



Ethnobotanical study of medicinal plants in Sekela District, northwestern Ethiopia

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ABSTRACT

Background: People in Sekela District, like others in Ethiopia, have a long tradition of using medicinal plants to treat human and livestock ailments. However, medicinal plants and their associated indigenous knowledge are currently under threat. Thus, the study was carried out to compile ethnobotanical knowledge about medicinal plants in the district.

Methods: A total of 352 informants from six study sub-districts (328 general and 24 key informants) were selected randomly and purposefully. Individual interviews, focus group discussions, guided field walks, and market surveys were used to acquire ethnobotanical data using semi structured interview questions. The informant consensus factor (ICF), fidelity level, preference ranking, direct matrix ranking, medicinal use, and Analysis of Variance were used.

Results: A total of 121 medicinal plants belonging to 106 genera and 55 families were documented. The Asteraceae family had the most species with 11 (9 %), followed by Lamiaceae with 8 (6.6 %), while leaves were the most utilized part with 56 (37 %). The majority of the remedies were made as a concoction (32, 17 %) and delivered orally (98, 57 %). There was a statistically significant difference in indigenous knowledge on medicinal plants among genders, ages, marital status, educational levels, and occupations ($p < 0.05$). The dermatological disease categories had the highest ICF (0.92) in human ailments.

Conclusion: The study revealed that Sekela District is rich in medicinal plants for treating human and livestock ailments, and has indigenous knowledge to utilize these resources effectively. However, overgrazing, agricultural expansion, and improper harvesting techniques threaten medicinal plants. This signals the need to make significant efforts to raise public awareness about their conservation and sustainable use.

Introduction

In traditional medicine system, plants are a great source of medicines used to treat a variety of diseases (Rahman et al., 2022b, 2022c; Süntar, 2020). Traditional medicine has not only played an important role in healing but has also contributed to the discovery of most pharmaceutically active substances in plants that have been used in the commercial production of drugs (Süntar, 2020).

It is estimated that up to 90 % of the population in developing countries relies on the use of medicinal plants (MPs) to meet their primary healthcare needs (Picking, 2024; Rahman et al., 2022a). Up to 80 % of Africans turn to traditional medicine to address their medical

needs, and the practice has long been ingrained into the continent's culture (Pemunta and Tabenyang, 2020). In Ethiopia, it is also standard practice to employ medicinal plants to cure a wide range of human and animal problems; this practice has a long history (Eshete and Molla, 2021). Assefa et al. (2021) asserts that traditional treatments are the most crucial and occasionally the only source of medicines for approximately 80 % of the population and that 95 % of traditional medicinal preparations in Ethiopia are derived from plants.

A review by Demissew et al. (2021) showed that the flora of Ethiopia and Eritrea is very diverse and rich in endemic species; it is estimated that the country has 6027 species of higher plants, 10 % of which are endemic. It is not surprising that the country is distinguished by multiple

Abbreviations: ANOVA, Analysis of Variance; ATCC, American Type Culture Collection; CFU, Colony Forming Unit; DMSO, Dimethylsulfoxide; ICF, Informant Consensus Factor; MBC, Minimum Bactericidal Concentration; MIC, Minimum Inhibitory Concentration; MP, Medicinal Plant; WHO, World Health Organization.

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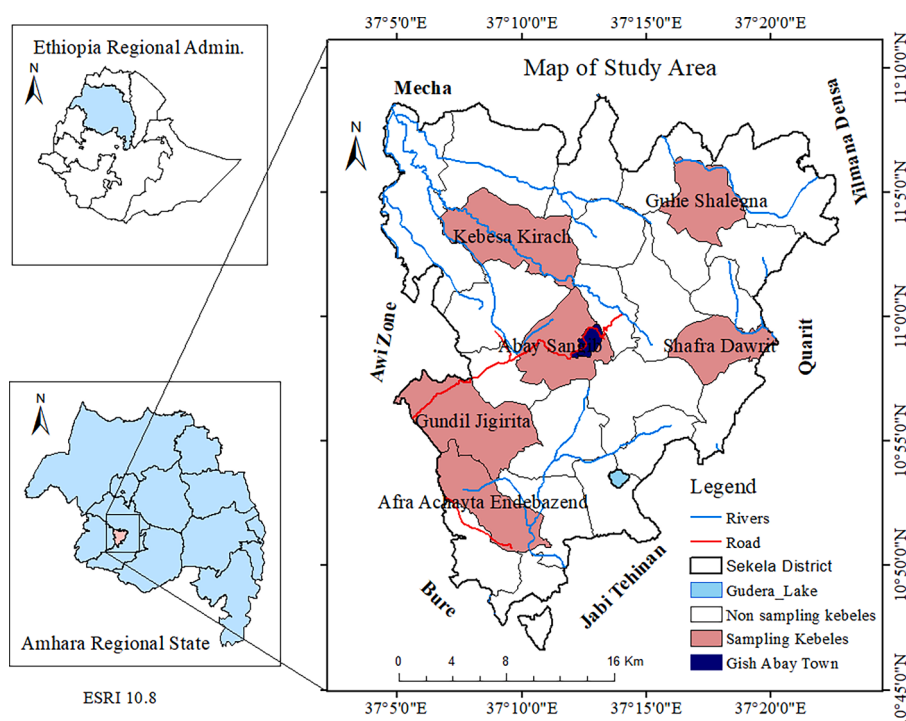


Fig. 1. Map of Ethiopia showing the Amhara Region and study district (ArcMap version 10.8).

ethnic groups (over 80 ethnic compositions), indicating that Ethiopians have a diverse indigenous culture. Furthermore, the majority of these plants have demonstrated very effective medicinal value for a variety of human and domestic animal ailments (López et al., 2021; Zeru et al., 2023). Despite the fact, knowledge on traditional medicinal plants (TMPs) has been lost for millennia because it has primarily been stored in the memories of elderly people and passed down primarily through word of mouth, migration from rural to urban areas, industrialization, the spread of modern health care (Mengistu, 2023; Wang et al., 2020).

The study revealed plants with significant healing potential, assisting locals in selecting the most important plants and possibly assisting scientific communities in performing future research on recognized species to generate new pharmaceuticals. Furthermore, the study highlighted hazards to MPs and species that were locally threatened, and any stakeholders interested in the management and conservation of medicinal plants in the study area used this information as input.

People in Sekela District, like others in Ethiopia, have a long history of using medicinal plants to treat human and livestock ailments, including when J. B. Bruce visited Ethiopia, notably the source of the Blue Nile (Hepper, 1980), because of their availability, affordability, and efficacy in treating human and livestock health problems. However, these medicinal plants are depleted due to agricultural development, habitat degradation, overgrazing, and deforestation. Therefore, the study aims to identify and document the indigenous knowledge (IK) of local people in Sekela District regarding the use of medicinal plants for treating human and livestock ailments.

Materials and methods

Description of the study area

The study was conducted in Sekela District located in the West Gojjam Zone of the Amhara Region, Northwest Ethiopia. The district lies between 37°5'0''–37°20'0''E (longitude) and 10°45'0''–11°10'0''N (latitude) (Fig. 1).

The most prevalent human diseases in the district are pneumonia, dyspepsia, acute upper respiratory infections, functional intestinal

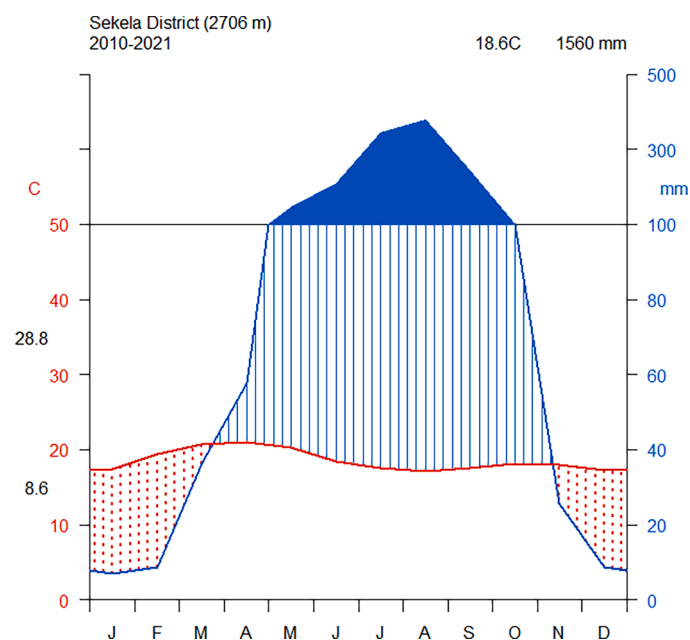


Fig. 2. Climate diagram of Sekela District from 2010 to 2021 (Source: NMSA, Ethiopia).

problems, and helminthiasis (SDHO, 2022). These diseases primarily afflict persons living in rural areas with little access to health care. The most prevalent livestock diseases in the research region include protozoal disease (gendi), anthrax, internal and external parasites, pastrolosis, and new castle disease (SDAAO, 2022).

The vegetation of the study area consists of dry evergreen afro-montane forest and grassland complex, a very complex plant type that occurs roughly above 1500 m and below 3200 m in altitude, with average annual temperatures of 14–25 °C and rainfall of 700–1100 mm, respectively. Thus, the forest is dominated by species including *Vachellia*

abyssinica, *Juniperus procera*, *Cynodon dactylon*, *Vernonia amygdalina*, *Maytenus arbutifolia*, *Olea europaea* subsp. *cuspidata*, *Rhamnus prinoides*, *Croton macrostachyus*, *Prunus africana*, *Dombeya torrida*, *Apodytes dimidiata*, *Acmella caulirhiza* and other indigenous plants are listed as major plants in the study (Friis et al., 2010).

The district's weather conditions are characterized by 70 % highland (Dega) and 30 % midland (Woyna Dega) agro-ecological zones (SDAO, 2022). The mean annual rainfall of the district is 1560 mm. The mean minimum and maximum temperatures of the study area are 8.6 °C and 28.8 °C, respectively, while the mean annual temperature is 18.6 °C (Fig. 2).

Research design

A descriptive cross-sectional study combining both quantitative and qualitative research approaches was carried out. To examine their knowledge, and use of medicinal herbs, a semistructured questionnaire survey was undertaken among randomly and purposefully selected informants.

Study site and informant selection

Six (6) Sub districts, four (4) from Dega and two (2) from Woyna-dega were selected by purposive sampling on the basis of the availability of traditional medicine practitioners, agroecological differences and vegetation coverage with the assistance of the district's Agricultural and Rural Development Office and the local community.

Representative households were calculated using the standard formula (Cochran, 1977).

$$n = \frac{z^2 pq}{e^2}, n = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)}, n = 384$$

Because populations are finite, a given sample size provides proportionately more information for a small population than for a large population (Cochran, 1977). The actual sample size can be adjusted using:

$$n'_{\text{actual}} = \frac{n}{1 + \left(\frac{n-1}{N}\right)}, n'_{\text{actual}} = \frac{384}{1 + \left(\frac{384-1}{4282}\right)}, n'_{\text{actual}} = 352$$

Following the calculation of the needed sample size, the researcher used a proportionate formula to select the needed sample households for each sampled kebeles.

$$nj = \left(\frac{Nj}{N}\right)n$$

The general informants were selected randomly by flipping the coin from the local people of the study area to assess their general knowledge of medicinal plants (Martin, 1995). Twenty-four (24) key informants were deliberately chosen. Twelve (12) wise informants with prior knowledge of traditional medicinal plants were purposefully selected for

focus group discussion (Martin, 1995).

Data collection

Individual/face-to-face interviews, group discussions, guided field walks, and market surveys were conducted with traditional medicine practitioners using semi structured interviews in the manner recommended by (Martin, 1995).

Brief focus group discussions were held to gather detailed and full information regarding to TMPs. It was carried out with the help of twelve (12) informants. Discussions were taking place based on the semi structured questions on the checklist.

Field observations were conducted with informants, and all relevant data, including vernacular plant names, plant parts used, human activities, and major threats, were recorded on site. Field walks were conducted in the study area with the assistance of local guides and informants.

A market survey was conducted on medicinal plants in two potential markets in Sekela District (Gish Abay and Agut). The multipurpose role of some therapeutic plants was observed and recorded in parallel with interviews with dealers and purchasers of medicinal plants.

Plant specimen identification

Specimens were identified using the descriptions given in Botanists' field guide books, volumes of Flora of Ethiopia and Eritrea taxonomy keys. Plants of the World Online (<https://powo.science.kew.org/>) provided additional information. Finally, the voucher specimens were stored in Debre Markose University's Herbarium.

Data analysis

Statistical analysis

The ethnobotanical data were analyzed using descriptive statistics and inferential statistical analysis (ANOVA) at a 95 % confidence level was performed to figure out on the average number of medicinal plants among sociodemographic variables, including age, gender, marital status, and education level to each other via the SPSS software package version 26. Quantitative ethnobotanical indices were also calculated: direct matrix ranking, preference ranking, informant consensus factor (ICF), fidelity level index (FL), as well as the use value (UV).

The researcher first grouped traditional remedies and corresponding diseases into ailment categories to compute informant consensus factor (ICF) using $ICF = \frac{n_{ur} - n_t}{n_{ur} - 1}$, where n_{ur} = the number of use citations in each disease category, n_t = the number of species used and n_{ur-1} = the number of use citations in each category minus one (Martin, 1995).

The fidelity level (FL) is the percentage of informants who claim to have used a specific plant species for the same major purpose or to treat the same ailment. Accordingly, the fidelity level for wound, evil eye, diarrhea, sun strike and tonsillitis were calculated as $FL (\%) = (IP/IU) \times 100$, where IP is the number of informants that claim a use of a plant species to treat a particular disease and IU is the number of informants that use the plants as a medicine to treat any disease as described by (Martin, 1995).

A study ranked eight (8) medicinal plants based on their wound healing power using ten key informants. The best plants were ranked highest, followed by the second-best plants and the lowest plants with lower healing power (Martin, 1995).

The study ranked eight (8) multipurpose plant species using a direct matrix to compare their use in various categories, including food, medicinal, agricultural tools, firewood, construction, charcoal, furniture, and fencing. Ten (10) key informants assigned use values, resulting in a summed and ranked ranking of each species (Cotton, 1996).

The most common medicinal plants used for multi disease management were identified using $UV = \frac{\sum U}{n}$ where UV = use value of a species;

Table 1

Taxonomic distribution of the most common medicinal plant species in the study area.

Family	No of species	Percent (%)	No of genera	Percent (%)
Asteraceae	11	9	8	7.5
Lamiaceae	8	6.6	7	6.6
Fabaceae	7	5.8	4	3.7
Poaceae	6	5	6	5.6
Solanaceae	6	5	4	3.7
Rosaceae	5	4	5	4.7
Cucurbitaceae	4	3.3	5	4.7
Euphorbiaceae	4	3.3	4	3.7
Ranunculaceae	4	3.3	3	2.8
Myrtaceae	3	2.5	2	1.8

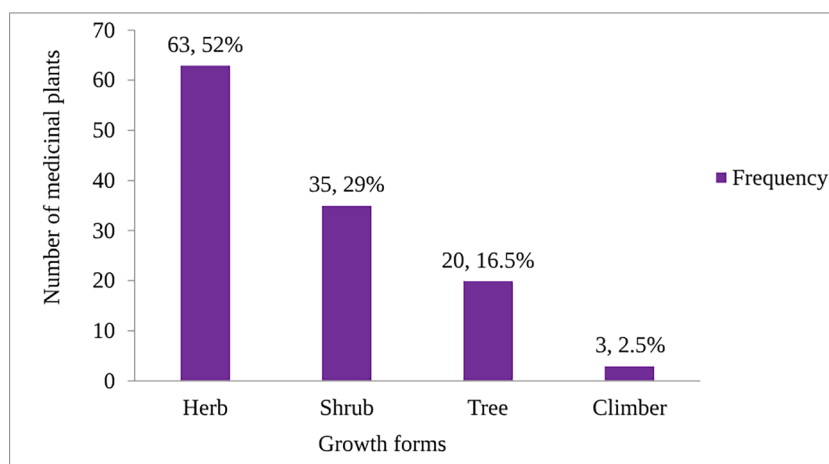


Fig. 3. Growth habits of medicinal plants in the study area.

U = number of citations per species; n = number of informants.

Results and discussions

Diversity and distribution of medicinal plants

A total of 121 medicinal plant species distributed in 106 genera and 55 families were documented for the treatment of human and livestock ailments in the study area. The leading family was Asteraceae, with 11 (9 %), followed by Lamiaceae 8 (6.6 %) (Table 1).

Despite environmental degradation and human activities, the district has a significant number of medicinal plants used for treating human and animal ailments. The number of MPs reported from the study district was higher than that of other areas in the country (Emre et al., 2021; Reta et al., 2015). This could be attributed to the informant's voluntary response, physical accessibility, cultural acceptability, economic affordability compared to modern medicine and efficacy-related aspects in the Sekela people's reliance on traditional medicine. In contrast the current study reported fewer medicinal plants than other studies (Chekole, 2017; Hu et al., 2020). This possibly due to regional differences in accessibility, economic, cultural acceptance, and efficacy, which may have influenced people's reliance on traditional medicine, as also mentioned in (Emre et al., 2021).

The widespread use of species from the Asteraceae, Lamiaceae and Fabaceae families could be linked to the presence of effective bioactive ingredients, successful pollination, and dispersal mechanisms as reported in (Alamgir and Alamgir, 2018). Additionally, the dominance of these families may be related to diverse species found in the flora books of Ethiopia and Eritrea.

Regarding the source of MPs, 85 (70 %) species were obtained from the wild, 24 (20 %) species were found in home gardens, and 12 (10 %) species were from both home gardens and the wild (see Supplementary file 1: Table S1). This may be due to the high secrecy of medicinal plant knowledge, the knowledgeable person may not have cultivated medicinal plants in his or her home garden.

Growth forms

The results of growth form analysis of medicinal plants showed that herbs constituted the highest proportion, represented by 63 (52 %) species, while there were 35 (29 %) shrub species (Fig. 3).

The high usage of herbs in the study area could be a result of their relative abundance compared to trees and shrubs. The findings of this study agreed with (Girma et al., 2022; Tefera and Kim, 2019) in Hawassa Zuria and Nensebo District. In contrast to Masresha et al. (2021), shrubs were the most commonly used plant species. This could be due to

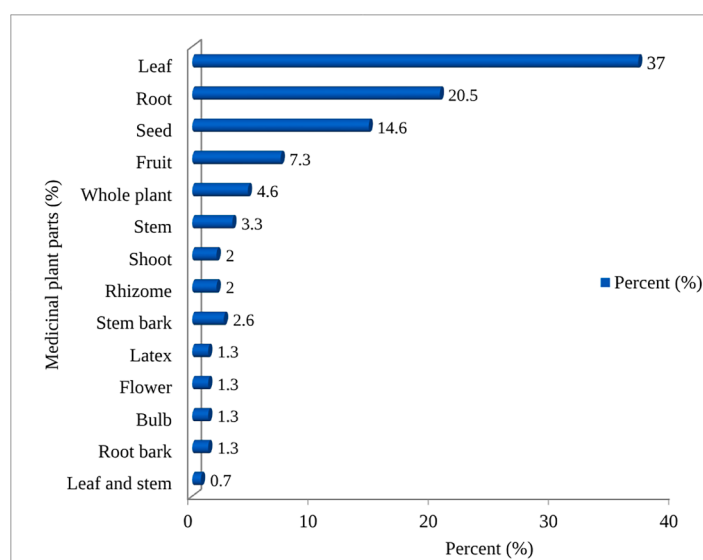


Fig. 4. Medicinal plant parts used to treat human and livestock ailments in the study area.

Table 2

Forms of medicinal plant preparation in the study area.

Form of preparation	Frequency	Percent (%)
Concoction	32	17
Squeezing	24	13
Pounding	20	11
Crushing	19	10
Chewing	17	9
Without processing	16	8.6
Powdering	13	7
Heating	12	6.5
Decoction	10	5.4
Infusion	7	4.0
Roasting	5	2.7

seasonal differences, the number of herbivorous animals, or other edaphic factors.

Plant parts used for remedies

The most widely used plant part for the treatment of human and livestock health problems was leaves, accounting for 56 (37 %) of the claimed remedies preparation, followed by roots, which accounted for 31 (20.5 %) and seeds 22 (14.6 %) (Fig. 4).

Leaves are widely used for treating human and livestock ailments due to their ease of preparation, bioactive ingredients, and ability to

minimize plant threats. This is not surprising given that harvesting of leaves may be due to ease of preparation, the presence of more bioactive ingredients in leaves, and leaves were more commonly used plant parts to minimize the threat posed to the mother plants' long-term survival. This is consistent with Ethiopian reports (Kidane et al., 2018; Tahir et al., 2023; Tefera and Kim, 2019). On the other hand, roots are the most harvested plant parts for remedy preparation, possibly due to traditional beliefs about their therapeutic effect (Shopo et al., 2022).

Condition of remedy preparation

The analysis of the conditions of plant remedy preparation revealed that 126 remedies (68 %) were prepared from fresh parts, 46 (25 %) from dry parts, and 14 (7 %) from both fresh and dry conditions (see Supplementary file 1: Table S2). This demonstrates that locals regard fresh material as more effective because it does not lose bioactive compounds. This agreed with, Megersa et al. (2013) and in contrast, Edo et al. (2023). The difference could be due to the marketability of plants in which the dried forms of the preparation of plant remedies were stored for a long period of time and make transportation easier than the fresh form.

Form of remedy preparation

The majority of remedy preparations were concoction, which accounted for 32 (17 %), followed by squeezing with 24 (13 %) and

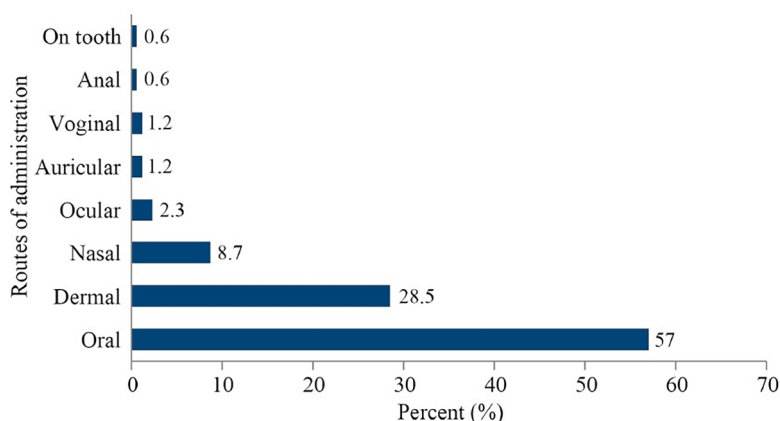
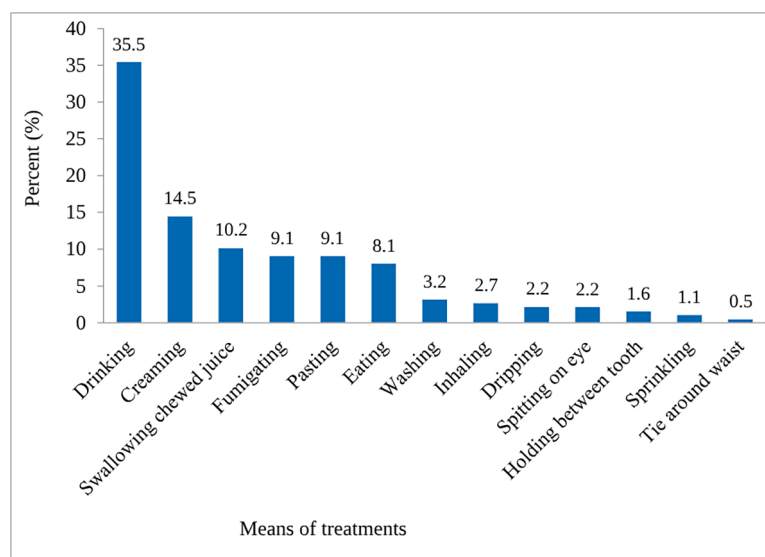
**Fig. 5.** Routes of administration of remedies in the study area.**Fig. 6.** Forms of applying traditional medication in the study area.

Table 3

Medicinal use value of some important medicinal plants in the study area.

Medicinal plant species	Local name (Amharic)	Total use Citation (ΣU)	Number of informants (n)	Medicinal use value (UV) = $\frac{\Sigma U}{n}$
<i>Clematis simensis</i>	Ye azo hareg	4	50	0.08
<i>Rumex nepalensis</i>	Tult	3	43	0.07
<i>Calpurnia aurea</i>	Ligita	4	68	0.06
<i>Dodonaea angustifolia</i>	Kitikita	3	57	0.05
<i>Rumex nervosus</i>	Ambuacho	4	81	0.05
<i>Euphorbia abyssinica</i>	Qulqual	3	72	0.04
<i>Croton macrostachyus</i>	Misana	3	94	0.03
<i>Plantago lanceolata</i>	Gorteb	3	90	0.03
<i>Verbena officinalis</i>	Atuch	3	86	0.03

chewing with 20 (11 %) preparations (Table 2).

The local people believed that the concoction was effective for extracting all of the plant's potential compounds and increasing the curative power of the medicine by increasing the number of different bioactive compounds and the efficacy of the remedy through faster physiological reactions. This was similar to Tolossa et al. (2013). Contrary to this finding, in the case of Ganta Afeshum District, the major method of preparation was direct and immediate/unprocessed (Kidane et al., 2018).

Routes of administration of remedies

The local people in the study area took most of the prepared remedies orally 98 (57 %), while 49 (28.5 %) were taken dermally, and 15 (8.7 %) were applied nasally (Fig. 5).

The oral routes allow for a faster physiological reaction of the prepared medicines with the ailments at hand, increasing the curative power of the remedies. The findings are consistent with those obtained in other parts of Ethiopia by (Girma et al., 2022; Hu et al., 2020; Tahir et al., 2023; Tefera and Kim, 2019).

Means of treatment or application of plant remedies

The study showed that drinking was the most widely used method, accounting for 66 (35.5 %) of all applications, followed by creaming 27 (14.5 %) (Fig. 6).

The most common treatment method was drinking, followed by creaming. This could be because more prevalent internal health issues, such as stomachache, dysentery, and diarrhea, were treated by drinking herbal extract, and external health problems, such as wounds, were treated by creaming, herbal extraction, or herbal secretion to treat infections until recovery.

Marketability of medicinal plants

Only 34 (28 %) of medicinal plants claimed to heal human and livestock ailments, with the majority (71.07 %) used by those in need after being taken from their natural habitat (See Supplementary file 1: Table S3). Six (6) species, including *Echinops kebericho* (kebericho), *Thymus schimperi* (tosign), *Olea europaea* subsp. *cuspidata* (woira), *Nigella sativa* (tikur azmud), *Otostegia integrifolia* (tunjit), and *Lepidium sativum* (feto) were identified during the market survey as being sold and bought for medicinal purposes. The remaining species were primarily purchased in bulk for their nonmedicinal applications. Practitioners in the district prepare and sell plant remedies in secret due to fear of selling them on the open market. Because people refer to it as "Debtera," "Tekuay," and "Sir mash" for those who are more knowledgeable about medicinal plants.

Medicinal use value

The results for medicinal use value revealed that some medicinal plant species were mentioned for more than one ailment to be treated. *Clematis simensis* (0.08) had the highest medicinal use value, followed by *Rumex nepalensis* (0.07) (Table 3).

The high medicinal use values, indicating their effectiveness in

Table 4

Results of the ICF for human health problems in the study area.

Ailment categories	Nt	Nur	ICF
Gastro-intestinal disorders (taeniasis (1), ascariasis (6), amoeba (1), diarrhea (10), dysentery (3), giardiasis (1), gastritis (5), internal parasite (3), tapeworm (1), fiber illness (1), stomachache (5), constipation (3))	40	452	0.91
Dermatological diseases (wound (14), skin cutting (1), eczema (4), scabies (3), bugniji (1), dandruff (2), hemorrhoid (3), skin rash (2), lumpy (1), skin TB (1), spider infection (1), cutaneous leishmaniasis (1), athlete's foot (1), ringworm (3))	38	494	0.92
Respiratory and associated health problems (tuberculosis (1), tonsillitis (7), pneumonia (1), anthrax (3), asthma (3), common cold (10), cough (4), sunstroke (5))	34	276	0.88
Reproductive (delivery problems) and venereal diseases (birth difficulty (1), gonorrhea (2), impotency (2), removal of retained placenta (2), syphilis (2))	9	40	0.79
Musculo-skeletal, dental, sensory system and neurological disorders (Alzheimer (1), abdominal pain (3), ear infection (1), bone dislocate (1), evil eye (9), headache (3), bone fracture (1), toothache (6))	25	168	0.86
Emergent health problems may cause immediate death as acute sickness (blood pressure or hypertension (2), hepatitis (2), liver problem (2), poisoning (2), cancer (1), anemia (1))	10	36	0.74
Others (intelligence (1), heartburn (1), malaria (3), rabies (3), teeth cleaning (1), scorpion bite (1), snake bite (1), kunkun (2), megagna (1))	14	87	0.85

Table 5

Results of the ICF for livestock health problems in the study area.

Ailment categories	Nt	Nur	ICF
Gastro-intestinal related diseases (bloating (1), constipation (2) diarrhea (1))	4	25	0.87
Dermatological diseases (wound (1), body swelling (1) eczema (2), scabies (1))	5	36	0.88
External and internal parasites (leech (1), intestinal parasite (1), tapeworm (2), skin parasite (2))	6	62	0.91
Respiratory and reproductive disorders (cough (1), removal of retained placenta (2), flu. (1), abortion (1))	5	38	0.89
Musculo-skeletal, sensory system and neurological disorders (bone dislocate (1), eye infection (4))	5	29	0.85
Emergent health problems may cause immediate death (coccidiosis (1), poisoning (2))	3	12	0.81
Others (megagna (1), rabies (3), epidemic (1))	5	22	0.81

treating various ailments. However, most medicinal plant species appear to have the lowest medicinal use values in the study area, which may not imply that they are less effective for treating ailments; rather, they were reported by a greater number of informants.

Efficacy of herbal medicines

Seven (7) major human ailment categories were identified. The dermatological disease category had the highest informant consensus

Table 6
Fidelity level values of common medicinal plants against human ailments.

Ailments	Medicinal plants	IP	IU	FL	FL (%)
Wound	<i>Rumex nervosus</i>	76	81	0.94	94
	<i>Plantago lanceolata</i>	84	90	0.93	93
	<i>Zehnera scabra</i>	77	96	0.80	80
Evil eye	<i>Rumex abyssinicus</i>	58	78	0.74	74
	<i>Allium sativum</i>	198	211	0.94	94
	<i>Echinops kebericho</i>	76	84	0.90	90
	<i>Otostegia integrifolia</i>	223	250	0.89	89
Diarrhea	<i>Verbena officinalis</i>	78	86	0.91	91
	<i>Brucea antidysenterica</i>	86	97	0.89	89
Sun strike	<i>Ocimum lamiifolium</i>	85	94	0.90	90
	<i>Zehneria scabra</i>	82	96	0.85	85
	<i>Cynoglossum coeruleum</i>	69	82	0.84	84

Table 7
Fidelity level values of common medicinal plants against livestock ailments.

Ailments	Medicinal plants	IP	IU	FL	FL (%)
Coccoides	<i>Phytolacca dodecandra</i>	44	78	0.56	56
	<i>Justicia schimperiana</i>	36	60	0.60	60
Rabies	<i>Phytolacca dodecandra</i>	32	78	0.41	41
	<i>Euphorbia abyssinica</i>	77	88	0.87	87
Eye infection	<i>Solanecio gigas</i>	22	40	0.55	55
	<i>Acmella caulirhiza</i>	68	74	0.92	92
Skin parasite	<i>Aloe macrocarpa</i>	57	79	0.72	72
	<i>Dodonaea angustifolia</i>	56	82	0.68	68

factor (ICF) values (0.92), followed by gastrointestinal disorders (0.91). Furthermore, the highest plant number (40) was recorded for the gastrointestinal tract, followed by the dermatological tract (39) (Table 4). Similarly, seven (7) major livestock ailment categories were identified from the 21 veterinary diseases reported in the district. The ICF values were recorded for external and internal parasites (0.91), followed by respiratory and reproductive disorders (0.89) (Table 5).

The high number of plant use citations may indicate the area's relatively high incidence of such diseases and ease of identifying ailments and corresponding curative plants. High ICF values, according to

Table 8
Preference ranking of eight medicinal plants used to treat wounds.

Medicinal plants	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Total	Rank
<i>Plantago lanceolata</i>	6	7	8	8	6	7	7	8	6	8	71	1th
<i>Calpurnia aurea</i>	8	7	6	8	8	5	6	7	8	6	69	2nd
<i>Rumex nervosus</i>	7	8	8	7	8	5	4	6	7	8	68	3th
<i>Clematis simensis</i>	7	7	8	4	7	8	5	7	6	7	66	4th
<i>Zehnera scabra</i>	5	5	7	6	5	4	8	7	5	5	57	5th
<i>Rumex abyssinicus</i>	6	4	7	7	5	6	5	6	5	6	57	5nd
<i>Chuita abyssinica</i>	5	7	4	3	4	6	6	6	4	2	47	7th

Key: R = respondent's.

Table 9
Direct matrix ranking of eight medicinal plant species.

Use diversity	Multipurpose plants list								Total	Rank
	<i>V. abyssinica</i>	<i>C. africana</i>	<i>A. abyssinicus</i>	<i>C. macrostachyus</i>	<i>C. anisata</i>	<i>E. globulus</i>	<i>F. sur</i>	<i>O. europaea</i> subsp. <i>cuspidata</i>		
Firewood	5	4	2	2	3	5	3	3	27	1th
Agricultural tool	3	2	4	1	3	5	1	5	24	2nd
Construction	3	3	4	1	2	5	1	4	23	3th
Medicine	3	2	2	5	3	4	2	3	22	4nd
Fencing	5	4	2	3	0	5	2	1	20	5th
Charcoal	5	3	1	1	1	5	0	2	18	6th
Furniture	0	5	1	0	0	2	1	2	11	7th
Food	0	4	0	0	0	0	5	0	9	8th
Total	24	27	16	13	12	31	15	20		
Rank	3nd	2nd	5nd	7nd	8nd	1nd	6nd	4nd		

N. B: Based on use criteria (5 = best; 4 = very good; 3 = good; 2 = less used; 1 = least used and 0 = no value).

Lulekal et al. (2013) are important for identifying plants of particular interest in the search for bioactive compounds.

Healing potential of medicinal plants

The results showed that the highest fidelity level (94 %) was recorded for *Rumex nurvosus*, followed by *Plantago lanceolata* (93 %) in wound infection, while *Allium sativum* (94 %) had the highest fidelity level value, followed by *Echinops kebericho* (90 %) in evil spirit disease (Table 6). Regarding livestock ailments, the highest fidelity level (92 %) was recorded for *Acmella caulirhiza*, followed by *Euphorbia abyssinica* (87 %) in eye infection and rabies infection (Table 7).

The highest FL values reported are thought to be a sign of these plants' high healing potential against the corresponding disease than multiple use or the diseases is managed only by the corresponding plant in a better way than other plants. On the contrary those plants with low FL mean the plants used to treat different diseases. It is not mean that the plant has less healing potential.

Preference ranking

The preference ranking exercise on medicinal plants reported to treat a wound, the most frequently reported disease in the dermatological disease category, revealed that *Plantago lanceolata* was the most preferred plant to treat the wound, followed by *Calpurnia aurea* (Table 8).

The most preferred species for treating a specific disease reflects its high efficacy, at least in the immediate vicinity of the people who use it. According to the results of this study's preference ranking, *Plantago lanceolata* was the most preferred species to treat wounds, the most frequently reported disease in the study area. This could be related to the fact that it contains active ingredients for treating wound infection.

Direct matrix ranking

The direct matrix ranking revealed that *Eucalyptus globulus* was ranked first and *Cordia africana* was ranked second (Table 9). Therapeutic plants are collected mostly for firewood, agricultural equipment, and construction rather than for therapeutic uses.

This finding clearly indicates that *Eucalyptus globulus* and *Cordia africana* were overharvested in the study area for their multiple uses.

Table 10

List of endemic and locally threatened medicinal plant species with their IUCN categories.

Species	Family	Local name (Amharic)	Endemism	IUCN category
<i>Aloe adigratana</i>	Aloaceae	Eret	Endemic	Vulnerable
<i>Dodonaea angustifolia</i> *	Sapindaceae	Kitikita	–	Not IUCN Red Lists
<i>Echinops kebericho</i> *	Asteraceae	Kebericho	Endemic	Not IUCN Red Lists
<i>Embelia schimperi</i> *	Myrsinaceae	Enkoko	–	Not IUCN Red Lists
<i>Eragrostis tef</i>	Poaceae	Tef	Endemic	Not IUCN Red Lists
<i>Erythrina brucei</i>	Fabaceae	Korch	Endemic	Not IUCN Red Lists
<i>Guizotia abyssinica</i>	Solanaceae	Nug	Endemic	Not IUCN Red Lists
<i>Impatiens tinctoria</i> *	Balsaminaceae	Ensosla	Endemic	Not IUCN Red Lists
<i>Lippia adoensis</i>	Verbenaceae	Koseret	Endemic	Not IUCN Red Lists
<i>Schefflera abyssinica</i> *	Araliaceae	Getem	–	Not IUCN Red Lists
<i>Solanecio gigas</i>	Asteraceae	Boz	Endemic	Least concern
<i>Solanum marginatum</i>	Solanaceae	Geber Embuy	Endemic	Not listed in IUCN
<i>Urtica simensis</i>	Urticaceae	Sama	Endemic	Least concern
<i>Withania somnifera</i> *	Solanaceae	Gizewa	–	Not IUCN Red Lists

Key: * indicates locally threatened but not under IUCN red lists.

Despite the fact that *E. globulus* ranked first, there is no fear of its extinction; consequently, people in the study area grow this plant in their home gardens. *C. africana*, on the other hand, was a more threatened species than the others in the study area due to overharvesting issues and poor cultivation practices. Similarly, Megersa et al. (2013) reported on the same pattern of high exploitation of *C. africana*.

Endemism and IUCN red lists of medicinal plants in the study area

The study's findings revealed the presence of endemic species in the district, which accounted for 10 (8.21 %) of the total collected MPs. Of these, 3 (2.48 %) species are also on the IUCN Red List (Table 10).

Medicinal plants such as *Echinops kebericho*, *Embelia schimperi*, *Impatiens tinctoria*, *Withania somnifera*, *Schefflera abyssinica*, and *Dodonaea angustifolia* were reported to be locally threatened in the study area, although they are not on the IUCN Red Lists (Table 10). This might be due to overuse, inappropriate harvesting techniques, and the multiuse of therapeutic herbs. Furthermore, the respondent revealed that *Embelia schimperi* is a climber, which means it relies on other plants for support, therefore if the host plant is destroyed, this species is also harmed.

Sociodemographic characteristics of respondents

The majority of survey participants (251, 71.31 %) were male, while 101 (28.74 %) were female. Male survey respondents reported medicinal plants at a rate of 76.60 %, whereas female respondents identified medicinal plants at a rate of 23.40 %. Regarding age, the majority of traditional healers (46.61 %) were between the ages of 41 and 60. According to the informants' marital status, there were 264 (75 %) married persons, followed by 61 (17.33 %) single people (Table 11).

The informants' educational status revealed that the majority of them were illiterate, accounting for 215 (61.12 %), followed by those who could read and write, who accounted for 52 (14.84 %). Farmers made up the largest group of informants 295 (83.82 %) (Table 11).

The findings demonstrate that there was statistically significant gender, age, marital status, education level and occupation disparities in indigenous knowledge of medicinal plants in the study area ($p < 0.05$).

Table 11

Statistical significance test on the average number of medicinal plants among sociodemographic variables.

Variables	Informant groups	Number	MPs Knowledge cited (%)	Mean $\pm$ SD	p-Value
Gender	Male	251	71.31	6.06 $\pm$ 4.60	0.004*
	Female	101	28.74	4.56 $\pm$ 4.37	
Age	20–40	105	29.80	3.12 $\pm$ 2.92	0.00*
	41–60	164	46.61	5.66 $\pm$ 4.04	
	61 $\geq$	83	23.65	8.77 $\pm$ 4.52	
Marital status	Single	61	17.33	2.95 $\pm$ 2.31	0.00*
	Married	264	75	6.29 $\pm$ 4.52	
	Divorce	6	1.70	1.83 $\pm$ 0.75	
Education level	Widowed	21	6	6.33 $\pm$ 4.14	0.00*
	Illiterates	215	61.12	5.86 $\pm$ 4.18	
	Read and write	52	14.84	4.92 $\pm$ 4.13	
	Primary school	31	8.83	4.87 $\pm$ 3.67	
	Secondary school	15	4.32	2 $\pm$ 1.13	
	Diploma	10	2.80	2.9 $\pm$ 2.81	
	First degree	10	2.81	2.6 $\pm$ 1.92	
	Church education	19	5.45	12.32 $\pm$ 4.02	
	Farmer	295	83.82	6.1 $\pm$ 4.44	
	Merchant	32	9.11	3.84 $\pm$ 3.42	
Occupation	Employee	13	3.71	2.31 $\pm$ 1.80	0.00*
	Unemployed	6	1.71	3.5 $\pm$ 3.39	
	Student	6	1.71	2 $\pm$ 1.09	

NB: *Significant difference ($p < 0.05$) at $\alpha = 0.05$.

This could be due to spiritual rules prohibiting females from learning church education, which is the primary source of traditional knowledge, and cultural taboos influencing females not to travel far from their homes. This is in agreement with a study done by (Tahir et al., 2023; Tefera and Kim, 2019).

There was a significant difference among age groups. This is why because elders may have had many years of accumulated experience on medicinal knowledge in relation to their daily life activities that interacted with their natural environment. Furthermore, there is a problem with sharing indigenous knowledge on medicinal plants with the younger generation because younger generations are less willing to acquire knowledge as a result of modernization's impact (Tefera and Kim, 2019).

Informants with no formal education appeared to have more knowledge of traditional medicine than educated informants. This suggests that traditional medicinal plants are not widely accepted in modern society. The findings are consistent with the findings of Tahir et al. (2023) but contrary to those of Tefera and Kim (2019). This could be due to differences in culture, religion, and socioeconomic status. Farmers reporting more medicinal plants than others. This could be because they live in a rural area that lacks modern hospitals and health care.

Table 12
Ranking of factors threatening medicinal plants.

Major threats	R1	R2	R3	R4	R5	R6	R7	R8	Total	%	Rank
Agricultural activities	5	5	4	5	5	5	4	5	38	23.75	1th
Over grazing	5	3	5	2	4	4	3	2	28	17.52	2th
Fire wood	4	4	3	2	3	3	3	4	26	16.25	3th
Construction	2	2	3	3	2	3	2	3	20	12.55	4th
Drought	3	1	2	2	3	2	2	1	16	10	5th
Charcoal production	1	2	1	1	2	1	1	2	11	6.87	6th
Timber production	2	1	2	1	1	2	1	1	11	6.87	6th

R = respondents, (values 1–5: 1 = the least destructive and 5 = the most destructive) (a single respondent mentioned two or more threats).

Threats and conservation of medicinal plants in the study area

Priority ranking factors also revealed that agriculture (23.75 %), overgrazing (17.5 %), and firewood (16.25 %) were major contributors to the threat of MPs (Table 12).

Informants ranked agricultural expansion as the most serious threat to medicinal plants. This could have occurred because the district’s residents were heavily reliant on farming activities. Secrecy in disclosing knowledge by traditional healers and negligence of the young generation in learning indigenous knowledge were also noted as factors that contribute to the loss of indigenous knowledge. Local people’s efforts to conserve medicinal plants in the district were found to be woefully inadequate. Some traditional practitioners have started to conserve medicinal plants by cultivating at home gardens. It was reported that medicinal plants were cultivated for their indirect uses, including aesthetic, food, shade, spice, charcoal and cultural uses. Medicinal plants can also be conserved by ensuring and encouraging their growth in special places, as they have been traditionally (Shafi et al., 2021). This can be possible in place of churches, mosques, grave yards, farm margins, and river banks.

Conclusions

Traditional medicinal plants (TMPs) and indigenous medicinal knowledge are critical in assisting the primary healthcare needs of both humans and livestock in the study area. The study also highlights the spread of Asteraceae, and Lamiaceae families, and the preference for local medicinal plant therapies for wounds, common colds, tonsillitis, and sunstrikes other than modern clinics. Traditional healers have indicated that the majority of traditional remedies are made from herbs harvested in their natural habitats, with fresh leaves blended into a concoction to be ingested orally. However, disparities in medical knowledge exist across sociodemographic characteristics. Thus, Traditional medicinal plant knowledge in a community is threatened by illiterate, less modernized healers and lack of documentation. Greater preference and loyalty for species such as *P. lanceolata* and *R. nervosus* in wound treatment may indicate the need for more phytochemical studies, and pharmacological inquiries. Firewood harvesting, over grazing, and agricultural development are all challenges for medicinal plants. Therefore, care for plant communities that are home to MP species is the most effective strategy to assure TMP conservation and long-term use. Further research on the chemical profiling of medicinal plants with high informant consensus factors, preference rankings, and fidelity levels served as inputs for future pharmacological investigations.

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None of the authors have any financial relationships or affiliations with organizations that may have a direct or indirect interest in the research presented in the manuscript.

Personal relationships

None of the authors have personal relationships with individuals or

organizations that could influence the research or its publication.

Ethics approval and consent to participate

First, authorization to conduct the study was obtained from the study district administration and kebele administrative offices by displaying formal written official letters written from the academic department: Department of Biology, Debre Markose University. Consent was obtained from the district authorities as well as cultural and religious leaders. Participants provided oral consent after the study’s purpose was briefly described in the local language.

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Availability of data and materials

All relevant data are within the manuscript and its supporting information files.

CRedit authorship contribution statement

Yitayih Dessie: Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Nigussie Amsalu:** Writing – original draft, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

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