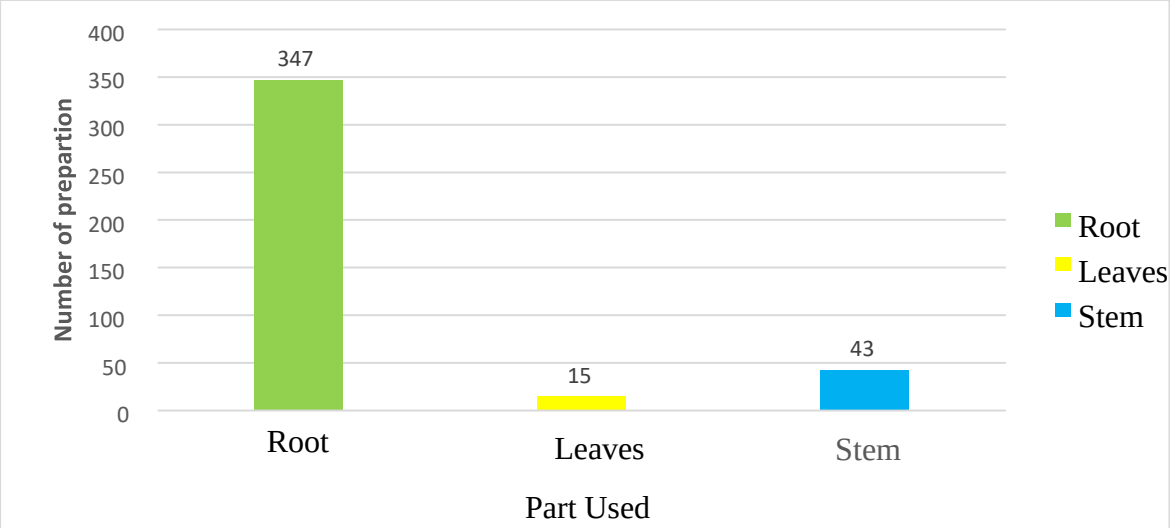

Figure 4. Plant parts used for treating livestock ailments in the study area

This suggests that the community perceives roots as the most potent component for addressing livestock ailments such as bloating, mastitis, and intestinal parasites. The minor use of stems and leaves indicates a selective approach, where plant parts are chosen based on perceived efficacy and availability. This pattern is supported by other relevant studies in Ethiopia, such as Dugda District in the Central Rift Valley, where roots accounted for 55.25% of the plant parts used in ethnoveterinary remedies (Asfaw *et al.*, 2024). The preference for roots may also be due to their year-round availability, as they remain protected underground even during prolonged dry seasons. This finding highlights distinct cultural and functional preferences in livestock healthcare and underscores the importance of adopting sustainable harvesting practices to prevent overexploitation of root-harvested species.

4.2.5 Methods of medicnal plant remedy preparations

The local people in the study area employed a variety of methods for preparing traditional remedies, depending on the nature of the ailment. The most commonly used techniques for preparation of remedy for treating human ailment were crushing and pounding, followed by topical application, fluid extraction, and concoction. Less frequently mentioned methods included fumigation, direct consumption, infusion, and a few others and similar preparation methods were employed for preparation of remedy for treating livestock ailment where pounding and crushing were the most commonly cited techniques. Direct consumption of raw plant parts was also reported, alongside minimal use of roasting (Table 4).

Table 4. Methods of remedy preparation for treating human and livestock ailments in the study area

Preparation Methods (Human ailments)	Total Use Reports	%	Preparation Methods (livestock ailments)	Total Use Reports	%
Crushing and pounding	1,149	59.14	Pounding	227	46.60
Fluid extraction	309	15.90	Crushing	181	37.10
Concoction	290	14.93	Direct Consumption	74	15.20
Fumigation or burning	91	4.68	Roasting	5	1.00
Direct consumption	91	4.68			
Infusion	10	0.51			
Other minor methods	3	0.15			

The dominance of crushing and pounding as the preferred preparation methods indicates a reliance on simple, accessible techniques that do not require specialized equipment or complex procedures. These methods effectively break down plant tissues to release active compounds, facilitating subsequent administration as liquids or topical applications. This simplicity makes traditional healthcare highly practical and readily deployable within the community using common household tools. The choice between crushing and pounding appears to be influenced by the condition of the plant material: remedies prepared from freshly harvested plant parts were typically crushed, whereas those made from dried materials were usually pounded. These findings are consistent with previous ethnobotanical studies. For instance, Firehun *et al.* (2025), Netsanet *et al.* (2020) and Yimer *et al.* (2021), reported that crushing was the most frequently used method of preparation, accounting for 49 instances (29.87%)**,** followed by pounding with 39 instances (23.78%). Informants further described the incorporation of additives such as water, oil, sugar, salt, milk, butter, honey, tea, and coffee to enhance taste, reduce potential side effects (e.g., vomiting, diarrhea), and to improve the overall effectiveness of the treatment. This practice indicates the deep understanding within the community of how to mitigate potential adverse effects of medicinal plants, such as strong bitterness that might induce vomiting or diarrhea. By enhancing the taste (palatability) and nutritional value (e.g., using milk or honey), local healers improve patient compliance and optimize the overall therapeutic experience. This

highlights the holistic nature of traditional healthcare practices, where effectiveness and patient well-being are interconnected. Similar practices were reported by Juhar *et al*. (2024) among the Gamo people, and by Asheber *et al*. (2024) in the Yeki District, where herbalists routinely use additives to improve both nutritional value and palatability. This consistent pattern across different communities suggests that these simple physical preparation methods are widely recognized as effective ways to prepare remedies for immediate use.

4.2.6 Route of medicnal plant remedy administration

The study revealed that medicinal plants were administered through various routes, depending on the nature of the ailment and local knowledge of effective delivery methods. Among treatments for humans, oral administration was by far the most frequently cited, followed by dermal, inhalation, buccal, topical**,** and ocular routes. Similarly, in ethnoveterinary practices, oral administration was the dominant route, while dermal applications were rarely used (Table 5).

Table 5. Administration Route of remedies for Human and Livestock ailments in the study area

Administration (Human)	No. of Preparations	%	Administration (Livestock)	No. of Preparations	%
Oral	1,373	70.64	Oral	470	96.60
Dermal	248	12.76	Dermal	17	3.40
Inhalation	134	6.89			
Buccal	103	5.30			
Topical	58	2.98			
Ocular	27	1.39			

The results indicate that both human and livestock remedies in the study area are predominantly administered orally, reflecting a clear preference for this route across different types of ailments. Dermal applications are secondary and mainly used for localized conditions, while less frequently employed routes, such as inhalation, buccal, and ocular administration, account for a small proportion of use. This pattern demonstrates that the community prioritizes ease of use, cultural acceptance, and practical effectiveness in remedy delivery. These findings align with previous studies in Ethiopia, which reported oral administration as the predominant route for both human and livestock remedies. For example, in Dibatie District, 52.2% of remedies were

administered orally, followed by dermal and fumigation methods (Baressa *et al.,* 2024). Similarly, in Bita District, oral administration accounted for 46.6% of remedies, with dermal and nasal routes less commonly used (Ashebir *et al*., 2025). The predominance of oral administration in the study area may be attributed to its practicality, cultural acceptance, and effectiveness in delivering active compounds through the gastrointestinal tract, while dermal application remains important for treating localized conditions such as skin infections or wounds. These results highlight the community's well-established knowledge and careful selection of effective routes of administration**.**

4.2.7 Dosage measurement

The study revealed that medicinal plant dosages in the study area are determined using various local measurement units, including the number of leaves, the length of a finger for roots and stem bark, a pinch for powdered plant parts, numerical counts for leaves, seeds, fruits, and flowers, and a cup for decoctions and infusions. Dosages were observed to vary depending on factors such as the age and physical condition of the patient, the stage of illness, pregnancy status, and the presence of additional ailments. These results indicate that traditional medicine practitioners rely on flexible and context-specific dosage determination rather than standardized measurements, adjusting quantities according to the perceived needs of the patient and the nature of the ailment. This practice reflects a deep understanding of the therapeutic properties of plants and the individualized approach to treatment in the community. Similar findings have been reported in other Ethiopian ethnobotanical studies, where local healers also use non-standardized units and adjust dosages based on patient-specific factors (Asheber *et al.,* 2024). The reliance on such flexible dosing practices demonstrates that the effectiveness of traditional remedies is closely linked to the healer's experience, knowledge, and careful observation of the patient, rather than strict adherence to fixed measurements.

4.3 Preference Ranking of Medicinal Plants

The results of a preference ranking conducted by nine key informants on eight medicinal plants used for treating intestinal parasites revealed that *Vernonia amygdalina*l was the most favored, receiving the top rank (1st) for its indicating strong consensus among traditional healers regarding its effectiveness against the disease, followed by *Cissampelos mucronata.* This was

followed by *Cissampelos mucronata* and *Croton macrostachyus*, ranking second and third, respectively, were recognized as effective, though to a lesser extent in relative preference. The remaining species, *Myrtus communis*, *Echinops kebericho,* and *Phytolacca dodecandra*, were perceived as less effective compared to the top-ranked plants (Table 6).

Table 6. Preference Ranking of the top preferred MPs for their effectiveness in treating intestinal parasite in humans in the study area

No	Plant name	A	B	C	D	E	F	G	H	I	Score	Rank
1	*Vernonia amygdalina*	5	5	5	5	5	5	4	5	5	44	1
2	*Cissampelos mucronata*	4	4	4	3	4	3	4	5	4	35	2
3	*Croton macrostachyus*	5	3	4	3	3	5	3	3	4	33	3
4	*Hagenia abyssinica*	4	4	5	4	3	3	2	3	4	32	4
5	*Verbascum sinaiticum*	3	3	3	3	3	3	3	5	5	28	5
6	*Myrtus communis*	3	3	3	3	3	2	3	3	3	26	6
7	*Echinops kebericho*	2	3	2	2	3	2	2	2	2	20	7
8	*Phytolacca dodecandra*	3	2	2	1	2	2	2	1	2	17	8

These results reveal a strong and consistent agreement among traditional healers regarding the relative effectiveness of the medicinal plants used to treat intestinal parasites in the study area. The high preference for Vernonia amygdalina suggests its significant role in the traditional management of intestinal parasites and underscores its potential for further pharmacological investigation. This preference also indicates that healers recognize the plant as effective based on long-standing empirical use and trust its reliability, availability, and perceived safety compared to other species. This finding is consistent with previous ethnomedicinal studies (Ashebir *et al.*, 2024; Muhidin *et al.*, 2023), which have also documented the traditional use of Vernonia amygdalina for treating intestinal parasites.

Similarly, for livestock ailments, the results of the ranking 5 plant species reported to treat the local illness called *"*Dingetegna*"*, revealed that *Plectranthus ecklonii* was the most preferred species, receiving the highest total score. It was followed by *Verbascum schimperi* and Salvia merjamie, ranking second and third, respectively. *Cissampelos mucronata*, ranking fourth, while *Verbascum sinaiticum* was the least preferred species in treating Dingetegna, ranking fifth (Table 7)

Table 7. Preference Ranking of the top preferred MPs for their effectiveness in treating livestock ailments in the study area

No	Species	A	B	C	D	E	F	G	H	I	Score	Rank
1	*Plectranthus ecklonii*	5	5	5	5	5	5	5	5	5	45	1
2	*Verbascum schimperi*	5	4	5	5	4	4	4	5	5	41	2
3	*Salvia merjamie*	4	3	4	5	4	4	4	4	4	36	3
4	*Cissampelos mucronata*	4	4	4	3	3	3	3	2	3	29	4
5	*Verbascum sinaiticum*	3	2	3	2	3	2	3	2	3	23	5

The findings of the preference ranking reveal a strong and consistent agreement among traditional healers regarding the relative effectiveness of medicinal plants in the study area against human intestinal parasites and the livestock ailment "Dingetegna". *Vernonia amygdalina* was consistently ranked highest as the most effective remedy for treating human intestinal parasites. This finding is consistent with previous ethnomedicinal studies (Ashebir *et al.,* 2024; Muhidin *et al.,* 2023), which have also documented its traditional use for treating intestinal parasites in other regions. Similarly, Plectranthus ecklonii was recognized as the leading and most effective treatment for the livestock ailment “Dingetegna,” also receiving the top rank by the key informants. The prominence of these species suggests that healers value them for their perceived effectiveness, reliability, local availability, and long-standing empirical use within the community's traditional healthcare systems. The high consensus demonstrated by the preference rankings highlights a clear hierarchy of trusted medicinal plants and underscores their significant potential as priority candidates for future phytochemical and pharmacological investigations.

4.4 Informant Consensus Factor (ICF)

In this study, ICF values showed strong agreement among informants for both human and livestock ailments. For human ailments, the highest consensus was observed in the categories of reproductive/urinary, gastrointestinal, dermatological, and neurological disorders, with ICF values ranging from 0.95 to 0.97. Similarly, in livestock, complete consensus (ICF = 1) was observed for infectious and dental diseases, while high agreement was also noted for reproductive, urinary, and dermatological disorders (Table 8).

Table 8. ICF values of medicinal plants for treating Human and Livestock ailments in the study area

Disease Category	Nur	Nt	ICF Value	Ailment Category	Nur	Nt	ICF Value
Reproductive/Urinary Disorders	360	9	0.97	Infectious diseases	19	1	1
Gastrointestinal Disorders	479	19	0.96	Dental disorders	43	1	1
Dermatological Disorders	382	17	0.96	Reproductive disorders	105	3	0.98
Neurological & Head-related Disorders	220	10	0.95	Urinary disorders	62	2	0.98
Hepatic (Liver) Disorders	22	2	0.95	Dermatological Disorders	32	2	0.97
Cancer & Tumors	44	2	0.95	Digestive disorders	226	9	0.96
Musculoskeletal Disorders	61	3	0.95				
Respiratory Disorders	157	9	0.94				
Spiritual Disorders	120	4	0.93				
Circulatory/Cardiovascular Disorders	34	4	0.91				
Poisoning and Envenomation	54	6	0.89				
Endocrine/Metabolic Disorders	7	2	0.83				

The high ICF values observed in this study indicate that a limited number of medicinal plants are repeatedly cited by many informants, suggesting strong confidence in their therapeutic effectiveness. Such consistency implies that these plants hold substantial cultural importance and have been validated through long-term community experience. High agreement among informants often emerges when certain species are well known, widely available, and consistently effective for treating common ailments.

In contrast, the lower ICF values found in a few ailment categories may reflect several factors. Some diseases may be less common, leading to fewer shared experiences among healers. Others may involve complex or poorly defined symptoms, resulting in the use of multiple plant species and therefore lower agreement. Additionally, variation in cultural beliefs, exposure to different knowledge sources, or ecological differences between villages may contribute to the use of diverse remedies for certain health problems. Similar patterns have been documented in other

Ethiopian ethnobotanical studies. For instance, Abebe *et al.* (2021) reported high consensus for reproductive and digestive disorders in southern Ethiopia, indicating that traditional healers commonly rely on a limited set of well-established plants to manage these conditions. The strong agreement across different regions points to the shared cultural knowledge systems and accumulated practical experience that shape medicinal plant use (Giday *et al.*, 2020). This shared understanding reinforces the reliability of these remedies within the community and supports their relevance for future pharmacological studies.

4.5 Fidelity Level (FL)

Fidelity Level (FL) values for human medicinal use varied widely among the species identified in this study, from complete agreement among informants to much lower levels of consensus. A total of 21 species achieved an FL of 100%, indicating unanimous recognition of their effectiveness for treating specific ailments. (Table 9).

Table 9. The fidelity level (FL) of top five species for treating human ailments in the study area

Species	Disease Treated	Np	N	FL (%)
Astropanax abyssinicus	Skin Irritation	6	6	100
Caesalpinia decapetala	Ascariasis	12	12	100
Carissa spinarum	Wound	26	26	100
Datura stramonium	Dhandacha (O)	23	23	100
Dovyalis abyssinica	Intestinal parasite	6	6	100
Embelia schimperi	Tapeworm	11	11	100
Hoffmannanthus abbotianus	Cataracts	4	4	100
Justicia schimperian	Rabies	6	6	100
Kalanchoe marmorata	Ear disease	48	48	100
Myrica salicifolia	Dermatitis	13	13	100
Myrtus communis	Stomach ache	11	11	100
Oncoba spinosa	Dermatitis	7	7	100
Plantago media	Hemorrhoid	3	3	100
Plectranthus ecklonii	Mich	23	23	100
Rubus apetalus	Digestiive issues	96	96	100
Rumex nervosus	Gofla (O)/Cancer	35	35	100
Salvia merjamie	Spider poison	16	16	100
Scolopia theifolia	Ascariasis	3	3	100
Verbascum sinaiticum	Stomach ache	8	8	100

Periploca linearifolia	Eye disease	4	4	100
Osyris quadrripartita	Evil eye	13	13	100
Ocimum lamiifolium	Mich	64	71	90.14085
Rosa abyssinica	Wound	9	10	90
Hagenia abyssinica	Tapeworm	34	40	85
Aloe pubescens	Dandruff	35	43	81.39535

In the ethnoveterinary context, the FL values varied among the recorded species. *Myrtus communis* for bloating and *Plectranthus ecklonii* for *Dingetegna* received complete agreement among informants, reflecting their long-standing recognition as reliable remedies within the community. Other species, such as *Foeniculum vulgare*, were frequently cited for specific ailments, whereas *Salvia merjamie* and *Withania somnifera* showed relatively lower FL values (Table 10).

Table 10. Fidelity Level (FL%) of top five five species for treating livestock ailments in the study area

Plant S	Np	N	FL (%)
Myrtus communis (Bloating)	12	12	100
Plectranthus ecklonii (Dngetegna)	33	33	100
Foeniculum vulgare (Urine retention)	27	32	84.38
Salvia merjamie(Dngetegna)	20	37	54.05
Withania somnifera (Itching)	15	28	53.57

Species with the highest Fidelity Level values, such as, *Astropanax abyssinicus, Caesalpinia decapetala, Carissa spinarum, Datura stramonium, Myrtus communis and Plectranthus ecklonii* hold a particularly important place in the community's traditional healthcare system, highlighting their consistent effectiveness, accessibility, and cultural familiarity. These findings align with earlier ethnobotanical research in Ethiopia, which has similarly reported strong community consensus around medicinal plants used for human ailments such as gastrointestinal disorders, wound healing, and helminth infections (Ermias *et al.,* 2013; Tugume *et al.,* 2024; Tadesse *et al.,* 2015). Comparable patterns of high agreement have also been documented in Ethiopian ethnoveterinary studies, where species such as Embelia schimperi and Glinus lotoides were consistently cited for treating livestock stomach disorders (Debebe *et al.,* 2015). This strong

agreement demonstrates a well-established, deeply rooted, and resilient ethnomedicinal knowledge system, in which certain species have maintained their relevance across generations due to repeated successful application. The consensus on these species underscores their reliability and wide availability, positioning them as priority candidates for conservation, phytochemical investigation, and further pharmacological evaluation.

In contrast, species with lower FL values, such as *Salvia merjamie* and *Withania somnifera*, indicate more variable or generalized use among healers. Plants with broader therapeutic applications often show reduced FL because they are employed across multiple ailments rather than being dedicated to a single condition. This pattern reflects a flexible and adaptive ethnoveterinary knowledge system, where highly specialized species are relied upon for targeted treatments, while more versatile plants are applied in multiple contexts depending on availability and local needs.

4.6 Relative Frequency of Citation (RFC)

In this study, for human medicinal use, the RFC values exhibited considerable variation, ranging from 0.13 to 0.53. *Ocimum lamiifolium* emerged as the most culturally prominent species, with the highest RFC underscoring its pivotal role in the traditional treatment (Table 11).

Table 11. Medicinal plant species with the Highest Relative Frequency of Citation (RFC) for treating human ailments in the study area

Plant Species	Nur	FC
Ocimum lamiifolium	64	53.33%
Lippia adoensis	60	50.00%
Kalanchoe marmorata	48	40.00%
Juniperus procera	40	33.33%
Bidens pilosa	40	33.33%
Rumex nervosus	35	29.17%
Aloe pubescens	35	29.17%
Hagenia abyssinica	34	28.33%
Rubus apetalus	32	26.67%
Echinops kebericho	31	25.83%

Similarly, the analysis of medicinal plants uses for treating Livestock ailments revealed a similar pattern of cultural valuation. *Echinops kebericho* stands out with the highest RFC value,

consistently reported for treating multiple conditions underscoring its multifaceted importance in ethnoveterinary medicine (Table 12).

Table 12. Medicinal plant species with the Highest Relative Frequency of Citation (RFC) for treating livestock ailments in the study area

Plant Species	FC	Percentage (%)
Echinops kebericho	78	65.5
Plectranthus ecklonii	33	27.5
Foeniculum vulgare	27	22.5
Verbascum sinaiticum	27	22.5
Salvia merjamie	20	16.7
Cissampelos mucronata	19	15.8
Salvia merjamie	17	14.2
Withania somnifera	15	12.5
Verbascum sinaiticum	12	10
Myrtus communis	11	9.2

High relative citation frequencies indicate species that are widely recognized, commonly used, and deeply embedded in the cultural and medicinal traditions of the community. Such plants often hold long-standing reputations for effectiveness, which encourages repeated use across generations and reinforces their importance in both human and livestock healthcare systems. The high RFC values observed in this study therefore reflect not only the therapeutic versatility of these species but also the community's confidence in their healing properties and their accessibility as dependable remedies. This pattern is consistent with previous ethnobotanical studies in Ethiopia, which similarly reported that species with elevated RFC values are those most frequently consulted for diverse ailments and are considered central pillars of local healthcare practices (Alemu *et al.*, 2024).

Conversely, species with lower RFC values may indicate medicinal plants with more specialized, localized, or eroding uses, possibly due to limited transmission of traditional knowledge or cultural shifts (Bhogaonkar and Devarkar, 2021). This ethnobotanical evidence underscores a dual imperative: first, to conserve widely used species that hold high cultural recognition and contribute significantly to local healthcare systems and biodiversity, and second, to document lesser-known medicinal plants that are at risk of disappearing due to generational shifts, thereby preserving the full spectrum of ethnobotanical heritage for both human and animal health applications

4.7 Relative importance index (RI)

The analysis of medicinal plants used to treat both human and livestock ailments showed considerable variation in RI values, indicating differences in their cultural prominence and therapeutic versatility (Table 13).

Table 13. Medicinal plants with the highest Relative Importance Index (RI) value in the study area

Plant species (Human)	RI	Plant Species (Livestock)	RI
Croton macrostachyus	0.9	*Echinops kebericho*	1
Echinops kebericho	0.61	*Foeniculum vulgare*	0.514
Cissampelos mucronata	0.52	*Cissampelos mucronata*	0.521
Cucumis ficifolius	0.5	*Plectranthus ecklonii*	0.484
Withania somnifera	0.47	*Withania somnifera*	0.474
Datura stramonium	0.44	*Salvia merjamie*	0.433
Bidens pilosa	0.4	*Verbascum sinaiticum*	0.428
Juniperus procera	0.36	*Myrtus communis*	0.24
Aloe pubescens	0.36		
Foeniculum vulgare	0.35		

Among human-use species, *Croton macrostachyus* exhibited the highest RI value followed by Other highly ranked species included *Echinops kebericho, Cissampelos mucronata, Cucumis ficifolius*, and *Withania somnifera.* This is consistent with earlier findings from other parts of Ethiopia where *C. macrostachyus* was frequently reported as a multi-use medicinal plant used to manage gastrointestinal disorders, malaria, wound healing, and febrile illnesses (Kassa *et al*., 2020, Bula *et al.*, 2024). Similarly, based on the RI index calculated for medicinal plants used to treat livestock ailments, *Echinops kebericho* recorded the highest RI value, followed by species such as *Cissampelos mucronata, Foeniculum vulgare, Plectranthus ecklonii*, and *Withania somnifera*, all of which demonstrated strong cultural recognition and wide therapeutic application. The high RI values indicate that these plants are widely recognized for their broad therapeutic applications and strong cultural importance within the community. Their prominence suggests that local people rely on these multi-purpose species to manage a wide range of health conditions, demonstrating accumulated traditional knowledge regarding their effectiveness for both human and livestock ailments. The consistent appearance of these plants among the top-ranked species reflects the community's preference for versatile and trusted remedies that serve

multiple medical needs. Overall, the high RI values highlight the central role of culturally significant, multi-use medicinal plants in sustaining traditional healthcare systems and ensuring the continued transmission of local healing practices.

In contrast, some species in the present study such as Juniperus procera *Aloe pubescens, Myrtus communis, Foeniculum vulgare, Verbascum sinaiticum* were found to have comparatively lower RI values, indicating more limited application and perhaps reduced cultural visibility in veterinary contexts. These results may point to a combination of factors, including narrow therapeutic application, ecological scarcity, or diminished knowledge transmission, particularly among the younger generation. Nonetheless, these species should not be overlooked, as low RI scores may mask pharmacological potential or reflect knowledge that is specialized or localized within particular healer networks. Bhogaonkar and Devarkar (2021) similarly note that under-reported species often hold untapped value, and their apparent marginality in ethnobotanical surveys may stem from secrecy in knowledge transmission or ecological threats limiting their availability.

4.8 Additional Uses of Medicinal Plants in The Study Area

Some medicinal plants documented in the study area serve diverse functions beyond their therapeutic applications, including soil erosion control, goat feed, timber, spices, edible fruits, fencing, and firewood. To assess their relative importance for these multiple uses, the Direct Matrix Ranking (DMR) analysis was employed. According to the DMR results, Croton macrostachyus emerged as the highest-ranked multipurpose medicinal plant, reflecting its broad range of uses beyond medicinal purposes. It was highly valued for soil erosion control, firewood, and fencing, making it a critical species for both ecological functions and local livelihoods. Following this, *Rubus apetalus* ranked second, noted for its significance in edible fruits, firewood, and fencing. Both *Carissa spinarum* and *Justicia schimperian* shared the third rank due to their notable roles, especially in goat feed, firewood, and fencing activities. *Podocarpus falcatus* was ranked fourth, with important contributions as a source of timber, firewood, and soil erosion control (Table 14).

Table 14. Direct matrix ranking score of five MPs in the study area

Use categories	*Croton macrostachyus*	*Rubus apetalus*	*Carissa spinarum*	*Justicia schimperian*	*Podocarpus falcatus*	Total	Rank
Soil erosion	5	5	5	5	5	25	1st
Goat feed	5	1	0	5	0	11	3rd
Timber	4	0	0	0	5	9	4th
Edible fruit	0	5	5	0	1	11	3rd
Fence	5	5	5	5	3	23	2nd
Firewood	5	5	5	5	5	25	1st
Total	24	21	20	20	19		
Rank	1st	2nd	3rd	3rd	4th		

These findings are consistent with previous studies in Ethiopia, which also identified *Croton macrostachyus* as a key multipurpose species valued for soil erosion control, goat feed, timber, fencing, and firewood (Moa *et al.,* 2023; Ashebir *et al.,* 2024; Netsanet *et al.,* 2020; Moa and Samuel, 2022). The high multipurpose value of these species can be attributed to their abundance, growth habits, and cultural and economic significance, which make them preferred resources for both daily household use and ecological functions. Their multifunctional roles are vital for sustaining local livelihoods and maintaining ecosystem stability, providing essential resources such as fodder, fuel, edible fruits, and soil protection. However, extensive exploitation for multiple purposes may threaten their availability for medicinal use and jeopardize the associated ethnobotanical knowledge. For instance, species like *Croton macrostachyus,* widely used for soil erosion control and firewood, also play a key role in maintaining ecosystem stability, highlighting the need for conservation strategies that consider both ecological and cultural significance. The multifunctional use of medicinal plants underscores the importance of integrated conservation approaches**,** including sustainable harvesting, community awareness, and active participation of governmental and non-governmental organizations, to safeguard these species for future generations. Without such measures, overharvesting could lead to biodiversity

loss and weaken local healthcare systems that depend on medicinal plants (Getachew *et al.*, 2022; Abebe *et al.*, 2021).

4.9 Cultural importance (CL)

The results of the Cultural Importance (CI) indices showed variation among species for both human and livestock uses. Among the species used for treating human ailments, *Croton macrostachyus* recorded the highest CI value, followed by *Cissampelos mucronata* and *Echinops kebericho* and among the species used for treating livestock ailments, *Echinops kebericho* and *Withania somnifera* were the top-ranked species, while other species like *Myrtus communis*, *Plectranthus ecklonii*, and *Verbascum schimperi* showed lower RI value (Table 15).

Table 15. Cultural importance (CL) values of medicinal plants used for treating human and livestock ailments in the study area

Botanical Name (human ailments)	CI	Botanical_Name (livestock ailments)	CI
Croton macrostachyus	0.13	*Echinops kebericho*	0.67
Cissampelos mucronata	0.04	*Withania somnifera*	0.5
Echinops kebericho	0.04	*Cissampelos mucronata*	0.34
Alysicarpus rugosus	0.03	*Foeniculum vulgare*	0.34
Olea africana	0.03	*Salvia merjamie*	0.34
Cucumis ficifolius.	0.03	*Verbascum sinaiticum Benth.*	0.34
Withania somnifera	0.03	*Myrtus communis*	0.17
Jasminum grandiflorum .	0.03	*Plectranthus ecklonii*	0.17
Podocarpus falcatus	0.03	*Verbascum schimperi*	0.17

The high CI value of *Croton macrostachyus* for human ailments and of *Echinops kebericho* and *Withania somnifera* for livestock ailments reflects frequent citation and multi-purpose use of these species within the community, i.e., they are culturally prioritized and used to treat diverse conditions. This pattern where a small number of species obtain high CI values while many others record low or moderate indices has been reported elsewhere in Ethiopia, where frequently cited taxa tend to hold greater sociocultural and therapeutic importance (Eshete and Molla, 2021). Species with low CI values (e.g., *Olea africana*, *Alysicarpus rugosus*, *Cucumis ficifolius*) appear to have narrower, more specialised uses or are less familiar to the broader community; nonetheless, their presence contributes to the overall ethnomedicinal richness and may represent

localized knowledge that warrants documentation. Overall, these CI patterns point out two practical implications: (1) taxa with high CI should be prioritised for conservation and pharmacological validation due to their wide cultural reliance, and (2) taxa with lower CI may require targeted documentation and community-based measures to safeguard specialised traditional knowledge.

4.10 Local Medicinal Knowledge in the Study Area

4.10.1 Transmission of local medicinal knowledge across generations

The study revealed that local medicinal knowledge in the research area was primarily transmitted orally, mostly within families, with eldest sons often serving as the main custodians. These observations align with findings from previous studies, which indicate that the majority of participants transmit this knowledge within their families, with eldest sons frequently assuming the role of custodians (Zelalem *et al.,* 2020; Aweke *et al.,* 2024). Some knowledge was shared with trusted neighbors and relatives, but a significant portion remained confidential, especially among traditional healers. These healers often withheld information due to concerns that sharing might reduce the effectiveness of medicinal plants or their economic benefits. This pattern is consistent with reports from other studies (Tamene *et al.,* 2023: Mohammed *et al.,* 2022). This secrecy, combined with modern influences such as the rise of formal healthcare, education, religious changes, and societal modernization, contributed to a decline in local knowledge transmission. Additionally, younger generations showed reluctance to learn traditional medicinal practices, posing a serious risk of losing this knowledge as elder healers age and pass away. Comparable finding has been reported in previous studies (Kindie, 2023).

4.10.2 Comparison of knowledge between key and general informants

The results of the Welch two-sample t-test revealed a statistically significant difference between key and general informants. Key informants demonstrated a significantly higher average knowledge score compared to general informants (Table 16).

Table 16. Comparison of knowledge between key and general informants in the study area

Characters	Informant groups	N	Mean ± SD	t-value	p-value
Knowledge Score	Key informants	15	14.47	-8.16	< 0.001
	General informants	105	7.25		

* Significant at $p < 0.05$

This indicates that key informants possess a greater depth of knowledge, likely due to their active and prolonged involvement in traditional medicinal practices, direct interaction with medicinal plants, and cultural influences. Their sustained engagement and experiential learning contribute to their extensive understanding and practical skills in the use of these plants. Knowledge among key informants highlights their critical role as custodians of local knowledge of MPs, which can be leveraged in conservation, sustainable utilization, and knowledge preservation efforts (Aweke *et al.*, 2024; Tahir *et al*., 2023; Leul *et al*., 2018)

4.10.3 Comparison of ethnomedicinal knowledge among different age groups

The results of the one-way ANOVA demonstrated a statistically significant difference in ethnomedicinal knowledge among the three age groups ($p = 0.026$), indicating that age has a meaningful influence on the depth of plant knowledge. Post-hoc analysis using Tukey's HSD revealed that the elder group possessed significantly higher knowledge than the middle-aged group. Although the young group showed relatively high mean knowledge, the differences between young and elder or young and middle-aged individuals were not statistically significant (Table 17).

Table 17. One-way ANOVA Summary and Tukey HSD for the Effect of Age Group on Ethnomedicinal Knowledge in the study area

Source of variation	**Df**	**Sum Sq**	**Mean Sq**	**F value**	**p-value**
Age Group	2	120.9	60.46	3.758	0.0262
Residuals	117	1882.4	16.09		
Age Group	**N**	**Mean ± SD**	**Post-hoc Comparison (Tukey HSD)**		

Young adults (25– 35)	18	9.28 ± 4.88	vs. Elders: t = -1.12, p = 0.27 (NS) vs. Middle-aged: t = -2.75, p = 0.056 (NS)
Middle-aged (36– 45)	32	6.53 ± 2.88	vs. Elders: t = 2.07, p = 0.045 (Significant)
Elders (>46)	70	8.60 ± 4.20	vs. Middle-aged: t = -2.07, p = 0.045 (Significant)

* Significant at $p < 0.05$

This result indicates that elder individuals hold a greater depth of ethnomedicinal knowledge than middle-aged adults, while younger adults show considerable knowledge but with greater variability. This finding is in a similar pattern with the findings of other studies where elder group holds significantly more ethnobotanical knowledge compared to the middle-aged group (Bekele *et al.,* 2022; Tahir *et al.,* 2023; Atinafu *et al.,* 2016). The higher knowledge among elders can be attributed to the accumulation of experience over many years, gained through repeated observation and practice, participation in traditional healthcare practices, and continuous engagement with medicinal plants. Younger adults also demonstrated relatively high knowledge, which may reflect their active participation in daily household healthcare, agricultural, and foraging activities, as well as exposure to ethnomedicinal practices through family and community interactions. This pattern highlights that both long-term experience and active involvement in healthcare practices contribute to knowledge retention, and periods of high external responsibility may limit engagement and reduce knowledge acquisition.

4.10.4 Comparison of knowledge between genders

The independent t-test revealed no significant difference in ethnomedicinal knowledge between male and female informants. The mean knowledge score for males was slightly higher than for females, but this difference was not statistically significant (Table 18).

Table 18. Comparison of knowledge between genders in the study area

Gender	N	Mean ± SD	t	df	p-value	Significance
Male	84	8.23 ± 4.47	-0.31	118	0.758	Not significant
Female	36	7.97 ± 3.14				

* Significant at $p < 0.05$

These results suggest that, despite a larger number of male informants, there is no evidence to indicate that gender influences the depth of ethnomedicinal knowledge in the study area. This finding is consistent with previous studies that also reported no significant gender differences in local knowledge of medicinal plants (Kidane *et al.,* 2018; Asnake *et al.,* 2016; Muhidin *et al.,* 2022). This may be attributed to equal opportunities for knowledge transmission between men and women, or similar social roles and responsibilities related to the use and management of medicinal plants. Both men and women likely engage in activities that expose them to medicinal plants, such as cultivation, collection, and household healthcare practices, leading to comparable levels of knowledge across genders. In contrast, other studies have shown the presence of a significant difference in local medicinal plant knowledge between men and women, where men possess more knowledge than women (Boja *et al.,* 2021; Silambarasan *et al.,* 2023; Kedir *et al.,* 2022.

4.10.5 Comparison of knowledge between education levels

The results of the t-test showed no statistically significant difference in the average number of medicinal plants known between the two groups ($t = –0.58$, $P = 0.57$), indicating that formal education level did not significantly affect individual knowledge of medicinal plants within the studied community (Table 19).

Table 19. Comparison of Knowledge Between Education Levels in the study area

Educational Status	N	Mean MPK ± SD	T-value	P-value
Non-litrate	90	8.01 ± 3.86		
Literate	30	8.57 ± 4.80	−0.58	0.57

* Significant at $p < 0.05$

This result suggests that medicinal plant knowledge is shared across the community regardless of formal education. This finding is consistent with Sintayehu *et al.* (2024), who also reported that informants, regardless of their educational status, possessed valuable local knowledge on medicinal plant use, indicating that formal schooling may not be a key factor influencing the acquisition of such knowledge. This could be attributed to the fact that medicinal plant knowledge is largely transmitted through informal, experiential, and socially embedded processes rather than through formal schooling. Individuals typically gain this knowledge

through daily interactions with family members, neighbors, and elders; participation in agricultural, grazing, and foraging activities; and engagement in cultural practices or rituals where medicinal plants are used. These shared pathways of learning enable both educated and non-educated people to develop comparable levels of knowledge. In addition to this Knowing how to identify, collect, and prepare medicinal plants often relies on observation, imitation, and repeated practice rather than written instructions, making formal education less influential.

4.11 Threats to Medicinal Plants and Their Associated Local Knowledge in the Study Area

The assessment of threats to medicinal plants using a 5-point Likert scale from the 30 informants (15 key and 15 general) revealed that both human and environmental factors pose challenges to the survival of medicinal plant species in the study area (Table 20).

Table 20. 5-Point Likert Scale Results for Threats to Medicinal Plants

Threat / Issue	Mean Score	Drivers	Priority
Overgrazing	4.7	Livestock feed on medicinal plants	High
Overharvesting	4.43	Driven by household use, market demand, construction; *Cissampelos mucronata*, *Myrtus communis* most vulnerable	High
Agricultural expansion	3.43	Habitat loss, herbicide use, farmland expansion	Medium
Climate variability	3.5	Long-term risk to plant survival	Medium
Soil erosion	2.73	Indirectly weakens conservation efforts	Low
Lack of funding	2.63	Hinders community-led conservation efforts	Low
Low awareness	2.43	Especially among youth and farmers; impacts medicinal plant protection	Low
Lesser threats	1.73–2.23	Landslides, lodging, and plant diseases	Very Low

These results indicate that both human activities and environmental changes are influencing the availability and sustainability of medicinal plant resources. Grazing, in particular, received the highest average Likert score, with 100% of participants rating it as a serious or very serious threat. Informants emphasized that livestock often feed on medicinal plants, either through direct

browsing or when plants are harvested and fed to cattle. Overharvesting, which was also rated as a very severe threat, is driven by increasing demand for medicinal plants in local markets, household use, and the construction of shelters, fences, and animal enclosures. Similarly, a study by Baressa *et al.* (2024) revealed that overgrazing or browsing was the second most cited threat, accounting for 18.75% of the total responses. The high priority given to grazing and overharvesting reflects the direct pressures that communities exert on wild plant populations. Key informants noted that plants like *Cissampelos mucronata* are especially vulnerable, as they are collected in large quantities and sold for income. The uncontrolled harvesting of these plants for multiple purposes contributes to their declining availability and potential extinction over time. This finding is consistent with previous studies, which reported that overexploitation for multiple uses has contributed to the current depletion of medicinal plants (Moa *and* Nigussie, 2022; Mikias *et al.,* 2023). A particularly concerning case is the medicinal plant *Myrtus communis*, which was identified during this study as being threatened due to a combination of overutilization and minimal conservation action. Despite its cultural and medicinal relevance, especially in treating stomach-related ailments, *Myrtus communis* has received little attention in local conservation initiatives, making it a threatened species in the study area.

Agricultural expansion emerged as another significant threat. Informants linked this issue to the growing pressure on land, as cultivation increases to meet food demands. In many cases, medicinal plant habitats are cleared to make way for farmland, and herbicides are applied to remove what are perceived as weeds some of which include valuable medicinal species. This finding reflects reports by Awoke *et al.* (2024), and Tadesse *et al.* (2024), who documented similar patterns of habitat loss due to agricultural development in various districts across Ethiopia. Climate variability was another threats mentioned by the infromants. Although less immediately visible than grazing or harvesting, climate change poses a long-term risk that requires integrated mitigation strategies. This result is in line with findings by Moa and Nigussie (2022), who also cited climate change as a threat to medicinal plants. Other threats such as soil erosion, lack of funding, and lack of awareness, were recognized but ranked lower by participants. While these factors may not directly destroy medicinal plant species, they create conditions that weaken conservation efforts and delay responses to degradation. Key informants stressed that funding shortages hinder community-led conservation, while low awareness especially among youth and farmers, contributes to practices that endanger medicinal plant

diversity. In some areas, plants are deliberately removed during land clearing or treated as invasive species due to a lack of knowledge about their medicinal value. Lesser concerns included landslides, lodging, and plant diseases, which were not viewed as significant threats by most participants. However, these issues may still impact medicinal plants indirectly and could become more serious under changing environmental conditions.

On the other hand, the results of the 5-point Likert scale for the assessment of threats on the local Knowledge revealed that Weak transmission to younger generations received the highest mean score, indicating a serious risk of knowledge loss. Secrecy by healers, lack of interest among youth, and modernization were additional factors limiting the transmission of local knowledge in the study area (Table 21).

Table 21. 5-Point Likert Scale Results of Threats to local Knowledge in the study area

Threats to local knowledge Transmission	Mean Score	Priority
Weak transmission to younger generations	4.5	High
Secrecy by healers, limiting knowledge sharing	4.2	Medium
lack of interest in younger generations	3.5	Medium
Modernization reducing transmission	3	Medium

These result indicates that a significant portion of local Knowledge is not being effectively passed down, which threatens its continuity. Secrecy by traditional healers reflects concerns that sharing knowledge could reduce the perceived effectiveness of remedies or diminish personal economic benefits. Lack of interest among youth and modernization further limit opportunities for intergenerational knowledge transfer. local Knowledge in the study area is vulnerable and increasingly fragile due to social and cultural changes that reduce the transmission of knowledge. Similar trends have been observed in other Ethiopian communities, where younger generations show limited engagement with traditional medicinal practices, and elders often withhold knowledge to protect its value (Tamene *et al.,* 2023; Mohammed *et al.,* 2022). The persistence of local Knowledge depends on active measures to facilitate knowledge transmission, such as structured mentorship, community learning forums, and documentation initiatives. Without such interventions, the erosion of local knowledge could undermine both cultural heritage and the

sustainable use of medicinal plants, emphasizing the need for community-based approaches to safeguard knowledge alongside conservation of plant resources.

4.12 Conservation Practices of Medicinal Plants and Their Associated Local Knowledge in the Study Area

The 5-point Likert scale revealed replanting as the most commonly practiced conservation measure in the study area, followed by sustainable collection methods**.** Patrolling of key harvesting sites, controlled harvesting, and awareness creation were also reported, although with comparatively lower mean scores (Table 22).

Table 22. 5-Point Likert Scale Results for Conservation Practices to Medicinal Plants in the study area

Conservation Effort	Mean Score	Priority
Replanting of medicinal plants	4.5	High
Sustainable collection methods	4.3	High
Patrolling of key harvesting sites	3.8	Medium
Controlled harvesting	3.5	Medium
Awareness creation/education	1	Low

The results indicate that many traditional healers and community members consciously engage in practices aimed at maintaining the long-term availability of medicinal plant species, particularly through replanting and selective harvesting. However, the relatively lower scores for practices such as patrolling, controlled harvesting, and awareness creation suggest that conservation actions are not yet systematic, relying instead on informal efforts by a few motivated individuals rather than coordinated, community-wide initiatives. These findings also suggest that local people in the study area recognize the increasing scarcity of certain medicinal plants and have begun taking small, informal steps to support their regeneration. This pattern aligns with previous studies from various regions of Ethiopia, which similarly report that conservation practices for medicinal plants remain limited, informal, and largely dependent on traditional healers, with minimal structured management or external support (Engedasew *et al.*, 2014; Awoke *et al.*, 2024). As reported in these studies, although communities practice replanting and selective harvesting, broader and more organized conservation measures remain

weak, mainly due to heavy reliance on wild collection and the absence of coordinated conservation frameworks. This highlights the urgent need for structured, community-wide conservation programs that formalize existing informal practices and provide external support to ensure the long-term sustainability of the local medicinal flora.

On the other hand, Assessment using the 5-point Likert scale showed that the preservation of local medicinal knowledge in the study area relies predominantly on informal, oral transmission, with minimal engagement in modern documentation practices. Followed by Community knowledge sharing and knowledge documentation (Table 23).

Table 23. 5-Point Likert Scale Results for Preservation of local Medicinal Knowledge

Conservation Practice	Mean Score	Priority
Transmission to younger generations	3	Medium
Community knowledge sharing (meetings, workshops)	2.7	Medium
Documentation of knowledge (writing, photos, audio)	1.5	Low

These results highlight a major vulnerability in the local Knowledge system: medicinal knowledge in the study area is insufficiently preserved and highly vulnerable to loss. Although some information is transmitted within families, the absence of structured knowledge-sharing mechanisms and the near complete lack of documentation expose the knowledge system to significant long-term risks. Oral transmission, traditionally the primary mode of sharing local knowledge, is especially fragile, as it can be disrupted by migration, loss of interest among younger generations, or the death of knowledgeable elders. This challenge is further intensified where knowledge is kept secret by specialized healers, limiting opportunities for broader community learning. Therefore, the combined effects of secrecy, modernization, and declining youth engagement weaken the transmission pathways that once supported the continuity of local medicinal knowledge. This pattern is consistent with studies from other regions of Ethiopia, which similarly report that conservation practices remain limited, informal, and largely reliant on individual healers, with minimal structured management or external institutional support (Kasa *et al.*, 2020; Awoke *et al.*, 2024). As documented in these works, broader frameworks for safeguarding ethnomedicinal knowledge are weak or absent. Overall, the results underscore the

urgent need for structured, community-wide programs that strengthen knowledge transmission, reduce dependence on secrecy, and introduce accessible documentation systems. Such measures are essential for ensuring the long-term sustainability and intergenerational continuity of local medicinal knowledge in the study area.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This ethnobotanical study conducted in Bekelecha Biftuu, Ifa Haqaa and Tokuma Jaalalaa documented medicinal plants used for treating both human and livestock ailments and their associated local knowledge. A wide diversity of plant species was recorded, with shrubs and herbs being most commonly used in both human ethnomedicine and ethnoveterinary practices. In human medicine, leaves were the most frequently utilized plant part, valued for their effectiveness and sustainable harvesting. On the other hand, roots were predominantly used for livestock treatments, raising conservation concerns due to their destructive harvesting methods. Local knowledge was mainly transmitted orally, often within families, with eldest sons typically serving as custodians. However, secrecy among traditional healers, modernization, and religious changes have contributed to a decline in knowledge transfer especially among the youth. Dosage determination lacked standardization, relying on local measurement units and adjustments based on patient condition, while additives such as butter and honey were used to enhance remedy efficacy and palatability.Quantitative indices like Informant Consensus Factor (ICF), Fidelity Level (FL), and Relative Frequency of Citation (RFC) revealed strong community agreement on key medicinal species, notably *Ocimum lamiifolium* and *Echinops kebericho*, though their multifunctional uses highlighted by Direct Matrix Ranking (DMR) pose risks of overexploitation. The sustainability of medicinal plant resources is further threatened by overharvesting, overgrazing, agricultural expansion, and climate variability, while conservation efforts remain largely informal. Age was a significant factor in knowledge variation; ANOVA results indicated that elders possessed more medicinal knowledge than middle-aged individuals, while young adults exhibited the highest but most inconsistent knowledge levels. In contrast, gender had no significant influence, as t-test analysis showed similar knowledge scores between men and women, aligning with some studies but contradicting others where men held more knowledge. Overall, medicinal plants remain central to community health, cultural identity, and livelihoods in the study area. However, the sustainability of both plant resources and associated local knowledge is at risk, underscoring the urgent need for documentation, implementation of conservation strategies, and promotion of intergenerational transmission. Integrating local wisdom into formal education and healthcare systems can play a vital role in safeguarding this valuable biocultural heritage.

5.2 Recommendations

The findings of this study highlight the urgent need to conserve culturally important medicinal plant species, many of which face increasing threats from habitat loss, overharvesting, and limited knowledge transfer. Effective conservation requires coordinated action from local communities, government institutions, and development partners. Based on the results, the following recommendations are proposed:

- Promote Community-Based Conservation Initiatives; local community associations, elders, and kebele administrations should collaborate to manage, monitor, and sustainably harvest medicinal plant species.
- Introduce On-Farm and Home Garden Cultivation; agricultural extension offices, farmers, and household members should work together to cultivate priority medicinal plants in home gardens and farms. This will reduce pressure on wild populations and ensure continous availability for both human and livestock treatments.
- Strengthen local Knowledge Transmission; cultural and community leaders, traditional healers, and education offices should facilitate structured mentorship programs that enable elders to train youths in plant identification, preparation methods, and conservation practices. Schools and local training centers can integrate basic ethnobotanical knowledge into extracurricular activities.
- Raise Public Awareness and Education; the Environmental Protection Authority, NGOs, and local institutions should organize awareness campaigns targeting farmers, youth groups, and women's associations. These initiatives should emphasize the importance of medicinal plants, sustainable harvesting, and the consequences of habitat degradation.
- Integrate Local Knowledge into Policy and Development Planning; district-level agricultural and environmental authorities should incorporate ethnobotanical knowledge into land-use planning, agricultural expansion programs, and natural resource management policies. This will help protect key habitats and reduce the negative impacts of deforestation and land conversion.
- Provide Institutional and Financial Support; governmental bodies, research institutions, and NGOs should provide funding and technical resources needed to support medicinal plant cultivation, conservation programs, and community-led initiatives.

- Conduct Further Research and Monitoring; universities, research centers, and environmental agencies should undertake long-term monitoring of medicinal plant populations, evaluate ongoing threats, and assess the effectiveness of implemented conservation strategies. Such evidence-based data will help refine future conservation and management plans.

6. REFERENCES

Abebe Gizachew, Bekele Woldemariam and Tesfaye Asres 2021. Medicinal plants used by traditional healers in southern Ethiopia: documentation and ethnobotanical study. *Journal of Ethnopharmacology,* 264:113-221.

Admasu Moges and Yohannes Moges 2020. Ethiopian common medicinal plants: Their parts and uses in traditional medicine Ecology and quality control. In Plant Science Structure, Anatomy and Physiology in Plants Cultured in Vivo and in Vitro. *IntechOpen,* 86-202. https://doi.org/10.5772/intechopen.

Alemayehu Tadesse, Abebe Hassen, and Mengistu Tadesse 2021. Antimicrobial activity of *Echinops kebericho* against human pathogenic bacteria and fungi. *African Journal of Traditional, Complementary and Alternative Medicines*, 13(6): 199–203.

Alemu Tesema, Tadesse Wondimu and Mulugeta Abebe 2024. Ethnobotanical study of traditional medicinal plants used to treat human ailments in Diga District, Western Ethiopia. *Journal of Medicinal Plants Research*, 18(3): 55–67.

Amare Bitew, Ali Mohammed and Abebe Kassa 2022. Ethnobotanical study of traditional medicinal plants used to treat human and animal diseases in Sedie Muja District, South Gonder. *Evidence-Based Complementary and Alternative Medicine*, 7328613.

Amare Desalegn, M. C. Egigu, J. Sasikumar 2022. Ethnobotanical study on medicinal plants used by ethnic people of Gechi District, South West Oromia, Ethiopia, *Nusantara Bioscience* 14:104-116

Amare Desalegn, Meseret Chimedesa, and Jagathala Mahalingam Sasikumar 2022. Ethnobotanical study on medicinal plants used by ethnic people of Gechi District, South West Oromia, Ethiopia. *Nusantara Bioscience*, 14(1): 104–116.

Amare Fassil and Getachew Gashaw 2019. An ethnobotanical study of medicinal plants in chiro district, West Hararghe, Ethiopia. *African Journal of Plant Science,* 13(11): 309-323.

Amare Fassil and Patrick Van Damme 2023. Diversity and role of woody non-timber forest products in Doba District, Eastern Ethiopia. *Nusantara Bioscience*, 15.

Asaye Asfaw, Ermias Lulekal, Tamrat Bekele, Asfaw Debella, Eyob Debebe and Bihonegn Sisay 2022. Medicinal plants used to treat livestock ailments in Ensaro District, North Shewa Zone, Amhara Regional State, Ethiopia. *BMC Veterinary Research*, 18: 235.

Asfaw Tora and Tarekegn Helisob 2017. Assessment of the indigenous knowledge and use of traditional medicinal plants in Wolaita Zone, Southern Ethiopia. *International Journal of Medicinal Plants and Natural Products*, 3(1): 16–22.

Ashebir Awoke, Girma Gudesho, Fetku Akmel and P. Shanmugasundaram 2024. Traditionally used medicinal plants for human ailments and their threats in Guraferda District, BenchiSheko Zone, Southwest Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 20: 82. https://doi.org/10.1186/s13002-024-00709-5

Ashebir Awoke, Girma Gudesho, Kindu Chane, Yared Siyum, Walle Tilahun, Habtamu Gebremedhin and Afework Tadesse 2025. Traditionally used phytomedicines and their associated threats in Bita district, southwestern Ethiopia. *Journal of Ethnobiology*, 21, 8. https://doi.org/10.1186/s13002-025-00753-9

Ashebir Awoke, Yared Siyum, Derbew Awoke, Habtamu Gebremedhin and Afework Tadesse 2024. Ethnobotanical study of medicinal plants and their threats in Yeki District, Southwestern Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 20(1): 107. https://doi.org/10.1186/s13002-024-00748-y

Asnake Solomon, Tilahun Teklehaymanot, Ariaya Hymete, Berhanu Erko, and Mirutse Giday 2016. Research Article Survey of Medicinal Plants Used to Treat Malaria by Sidama People of Boricha District, Sidama Zone, South Region of Ethiopia. *National Library of Medicine,* doi: 10.1155/2016/9690164.

Atinafu Kebede, Shimelis Ayalew, Akalu Mesfin, and Getachew Mulualem 2016. Ethnobotanical investigation of traditional medicinal plants commercialized in the markets of Dire Dawa city, eastern Ethiopia. *Journal of Medicinal Plants Studies*, 4(3): 170-178.

Atinafu Kebede, Shimels Ayalew, Akalu Mesfin and Getachew Mulualem. 2017. An ethnoveterinary study of medicinal plants used for the management of livestock ailments in selected Kebeles of Dire Dawa Administration, Eastern Ethiopia. *Journal of Plant Sciences*, 5(1): 34–42.

Augustino, S., Gillah, P.R. 2015. Medicinal plants in urban districts of Tanzania: Plants, gender roles and sustainable use. *Forest International Review,* 7: 44–58.

Banchiamlak Nigussie and Young-Dong Kim 2019. Ethnobotanical study of medicinal plants in the Hawassa Zuria District, Sidama zone, Southern Ethiopia. *Journal of ethnobiology and ethnomedicine*, 15(25). https://doi.org/10.1186/s13002-019-0302-7

Baressa Anbessa, Ermias Lulekal, Asfaw Debella and Ariaya Hymete 2024. Ethnobotanical study of medicinal plants in Dibatie district, Metekel zone, Benishangul Gumuz Regional State, western Ethiopia. *Journal Ethnobiology Ethnomedicine*, 20,85 https://doi.org/10.1186/s13002-024-00723-7

Behailu Bizuayehu and Temesgen Assefa 2017. Ethnobotanical value of medicinal plant diversity in Cheha District, Guraghe Zone, Southern Nations, Nationalities and Peoples (SNNPR) of Ethiopia. *Journal of Medicinal Plants Research*, 11(28): 445–454.

Bekele Kinde, Chala Tamiru and Tahir Abdala 2022. Ethnobotanical study of medicinal plants and conservation status used to treat human and livestock ailments in Fadis District, Eastern Ethiopia. *Ethiopian Biodiversity Institute, Harar Biodiversity Centre*, 8(1): 1–

Bekele Kindie 2023. Analysis of Medicinal Plants and Traditional Knowledge Development in

Bekele Kindie and Chala Tamiru. 2020. Assessment of traditional medicinal plant ethnomedicinal value and its sustainable conservation status used by indigenous people to treat different ailments in Babile District, Oromia Region, Ethiopia. *MOJ Biology and Medicine*, 6(3): 101–106. https://doi.org/10.15406/mojbm.2021.06.00140

Bekele Melese, Feleke Woldeyes, Ermias Lulekal, Tamrat Bekele and Sebsebe Demissew 2022. Ethnobotanical investigation of medicinal plants in Buska Mountain Range, Hamar District, Southwestern Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 18(1): 1– 26.

Berkes, F. 1999. *Sacred ecology: Traditional ecological knowledge and resource management*. Taylor & Francis.

Bhogaonkar Prakash Yashwant and Devarkar Vijay Dattatraya 2021. Documentation of lesser-known medicinal plants: A case from tribal India. *BMC Complementary Medicine and Therapies*, 21(1): 195.

Biodiversity and Conservation, 32(4): 829–847. https://doi.org/10.1007/s10531-02302569-z

Boja Tilinti, Yoseph Melka and Tesfaye Awas 2021. Ethnobotanical Study of Medicinal Plants in Hidabu Abote District, North Shewa Zone, Oromia Region, Ethiopia. 10.21203/rs.3.rs-338768/v1.

Bula Kere Oda, Ermias Lulekal, Bikila Warkineh, Zemede Asfaw and Asfaw Debella 2024. Ethnoveterinary medicinal plants and their utilization by indigenous and local communities of Dugda District, Central Rift Valley, Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 20: 32. https://doi.org/10.1186/s13002-024-00665-0.

Chen, S. L., Yu, H., Luo, H. M., Wu, Q., Li, C. F. and Steinmetz, A. 2016. Conservation and sustainable use of medicinal plants: Problems, progress, and prospects. *Chinese Medicine*, 11(37): 1–10. https://doi.org/10.1186/s13020-016-0108-7.

Constant, N.L. and Tshisikhawe, M.P. 2018. Hierarchies of knowledge: ethnobotanical knowledge, practices and beliefs of the Vhavenda in South Africa for biodiversity conservation. *Journal of Ethnobiology and Ethnomedicine*, 14: 56. https://doi.org/10.1186/s13002-018-0255-2.

Cotton, C.M. 1996. *Ethnobotany: Principles and Applications*. John Wiley and Sons, New York, 412 pp.

Creswell, J.W. and Plano Clark, V.L. 2007. *Designing and Conducting Mixed Methods Research*. Thousand Oaks, CA: Sage.

Dereje Atomsa and Duguma Dibbisa 2019. Floristic composition and vegetation structure of Ades Forest, Oromia regional state, West Hararghe zone, Ethiopia. *Trop Plant Res*, 6: 139-147. DOI: 10.22271/tpr. v6. i1.020.

Desalegn Amare, Meseret Chimdesa Egigu and Jagathala Mahalingam Sasikumar 2022. Ethnobotanical study on medicinal plants used by ethnic people of Gechi District, South West Oromia, Ethiopia. *Nusantara Bioscience*, 14(1). District, Tanzania. *Open Access Library Journal*, 7: 1–10. https://doi.org/10.4236/oalib.1106545

Duguma Dibbisa and Dereje Atomsa 2019. Woody species composition and natural regeneration status of Ades Forest, Oromia Regional State, West Hararghe Zone, Ethiopia. *Journal of Tropical Forestry and Environment*, 9: 27–36. https://doi.org/10.31357/jtfe.v9i1.3947.

Engedasew Andarge, Abraham Shonga, Mathewos Agize and Asfaw Tora 2015. Utilization and conservation of medicinal plants and their associated Indigenous Knowledge (IK) in Dawuro Zone: An ethnobotanical approach. *International Journal of Medicinal Plant Research*, 4 (3), pp. 330-337.

Ermias Lulekal, Asfaw Zemede, Kelbessa Ensermu and Van Damme Patrick 2013. Ethnomedicinal study of plants used for human ailments in Ankober District, North Shewa Zone, Amhara Region, Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 9: 63. https://doi.org/10.1186/1746-4269-9-63

Ermias Lulekal, Zerihun Asfaw, Endale Kelbessa and Pieter Van Damme 2013. Ethnobotanical study of medicinal plants in the highlands of Maichew District, Tigray Region, Northern Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 9(1): 63.

Eshete Mersha and Ermias Lulekal 2021. Cultural significance of medicinal plants in healing human ailments among Guji semi-pastoralist people, Suro Barguda District, Ethiopia. *Journal of ethnobiology and ethnomedicine*, 17, 1:61. https://doi.org/10.1186/s13002-021-00461-x

Field, A. 2013. *Discovering Statistics Using IBM SPSS Statistics* (4th ed.). Sage Publications.

Firehun Lulesa, Shiferaw Alemu, Zewdie Kassa and Ashebir Awoke 2025. Ethnobotanical investigation of medicinal plants utilized by indigenous communities in the Fofa and Toaba sub-districts of the Yem Zone, Central Ethiopian Region. *J Ethnobiology Ethnomedicine*, 21, 14

Fisseha Mesfin, Sebsebe Demissew & Tilahun Teklehaymanot 2009. An ethnobotanical study of medicinal plants in Wonago Woreda, SNNPR, Ethiopia. *J Ethnobiology Ethnomedicine,* 5(28). https://doi.org/10.1186/1746-4269-5-28

Fongang Fotsing Yannick S., Bankeu Kezetas Jean J., Gaber El-Saber B., Iftikhar A. and Lenta Ndjakou B. 2021. Extraction of bioactive compounds from medicinal plants and herbs. *IntechOpen*. https://doi.org/10.5772/intechopen.98602.

Fox, J., & Weisberg, S. 2019. *An R companion to applied regression* (3rd ed.). Thousand Oaks, CA: Sage.

Gemedi Abdela and Mustefa Sultan 2018. Indigenous Knowledge, Major Threats and Conservation Practices of Medicinal Plants by Local Community in Heban Arsi District, Oromia, South Eastern Ethiopia.

Getachew Alemu, Worku Lemma and Kebede Abebe 2022. Community-based conservation of medicinal plants: a case study from the Oromia region, Ethiopia. *Plants*, 11(7): 891.

Getaye Gizaw 2021. Determinants of agricultural output in Doba Woreda, Oromia National Regional State, Ethiopia. *Journal of Economics and Sustainable Development*, 12: 24–

Getenet Chekole 2017. Ethnobotanical study of medicinal plants used against human ailments in Gubalafto District, Northern Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 13: 55. https://doi.org/10.1186/s13002-017-0182-7.

Giday Mirutse, Ameni Getachew, Teklehaymanot Tesfaye and Erko Beyene 2020. Ethnoveterinary medicinal plants used by pastoralists in the Ankober District, North

Haile Abebe 2022. Ethnobotanical study of medicinal plants used by local people of Mojana Wadera Woreda, North Shewa Zone, Amhara Region, Ethiopia. *Asian Journal of Ethnobiology*, 5(1): 35–43.

Harshberger, J. W. (1895). The purposes of ethno-botany. Botanical Gazette, 21(3), 146–154

Heinrich, M., Ankli, A., Frei, B., Weimann, C., & Sticher, O. (1998). Medicinal plants in Mexico: healers' consensus and cultural importance. Social Science & Medicine, 47(11), 1859-1871.

Ibrahim Oumer Duguma and Molalegn Mesele 2019. Use and management of medicinal plants by indigenous people in Boji Birmeji district, Western Ethiopia. *Ghana Journal of Science*, 60(1): 37–49. https://doi.org/10.4314/gjs.v60i1.4

Jagrati Tripathi, Ranjana Singh and Raghvendra Prakash Ahirwar 2017. Ethnomedicinal study of plants used by Tribal person for diarrhoea diseases in Tikamgarh District. *Journal of Medicinal Plants Studies*, 5(1): 248–253. ISSN 2320-3862.

Jeelani, S.M., Rather, G.A., Sharma, A. and Lattoo, S.K. 2018. In perspective: Potential medicinal plant resources of Kashmir Himalayas, their domestication and cultivation for commercial exploitation. *Journal of Applied Research on Medicinal and Aromatic Plants*, 8: 10–25.

Jima Teshome and Megersa Mulatu 2018. Ethnobotanical study of medicinal plants used to treat human diseases in Berbere District, Bale Zone of Oromia Regional State, Southeast Ethiopia. *Evidence Based Complementary and Alternative Medicine*, Article 8602945. https://doi.org/10.1155/2018/8602945

Journal of Ethnobiology and Ethnomedicine, 19(1): 38.

Juhar Zemede, Tegenu Mekuria, Clintone Onyango Ochieng, Guy Eric Onjalalaina and GuangWan Hu 2024. Ethnobotanical study of traditional medicinal plants used by the local Gamo people in Boreda Abaya District, Gamo Zone, southern Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 20(28). https://doi.org/10.1186/s13002-024-00666-z

Junsongduang A., Kasemwan W., Lumjoomjung S., Sabprachai W., Tanming W. and Balslev H. 2020. Ethnomedicinal knowledge of traditional healers in Roi Et, Thailand. *Plants*

Kasa Zelalem Alemu, Demissew Asfaw Zewdu and Tadesse Seid 2020. Threats and conservation of medicinal plants in Ethiopia: A review. *Journal of Medicinal Plant Research*, 14(5): 195–210.

Kassa Zelalem, Demissew Asfaw and Tadesse Seid 2020. An ethnobotanical study of medicinal plants in Sheka Zone of Southern Nations Nationalities and Peoples Regional State, Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 16(1): 1–5.

Kebede Tewodros, Mekonnen Yonas and Zerihun Abebe 2018. Medicinal plants used for ophthalmic ailments in Ethiopia: A review. *Pharmacognosy Reviews*, 12(23): 198–204.

Kedir Adem Usman, Meseret Chimdessa Egigu and Jagathala Mahalingam Sasikumar 2022. Ethnobotanical study on traditional medicinal plants used by Oromo ethnic people of Goro district, Bale zone of Oromia region, Ethiopia, *EthnobotanyResearch and Application* 24: 8.

Keneni Gobu 2018. Ethnobotanical study of traditional medicinal plants of Tole Woreda, South West Shoa Zone of Oromia Region, Ethiopia. MED Thesis, Haramaya University, Haramaya, Ethiopia.

Kidane Leul, Gebrecherkos Gebremedhin, and Tadesse Beyene 2018. Ethnobotanical study of medicinal plants in ganta afeshum district, eastern zone of tigray, northern Ethiopia." *Journal of ethnobiology and ethnomedicine*, 14, no. 1: 64.

Kindie Bekele, Chala Tamiru and Tahir Abdala 2021. Ethnobotanical study of medicinal plants and conservation status used to treat human and livestock ailments in Fadis District, Eastern Ethiopia. *International Journal of Homeopathy and Natural Medicines*, 7(1): 7–

Kirk, R. E. 2013. *Experimental Design: Procedures for the Behavioral Sciences* (4th ed.). Sage Publications.

Legendre, A. M. 1805. *Nouvelles méthodes pour la détermination des orbites des comètes*. Paris: F. Didot.

Martin, G.J. 1995. *A Method Manual*. Chapman and Hall, London. Ethnobotany pp: 267, 347.

Mekonnen Giday, Gebrehiwot Gebrelibanos and Tesfaye Gebremariam. 2023. Ethnoveterinary medicinal plants used by pastoralists in eastern Ethiopia for treatment of livestock ailments. *Journal of Veterinary Science & Technology*, 14(2): 130. https://doi.org/10.4172/2157-7579.1000130

Melese Furgasa and Tessema Zewdu 2023. Effect of Slope Gradient on Soil Attributes of Gara Ades Forest in Western Hararghe Zone of Oromia Region, Ethiopia. *American Journal of Agriculture and Forestry*, 11(6), 218-227. https://doi.org/10.11648/j.ajaf.20231106.12

Melese Mengistu, Dargo Kebede, Dereje Atomsa, Arayaselasie Abebe, Dinkayehu Alemnie, and Fatih Yildiz. 2019. Status and utilization of medicinal and aromatic plants in Eastern Hararghe, Ethiopia. *Cogent Food & Agriculture*, 5(1). https://doi.org/10.1080/23311932.2019.1701349

Merera Teso and Mesfin Woldearegay. 2023. Medicinal Plants of Ethiopia: Conservation, Traditional Knowledge, and Sustainable Use. https://doi.org/10.59411/721y5z60

Meskerem Bogale, J M Sasikumar, Meseret C Egigu 2023. An ethnomedicinal study in Tulo district, west Hararghe zone, Oromia Region, Ethiopia. *Heliyon*, 9 e15361

Meskerem Bogale, Jagathala Mahalingam Sasikumar and Meseret Chimdessa Egigu 2023. An ethnomedicinal study in Tulo District, West Hararghe Zone, Oromia Region, Ethiopia. *Heliyon*, 9: e15361. https://doi.org/10.1016/j.heliyon.2023.e15361

Mikias Solomon, Girma Tesfaye and Bekele Tadesse 2025. Conservation challenges of medicinal plants in Ethiopia: A community perspective. *Journal of Ethnobiology and Conservation*, 18(1): 33–48.

Mikias Teshome, Firew Kebede and Tamene Yohannes 2023. An Ethnobotanical Survey of Indigenous Knowledge on Medicinal Plants Used by Communities to Treat Various Diseases around Ensaro District, North Shewa Zone of Amhara Regional State, Ethiopia. *Scientifica (Cairo)*, 1: 5575405.https://doi.org/10.1155/2023/5575405

Moa Megersa and Nigussie Tamrat 2022. Medicinal Plants Used to Treat Human and Livestock Ailments in Basona Werana District, North Shewa Zone, Amhara Region, Ethiopia.

Evidence Based Complement Alternat Med, 5242033. doi: 10.1155/2022/5242033. PMID: 35463078; PMCID: PMC9023155.

Moa Megersa and Samuel Woldetsadik 2022. Ethnobotanical study of medicinal plants used by local communities of Damot Woyde District, Wolaita Zone, Southern Ethiopia. *Nusantara Journal of Biological Science*, 14(1). https://doi.org/10.13057/nusbiosci/n140102

Moa Megersa, Tesfaye Nedi and Shiferaw Belachew. 2023. Ethnobotanical Study of Medicinal Plants Used against Human Diseases in Zuway Dugda District, Ethiopia. *Evidence-Based Complementary and Alternative Medicine*, 5545294, 22. https://doi.org/10.1155/2023/5545294

Mohammed Yimam, Siraj Mammo Yimer and Tamirat Bekele Beressa 2022. Ethnobotanical study of medicinal plants used in Artuma Fursi district, Amhara Regional State, Ethiopia. *Trop Med Health*, 5**0(**85). https://doi.org/10.1186/s41182-022-00438-z

Muhidin Tahir, Hiwot Asnake, Tadesse Beyene, Patrick Van Damme and Amin Mohammed. 2023. Ethnobotanical study of medicinal plants in Asagirt District, Northeastern Ethiopia. *Trop Med Health*, 51(1): 1. https://doi.org/10.1186/s41182-023-00493-0. PMID: 36617576; PMCID: PMC9827656.

Muhidin Tahir, Letebrhan Gebremichael, Tadesse Beyene and Patrick Van Damme 2021. Ethnobotanical study of medicinal plants in Adwa District, Central Zone of Tigray Regional State, Northern Ethiopia. *Journal of Ethnobiology Ethnomedicine*, 17 https://doi.org/10.1186/s13002-021-00498-1

Mutie F.M., Gao L.L., Kathambi V., Rono P.C., Musili P.M., Ngugi G., Hu G.W. and Wang Q.F 2020. An ethnobotanical survey of a dryland botanical garden and its environs in Kenya: The Mutomo Hill Plant Sanctuary. *Evidence-Based Complementary and Alternative Medicine*, Article ID 1543831. https://doi.org/10.1155/1543831

Ndidzulafhi Innocent Sinthumule and Mbuelo Laura Mashau 2020. Traditional ecological knowledge and practices for forest conservation in Thathe Vondo in Limpopo Province, South Africa. Journal homepage: http://www.elsevier.com/locate/gecko

Netsanet Gonfa, Dereje Tulu, Kitessa Hundera and Dasalegn Raga 2020. Ethnobotanical study of medicinal plants, its utilization, and conservation by indigenous people of Gera District, Ethiopia. *Cogent Food & Agriculture*, 6(1): 1852716.

Nigussie Amsalu, Yilkal Bezie, Mulugeta Fentahun, Addisu Alemayehu and Gashaw Amsalu 2018. Conservation of medicinal plants by indigenous people of Gozamin Wereda, East Gojjam Zone of Amhara Region, Ethiopia: An ethnobotanical approach. *Evidence-Based Complementary and Alternative Medicine*. https://doi.org/10.1155/2018/2973513. PMID: 29743921; PMCID: PMC5884302.

Patrick Tugume, Edward Kakudidi, Martin Buyinza, Alex Katende, Joseph Namukobe and Moses Nanyingi 2024. Diversity and use of medicinal plants for veterinary care in Uganda. *Journal of Ethnobiology and Ethnomedicine*, 20(1): 12.

Prakash Yashwant Bhogaonkar and Vijay Dattatraya Devarkar 2021. Documentation of lesserknown medicinal plants: A case from tribal India. *BMC Complementary Medicine and Therapies*, 21(1): 195.

Reinaldo R, Albuquerque U, Medeiros P 2020. Taxonomic affiliation influences the selection of medicinal plants among people from semi-arid and humid regions: a proposition for the evaluation of utilitarian equivalence in Northeast Brazil. PeerJ. 8: e9664

Sadat-Hosseini M, Farajpour M, Boroomand N, Solaimani-Sardou F 2017.

Safitri S, Mulyadi A, Yoswaty D 2024. Ecological and potential ethnobotanical characterization of mangrove ecotourism area Sungai Bersejarah, Siak Regency, Riau, Indonesia. *Int J Sustain Develop Plan*, 19(9):3453.

Seble W/Yohannis 2013. An ethnobotanical study of medicinal plants used by local people in Menz Gera Midir District, North Shewa Zone of Amhara Regional State, Ethiopia. MSc Thesis, Addis Ababa University, Department of Plant Biology and Biodiversity Management.

Shah S.A., Shah N.A., Ullah S., Alam M.M., Badshah H., Ullah S. and Mumtaz A.S. 2016. Documenting the indigenous knowledge on medicinal flora from communities residing near Swat River (Suvastu) and in high mountainous areas in Swat-Pakistan. *Journal of Ethnopharmacology*, 182: 67–79.

Shewa Zone, Ethiopia. *BMC Veterinary Research*, 16(1): 87. https://doi.org/10.1186/s12917-020-02277-6.

Silambarasan R, Sasidharan S, Hareendran Nair J, Nishanth Kumar S, Aravind R, Nair AS, Selavinayagam KT 2023. A multivariate and quantitative assessment of medicinal

plants used by the indigenous malayali tribes in the Javadhu hills of Tiruvannamalai district, Tamil Nadu, India. Heliyon. 9(5): e15607.

Sintayehu Tamene, Mesele Negash, Fortunatus Bulabo, and Linley Chiwona-Karltun 2024. Influence of socio-demographic factors on medicinal plant knowledge among three selected ethnic groups in south-central Ethiopia. *Journal of ethnobiology and ethnomedicine*, 28;20(1):29. doi: 10.1186/s13002-024-00672-1. PMID: 38419117; PMCID: PMC11340053.

Suma F. Kibonde 2020. Indigenous knowledge and conservation of medicinal plants in Rungwe

Tadesse Teklay, Woldemariam Zelalem and Asfaw Zemede, 2015. Traditional medicinal plants used for eye diseases in Ethiopia. *Ethnobotany Research and Applications*, 13: 65–78.

Tahir Getachew, Ayalew Gebre and Tesfaye Hailu 2023. Multipurpose use and conservation status of medicinal plants in Bale Mountains National Park, Ethiopia. *Journal of Ethnobiology and Conservation*, 15(2): 45–60.

Tahir Mohammed, Gebremichael L., Beyene T., Van Damme P. 2021. Ethnobotanical study of medicinal plants in Adwa District, Central Zone of Tigray Regional State, Northern

Takele Bassa 2017. Ethnobotanical Study of Medicinal Plants in Wolaita Zone, Southern Ethiopia. *Journal of Biology, Agriculture and Healthcare*, 7(23): 60.

Tamene Sintayehu 2020. Ethnobotanical study of indigenous knowledge on medicinal plant uses and threatening factors around Malga District, Southern Ethiopia. *International Journal of Biodiversity and Conservation*, 12(3): 215–226.https://doi.org/10.5897/IJBC.1416

Tamene Sintayehu, Negash Mekonnen, Makonda F. B., Chiwona-Karltun Liselotte, and Kibret Kifle S 2023. Ethnobotanical study on medicinal plant knowledge among three ethnic groups in peri-urban areas of south-central Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 19(1):55. https://doi.org/

Tardío, J., & Pardo-de Santayana, M. (2008). *Cultural importance indices: a comparative analysis based on the useful wild plants of Southern Cantabria (Northern Spain)*. Economic Botany, 62(1), 24–39.

Tariku Berihun, Asfaw Zemede, Ermias Lulekal and Tamrat Bekele 2024. Ethnobotanical study of traditional medicinal plants used to treat human ailments by the local people of the Diga District, western Ethiopia. https://doi.org/10.21203/rs.3.rs-4227856/v1

Tesfaye Hailemariam Bekalo, Sebsebe Demissew Woodmatas & Zemede Asfaw Woldemariam 2009. An ethnobotanical study of medicinal plants used by local people in the lowlands of Konta Special Woreda, southern nations, nationalities and peoples regional state, Ethiopia. *J Ethnobiology Ethnomedicine*, 5(26). https://doi.org/10.1186/1746-4269-5-26

Tewodros Kelemu and Worku Wolde 2018. Ethnobotanical study of indigenous knowledge on medicinal plants used to treat diseases in selected districts of Amhara Regional State, Ethiopia. Department of Biology, College of Natural and Computational Sciences, Debre Berhan University, Debre Berhan, Ethiopia.

Tezera Jemere, Dessie Tegegne and Kefyalew Ayalew Getahun 2020. Assessment of knowledge, attitude, and utilization of traditional medicine among the communities of Debre Tabor Town, Amhara Regional State, North Central Ethiopia: A cross-sectional study. *Evidence-Based Complementary and Alternative Medicine*, Article ID 6565131. https://doi.org/10.1155/6565131

Tukey, J. W. 1949. Comparing individual means in the analysis of variance. *Biometrics*, 5(2), 99-114.

Welch, B. L. 1947. The generalization of "Student's" problem when several different population variances are involved. *Biometrika*, 34(1-2), 28-35.

WHO (World Health Organization). 2016. Legal status of traditional medicine and complementary/alternative medicine: A worldwide review. WHO, Geneva; 2001.

Wondimu Mekonnen 2019. Ethnobotanical knowledge erosion: Medicinal plants in Adami Tulu Jido Kombolcha District, Oromia, Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 15(1): 12. https://doi.org/10.1186/s13002-019-0322-7

Yihenew Simegniew, Sintayehu Lesha, Yihalm Abebe, and Nakachew Minuye. 2023. Medicinal plants with traditional healthcare importance to manage human and livestock ailments in Enemay District, Amhara Region, Ethiopia. *Acta Ecologica Sinica*, 43(2). https://doi.org/10.1016/j.chnaes.2023.01.002

Yimer Assen, Mesfin Woldearegay and Abeba Haile 2021. An Ethnobotanical Study of Medicinal Plants in Kelala District, South Wollo Zone of Amhara Region, Northeastern. *Evid Based Complement Alternat Med*, 24:6651922. doi: 10.1155/2021/6651922. PMID: 33680058; PMCID: PMC7929653.

Zelalem Getnet, Subramanian Chandrodyam, and Getinet Masresha. 2016. Studies on traditional medicinal plants in Ambagiorgis area of Wogera district, Amhara Regional State, Ethiopia. *International Journal of Pure and Applied Bioscience*, 4(2): 38–45. https://doi.org/10.18782/2320-7051.2240

Zemede Asfaw, Teklay Tadesse, and Birhanu Mekonnen. 2022. Ethnoveterinary plants used in bone fracture and ectoparasite treatments: A study in Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 18(1): 12. https://doi.org/10.1186/s13002-022-00515-y

Zerihun Doda 2017. Sacred natural sites, herbal medicine, medicinal plants and their conservation in Sidama, Ethiopia. *Cogent Food & Agriculture*, 3(1): 1365399. https://doi.org/10.1080/23311932.2017.1365399

Zerihun Girma, Gemedi Abdela, and Tesfaye Awas. 2023. Ethnobotanical study of medicinal plants in Nensebo District, Southeastern Ethiopia. *Ethnobotany Research and Applications*. https://ethnobotanyjournal.org/index.php/era/article/view/3881

Zewdie Kassa, Zemede Asfaw and Sebsebe Demissew 2020. An ethnobotanical study of medicinal plants in Sheka Zone of Southern Nations Nationalities and Peoples Regional State, Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 16(1). DOI: 10.1186/s13002-020-0358-4.

Zhou H., Zhang J., Kirbis B.S., Mula Z., Zhang W., Kuang Y., Huang Q., Yin L. 2023. Ethnobotanical study on medicinal plants used by Bulang people in Yunnan, China. 19, 38. https://doi.org/10.1186/s13002-023-00609-0.

7. APPENDIX

APPENDIX A: Data Collection Questionnaire for Medicinal Plants (TMPs)

Region: _____ Zone: _____ Woreda: _____ Kebele: _____
Interviewer ID: _____

SECTION 1: SOCIO-DEMOGRAPHIC INFORMATION

1. **Marital Status:**
   □ Single □ Married □ Divorced □ Widowed
2. **Gender:**
   □ Male □ Female
3. **Location:**
   □ Urban □ Rural
4. **Age Group:**
   □ 25–35 □ 36–45 □ Over 46
5. **Occupation:**
   □ Traditional healer □ Artisan
   □ Part-time traditional healer □ Retired
   □ Farmer □ Bone setter (Wegesha)
   □ Trader □ Spiritual healer
   □ Other: _____

6. **Educational Status:**
   □ Cannot read/write □ Read only □ Read & write
   □ Elementary school □ Secondary school □ College/University
   □ Other: _____
7. **Household Income (ETB/month):**
   □ Up to 1,000 □ 1,001–5,000 □ Over 5,000
8. **Climate of Area:**
   □ Dega (Highland) □ Woyena Dega (Mid-highland) □ Kolla (Lowland) □ Desert

SECTION 2: MEDICINAL PLANT USE

9. **Do you use medicinal plants?**
   □ Yes □ No
   If yes, specify how you use them: _____
10. **List the medicinal plants commonly used in your household/community:**

SECTION 3: PLANT IDENTIFICATION AND DETAILED INFORMATION

11. **Local name, scientific name, and family: _____**
12. **Growth form:**
    □ Tree □ Shrub □ Herb □ Climber/Liana □ Epiphyte □ Parasite
13. **Specimen collection information:**
    • Collector's name: _____
    • Place of collection (Kebele/Village): _____
    • Voucher number: _____
14. **Specific medicinal uses (ailments treated):_____**
15. **Plant parts used:**
    □ Leaves □ Root □ Stem □ Fruit □ Seeds □ Flower
    □ Root bark □ Stem bark □ Sap/latex □ Whole plant
16. **Preparation methods (e.g., boiling, pounding, grinding):_____**
17. **Basis for selecting the plant for each ailment:_____**
    □ Family knowledge
    □ Observing others
    □ Trial and error
    □ Consultation with elders/healers
    □ Other: _____
18. **Source of the plant:**
    □ Wild areas □ Home garden □ Both
19. **Mode of administration:**
    • Applied on skin/mucosa
    • Swallowed raw
    • Drunk after mixing with liquid: _____
    • Chewed and swallowed
    • Smoked
    • Inhaled (smoke or vapor)
    • Inhalation of steam
    • Sniffing the fresh plant
    • Other: _____
20. **Additional ingredients added (if any): _____**
21. **Dosage (with consideration for age, gender, pregnancy, etc.): _____**
22. **Other non-medicinal uses (food, spices, cosmetics, etc.): _____**

SECTION 4: INDIGENOUS KNOWLEDGE SHARING

23. **Do you share your knowledge of medicinal plants with others?**
    □ Yes □ No
    If yes, how do you share it? _____

SECTION 5: THREATS TO MEDICINAL PLANT SPECIES

24. **Rank the main threats to medicinal plants (1 = most serious, 5 = least serious):**
    a. Overharvesting □1 □2 □3 □4 □5
    b. Land-use change □1 □2 □3 □4 □5
    c. Climate change □1 □2 □3 □4 □5
    d. Soil erosion/degradation □1 □2 □3 □4 □5
    e. Invasive species □1 □2 □3 □4 □5
    f. Pest/disease outbreaks □1 □2 □3 □4 □5
    g. Cultural shifts/lack of knowledge □1 □2 □3 □4 □5
25. **How have these threats affected the availability of medicinal plants? _____**
26. **Are there any plants that have become scarce? If yes, list them: _____**
27. **How do you ensure sustainable harvesting or conservation? _____**

SECTION 6: AVAILABILITY AND CONSERVATION PRACTICES

28. **Current availability of medicinal plants:**
    □ Easy to find
    □ Moderately easy
    □ Difficult to find
    □ Very difficult to find
    □ Not available
29. **Have you observed changes in availability over the years?**
    □ Yes □ No
    If yes, describe: _____
30. **Conservation practices followed:**
    □ Harvest at sustainable levels
    □ Plant in home gardens
    □ Protect wild plants
    □ Participate in community conservation
    □ Teach others
    □ Other: _____

31. **Are conservation practices promoted by government/NGOs?**
    □ Yes □ No
    If yes, describe: _____
32. **Should more be done to conserve medicinal plants?**
    □ Yes □ No
    If yes, what actions do you suggest? _____
33. **Are there community members or healers actively involved in conservation?**
    □ Yes □ No
    If yes, who and what do they do? _____

SECTION 7: BROADER CONTEXT & FUTURE SOLUTIONS

34. **Is the younger generation interested in learning about medicinal plants?**
    □ Yes □ No □ Not sure
    If no, why? _____
35. **Role of government or NGOs in protecting medicinal plants: _____**
36. **Would you support local initiatives for sustainable use (gardens, education, etc.)?**
    □ Yes □ No
    If yes, how would you participate? _____
37. **Are there legal or policy measures needed?**
    □ Yes □ No
    If yes, which measures? _____

SECTION 8: ADDITIONAL COMMENTS

38. **Any additional insights or information:**

_____
_____
__

Appendix B: List of Informants / Participants

INFORMANT ID	GENDER	AGE	LOCATION	OCCUPATION
IN001	M	>46	Bekelcha biftu	Farmer and traditional healer
IN002	M	>46	Bekelcha biftu	Trade and traditional healer
IN003	M	>46	Bekelcha biftu	Farmer and traditional healer
IN004	F	>46	Bekelcha biftu	Farmer and traditional healer
IN005	F	>46	Bekelcha biftu	Farmer, trade and traditional healer
IN006	M	>46	Bekelcha biftu	Farmer and traditional healer
IN007	M	>46	Bekelcha biftu	Farmer and traditional healer
IN008	F	>46	Bekelcha biftu	Farmer, Traditional healer
IN009	M	>46	Bekelcha biftu	Farmer
IN010	F	25-35	Bekelcha biftu	Student
IN011	M	25-35	Bekelcha biftu	Student
IN012	M	36-45	Bekelcha biftu	Farmer
IN013	M	36-45	Bekelcha biftu	Farmer, trade and traditional healer
IN014	M	36-45	Bekelcha biftu	Police
IN015	M	36-45	Bekelcha biftu	Farmer
IN016	M	36-45	Bekelcha biftu	Farmer
IN017	M	36-45	Bekelcha biftu	Farmer
IN018	F	36-45	Bekelcha biftu	Farmer
IN019	M	36-45	Bekelcha biftu	Farmer
IN020	F	>46	Bekelcha biftu	Farmer
IN021	M	>46	Bekelcha biftu	Farmer
IN022	F	36-45	Bekelcha biftu	Farmer
IN023	F	>46	Bekelcha biftu	Farmer
IN024	F	36-45	Bekelcha biftu	Farmer
IN025	F	25-35	Bekelcha biftu	Student
IN026	F	>46	Bekelcha biftu	Farmer
IN027	M	36-45	Bekelcha biftu	Farmer
IN028	M	25-35	Bekelcha biftu	Student, Farmer
IN029	M	36-45	Bekelcha biftu	Farmer
IN030	M	25-35	Bekelcha biftu	Farmer, Student
IN031	M	36-45	Bekelcha biftu	Farmer
IN032	M	36-45	Bekelcha biftu	Police
IN033	M	25-35	Bekelcha biftu	Student
IN034	M	25-35	Bekelcha biftu	Student
IN035	F	25-35	Bekelcha biftu	Student

IN036	F	25-35	Bekelcha biftu	Student
IN037	F	>46	Bekelcha biftu	Farmer, Trader and traditional healer
IN038	M	>46	Bekelcha biftu	Farmer, Forest guardian
IN039	M	>46	Bekelcha biftu	Farmer, Forest guardian
IN040	M	>46	Bekelcha biftu	Farmer, Traditional healer, Trader
IN041	M	>46	Ifa Haqa	Farmer, Traditional healer
IN042	M	>46	Ifa Haqa	Farmer, Traditional healer
IN043	M	>46	Ifa Haqa	Farmer, Traditional healer
IN044	M	>46	Ifa Haqa	Farmer, Traditional healer
IN045	M	>46	Ifa Haqa	Farmer, Traditional healer
IN046	M	>46	Ifa Haqa	Farmer, Traditional healer
IN047	M	>46	Ifa Haqa	Farmer, Traditional healer
IN048	M	>46	Ifa Haqa	Farmer, Traditional healer
IN049	M	25-35	Ifa Haqa	Farmer
IN050	M	36-45	Ifa Haqa	Farmer
IN051	F	>46	Ifa Haqa	Farmer
IN052	M	35-45	Ifa Haqa	Farmer
IN053	F	>46	Ifa Haqa	Farmer, Trader and traditional healer
IN054	F	>46	Ifa Haqa	Farmer, Traditional healer
IN055	F	>46	Ifa Haqa	Farmer, Traditional healer
IN056	M	36-45	Ifa Haqa	Farmer
IN057	M	>46	Ifa Haqa	Farmer
IN058	M	>46	Ifa Haqa	Farmer, Traditional healer
IN059	M	>46	Ifa Haqa	Farmer
IN060	M	>46	Ifa Haqa	Farmer, Traditional healer
IN061	F	>46	Ifa Haqa	House wife
IN062	F	>46	Ifa Haqa	House wife
IN063	F	>46	Ifa Haqa	House wife
IN064	F	>46	Ifa Haqa	House wife
IN065	F	>46	Ifa Haqa	House wife
IN066	M	>46	Ifa Haqa	Farmer
IN067	F	>46	Ifa Haqa	Trader
IN068	M	>46	Ifa Haqa	Farmer
IN069	M	46>	Ifa Haqa	Farmer
IN070	M	46>	Ifa Haqa	Farmer
IN071	M	46>	Ifa Haqa	Traditional healer
IN072	M	46>	Ifa Haqa	Farmer and trader
IN073	M	35-46	Ifa Haqa	Farmer and trader

IN074	M	35-46	Ifa Haqa	Farmer, trader and student
IN075	M	46>	Ifa Haqa	Farmer and trader
IN076	M	46>	Ifa Haqa	Farmer and trader
IN077	M	46>	Ifa Haqa	Farmer and trader
IN078	M	46>	Ifa Haqa	Farmer and trader
IN079	F	46>	Ifa Haqa	Farmer and trader
IN080	M	36-45	Ifa Haqa	Farmer
IN081	M	25-35	Tokkuma Jalala	Student
IN082	M	25-35	Tokkuma Jalala	Student
IN083	M	25-35	Tokkuma Jalala	Farmer
IN084	F	25-35	Tokkuma Jalala	Student
IN085	F	25-35	Tokkuma Jalala	Student
IN086	M	25-35	Tokkuma Jalala	Student
IN087	M	25-35	Tokkuma Jalala	Student
IN088	M	25-35	Tokkuma Jalala	Farmer
IN089	M	46>	Tokkuma Jalala	Farmer
IN090	F	36-45	Tokkuma Jalala	Farmer
IN091	M	36-45	Tokkuma Jalala	Farmer
IN092	F	36-45	Tokkuma Jalala	Farmer
IN093	M	46>	Tokkuma Jalala	Farmer
IN094	M	36-45	Tokkuma Jalala	Trader, olice
IN095	F	46>	Tokkuma Jalala	Farmer
IN096	F	36-45	Tokkuma Jalala	Farmer
IN097	M	46>	Tokkuma Jalala	Farmer
IN098	M	36-45	Tokkuma Jalala	Trader, farmer
IN099	M	46>	Tokkuma Jalala	Farmer
IN100	M	46>	Tokkuma Jalala	Farmer
IN101	M	46>	Tokkuma Jalala	Farmer
IN102	M	46>	Tokkuma Jalala	Farmer
IN103	M	36-45	Tokkuma Jalala	Police
IN104	M	36-45	Tokkuma Jalala	Police
IN105	F	46>	Tokkuma Jalala	Farmer
IN106	F	46>	Tokkuma Jalala	Farmer
IN107	M	46>	Tokkuma Jalala	Traditional healer
IN108	M	46>	Tokkuma Jalala	Farmer and traditional healer
IN109	M	35-46	Tokkuma Jalala	Farmer and traditional healer
IN110	M	35-46	Tokkuma Jalala	Farmer and traditional healer
IN111	M	46>	Tokkuma Jalala	Farmer and traditional healer
IN112	M	46>	Tokkuma Jalala	Farmer and traditional healer
IN113	M	46>	Tokkuma Jalala	Farmer and traditional healer
IN114	M	46>	Tokkuma Jalala	Farmer and traditional healer

IN115	F	46>	Tokkuma Jalala	Farmer and traditional healer
IN116	F	46>	Tokkuma Jalala	Trader
IN117	F	46>	Tokkuma Jalala	Housewife
IN118	M	46>	Tokkuma Jalala	Farmer
IN119	M	35-46	Tokkuma Jalala	Farmer
IN120	M	35-46	Tokkuma Jalala	Farmer