Use and management practices of medicinal plants in and around mixed woodland vegetation, Tigray Regional State, Northern Ethiopia

Mehari Girmay, Ermias Lulekal, Tamrat Bekele and Sebsebe Demissew

Research

Abstract

Background: The concept of ethnomedicine deals with the cultural interpretations of health and illness through analyzing and using indigenous perceptions/practices. Although the tradition of using medicinal plants in Ethiopia is practiced for a long time, the documentation is not as intense as its long history and exercise wildly. This study was conducted in districts surrounding Hirmi Vegetation to; document and identify medicinal plant species, record indigenous knowledge of the people on medicinal plants and conservation measures practiced in the study area.

Methods: Data were collected using semi-structured interviews, guided field walks and focus group discussions. A total of 335 informants participated the data acquisition. Preference ranking, informant consensus factor, direct matrix ranking and t-tests in SPSS were employed to analyze the data.

Results: About 85 medicinal plant species used to treat 71 human and 16 livestock ailments were documented. Herbs comprised the largest category (40%) followed by shrubs (35.3%) and trees (24.7%). *Zehneria scabra* (L.f.) Sond*, Plumbago zeylanica* L. and *Zingiber officinale* Roscoe were the most preferred medicinal plants to treat the abdominal disease which have the highest informant consensus factor values (0.95). Overgrazing, deforestation and expansion of agriculture were the most repeated threats to the medicinal plants. Growing in homegarden, fencing and replanting were among the conservation techniques used by the local community. There was a significant indigenous knowledge differences ($p<0.05$) on traditional medicinal plants between age groups, educational status, marital status and experience of informants. However, religion and gender did not exert statistically significant differences ($P >0.05$).

Conclusion: Traditional healers and relevant professionals should provide education on how to use and manage the medicinal plants to their descendants by disseminating the required information and knowledge. Furthermore, phytochemical and toxicological investigations of these preferable medicinal plants should be carried out intensively.

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Background

About 65-80% of the world's population in developing countries depends essentially on herbal remedies for their primary healthcare due to poverty and lack of access to modern medicine (Awoyemi 2012). Ethiopia is one of the developing country with 80% of its population dependent on traditional medicine. Over the past decades, local people have been practiced their knowledge and perceptions to categorize plant species based on their services (Abebe & Hagos 1991). However, the destruction of plant resources with the loss of indigenous knowledge on the traditional medicine value of the country is accelerating from time to time (Abebe 2001, Giday *et al.* 2003). To tackle the problem, studies conducted at different times and in different parts of the country suggested that urgent documentation of indigenous knowledge related to plant use and management practice is essential for its future availability and sustainability.

Studies conducted by Abrha *et al*. (2018), Beyene (2015), Kidane *et al.* (2018), Mesfin *et al.* (2013), Teklay *et al.* (2013),Yirga (2010), Zenebe *et al*. (2012) describe the wide use of local traditional medicinal plants to cure human and animal health in Tigray. This might be associated with the poor developments of health centers in and around their vicinity as well as the perceptions of the people toward traditional medicines. Though people around Hirmi woodland vegetation are endowed with indigenous knowledge of how to use and conserve herbal plants to secure their health as well as the health of their livestock, it is not yet scientifically documented. Besides, a study conducted by Abebe (2010) and by Girmay *et al*. (2020) in and around Hirmi woodland vegetation reveals that the plant resources that provide various services to local community are dwindling continuously because of human and livestock pressures. They suggested that proper investigations on these plants are imperative to acquire the incessant services. Thus, ethnomedicinal investigation in districts surrounding Hirmi mixed vegetation has a crucial role in documenting medicinal plants and the associated knowledge as well as for the conservation scheme of the overall plants around the study area. While people gain direct health services from the vegetation and plants around their vicinity, it would pin the concern of conservation and medicinal benefit directly. Therefore the objective of this study was to: (i) identify and document the medicinal plants in the study area (ii) assess the knowledge, attitude, use and management practice as well as to identify the major threats to the medicinal plants used to cure human and livestock heaths in the study area.

Materials and Methods

Study area

The study was conducted in three districts namely; Tahtay Koraro, Medebay Zana and Asgede Tsimbla of the Northwest zone of Tigray National Regional State, Northern Ethiopia (Figure 1). The study area is 110 km North of Addis Ababa (Ethiopian capital). The study area has a minimum and maximum monthly mean temperature of 13.1 ºC and 31.9 ºC, respectively. The study area receives a unimodal rainfall with a mean annual of 888 mm/year from May to September and dry from October to April. Hirmi woodland vegetation is stretched in the three study districts. The vegetation type is characterized as a mix of *Combretum-Terminalia* woodland and wooded grassland and *Acacia-Commiphora* woodland and bushland (MEF 2015, Girmay *et al*. 2020). Tree species including *Combretum hartmannianum* Schweinf*., Terminalia macroptera* Guill*., Anogeissus leiocarpa* (DC.) Guill. & Perr*., Acacia abyssinica* Hochst. ex Benth*., Combretum adenogonium* Steud. ex A. Rich*., Acacia polyacantha* Willd*., Boswellia papyrifera* (Del.) Hochst. and *Diospyros mespiliformis* Hochst. ex A. DC*;* shrub species including *Euclea racemosa* subsp*. Schimperi, Dodonaea angustifolia* L.f*., Flueggea* virosa (Willd.) Voigt. and *Ziziphus mucronata* Willd. and herbs including *Trifolium campestre* Schreb*., Bidens pilosa* L. *Bidens macroptera* (Sch.-Bip. ex Chiov.) Mesfin*, Oxytenanthera abyssinica (*A. Rich.) Munro and *Oplismenus burmannii* (Retz.) P. Beauv. were among the dominant species in and around the Hirmi vegetation (Gebrehiwot *et al*. 2016, Girmay *et al*. 2020). Inside the vegetation, there are several wildlife species including Leopard, Bush Pig, Wild Cat, Jackals and Warthog (Gebrehiwot *et al*. 2016).

Socioeconomy and demography

The majority of the inhabitants are leading their way of life through agriculture. *Eragrostis tef (*Zucc.) is the main food crop grown in the area followed by barley, finger millet and maize. About 91% of the farmers own livestock, predominantly cattle and goats. The inhabitants use both crops and livestock as a source of cash income (CSA 2007). There are also people that boost their cash incomes through the selling of plant and plant products such as charcoal, firewood, incense gum, medicinal plants and firewood. According to the Central Statics Agency (CSA) of Ethiopia conducted in 2007, the total population in the three study districts was estimated to be 329,638. Of these 165,597 of them were male and 164,041 of them were female. The majority of the inhabitants practice Ethiopian Orthodox Christianity (97.7%), while the remaining 2.3% were Muslim. About 84.3% of the population is rural dwellers and 15.7% is urban dwellers. About 99.6% of the inhabitants are Tigrigna speakers.

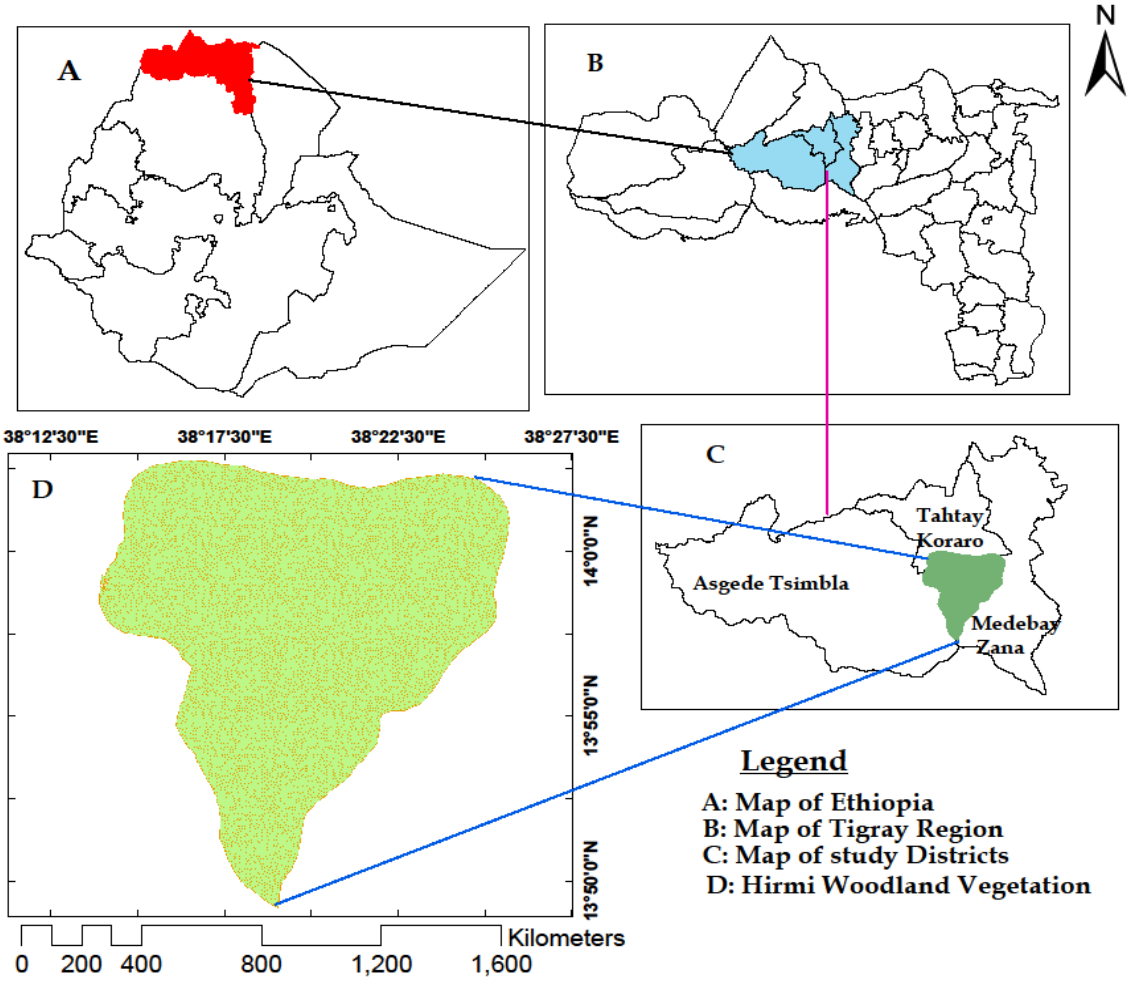

Figure 1. Map of the study area

Data Collection

Site selection

Hirmi vegetation spreads in 12 Kebeles (Small local administrations) of the three study districts (Girmay *et al*. 2020). A total of six (6) Kebeles namely: Kelakil and Adi-Gidad (from Tahtay Koraro district), Adi-Shankur and Menfig (from Medebay Zana district), Bete-Marya and Badnako (from Asgede Tsimbla district) were selected purposively by giving priority for those Kebeles closest to Hirmi vegetation. In these Kebeles there are 2,066 households (ANRBNWZT 2019).

Selection of informants

A total of 335 informants were selected using Cochran's (1977) formula as follows:

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

Where, n = sample size; N = total number of households in all 6 kebeles (i.e. 2,066); e = maximum variability or margin of error 5% (0.05). Accordingly, stratified random sampling was used to select the general informants and purposive sampling approaches for the key informants (Alexiades 1996). Of the total 335 informants, 20 of them were key informants that were selected with the help of elderly people and local administrators.

Data collection

Before the ethnobotanical data collection, formal written permission was obtained from the Department of Plant Biology and Biodiversity Management, Addis Ababa University and Northwest Zone of Tigray Administration to each study districts to create a workable environment between informants and the researcher. Subsequently, the objective of the study was explained briefly and clearly for the informants and local administrators. The interview was done after the informants showed their agreement to participate and cooperate in the study. Ethnobotanical data related to the traditional way of medicinal plant utilization and the associated indigenous knowledge was collected from the study area by means of a semi-structured interview. The semi-structured interviews were applied synergistically with field walks, observation and discussions. The field walks and observations are mainly important to collect the

voucher specimens of the medicinal plant species with the help of the informants and local field assistants as well as to observe and discuss signs of harvesting or patterns of plant distribution (Cunningham 2001). The interviews and discussions were conducted using the local language (Tigrigna).

Focus group discussion was carried out with an average number of five informants in each Kebele to prove the reliability of the data collected through semi-structured interviews as recommended by Alexiades (1996). The group discussion includes knowledgeable and elder informants, guards of the Hirmi vegetation, male households and female households. Traditional healers also participated in some of the discussions. This method was used to record information related to the mode of collection, preparation, utilization, conservation attempts and supposed threatening factors of the medicinal plants.

Data analysis

Descriptive statistics

Descriptive statistics were applied to analyze the required information gathered on medicinal plants' number and percentage as well as their families, medicinal value, application, methods of preparation, route of application, disease treated, part and growth form used, threats and conservation methods (Alexiades 1996). Data on informants' backgrounds and medicinal plants in the districts were entered into Excel spreadsheet software and prepared for statistical analysis. The indigenous knowledge dynamics on traditional medicinal plants among the informants (men and women; young and elderly; literate and illiterate; single and married; Christian and Muslim; key and general informants) was computed using t-test on SPSS (Ver. 22) programs.

Direct matrix and preference ranking

Preference ranking is a system of ranking of lists or groups of plants in order of the first choice of importance across a community (Martin 1995). In this study, preference ranking was used to determine the level of local communities' preference for ranking of the most preferable medicinal pant used to cure both human and animal illness. Accordingly, 10 key informants were purposively selected to rank the most preferable medicinal plants from those highly cited by the general informants as described by Alexiades (1996). Direct matrix ranking is a system of ranking items in which instead of arranging a series of objects on one characteristic, the informant was requested to order them by considering several attributes one at a time i.e. it draws explicitly upon multiple dimensions (Martin 1995). The direct matrix in this study was used to order the medicinal plants with multiple uses and the most threatened medicinal plants using the selected 10 key informants.

Informant Consensus Factor (ICF)

The calculation of the informant consensus factor (ICF) was used to test homogeneity on the informant's knowledge in choosing certain medicinal plants against a given ailment. ICF is important to select ailment categories where there is consensus on the use of plants among the informants and to identify species with particular importance in culture. The factor provides a range of 0 to 1, where a high value acts as a good indicator for a high rate of informant consensus. Informant consensus factor (ICF) was computed after the reported traditional remedies and corresponding diseases were grouped into 12 and 5 categories of human and livestock ailments, respectively. This was computed as; Number of use citations for each disease category (n_{ur}) minus the number of times species used (n_t), divided by the number of use citations in each category minus one (Heinrich *et al.* 1998).

$$\mathbf{IFC} = \frac{\mathbf{nur} - \mathbf{nt}}{\mathbf{nur} - \mathbf{1}}$$

Results

Diversity

A total of 85 medicinal plant species used to treat human and livestock ailments were gathered and documented from the study area. These species belong to 78 genera in 47 botanical families. Fabaceae was the most species-rich family with 9 species (10.6%) followed by Lamiaceae 7 (8.2%), Euphorbiaceae 6 (7.1%), Solanaceae 5 (5.9%), Asteraceae 3 (3.5%) and Cucurbitaceae 3 (3.5%). The remaining 30 (63.8%) and 11 (23.4%) plant families were represented by single and two species, respectively. Eighty-three medicinal plant species (97.6%) were used to treat human disease and 27 species (31.8%) were used to treat livestock ailments. About 92.6% (25) of the medicinal plants used to treat livestock disease were also used to treat human ailments.

Growth forms of medicinal plant species

Out of the total medicinal plants recorded from the study area, herbs comprised the largest category (34 species, 40%) followed by shrubs (30 species, 35.3%) and trees (21 species, 24.7%). Herbs were also dominantly (38.5%) used to treat human ailments, whereas shrubs were predominantly (51.8%) used to treat livestock disease.

Habitat of the medicinal plants

Communities in the districts surrounding Hirmi woodland vegetation collect the medicinal plants from their vicinity including cultivated land (homegardens and agricultural land) and wild environment mainly from the vegetation and common lands. The greater proportions of the medicinal plants (62 species, 72.9%) were collected

from the wild environment. The remaining 23 (27.1%) species were collected from cultivated land.

Regarding the medicinal plants used to treat human health, 61 (73.5%) species were from the wild environment whereas 22 (26.5%) species were collected from the cultivated land. Of the medicinal plants used to treat livestock diseases, 88.9% (24 species) were collected from the wild environment while 3 species (11.1%) were gathered from the cultivated land.

Plant parts used for medicine

The local inhabitants used different plant parts to prepare human and livestock remedies. About 14 plant parts were mentioned to prepare remedies to cure different ailments in the stud area. Of these, the most common plant parts used for the preparation of remedies were leaf (33.1%) and roots (16.2%) followed by stem (12.5%), fruit (8.8%) and Bark (8.1%). The remaining plant parts used were described in the following Table 1.

Table 1. Used parts of medicinal plant species

Plant part used	Number of species used	Percent (%)
Leaf	45	33.1
Root	22	16.2
Stem	17	12.5
Fruit	12	8.8
Bark	11	8.1
Whole plant	7	5.1
Seed	4	2.9
Latex	4	2.9
Leaf and root	3	2.2
Leaf and bark	3	2.2
Young twig	3	2.2
leaf & fruit	2	1.5
Bulb	2	1.5
Rhizome	1	0.8

Modes of remedy preparation and application

Herbal medicines were prepared in diverse modes of preparation by the local people of the study area to treat both human and livestock ailments. Twelve modes of remedy preparations and applications were reported to treat human disease (Figure 2).

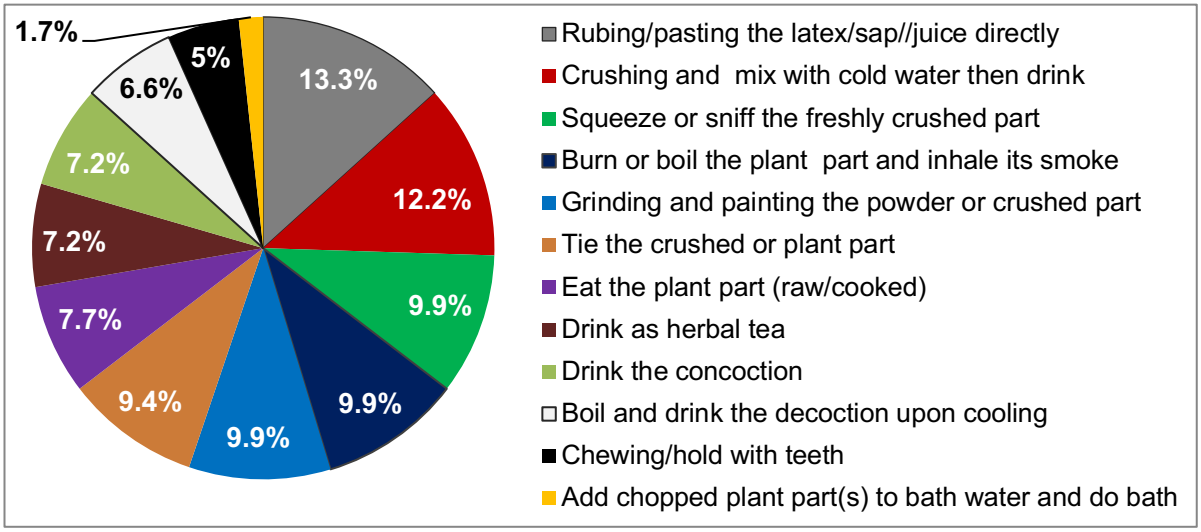

Figure 2. Methods of remedy preparations and applications of medicinal plants used for human ailments

There are also eight (8) modes of remedy preparations and applications to treat livestock ailments (Figure 3).

Dosages, antidotes, routes of remedy administration

There were inconsistent reports among the informants on the doses and measuring materials/units for the medicinal plants that they use. However, estimated dosages were reported considering age, gender and pregnancy. Remedies were reported to be measured in coffee cups, water glasses, liters, handful or spoonful. Honey, water, milk and butter were the commonly used antidotes for herbal preparations in case they feel pains and for those species with adverse effects. However, none of the traditional healers reported any adverse side effects of the traditional medicinal plants. Few informants (4.5%) reported that some species including *Zingiber officinale* Roscoe, *Datura stramonium* L. and *Phytolacca dodecandra* L'Her. have temporal pain and body scars.

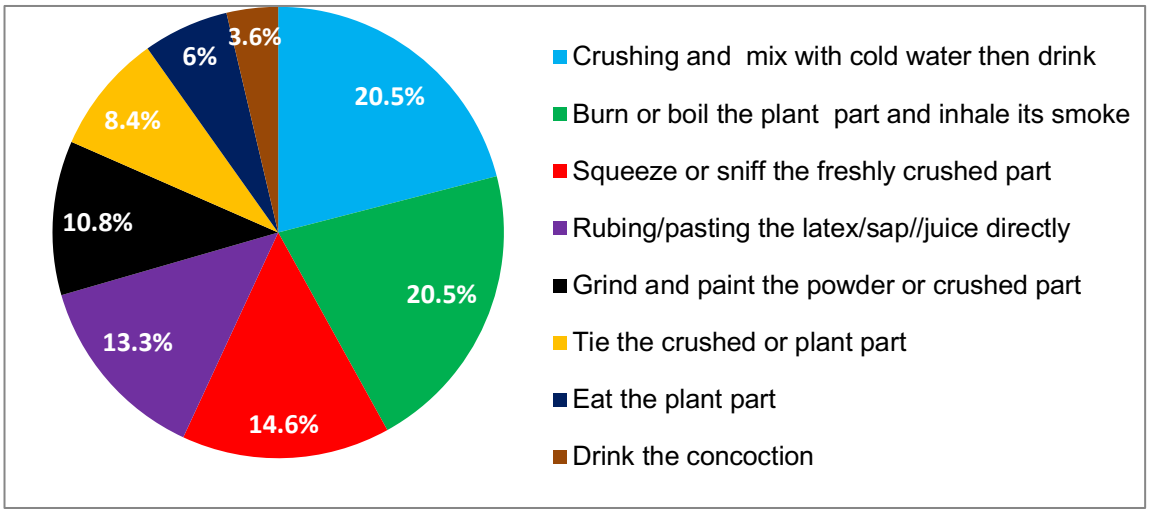

Figure 3. Methods of remedy preparation and application of medicinal plants used for livestock ailments

Oral, dermal, nasal, optical and auricular were among the common routes of administration of medicinal plants to treat human and livestock diseases. Of the routes of administration of remedies used against different human ailments in the traditional health care system, oral application was the most common route of administration (84 preparations, 45.7%) followed by dermal (76 preparations, 41.3%), nasal (16 preparations, 8.7%), optical (5 preparations, 2.7%), tooth surface (2 preparations,1.1%) and auricular (1 preparation, 0.5%). Four routes of remedy administrations were commonly reported for livestock ailments. Of these the highest was dermal (20 preparations, 54.1%) followed by oral (11 preparations, 29.7%), nasal (5 preparations, 13.5%) and optical (1 preparation, 2.7%) applications (Table 2).

Table 2. Modes of remedy application (MRA= modes of remedy application, NP= Number of preparations)

MRA	MRA for human		MRA for livestock	
	NP	%	NP	%
Oral	84	45.7	11	29.7
Dermal	76	41.3	20	54.1
Nasal	16	8.7	5	13.5
Optical	5	2.7	1	2.7
Tooth surface	2	1.1	0	0
Auricular	1	0.5	0	0

Human ailments treated with medicinal plants

Medicinal plants recorded in the study area were reported to treat 71 human ailments (Table 3). Out of the reported human diseases, abdominal diseases were treated with the highest number of medicinal plants (12 species) followed by the evil eye, eye disease, headache, tooth disease/ache and wound which were all reported to be treated with 7 species each. Other ailments such as body swelling, blood pressure, evil spirits were mentioned to be treated with 6 species each and insect bite was reported to be treated by 5 species.

Livestock ailments treated with medicinal plants

The reported 16 livestock diseases were treated using 27 medicinal species (Table 4). Most (92.6%) of the medicinal plants used to treat livestock ailments were also used to treat different human diseases. Among the livestock ailments reported in the study area, skin diseases were treated via a high number of medicinal plant (7 species) prescriptions followed by that of wound (6 species), leech infection (4 species), ectoparasite (4 species) and anthrax (3 species).

Species such as *Adansonia digitata* L., *Citrus aurantiifolia* (Christm.) Swingle, *Phytolacca dodecandra* L'Her., *Plumbago zeylanica* L. and *Ricinus communis* L. were used to treat ≥ 5 ailments (Table 5).

Table 3. List of plant species and methods of preparation to treat human ailments

Scientific name	Family	Local name	Growth form	PU	MRPA	RA	Disease treated	Other uses	Voucher Number
Acacia abyssinica Hochst. ex Benth.	Fabaceae	**Chea**	T	B	12	Dm	Internal bleeding	- Firewood	HH6
				B	10	Or	Dysentery	-Charcoal production -Fence -Soil fertility	
Acacia albida Del.	Fabaceae	**Momona**	T	B	6	Dm	Viral skin disease	-Soil fertility -Fence	HH29
Achyranthes aspera L.	Amaranthaceae	**Michiele**	H	R	8	Op	Eye irritation	-	HH41
Acokanthera schimperi (A.DC.) Schweinf.	Apocynaceae	**Mebtie**	S	L	9	Dm	Insecticide	-Firewood	HH63
				L	11	Dm	Insect bite	-Fence	
Adansonia digitata L.	Bombacaceae	**Dima**	T	F	4	Dm	Drink appetite	-Food	HH25
				B	1	Dm	Infant fever	-Fodder	HH43
				L	4	Or	Stomachache		
				L	4	Or	Infant diarrhea		
				R	12	Or	Backbone ache		
Agave sisalana Perrine ex Engl.	Agavaceae	**Eka**	H	L	6	Dm	Ear disease	-Material culture	HH68
Allium sativum L.	Alliaceae	**Tseada-shungurti**	H	Bl	10	Or	Abdominal pain	-Spice	HH62
				Bl	7	Or	Blood pressure		
				Bl	1	Or	Common cold		
				Bl	7	Or	Bad mouth smell		
Aloe elegans Tod.	Aloaceae	**Ere**	H	Lx	6	Dm	Eye disease	-	HH22
				R	4	Or	Diabetes		
Anogeissus leiocarpa (DC.)Guill. & Perr.	Combretaceae	**Hanse**	T	L	7	Or	Diarrhea/abdominal disease	-Fodder	HH35

				R	4	Or	Pneumonia	-Material culture	
Azadirachta indica A. Juss.	Meliaceae	**Niem**	T	L	4	Na	Leech infestation	-	HH44
				L	4	Na	Ear diseases		
Brassica nigra (L.) Koch	Brassicaceae	**Hamli-Adri**	H	L	7	Or	Abdominal diseases	-Food	HH75
				F	7	Or	Hea ache		
Boswellia papyrifera (Del.) Hochst.	Burseraceae	**Meker**	T	S	9	Dm	Abdominal diseases	-	HH8
				Lx	9	Na	Evil sprit		
Buddleja polystachya Fresen.	Loganiaceae	**Metere**	T	Yt	2	Dm	Headache or migraine	-Firewood	HH34
Calpurnia aurea (Alt.) Benth.	Fabaceae	**Hintsawutsi**	S	S	9	Dm	Anti-insect bite	-Firewood	HH54
				L	4	Or	Abdominal pain		
Calotropis procera (Ait.)	Asclepiadaceae	**Gindae**	H	L	12	Dm	Snake / scorpion bite	-	HH79
				S	6	Ts	Tooth disease		
				S	6	Or	Hemorrhoids		
Capparis tomentosa Lam.	Capparidaceae	**Andiel**	S	R	1	Or	Common cold	-	HH83
				B	11	Dm	wound		
				R		Or	Tooth disease		
				R	9	Dm	Evil sprit		
Capsicum annuum L.	Solanaceae	**Berbere**	H	L	2	Dm	Tinea versicolor		HH57
Carissa spinarum L.	Apocynaceae	**Agam**	S	S	9	Dm	Evil eye	-Food	HH37
				R	8	Or	Tooth ache	-Firewood	
Citrus aurantiifolia (Christm.) Swingle	Rutaceae	**Lemin**	S	F	2	Na	Cough	-	HH5
				F	2	Na	Headache		
				F	6	Dm	Tetanus		
				F	5	Or	Blood pressure		
				R	7	Or	Insect bite		
Cissus petiolata Hook. f.	Vitaceae	**Alke**	WC	S	12	Dm	Anti-Evil	-	HH33

				S	12	Dm	Epilepsy		
Clerodendrum myricoides (Hochst.) Vatke	Lamiaceae	**Surbetri**	S	S	12	Dm	Sprain	-	HH9
				R	9	Dm	Epilepsy		
Coffea arabica L.	Rubiaceae	**Buna**	S	Sd	10	Or	Amoebiasis	-	HH40
				Sd	4	Or	Head ache		
				Sd	4	Or	Blood pressure		
Combretum adenogonium Steud. ex A. Rich.	Combretaceae	**Weyba**	T	B	1	Or	Diarrhea	- Firewood	HH53
				L	6	Dm	Jaundice	-Wood materials	
				B	6	Op	Eye blinking jaundice		
Cordia africana Lam.	Boraginaceae	**Awhi**	T	L	10	Dm	Fever	-Furniture -Food	HH65
Croton macrostachyus Hochst. ex Delile	Euphorbiaceae	**Tamboque**	T	R	10	Or	Indigestion	-Firewood	HH69
				R	4	Or	Rabbis	-Material	
				B	1	Or	Tapeworm infestation	culture -	
				SD	6	Au	ear problems		
Cucurbita pepo L.	Cucurbitaceae	**Duba**	H	Sd	7	Or	Tapeworm	-Food	HH82
				F	10	Or	Urine retention		
Cynoglossum lanceolatum Forssk.	Boraginaceae	**Teneg**	H	L	11	Dm	Wound/injured body		
Datura stramonium L.	Solanaceae	**Mezerba'e**	H	L	11	Dm	Tetanus		HH10
				L	4	Or	Abdominal cramp		
				L	11	Dm	Leishmaniosis		
				L/F	4	Or	Intelligence		
Dichrostachys cinerea (L)	Fabaceae	**Gonok**	S	S	12	Dm	Dislocated bone	-Fence	HH42
Dodonaea angustifolia L.	Sapindaceae	**Tahsos**	S	L	11	Dm	Herpes zoster	-Firewood,	HH76
				L	11	Dm	Wound	-Material culture	
				S	6	Dm	Warts		

Echinops macrochaetus Fresen.	Asteraceae	**Dander**	H	R	2	Dm	Headache	-Fence	HH80
Erythrina abyssinica Lam. ex DC.	Fabaceae	**Zwawue**	T	B	9	Na	Evil eye	-	HH11
				L	11	Dm	Tenia versicolor / mada		
Eucalyptus camaldulensis Dehnh.	Myrtaceae	**Kelamitos**	T	L	9	Na	Evil eye	-Firewood, -fence	HH46
Euphorbia abyssinica Gmel.	Euphorbiaceae	**Kolankul**	T	Lx	6	Or	coughs	-Fence	HH14
				Lx	6	Or	Tuberculosis		
				lx	6	Or	Gonorrhea		
Euclea racemosa subsp. schimperi	Ebenaceae	**Kuleo**	S	R	4	Or	Scorpion bite	-Firewood	HH16
				S	3	Dm	Rheumatism / joint pain		
Eulophia streptopetala Lindl.	Orchidaceae	**Shingurti-zibie**	H	Bl	12	Dm	Elephantiasis		HH12
				WP	3	Dm	Evil eye		
Euphorbia tirucalli L.	Euphorbiaceae	**Kinchib**	T	Lx	6	Dm	Skin disease/warts	-Firewood	HH47
Flueggea virosa (Willd.) Voigt.	Euphorbiaceae	**Harmazo**	S	Yt	2	Dm	Sprain	-Fruit is edible	HH2
Foeniculum vulgare Mill	Apiaceae	**Shilyan**	H	F	5	Or	Kidney sandstone	-For smelling	HH13
				F	5	Or	Urine retention		
				S	8	Ts	Mouth bad smell		
Gardenia ternifolia Schumach. & Thonn.,	Rubiaceae	**Hatsinay**	S	S	12	Dm	Sprain	-Firewood	HH48
				R	10	Or	Malaria		
				R	10	Or	Energy loss		
				L	7	Or	Abdominal cramp		
Grewia ferruginea Hochst. ex A. Rich.	Tiliaceae	**Tsumkuya**	T	R	6	Dm	Hemorrhoids	-Food	HH81
				L	7	Or	Abdominal disease		
				L	2	Dm	Fire burn		
	Oleaceae	**Habitselim**	S	L	7	Or	Tape worm	-Firewood	HH51

Jasminum abyssinicum Hochest. ex DC.				L	8	Or	Vomiting		
				L	8	Or	Abdominal disease/Nausea		
				L	5	Or	Ascariasis		
Justicia schimperiana (Hochst. ex. A.Nees) T. Anders	Acanthaceae	**Simieza**	S	L	5	Or	Ascariasis	-Fodder	HH66
Kleinia grantii (Oliv. & Hiern) Hook. f.	Asteraceae	**Bierir**	H	L	11	D	Swelling		HH27
				WP	9	Na	Evil eye/ evil spirit		
Lagenaria siceraria (Molina)	Cucurbitaceae	**Amham**	H	F	9	Na	Influenza	-Furniture	HH1
				L	6	Dm	Dandruff		
Lantana camara var. alba	Verbenaceae	**Alalimo**	H	L	2	Dm	Scabies	-	HH26
				L	6	Dm	Fresh wound		
Leucas martinicensis (Jacq.) R. Br.	Lamiaceae	**Karsa-karsa**	H	WP	2	Dm	Tumor	-	HH61
Linum usitatissimum L.	Linaceae	**Entatie**	H	F	11	Or	Abdominal desiccation	-	HH15
Lippia adoensis Hochst. ex Walp.	Verbenaceae	**Kosoeret**	S	L	2	Dm	Body swelling	-	HH49
Maytenus arbutifolia (A. Rich.)	Celastraceae	**Atat**	S	L	12	Dm	Sprain	-Fence	HH50
Maytenus senegalensis (Lam.) Exell	Celastraceae	**Argudi**	S	R	4	Or	Irregular / excessive menstruation	-Fence	HH3
Mentha longifolia L.	Lamiaceae	**Setisemhal**	H	L	2	Na	Headache	-Source of income	HH28
Moringa stenopetala (Bak. f.) Cuf	Moringaceae	**Moringa**	H	L	7	Or	Diabetes mellitus	-Food	HH39
				L	5	Or	Blood pressure	-Source of income	
				L	5	Or	Diarrhea		
				F	11	Dm	Pimple / cosmetics		
Olea europaea subsp. cuspidata	Oleaceae	**Awulie**	T	B	9	Na	Bronchitis/tonsil	-Firewood	HH55
				R	8	Or	Toothache	-Furniture	

				L	10	Or	Asthma		
Ocimum basilicum L.	Lamiaceae	**Seseg/rihan**	H	WP	2	Dm	Swelling	-	HH36
Ocimum lamiifolium Hochst. ex Benth.	Lamiaceae	**Demakese**	H	L	2	Dm	Fever	-	HH58
				L	5	Or	Febrile illness (michi)		
Opuntia ficus-indica (L.) Miller	Cactaceae	**Beles**	S	L	6	Dm	Tenia versicolor	-Food -Fodder	HH7
Ormocarpum pubescensm (Hochst.) Cuf. ex Gillett	Fabaceae	**Alendia**	S	S	2	Dm	Ligament/joint disease	-Firewood -Fence	HH64
Otostegia integrifolia Benth.	Lamiaceae	**Chiendog**	S	L	5	Or	Blood pressure	-	HH74
				R	9	Na	Pneumonia		
Persea Americana Mill.	Lauraceae	**Avocado**	T	F	7	Or	Malaria	-Food	HH78
Phytolacca dodecandra L'Her.	Phytolaccaceae	**Shibti**	WC	F	4	Or	Rabies	-For washing cloth	HH19
				L	11	Dm	Warts		
				F	6	Or	Abortion		
				L	7	Or	Children's TB		
Piliostigma thonningii (Schumach.)	Fabaceae	**Amamgimel**	T	S	12	Dm	Broken bone	-	HH70
				L	12	Dm	Wound		
Plumbago zeylanica L.	Plumbaginaceae	**Aftuh**	H	R	7	Or	Tooth infection,	-Fodder	HH71
				L	4	Or	Stomach pain / diarrhea		
				L	2	Dm	skin swelling		
				L	12	Dm	Ear problems		
				WP	12	Dm	Evil sprit		
Otostegia fruticosa (Forssk.) Schweinf.ex Penzig	Lamiaceae	**Sasa**	S	L	4	Or	Ascariasis	-	HH38
Rhamnus prinoides L'Herit.	Rhamnaceae	**Gesho**	S	L	6	Dm	Dandruff	-For making 'Tela"	HH59
				L	1	Or	Tonsil		

Rhus retinorrhoea Oliv.	Anacardiaceae	**Tetealo**	S	R	4	Or	Anti-abortion of women	-Food	HH17
Ricinus communis L.	Euphorbiaceae	**Guile**	S	Lx	6	Dm	Hemorrhoids	-Fruit is for backing, -Firewood	HH24
				Lx	6	Dm	Wounds		
				F	6	Dm	dandruff		
				Sd	5	Or	Giardiasis / Amoebiasis		
				Sd	11	Dm	Dandruff		
Rumex abyssinicus Jacq.	Polygonaceae	**Mokmoko**	H	R	5	Or	Vomiting	- Eaten as spice	HH45
				R	5	Or	TB		
				R	8	Or	Tooth disease		
Rumex nervosus Vahl.	Polygonaceae	**Machicho / hahot**	S	L	11	Dm	Herpes zoster	-food	HV52
				S	10	Or	Gastritis		
Ruta chalepensis L.	Rutaceae	**Chena-adam**	H	L	2	Na	Evil spirit/ Evil eye	-	HH73
				L	1	Or	Headache		
				L	1	Or	Fever		
				L	1	Or	Common cold		
Schinus molle L	Anacardiaceae	**Tikurberbere**	T	L	1	Or	Digestion problem	-Firewood, -Furniture	HH4
				L	9	Op	Eye infection		
Senna singueana (Delile) Lock	Fabaceae	**Hambohambo**	S	S		Dm	Pesticide	-Firewood	HH32
				R	8	Or	Jaundice		
Sida rhombifolia L.	Malvaceae	**Dekidaero**	H	R	9	Na	Epilepsy	-	HH56
				WP	12	Dm	Anti-swelling		
Solanum incanum L.	Solanaceae	**Engule**	H	R	10	Or	Stomach pain		HH77
				R	6	Op	Eye infection		
				R	8	Or	Tooth disease		
Stereospermum kunthianum Cham	Bignoniaceae	**Adgizana**	T	B	12	Dm	Dislocated backbone	-Firewood	HH31
				S	12	Dm	Broken limb		

				L	11	Dm	Bleeding wound		
Tagetes minuta L.	Asteraceae	**Etsefarus**	H	WP	9	Na	Evil eye	-	HH18
Tragia cinerea (Pax) Gilbert & Radcl.-Smith	Euphorbiaceae	**Ame'e**	H		2	Dm	Tinea versicolor	-	HH20
Verbascum stelurum Murb.	Scrophulariaceae	**Tirnaka**	H	L	11	Dm	Bleeding	-Firewood	HH72
				L	9	Op	eye disease		
				L	11	Dm	Fire burn		
Withania somnifera (L.) Dunal	Solanaceae	**Agol**	H	L	2	Dm	Swelling	-	HH60
				L	3	Dm	Itch infection		
				aF&L	9	Na	Eye disease		
Ximenia americana L.	Olacaceae	**Muleo**	S	L	4	Or	Vomiting	-Food	HH21
				B	1	Or	Malaria	-Source of income	
				B	11	Dm	Wound		
Zehneria scabra (L.f.) Sond	Cucurbitaceae	**Hafaflo**	C	R	4	Or	Abdominal disease/Diarrhea	-	HH30
				F	10	Or	Food poisoned infections		
				R	10	Or	Tuberculosis		
Zingiber officinale Rosc.	Zingiberaceae	**Gingibl**	T	Rz	4	Or	Blood pressure		
				Rz	1	Or	Common cold		
				Rz	5	Or	Abdominal cramp/disease		
Ziziphus spina-christi L.	Rhamnaceae	**Gaba**	T	B		Or	Abdominal pain	-Food	HH23
				L		Dm	Dandruff	-Source of income	

Key: Scientific name; local name; family; growth form: T = tree, S = shrub, H= herb; PU = plant part used: L = leaf, S = stem, R = root, B = bark, WP = Whole plant, F= fruit, Sd = seed, Rh = Rhizome, Bl = Bulb, Yt =Young twig, Lx = latex; MRPA = mode of remedy preparation and application: 1 = Boil and drink the decoction up on cooling, 2 = Squeeze or sniff the freshly crushed part, 3 = Add chopped plant part(s) to bath water and do bath, 4= Crushing and mix with cold water then drink;, 5=Drink as herbal tea, 6 = Rubbing/pasting the latex/sap//juice directly, 7 = Eat the plant part (raw/cooked), 8 = chewing/hold with teeth, 9 = Burn or boil the plant part and fumigation, 10 = Drink the concoction, 11 = Grind and painting the powder or crushed part, 12 = tie the crushed or plant part; RA = route of remedy administration: Or = oral, Au = auricular, Na = nasal, Dm = dermal, Op = optical, Ts = Tooth surface; Voucher umber: HH= Herbals for human

Table 4. List of plant species and methods of preparation to treat Livestock ailments

Scientific name	Family	Local name	Habit	PU	MRPA	RA	Disease treated	Other uses	Voucher Number
Acacia venosa Hochst. ex Benth.	Fabaceae	**Kentib**	S	S	6	Dm	Dislocated bone	Fence	HA1
Anogeissus leiocarpa (DC.) Guill. & Perr.	Combretaceae	**Hanse**	T	R	1	Or	Anthrax	Fodder Material culture Firewood	HA2
Azadirachta indica A. Juss.	Meliaceae	**Niem**	T	L	1	Or	Anthrax		HA3
				L	1	Or	Diarrhea of hens		
Boswellia papyrifera (Del.) Hochst.	Burseraceae	**Meker**	T	S	2	Dm	Snake repelling		HA4
Buddleja polystachya Fresen.	Scrophulariaceae	**Metere**	T	Yt	4	Dm	Skin disease	Firewood Fodder	HA5
				Yt	4	Dm	Animal wound		
Calotropis procera (Ait.)	Asclepiadaceae	**Gindae**	S	R	3	Na	Snake repelling		HA6
Capparis tomentosa Lam.	Capparidaceae	**Andiel**	S	B	5	Dm	Wound		HA7
Calpurnia aurea (Alt.) Benth.	Fabaceae	**Hitsawutsi**	S	L	2	Dm	Skin disease		HA8
Cissus petiolate Hook. f.	Vitaceae	**Alkie**	WC	S/L	2	Dm	Skin disease		HA9
				L	4	Or	Swelling		
Citrus aurantiifolia (Christm.) Swingle	Rutaceae	**Lemin**	S	F	2	Dm	Animal's ectoparasites		HA10
Croton macrostachyus Del.	Euphorbiaceae	**Tamboque**	T	S/B	2	Dm	Animal's, Ectoparasite	Firewood Material culture	HA11
Datura stramonium L.	Solanaceae	**Mezerbae**	H	L	4	Dm	Skin disease		HA12
Dodonaea angustifolia L. f.	Sapindaceae	**Tahsos**	S	L	4	Dm	Wound	Firewood, Material culture	HA13
Echinops macrochaetus Fresen.	Asteraceae	**Dender**	H	R	6	Dm	Bone distortion	Fence	HA14

Flueggea virosa subsp	Euphorbiaceae	**Harmazo**	S	R	8	Or	Rabbis infected animal	Food	HA15
Grewia ferruginea Hochst	Tiliaceae	**Tsumkuya**	S	L	1	Or	Leech infection	Firewood	HA16
Justicia schimperiana (Hochst. ex. A.Nees) T. Anders	Acanthaceae	**Simieza**	S	R	6	Dm	Blackleg / cattle limp disease	Fodder	HA17
Nicotiana tabacum L.	Solanaceae	**Timbuaqua**	H	L	1	Na	Leech infection		HA18
				L	4	Dm	Skin parasites / Ectoparasites		
Phytolacca dodecandra L'Her	Phytolaccaceae	**Shibti**	WC	S	5	Na	Leech infection	For washing cloth	HA19
				F	5	Dm	Ectoparasite		
				R	4	Or	Rabbis		
Plumbago zeylanica L.	Plumbaginaceae	**Aftuh**	H	L	7	Or	Anthrax, to cure cattle with bloody milk	Fodder	HA20
				L	3	Dm			
Premna oligotricha L.	Lamiaceae	**Sasa**	S	L	3	Or	Cattle's thin down		HA21
Senna singueana (Delile) Lock	Fabaceae	**Hambahambo**	S	L	1	Or	Abdominal cramp	Firewood	HA22
				L	3	Dm	Abdominal swelling		
Solanum incanum L.	Solanaceae	**Engule**	H	F	1	Na	Cattle cough		HA23
				R	1	Or	Goat cough		
Stereospermum kunthianum Cham	Bignoniaceae	**Adgizana**	T	B	5	Dm	Wound	Firewood	HA24
Tragia cinerea (Pax) Gilbert & Radcl.-Smith	Euphorbiaceae	**Ami'e**	H	L	3	Dm	Bleeding		HA25
Ximenia americana L.	Olacaceae	**Mileo**	S	L	1	Na	Leech infection	Food	HA26
				B	5	Dm	wound	Source of income	
Zehneria scabra (L.f.) Sond	Cucurbitaceae	**Hafaflo**	H	R	5	Op	Eye infection	Fodder	HA27

Key :Habit: H= herb, T= tree, S= shrub, C= climber and WC= woody climber; PU=plant part used: L=leaf, S=stem, R=root, B= bark, F= fruit, Sd= seed, Yt=Young twig, Lx=latex; MRPA= mode of remedy preparation and application; 1 = crushing and mix with cold water then drink, 2 = Burn or boil the plant part and inhale its smoke, 3 = Squeeze or sniff the freshly crushed part, 4 = Rub/paste the latex/sap/juice directly, 5 = Grinding and painting the powder or crushed part, 6 = Tie the crushed or plant part, 7 = Eat the plant part, 8 = Drink the concoction; RA=route of remedy administration (Or=oral, Na=nasal, Dm=dermal, Op=optical; Voucher Number: HA= Herbals for Animal

The most preferred medicinal plants to treat human ailments

According to the preference ranking (Table 6) implemented by 10 key informants on medicinal plant species that were reported to be used against abdominal disease (the frequently cited human disease in the study area) revealed that *Zehneria scabra* (L.f.) Sond*, Plumbago zeylanica* L. and *Zingiber officinale* Roscoe were the most preferred species in the study area.

Table 5. Plants prescribed for ≥ 5 diseases in the study area

Species	Number of Diseases treated	Diseased treated
Adansonia digitata L.	6	Insect bite, Drink appetite, Infant fever, stomachache, Infant diarrhea, Backbone ache
Citrus aurantiifolia (Christm.) Swingle	5	Cough, Headache, Tetanus, Blood pressure, Insect bite
Phytolacca dodecandra L'Her.	6	Rabies, warts, Abortion, children's TB, Leech infection, Exo-parasite
Plumbago zeylanica L.	5	Tooth infection, stomach pain/diarrhea, skin swelling, ear problems, Evil sprit
Ricinus communis L.	5	Hemorrhoids, Wounds, dandruff, Giardiasis, amoebiasis

Table 6. Results of preference ranking of ten medicinal plants reported for treating abdominal disease (human ailments)

Medicinal plant	Informants labeled A to J										Total Score	Rank
	A	B	C	D	E	F	G	H	I	J		
Zehneria scabra (L.f.) Sond	7	3	8	8	10	7	9	10	10	10	82	1st
Plumbago zeylanica L.	9	2	9	7	4	10	10	9	9	8	77	2nd
Zingiber officinale Roscoe	2	1	6	1	9	3	5	5	5	1	72	3rd
Allium sativum L.	10	8	7	6	3	9	8	4	8	9	57	4th
Calpurnia aurea (Ait.) Benth.	8	4	10	4	6	6	3	8	2	6	53	5th
Datura stramonium L.	5	7	2	9	2	4	7	6	6	5	47	6th
Boswellia papyrifera (Del.) Hochst.	6	9	1	10	1	8	2	7	1	2	45	7th
Anogeissus leiocarpa (DC.) Guill. & Perr.	1	5	4	5	5	5	4	2	7	7	42	8th
Jasminum abyssinicum Hochst. ex DC.	4	6	3	2	8	2	6	3	4	4	38	9th
Gardenia ternifolia Schumach. & Thonn.	3	10	5	3	7	1	1	1	3	3	37	10th

Other uses of medicinal plants

The majority of the medicinal plant species used to treat both human and livestock disease were cited for one or more other uses in addition to the medicinal role. The proportion of medicinal plant species over different use categories is summarized in Figure 4.

Source and transfer of indigenous knowledge on medicinal plants

About seven sources of indigenous knowledge on medicinal plants were reported. Out of these, parents and grandparents were the main sources. The majority (> 80 %) of the informants reported that the indigenous knowledge is transferred through oral secrecy from parents to one of the family member that fulfills their criteria. The remaining of them responded that parents and traditional healers transfer their knowledge either to their friends or to neighbors secretly.

Threats to medicinal plants and indigenous knowledge

The respondents in the study area distinguished more than two threats for the medicinal plants. Out of the eight recorded threats, the highest reported threats were overgrazing/ browsing, deforestation and expansion of agriculture, accounting for 20%,

19.1% and 17.3% respectively. The remaining reported threats were over-harvesting by humans (11.9%), lack of knowledge on the use and management (10.1%), drought (9.3%), firewood collection (6.9%) and charcoal production (5.4%).

For the purpose of identification of plants that need conservation priority, ten key informants were requested to identify and rank seven threatened medicinal plant species with multipurpose uses in the study area. Accordingly, *Dodonaea angustifolia* L.f., *Boswellia papyrifera* (Del.) Hochst. and *Gardenia ternifolia* Schumach. & Thonn were found the most threatened species (Table 7).

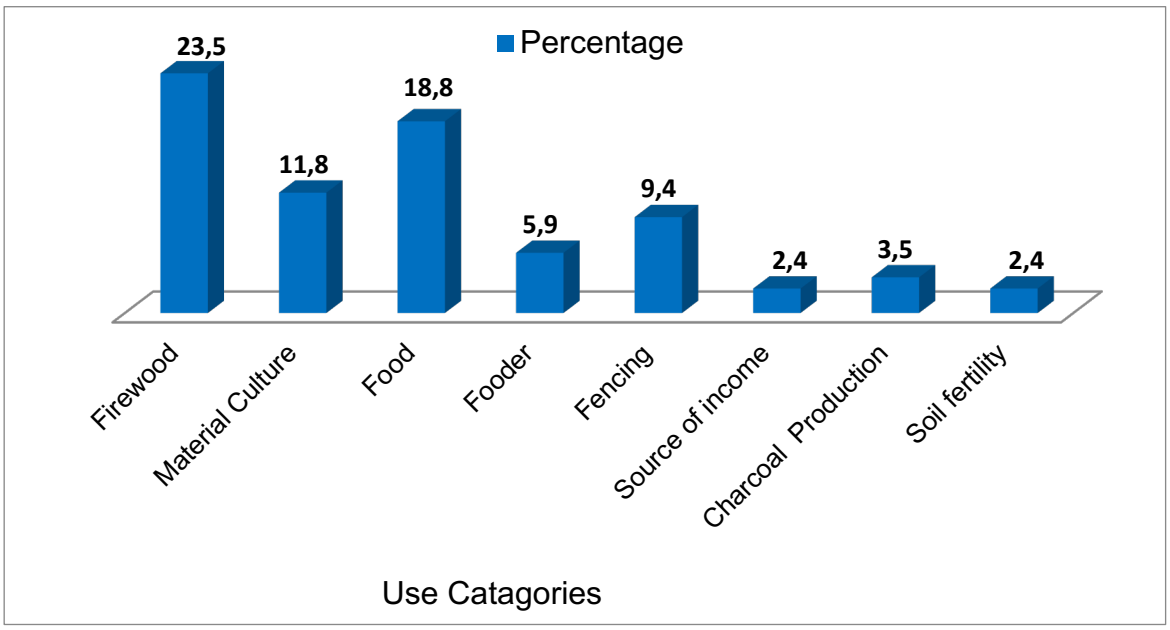

Figure 4. Other uses of medicinal plants in the study area

Table 7. Ranking of threatened medicinal plant species

Medicinal plant	Informants labeled A to J										Total Score	Rank
	A	B	C	D	E	F	G	H	I	J		
Dodonaea angustifolia L. f.	7	6	5	5	5	7	7	6	6	7	61	1st
Boswellia papyrifera (Del.) Hochst.	5	5	6	6	7	5	5	5	7	6	57	2nd
Gardenia ternifolia Schumach. & Thonn	6	2	7	7	4	6	6	7	4	5	54	3rd
Piliostigma thonningii (Schumach.) Milne-Redh.	4	7	4	4	6	4	4	4	5	4	46	4th
Olea europaea subsp. *cuspidata*	3	3	2	2	3	3	1	3	3	3	26	5th
Adansonia digitata L.	2	4	1	1	2	1	3	1	2	2	19	6th
Clerodendrum myricoides (Hochst.) Vatke	1	1	3	3	1	2	1	2	1	1	15	7th

Management and conservation of medicinal plants by the local people

About six management and conservation techniques were reported from all respondents in the study area. Of these, homegardening was among the highly used management technique cited by 24.2% of the respondents followed by fencing (20.9%), replanting (17%), education (13.1%), efficient use (9.9%) and using alternative energy (8.4%). Few numbers 22(6.5%) of respondents had no idea regarding the conservation methods of the medicinal plants.

Informant consensus on medicinal plants treating human ailments

Medicinal plants that are effective in treating certain diseases and well known by community members also have higher informant consensus factor values. The 71 human diseases identified in the study area were grouped into 12 disease categories. As indicated in Table 8, the abdominal complaints related disease has the highest informant consensus value (0.95) whereas the category of diabetes and blood pressure scored the least informant consensus value (0.86).

Table 8. ICF values of traditional medicinal plants used for treating human ailments (ICF = informant consensus factor, n_{ur} = Number of use citation to each disease, category n_t = number of species used)

Diseases category	n_t	n_{ur}	ICF	Rank
Abdominal complaints related disease	12	206	0.95	1
Skeletal, Bone disease, dental problem	7	98	0.94	2
Evil spirit, evil eye	8	120	0.94	2
Wound, External injuries/Sprain	8	119	0.94	2
Insect and snake bite	8	110	0.93	5
Problems of the respiratory system	9	114	0.93	5
Skin diseases, Ectoparasite	10	133	0.93	5
Eye disease	5	60	0.93	8
Headache	5	54	0.92	9
Fever, appetite loss, digestion problems	7	70	0.91	10
Elephantiasis, body swelling	7	48	0.87	11
Diabetes, blood pressure	4	23	0.86	12

Informant consensus of medicinal plants treating livestock ailments

The identified 16 livestock diseases were grouped into five major categories which were treated by the local medicinal plants in the study area (Table 9). The categories of dermal/skin disease and ectoparasite had the highest informant consensus factor value (0.89) while the category of swelling/ Tumor scored the least ICF value (0.83).

Table 9. ICF values of traditional medicinal plants used for treating livestock ailments (ICF = informant consensus factor, n_{ur} = Number of use citation each disease, category n_t = number of times species used)

Diseases category	Nt	Nur	ICF	Rank
Dermal/skin disease and Ectoparasite	10	85	0.89	1st
Wound	9	70	0.88	2nd
Problems of the Respiratory System	7	48	0.87	3rd
Leech infection	5	28	0.85	4th
Swelling/ Tumor	4	19	0.83	5th

Distribution of indigenous knowledge on medicinal plants among the informants

There was a significant difference (P< 0.05) in the number of medicinal plants reported by age groups of 18-40 (young age groups) and > 40 years (Elder age group), illiterate and literate informants, single and married informants, general and key informants. High average numbers of medicinal plants were reported by elders than younger age groups, illiterate than literate and key informants than general informants. Although there was no significant difference (P > 0.05) in the number of medicinal plants reported by men and women as well as Orthodox Christian and Muslims, high numbers of medicinal plants were reported by men than women and Orthodox Christian followers than Muslims (Table 10).

Table 10. Statistical test of significance, t-test, on the average number of reported medicinal plants among different informant groups (*Significant difference (p<0.05)

Parameters	Informant group	Number	Average ± SD	t-Value	P-value
Gender	Male	176	1.57 ± 0.5	2.9	0.15
	Female	169	1.38± 0.49		
Age	Youngster (18-40 years)	120	1.48± 0.50	-7.36	0.00*
	Elder (> 40 years)	215	1.89±0.32		
Educational status	Illiterate	256	1.52± 0.50	7.6	0.00*
	Literate	79	1.1 ±0.30		
Marital status	Single	112	1.52 ±0.50	-7.2	0.00*
	Married	223	1.91± 0.28		
Religion	Orthodox	307	1.24± 0.41	-2.3	0.22
	Muslim	28	1.14± 0.35		
Informants	General	317	1.0± 0.00	4.37	0.00*
	Key	18	1.16± 0.36		

Discussion

Ethnomedicinal plant Species

The ethnomedicinal study result showed that there are 85 medicinal plants used to treat various ailments. This indicates people in the study area have a tradition of using diverse plants as herbal medicine for themselves and their livestock. Cultural acceptability, ease of accessibility and less cost could be the factor to rely on traditional medicine (Lulekal 2014). The number of medicinal plants species recorded in the study area was significantly higher than to those reported elsewhere in Ethiopia such as in Aba'ala district (58 species; Meragiaw 2016), Asgede Tsimbila districts (68 species; Zenebe *et al*. 2012), Gemad district (31 species; Mesfin *et al.* 2013), in and Around Alamata (16 species; Yirga 2010). However, it was less as compared to studies conducted in Ankober (151 species; Lulekal 2014), Central Zone of Tigray (129 species; Abrha *et al*. 2018), Kilte Awlaelo (114 species; Teklay *et al.* 2013), South Omo (91 species; Tolossa *et al.* 2013). The variation in the number of reported medicinal plants of the study area with other parts of the country, possibly associated with cultural use and perception difference among the study communities (Akhagba 2017; Masika & Afolayan 2003) as well as the variations of plant uses among different groups (Avocèvou-Ayisso 2011, Teka 2020). The families Fabaceae, Lamiaceae, Euphorbiaceae and Solanaceae comprise a high number of medicinal species in the study area. These families are also with higher numbers of species that have wide geographical and habitat distribution in Ethiopia (Tadesse 2004). Of the 68 medicinal plant species reported by Zenebe *et al.* (2012) in Asgede Tsimbila, 40 (58.8%) of them were also used to treat human and livestock diseases in the present study area. This is because the selected Kebeles were in the vicinity of the present study area. This implies people found in a close locality or similar geographical location possibly have a similar culture in using medicinal plants (Ososki *et al*. 2007) and often exchange information on the most important plants and use similar herbal plants (Teka 2020).

Herbs were the most prominent (40%) growth forms of medicinal plant species followed by shrubs (35.3%) reported to cure both human and livestock disease via the local communities. This might be related with easily accessible herbs in the vicinity of the community and shrubs are dominant woody species in the study area. This result concurred with other studies conducted in Ethiopia by Beyene (2015), Dalle *et al*. (2005), Giday *et al*. (2003). Regarding the source of the medicinal plant species, wild environments yielded more medicinal plant species (62 species, 72.9%) than cultivated fields and fallow land (23 species, 17.1%). This implies the natural vegetation patches, or the wild environments have a great role in harboring various medicinal plant species that support community health care. This is due to the fact that wild plants are abundant, grown freely with no human interference in relative to those grown in/around agricultural areas and human dwellings. Related findings were reported elsewhere in Ethiopia by Asfaw (1997), Awas & Demissew (2009), Beltran *et al.* (2014), Giday *et al.* (2009), Lulekal *et al.* (2013).

Out of the reported 12 plant parts used for remedial preparation to treat the human and livestock illness, leaves were the foremost (34.9%) followed by roots. The higher usage of leaves to prepare remedy from plants is due to their abundance, simplicity to collect and ease of their application (Abebe & Hagos 1991). Roots were the other plant parts frequently used to prepare a remedy by the local community. This was due to the fact that roots are hidden in the soil for a long time and not exposed to herbivores but available for the practitioners whenever they desire it, even during the long dry season especially in drylands like the present study area. Studies conducted in other parts of Ethiopia by different researchers such as Giday *et al*. (2009), and by Alemayehu *et al*. (2015) reported similar results.

Rubbing/pasting the latex/sap/flesh/juice directly, crush and mix with cold water then drink and burn or boil the plant part and inhaling its smoke were among the common remedy preparations and applications which accounted for 45% of the total. The mode of remedy preparation and application are managed according to the type of ailment, which they identify with reference to symptoms observed either on humans or livestock. Abebe (2011), Getaneh Girma (2014), Mesfin *et al*. (2013) reported comparable ethnobotanical study results. The majority of the remedy preparation was in fresh form, which was consistent with other studies indicated by Bussmann and Sharon (2006), Lulekal *et al*. (2013), Yineger *et al*. (2007). The preferences of the fresh part of the medicinal plant probably relates to the expected potency to capture volatile substances that determine the therapeutic efficacy of herbal preparations (Addis *et al*. 2001).

The routes of administrations for remedies used against different human ailments in traditional health care systems were mostly (45.7%) implemented internally through oral application. This was related to the fact that the most frequent ailment in the study area was abdominal diseases, thus medication is prescribed to ingest the herbal medicine. Regarding the route of remedy admirations for livestock ailments, the majority of them (dermal, 54.1%) were implemented externally. This was associated with the frequently occurred external diseases in the study area including skin diseases, wounds and

ectoparasites. Similar findings were reported in different parts of the country (Abebe 1986, Giday & Teklehaymanot, 2013, Mesfin *et al*. 2009, Teklay *et al*. 2013, Yineger *et al.* 2008).

There were unstandardized and inconsistent doses of herbal preparations reported by traditional healers for any of the preparations used to treat human and livestock ailments in the study area. This attributes the variations in perception and culture of utilization among healers of the study area. The variation in quantity and unit of measurement was also noted in a study conducted elsewhere in Ethiopia (Teklay *et al*. 2013). Though no adverse side effects were reported, unstandardized and unprescribed doses of herbal medicine could lead to serious health problems in patients (Abbiw 1996, Hillenbrand 2006). Lack of side effect reporting could relate to the fact that the healers are orienting for their user clients to keep the secret about the medicine since their livelihoods depend on the selling of remedies. Consequently, neither the healers nor the users were voluntary to state the side effects of these medicinal plants. However, respondents reported that honey, water, milk and butter were the commonly used antidotes for herbal preparations in case they feel pains and for these species with adverse effects. This finding is consistent with reports elsewhere in the country (Lulekal 2014).

About 80% of the reported medicinal plants have more than one role (multipurpose) and 20% of them were used only for medicinal value. There are eight other use types of medicinal plants stated by the local communities. Of these firewood (23.5%), food (18.8%), material culture (11.8%) and fencing (9.4%) were among the frequently stated other use types. Medicinal plants have different uses both in rural and urban areas (Bye & Linares 1983). In the study area *Dodonaea angustifolia* L. f., *Boswellia papyrifera (*Del.) Hochst. and *Gardenia ternifolia* Schumach. & Thonn were among the most threatened species. The multiple uses of these species could fall them under high exploitation pressure. As a result, these species were found in seldom (even inside the Hirmi woodland vegetation) and restricted to some sites of the study area. Other studies conducted in Ethiopia (Beltran *et al*. 2014, Lulekal *et al*. 2013, Yineger *et al*. 2007) also showed that medicinal plants were exploited for non-medicinal value than medicinal purposes. Unless sustainable conservation practices are conducted by prioritizing the most important use value of these plants, there will be a high probability of extinction from the long-term uses.

Humans and livestock ailments treated with medicinal plants

The documented 71 human and 16 livestock ailments were treated by 85 medicinal plants. About 85 medicinal plants were used to treat 82 various human and livestock ailments in Erob and Gulomahda (Beyene 2015) and 68 ailments in Gimbi district (Tolasa 2007) which is less than the present findings. The culture and perceptions toward the medicinal plant utilization varies from one area to the other area (Masika & Afolayan 2003). Some medicinal plant species in the study area including *Adansonia digitata* L.*, Citrus aurantiifolia* (Christm.) Swingle, *Phytolacca dodecandra* L'Her., *Plumbago zeylanica* L. and *Ricinus communis* L. were used to treat a large number (≥ 5) human and livestock ailments. This indicates that some human and livestock ailments have an opportunity to be treated by more plant species in the study area.

Of the reported human illness, abdominal diseases were treated using a high number (12) of medicinal plants. This might be to encounter for the frequently revealed abdominal diseases in the study area. Regarding the livestock ailments, skin diseases were treated via a high number of medicinal plants (7 species) prescriptions. This was associated with the high prevalence of skin diseases reported in the study area. *Phytolacca dodecandra* L'Her., *Cissus petiolate* Hook. f. and *Nicotiana tabacum* L. were among the species used to treat the highest number of livestock ailments. These medicinal plants used to treat various livestock ailments were also mentioned in the study conducted by Abrha *et al.* (2018), Gebrehiwot (2010), Zenebe *et al*. (2012).

Based on the preference ranking done by the selected key informants, *Zehneria scabra* (L.f.) Sond*, Plumbago zeylanica* L. and *Zingiber officinale* Roscoe were the most preferred human medicinal plant species to treat abdominal diseases, which was among the highly cited ailment by the informants in the area. The most favored species to treat a particular disease reflects its high efficacy in the study area. This finding was fairly in line with a study conducted by Zenebe *et al*. (2012) in Asgede Tsimbila District, Northern Ethiopia.

Healing potential and ranking of medicinal plants

The overall informant consensus was found to be high (0.86-0.95) which indicates the participants seem to have similar perceptions and knowledge on the nominated medicinal taxa. On the other hand, high informant consensus implies, few 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 the category of disease (Canales *et al*. 2005). Of the human disease categories, the highest informant consensus value (0.95) was scored for the abdominal complaints related disease whereas the least informant consensus value (0.86) was scored for diabetes and blood pressure disease category.

Concerning the livestock disease, the category of dermal/skin disease and ectoparasite had the highest informant consensus factor value (0.89) whereas swelling/ tumor scored the least ICF value (0.83). The ICF score of these disease categories indicates the relative incidences of these diseases in the area. The score of the informant consensus factor is also a good indicator to identify plants of particular interest in the search for bioactive compounds. Accordingly, medicinal plants including *Zehneria scabra* (L. f.) Sond, *Boswellia papyrifera* (Del.) Hochst*., Plumbago zeylanica* L*., Jasminum abyssinicum* Hochst. ex DC*., Anogeissus leiocarpa* (DC.) Guill. & Perr., *Datura stramonium* L. and *Gardenia ternifolia* Schumach. & Thonn. which were used to treat the frequently revealed ailments (scored high ICF) requires further investigation for their pharmacological value. Other researchers such as Trotter & Logan (1998) stated a related suggestion.

Threats and conservation practices of medicinal plants

Respondents have reported various threats to the medicinal plants in the study area. Overgrazing, deforestation, expansion of agriculture, over-harvesting by humans, lack of knowledge on the utilization and management, drought, firewood collection and charcoal production were among the reported threats to medicinal plants. The intensity of these threats was not the same. Overgrazing, deforestation and expansion of agriculture were among the most serious threats to medicinal plants. The majority (> 85%) of the local people are engaged mainly in agricultural activities as well as livestock production (ANRBNWZT 2019). Charcoal production was also the additional source of income for many people. Hence, these activities severely affect the medicinal plants in the study area. These threats were also common in other parts of the country as reported by different authors (Abrha *et al*. 2018, Ashagre 2011, Kidane *et al*. 2018, Mesfin *et al*. 2009, Tolosa 2007, Yirga 2010). The root causes of the entire threat in the study area were rapid population growth that demands extensive agricultural and grazing land (Gebrelibanos & Assen 2015). The study conducted by Kelbessa *et al*. (1992) stated that the rapidly growing population and poverty of the rural people could be the major causes for the overutilization of plant species as well as the whole biodiversity in Ethiopia. Furthermore, the traditional healers and parents keep the indigenous knowledge on the medicinal plant utilization and management secretly could be another possible threat to the medicinal plants and associated indigenous knowledge (Caniago & Siebert 1998).

Conservation of local vegetation in the study area is not only significant for the medicinal value but also to sustain the associated knowledge and to get further benefits such as food, market value, material culture, fodder, wood and soil fertility. Thus, people in the study area practice different techniques to conserve medicinal plants. Out of these, homegardening, fencing, replanting and education (awareness) were the most used mechanisms reported by the informants. These conservation approaches are mostly recommended as a guarantee for the continual survival of traditional medicinal plants for the coming generation (Cunningham 2001). Despite, the local community uses the above conservation mechanisms, most of the medicinal plants were found in the wild environment which is out of their management scope and not reliable to rescue them. Hence, the local government should enforce the regulations regarding the utilization of natural resources particularly the plants for the sustainable use of medicinal plants. Side by side with this work an awareness creation should be taken up intensively.

Distribution of indigenous knowledge on medicinal plants among the informants

Gender had no significant difference (P >0.05) in the reporting of medicinal plants in the study area. This indicates females in the study area are equally knowledgeable with males, which could be related to the exposure similarity toward the interaction with medicinal plants as well as equal opportunity in receiving indigenous knowledge from their parents. Similar reports were stated by other authors (Almeida *et al*. 2010, Bisht *et al*. 2006, Lulekal 2014). The number of medicinal plants reported by different age groups in the study area showed significant differences (P = < 0.05). The elder age groups of the community (age > 40 years old) reported a high number of medicinal plants than the young age groups (18 - 40 years old). This reveals the elderly age groups have more experience and knowledge about medicinal plant species than young age groups. A study by Silva *et al.* (2011) also states the knowledge and exposures of people increase with age. Livelihood modernizations including urbanization and the advent of formal education might be the other factors that affect youngsters' indigenous knowledge of medicinal plants (Bussmann 2006).

The educational status of the community members has a significant variation in the number of reporting different medicinal plants. More than 76% of the medicinal plants were reported by the illiterate individuals. This indicates that illiterate people relatively have good knowledge of medicinal plant species whereas the literate groups rely on the modern health care system than on traditional medicinal plants use. Related findings were reported by Alemayehu (2017), Awas & Demissew (2009),

Bussmann (2006), Gedif & Hahn (2003), Lulekal *et al*. (2013). The average number of medicinal plants reported by married people were higher than single informants. This might be due to married people were relatively older (experienced) than single informants. A study conducted in Debre Tabor Town by Jemere *et al*. (2020) made similar conclusions. There was no significant variation shown between different religious followers of the informants, despite a higher number of medicinal plants (307 species) reported by Orthodox Christians than Muslim (28 species) followers. The other significant difference was between key and general informants. Though the numbers of key informants were less than the number of general informants, they all reported that a high number of medicinal plants. This could be associated with the lifelong experience and confidentiality (holding the medicinal secret) in using medicinal plants (Gedif & Hahn 2003, Lulekal *et al*. 2013, Mekuanent *et al*. 2015).

Conclusion

The ethnomedicinal survey showed that people in the study area used 85 medicinal species to treat 71 human and 16 livestock ailments. This could be related to easy access, perceived efficacy and cultural values attached to the plants. Of the recorded medicinal plants, 65.9% of them were found in Hirmi woodland vegetation. Herbs were the most used growth forms of medicinal plants. The majority of the medicinal plants have multiple or more than one use. This puts them into further exploitation. The most frequently revealed ailments for humans and livestock in the study districts were abdominal diseases and skin diseases, respectively. Thus, more numbers of species were prescribed to treat these diseases. Overgrazing, deforestation and expansion of agriculture were the most proximate threats for medicinal plants. Consequently, some important medical plant species such as *Dodonaea angustifolia* L. f.*, Boswellia papyrifera* (Del.) Hochst. and *Gardenia ternifolia* Schumach. & Thonn were highly exploited and found rarely. To rescue these and other medicinal plants, local communities used various conservation techniques including growing them in their homegarden, replanting, fencing and awareness raising. However, not all inhabitants are aware enough and committed to manage and use medicinal plants in their vicinity. This brings a significant difference in reporting of medicinal plant use among the age groups, educational status, marital status and experience of informants. Therefore, traditional healers and relevant professionals should provide education on how to use and manage the medicinal plants to their descendants by disseminating the required information and knowledge. Moreover, none of the traditional healers were volunteer to tell the side effects of the traditional medicine. Hence, the phytochemical and toxicological investigations should further be carried out by emphasizing the more preferred and frequently used medicinal plant species including *Zehneria scabra* (L. f.) Sond, *Plumbago zeylanica* L.*, Zingiber officinale* Roscoe*, Calpurnia aurea* (Alt.) Benth., *Boswellia papyrifera* (Del.) Hochst*., Anogeissus leiocarpa* (DC.) Guill. & Perr*., Jasminum abyssinicum* Hochets. ex DC. and *Gardenia ternifolia* Schumach. & Thonn. for their pharmacological value.

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Declarations

List of abbreviations: ANRBNWZT: Agriculture and Natural Resource Bureau of Northwetern Tigray Regional State, Shire-Ethiopia; ICF: Informant Consensus Factor; NMSA: National Metrological Service Agency; MEF: Ministry of Environment and Forest; SPSS: Statistical Package for Social sciences

Ethics approval and consent of to participate: The study is part of Ph.D. dissertation. The Department of plant biology and Biodiversity management, Addis Ababa University wrote an ethical clearance to the Northwestern Zone of Tigray. Northwest Zone of Tigray Administration also wrote to each of the districts in the study area to create a conductive environment between informants and the researcher consent obtained from the participants.

Consent to publication: Not applicable.

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Competing interest: The authors declare that they have no competing interests.

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Authors' contributions: The first author (Mehari Girmay) collects and analyzes the data, and wrote the manuscript. The other authors (Tamrat Bekele, Ermias Lulekal and Sebsebe Demissew) have participated in formulating the research as well as analysis, interpreting, and editing of the manuscript. The author(s) read and approved the final manuscript.

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