Medicinal Plants Used for Treating Human and Livestock Ailments in Tiyo District, Arsi Zone of Oromia, Ethiopia

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Abstract

Background Systematic documentation and promotion of indigenous knowledge associated with medicinal plants are limited. The aim of this study was to undertake ethnobotanical investigation on medicinal plants used for the treatment of human and livestock ailments and document indigenous knowledge of local communities on the preparation and administration of herbal remedies in the study area.

Methods The study involved 153 informants from nine kebeles, comprising traditional healers, knowledgeable elders and local user communities. Various ethnobotanical techniques were used to collect and analyze data: semi-structured interview, guided field walk, group discussion, preference ranking, and fidelity level index. Data was analyzed using descriptive statistical analysis.

Results Local communities had rich and diverse indigenous knowledge on medicinal plants, types of ailments, methods of remedy preparations and routes of applications. There were differences in this indigenous knowledge across age and sex. A total of 83 medicinal plants were documented during this study. Fifty two (62.65%) plants were used for treating human ailments, 20 species (24.10%) for treating health problems of livestock and the remaining 11 (13.25%) for treating both human and livestock ailments. The highest informant consensus was documented for the plants Allium sativum , Asparagus africanus and Azadirachta indica. Leaves were the most commonly used parts of medicinal plants accounting for 51.81% of the total followed by roots (20.48%) and barks (2.41%). Oral administration of the herbal medicine was the dominant route 66.3%, followed by dermal (22.7%) which included washing, holding on, rubbing and brushing. Smoking (8.5%) was also important. It was documented that 27 species (32.5%) were used in fresh, 13 species (15.7%) dried and 43 species (51.8%) either in dry or fresh state.

Conclusion Owing to their access, curing ability, manageable charges, existence of deep indigenous knowledge and other associated cultural values, medicinal plants continued to play a significant role in meeting healthcare needs of the community in the study area. Conservation and sustainable use of the diverse medicinal plants need to be promoted. Systemic documentation and protection of the rich knowledge of local communities and further research on selected potential species was recommended as a result of this study.

Background

Ethnobotany is a broad and complex term referring to the study of direct interactions and interrelations between humans and plants [1, 2]. Local communities especially in rural developing countries are dependent on herbal medicines. This indispensable dependency of human communities upon plants for their livelihood was primarily started by domestication and dates back to 10,000 years [1].

Globally, the estimate of medicinal plants ranges from 35,000–50,000 species and out of this about 4000–6000 species have entered the world market of medicinal plants [3]. However, only about 100 species have been used as a source of modern drugs. Ethiopia has rich floristic composition and is among few megadiverse countries in the world. Out of the estimated 6000 vascular plant species in Ethiopia, about 10% are estimated to be edible [4] and over 10% (about 600 to 1,000 species) have medicinal values [5]. The country is also home to many languages, cultures and beliefs which have in turn contributed to the high diversity of traditional knowledge and practices [6]. Following the concentration of biological and cultural diversity, the greater concentration of medicinal plants is found in the south and south western parts of Ethiopia [7].

Medicinal plants and traditional medicine play an important role in the healthcare system of most developing countries. Traditional medicinal plants have been used in Ethiopia as a source of medicine since antiquity to treat

various health problems. It is estimated that about 80% of the rural people in Ethiopia and about 90% of the livestock population rely on traditional medicine to meet their primary healthcare needs [5, 8, 9]. The wide spread use of traditional medicine in Ethiopia could be due to cultural acceptability, efficacy against certain types of diseases, physical accessibility and economic affordability as compared to modern medicine [5, 9, 10].

Indigenous knowledge on plants appeared when humans started and learned how to use plants [11]. Over centuries, indigenous people have developed their own locality specific knowledge on plant use, management and conservation [12]. The complex knowledge, beliefs and practices generally known as indigenous knowledge (IK) or traditional knowledge develops and changes with time and space, with change of resources and culture.

In Ethiopia, traditional medicine has been facing challenges of sustainability and continuity mainly due to the loss of taxa of medicinal plants [13]; as well as habitats and cultures [14]. Other studies also showed that the diversity of plants in Ethiopia is on the process of being eroded mainly due to human induced pressures [15]. Habitat destruction and deforestation for commercial timber, encroachment by agriculture and other land uses have resulted in the loss of some thousand hectares of forest that harbour useful medicinal plants, annually over the past several decades. With the present ecological and socio-economic changes, the medicinal plants together with ethnobotanical knowledge, may disappear and thus may be lost from humanity forever [16].

Traditional medicine continues to be widely used in Ethiopia despite the growing importance of manufactured drugs and expansion of health care facilities into rural areas. However, little is known about the public health importance and potential pharmaceutical uses of plant medicines. The chemistry and economic importance of most of the Ethiopian medicinal plants have never been studied in-depth and also documentation of all medicinal plants in the country is far from complete. Only few studies were geared towards indigenous medicinal plants with the objective of improving their usage. Consequently, the overall use of these plants remained within the domain of local healers. Studies show that home remedy is the most popular but is an overlooked sector of health strategy among all societies in Ethiopia and elsewhere [17].

Moreover, the indigenous knowledge associated with the conservation and use of medicinal plants is also disappearing at an alarming rate. With the current ecosystem degradations and loss of biodiversity, it was found important and timely to document indigenous knowledge of local communities with focus on list of species, the conservation and sustainable use of practices these medicinal plants and specific medicinal uses.

There were limited research coverage that focused on compilation and documentation of data on the potential medicinal plants, common ailments treated by traditional system, methods of remedy preparations, associated indigenous knowledge of utilization, conservation, traditional management system practiced by people in the study area. The overlooked traditional knowledge associated with medicinal plant resources would result in the loss of the species and the failing of the delivery mechanism of native knowledge to new generations. This study is aimed at filling a research gaps through providing some data that serve as baseline information for further ethnobotanical investigation and to plan and implement appropriate conservation measures. This in turn contributes to the national policies and strategies that support sustainable management of medicinal plants through effective conservation and utilization.

Therefore, this study aimed at documenting plants of medicinal value to humans and livestock with emphasis on their utilization and associated traditional knowledge with the following specific objectives: (i) collect and identify plant species used for medicinal purposes, in treating human and livestock ailments in the study area; (ii) identify

and document the plant parts used for medicinal purposes and the methods of medicine preparation; (iii) identify and document indigenous knowledge on medicinal plants and methods of transfer.

Methods

Geographic Location and Description of the Study Area

The study was conducted in Tiyo District of East Arsi Administrative Zone, Oromia National Regional State of Ethiopia (Fig. 1).

The area is located at about 175 Km southeast of Addis Ababa. The Addis Ababa-Asela all-weather road provides the primary access to the District. Geographically, Tiyo District is found approximately between 7^0 45' 55" and 8^0 02' 02" N latitude and 38^o 56' 42" to 39^o 18' 31" E longitude. It is located just on the top of the eastern edge of the Ethiopian Rift Valley. Topography of the District is a part of the Arsi-Bale Mountains chain in general and Chilalo-Galama Mountains in particular. The District is characterized by flat (0^0) to very steeply topographic features (58.6^0). Its altitude ranges from 1850 to 4050 m.a.s.l. The District is characterized by three agroecological zones: Dega (highland) is about 52%; Woyenadega (middle land) about 37% and Kola (lowland) is 11%.

Climate

According to the records of the National Meteorological Agency (NAMA) of Ethiopia, the mean annual rainfall of the District is 1100 mm. Distribution of the rainfall is bimodal, which occurs in the major rainy season (Kiremt) and the short rainy season is (belg). The major rainy season occurs from June to October and the short rainy season occurs in March, April and May. The dry season extends from November to February. The mean annual maximum temperature was 23.1^oC and the mean monthly maximum values ranged from 21.1 to 25^oc.

The mean annual minimum temperature is 9.1^oc and the mean monthly minimum values ranges from 7.1 to 11^oc. The coldest months were October, November and December whereas March, April and May were the hottest months of the years NMA, 2004–2013 (Fig. 2).

Sampling Study Sites And Informants

Study sites were selected purposively through feasibility study based on the agro-ecological zones of the district (lowland, middle and highland) because such stratification can represent the whole district. This helps for the effective evaluation of the distribution of medicinal plants and the variability of traditional knowledge in different agro-climatic zone. The Kebeles selected are shown in Fig. 1.

Representative informants were selected through systematic random sampling by flipping a coin for household and/or for individuals to be selected based on the age, sex and educational background. When the coin comes up a head, the informant was selected, if tail comes up the informant was not selected following the method recommended by Martin [1]. This helps to provide equal statistical chance to all members of population with the age ranges between 18 and 75, different sex and level of educational back ground, etc. Knowledgeable informants were selected by using purposive sampling methods based on recommendation obtained from elders and local authorities (Development Agents and kebele administration leaders). The total sample size was decided by using the following simplified formula following Yamane Taro [18]:

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

Where n= Sample size

N= Household size

e = level of precision (0.08)

$$n = \frac{8641}{1+8641(0.08)^2} = 153$$

Table 1 summarizes number of households and sample size in each Kebele.

Table 1
Number of Households and sample sizes in each Kebele (Lowest administrative units) in Tiyo District, Arsi Zone, Ethiopia.

Name of the kebele	No of Household	Sample size
Oda Deweta	1094×153	19
	8643	
Gora Silingo	1260	22
Burka Chilalo	889	16
Dosha	789	14
Dugdea Ukulu		714
13		
Murkicha Kobo	658	12
Abosera Alko	972	17
Haro Bilalo	985	17
Bore Chilalo	1280	23
Total	**8641**	**153**

General Features Of The Respondents

A total of 153 respondents (84 males and 69 females) grouped into four age classes, 18–30, 31–45, 46–60 and 61–75 (Table 2) were involved in this study with age ranges from 18–75 and an average age of 45 years. From the total respondents fifty knowledgeable informants were selected based on recommendation of elders and local authorities. From fifty knowledgeable informants 26 key informants were selected and involved in different exercises.

Table 2
Age, educational status and occupation of the respondents in three agro-ecological zones of Tiyo District, Arsi Zone, Oromia, Ethiopia.

Variables	Low land		Middle		High land			
	N=(46)	%	N=(56)	%	N=(51)	%	Total	%
Informants category								
Key informants	14	30.43	20	35.71	16	31.37	50	32.68
General informants	32	69.57	36	64.29	35	68.62	103	67.32
Age								
18–30	10	21.74	13	23.21	12	23.53	35	22.88
31–45	11	23.91	14	25.00	12	23.53	37	24.18
46–60	13	28.26	14	25.00	13	25.49	40	26.14
61–75	12	26.09	15	26.79	14	27.45	41	26.80
Education								
Illiterate	17	36.96	14	25.00	16	31.37	47	30.72
Read and Write	12	26.09	15	26.79	14	27.45	41	26.80
Primary	7	15.23	18	32.14	8	15.68	33	21.57
Secondary	5	10.87	10	17.86	5	9.80	20	13.07
Diploma	3	6.52	2	3.57	1	1.96	6	3.92
Religious studies	2	4.35	2	3.57	2	3.92	6	3.92
Occupation								
Farmers	41	89.13	52	92.86	46	90.20	139	90.85
Merchants	1	2.17	2	3.57	2	3.92	5	3.27
Herbalist	4	8.70	2	3.57	3	5.88	9	5.88

The informants in this study were comprised of four different age category and this helped to evaluate their views on traditional medication system, indigenous knowledge maintained, traditional conservation methods and management system practiced by society of different age groups. A larger of the informants (31.65%) were illiterate. The major occupation of the informants is agriculture and have long year of experiences in using vegetation of their surroundings for their daily life and this helped to get informants with deep knowledge on traditional medicine.

Data Collection Methods

Ethnobotanical data were collected from October 1/2013 to January 30/2014 in several field trips, closely working with and clearly mentioning the aim of the study to informants to obtain clear and objective responses through

different ethnobotanical methods. Semi-structured interview, focus group discussion, guided field walk, free listing, informants' consensus, preference ranking, direct matrix ranking, paired comparison and fidelity level index were used for collecting data as described below.

Semi-structured Interview

Semi-structured interview was conducted using prepared questions in Afaan Oromo, which is the local language of the informants following the accepted practice [1, 12]. During interview, issues regarding name, age, sex, level of education, occupation, religion and ethnicity of the informants were included. Moreover, informants were asked about the local name of the medicinal plants used, human and livestock ailments treated, plant parts used, condition of plant parts used (fresh or dried), other ingredients or additives if any, methods of remedy preparation, source of knowledge, methods of traditional knowledge transfer and number of years of services as traditional healers were focused in detail.

Focus Group Discussion

Discussion with knowledgeable informants over all kebeles were also designed and performed so as to gather further information on medicinal plants and in general to prove reliability of information gathered during semi-structured interview.

Guided Field Walk

Two to three field walks were made as necessary with knowledgeable informants and this provided an opportunity for more discussion with the herbalists' and the practical identification of traditionally used medicinal plants in their natural environment. It also helps to obtain firsthand impression on the abundance, habit and habitat characteristics of the plant species mentioned during interviews. During this observation medicinal plant species were identified, specimens collected and photographs were taken.

Free Listing

In this exercise the informants were asked to list all medicinal plants which are used for a particular purpose. The medicinal plants which are more significant were more likely to be mentioned by several informants.

Informant Consensus

In order to evaluate the reliability of information recorded during the interview, informants were visited more than one times for the same ideas and the validity of the information was proved and recorded. Consequently, if the idea of an informant deviates from the original information, it was rejected since it was considered irrelevant information. Only the relevant ones were taken into account and statistically analysed by the methods adopted from Alexiades [19]. Informant Consensus Factor (ICF) was calculated for each category to identify the agreements of the informants on the reported cures for the group of ailments as: number of use citations in each category (Nur) minus the number of species used (Nt), divided by the numbers of use citations in each category minus one [20].

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

Where ICF = Informants Consensus Factor

Nur = Number of use citation in each category

Nt = Number of species used

Preference Ranking

Nine key informants took part in preference ranking exercise in the manner recommended by Martin [1] to identify the most preferred plants among 12 medicinal plant species used for treating the most common ailments in the study area and to prioritize the most threatening factors on vegetation of the study area in general and medicinal plants in particular. Medicinal plants were arranged based on the personal preference on their efficacy. In this exercise, the set of medicinal plants namely: *Solanum campylacanthum, Helichrysum elephantinum, Kalanchoe petitiana, Calpurnia aurea, Podocarpus falcatus, Solanum somalense, Asparagus africanus, Coccinia abyssinica, Stephania abyssinica*, *Datura stramonium, Clematis simensis* and *Phytolacca dodecandra* were selected from the list of medicinal plants that were reported by most informants in treating rabies in the study area. They were provided to those randomly selected key informants to rank them based on the efficacy of their medicine. Each informant gave a numerical score of 1, 2, 3, 4 to 5 with the most effective receiving the highest number (5). The medicinal plant supposedly most effective were given the highest value and the least effective one was given the lowest value. Finally, total values were calculated and an overall ranking was determined.

Direct Matrix Ranking

Data on the multipurpose use of medicinal plants were evaluated and compared through direct matrix ranking exercise as described in Martin [1], by involving key informants who have long years of experiences as traditional herbal medicine practitioners in the study area. The multipurpose plant species commonly reported by informants were selected out of the total collected medicinal plants and use diversity of these plants were listed by key informants who ordered them by considering several attributes at a time. For instance (5 = most valuable, 4 = very good, 3 = good, 2 = less used, 1 = least valuable, and 0 = not used). Accordingly, the use values given for each multipurpose medicinal plant by each key informant were averaged and the values of each species summed up and ranked.

Paired Comparison

A paired comparison was conducted for five medicinal plants that were used for treating wart. Nine key informants participated in the paired comparison. Accordingly, *Euphorbia dumalis* was first followed by *Lepidium sativum* as shown in Table 12. This result indicated that *Euphorbia dumalis* wa*s* much favored over other plant species cited for treating wart in the area. Moreover, the result could be a testimony for the efficacy of these two plant species to treat wart at least in the study area.

Table 12
Paired comparison of medicinal plants used to treat Wart in Tiyo District, Arsi Zone, Oromia, Ethiopia.

Plant species	Respondents									Total	Rank
	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9		
Euphorbia chumalis	5	5	4	4	5	4	4	5	5	41	1st
Lepidium sativum	5	4	4	5	4	5	5	4	3	39	2nd
Dodonaea angustifolia	4	5	2	5	5	5	4	4	4	38	3rd
Verbascum sinaiticum	4	3	5	3	4	4	5	5	4	37	4th
Euphorbia candelabrum	4	3	3	4	4	5	5	4	4	36	5th

Fidelity Level Index

Many plant species were used in the same use category that necessitated to determine the most preferred species used in treatment of a particular ailment, which can be done with the fidelity level [22]. The fidelity level (FL), is the percentage of informants claiming the use of a certain plant species for the same major purpose. It was calculated for the most frequently reported diseases as:

$$\mathrm{FL}\ (\%) = \left(\frac{Np}{N}\right) x100$$

Where *N*p is the number of informants that claim the use of a plant species to treat a particular disease, and N is the number of informants that use the plant species as a medicine to treat any given disease [19].

Review Of Secondary Sources

Data of secondary sources were reviewed from public and livestock health centers to evaluate their view of traditional medication system, to obtain the list of the most frequent health problems in the District, Agricultural and Rural Development office of the district to gather information about the socio-economic, demographic, location, climatic (ten years climatic data), edaphic and vegetation characteristics of the study area. In addition, information on the working cooperation between modern health practitioners and traditional herbalists were gathered.

Voucher Specimen Collection And Identification

All interviews, discussions as well as field surveys were accompanied with voucher specimen collection that was carried out with the help of traditional healers and local field assistants. The specimens were air-dried, numbered, labelled, pressed, heater-dried, deep-frozen, identified and deposited at the National Herbarium (ETH) in Addis Ababa University. Identification of specimens were performed both in the field and later at ETH using taxonomic keys and the relevant volumes of the Flora of Ethiopia and Eritrea [23–29].

Ethical Consideration

All participants in this ethnobotanical survey were informed about the detailed objectives of the research before starting any data collection and information sharing. Informants were clearly informed that the results will be used for academic purposes only not for commercial purpose. The procedure involved asking permission of the local administration and each informant.

Data analysis

Ethnobotanical data analysis

Descriptive statistical methods (both qualitative and quantitative analytical tools) were used for data analysis following Martin [1] and Cotton [12]. Data on informants' background, medicinal plants used and associated traditional knowledge were entered in Excel spread sheet software and organized for statistical data analysis. Traditional knowledge dynamics on use of medicinal plants by men and women, young to middle aged and elder; literate (completed at least primary education) and illiterate, knowledgeable (key) and local (encountered randomly) informants were compared by using SPSS and Excel software.

Descriptive statistical methods were also applied to analyze medicinal value, methods of preparation, application techniques, route of administration, disease treated, plant parts used and habit of medicinal plants. In addition, six categories of plant use-reports, frequency and relative frequency of tree species were employed to analyze data statistically.

Results

Indigenous knowledge about health in the study area

From 153 (50 knowledgeable and 103 general informants) involved in the study, all have deep concept on health which is called Fayya in Afaan Oromo and perceived as special wealth provided by the natural superpower. They reflected the value of health through several poems, proverbs and songs that were recorded during discussion with elders. They gave high value for their health, as they believed that their health is their life and security. To cite few of these:

“Fayyan faayaa eeggadhu” meaning health is very precious take care of it.
“Dhibbi abbaan hin beekne fayyaadha" meaning health is a great wealth and gift not well recognized by oneself.
“FayyaA tapha seete qayyaan laga ceete” meaning health needs special care.

From these local proverbs, it is clear that health is considered as a great asset, and a life engine for any aspect of life activities in the area.

One hundred fifty two (96.2%) informants were supportive of traditional medication system provided by indigenous herbalists. They also believed that diseases were not created without medicine. According to the perception of these participants, all plant materials on the earth are created to cure diseases unless it is beyond the scope of human knowledge. They were also classifying health problems into those that can be treated and those that cannot be treated. For instance, 96.2% informants pointed out that locally acceptable spiritual diseases (dhibee ayyanaa) were non-curable either traditionally or by modern treatment but evil eye; evil spirit and jaundice can be cured by traditional means than the modern treatment. The rest six informants did not support the traditional medication system and did

not believe in the efficacy of herbal medicine. They reported that they were not using herbal medicine against human and livestock diseases.

Indigenous knowledge on treatment of ailments in the study area

The results obtained from the community of the study area showed that treatment strategies could be classified as home remedy, indigenous medicine and modern medicine. Despite their distinct features and procedures of treatment, these healthcare strategies often overlap, as patients appear to utilize one strategy after another without taking time to see the effect of each medication. As gathered from group discussion and interviews made during field observation, the local people always exploit their shared wisdom in order to manage health problems at home before looking for other options regardless of the type of health problem and its intensity. Accordingly, the sick person is given either traditional medicine (prepared from plant and/or animal sources) or treated spiritually through prayer according to their religion. In most cases, all these were employed in combination for the treatment of specific health problems. Seeking modern health service often comes after the above were exhausted or rarely simultaneously. According to their reports, they first look for traditional medication system because of several reasons including:

Easy access

Unlike modern healthcare station, local healers are found within accessible distance at their neighbours. This was found to be helpful in emergency cases (dhibee tasaa) to provide first aid and/or full treatment.

Efficacy on treatment

They also reported that traditional medication system was very effective to cure locally acceptable diseases caused by devil (seeyxaana) or, evil eye (budaa), manmade poisoning (falfala), hookworm (maagaa), urine of bat (simbira), infectious eczema (sarariitii) and rabies (waan saree). They perceived that these diseases could easily be treated at local level by traditional healers. On the other hand, gastritis, cardiovascular, mental and gastrointestinal problems are often taken to modern health centers.

Cost of treatment: The problems related to getting fast health service with affordable cost was among major factors that determine healthcare choice of individuals or communities. According to most informants (96.20%), local healers provide healthcare with relatively manageable and negotiable charges. In the study area, there was traditional rule among healers and their clients which says " pay once and be treated many times", i.e. once the payment is made for the treatment of a particular health problem, no more payment is asked for repeated medications that runs up to curing. If the client is not in a position to pay any amount of cash at all, he/she may then give the healer a few blades of fresh grass called (irressaa). This is simply made for moral satisfaction of both the healer and his client. According to information obtained from elders, this irressa has dual purposes: Thanks/respect to the healer and maintenance of curative power to the drugs. According to their cultural belief, it was also generally accepted that the herbal drug given free or without any irressa will lose its curative power.

Medicinal Plants Used For The Treatment Of Human Ailments

This study documented a total of 52 (62.65% of total) medicinal plants used for treating human ailments (Table 3).

Table 3

Medicinal plants used for the treatment of human ailments and their parts used in Tiyo District, Arsi, Oromia, Ethiopia.

No.	Scientific Name	Family	Parts used	Disease treated	Local Name (Afan Oromo)
1	*Acacia seyal* Delile	Fabaceae	Bud	Cold	Waaccuu
2	*Ajuga integrifolia* Buch.-Ham. ex D. Don	Lamiaceae	Leaf	Tonsillitis, Sudden sickness	Harmaguusa
3	*Allium sativum L*.	Alliaceae	Bulb	Liver infection, stomach ache, common cold & intestinal parasites	Qullubbii adi
4	*Aloe capensis*	Aloaceae	Bark	Goiter, Cough, Sharp pain	Hargiisa
5	*Anethum gravelens* L.	Apiaceae	Fruit	Mental sickness	Qoricha dhibee sammuu
6	*Carissa spinarum L*.	Apocynaceae	Root	Abdominal pain, Evil eye, Evil spirit	Agamsa
7	*Cassipourea malosana* (Baker) Alston	Rhizophoraceae	Bark	Sexual disability	Laalessa
8	*Cheilanthus farinosa* (Forssk.) Kaulf.	Sinopteridaceae	Leaf	Fire burn	Ati gubadhu an sii jiraa
9	*Chloris virgata* Swartz.	Poaceae	Leaf	Suntrock, typhoid	Mata bokko
10	*Clematis simensis* Fresen.	Ranunculaceae	Leaf	Tonsillitis	Fitii
11	*Clerodendrum alatum* Guerke	Lamiaceae	Leaf	Fire burn	Misirich
12	*Cordia africana* Lam.	Boraginaceae	Leaf	Fracturing, wounds, gastritis/ constipation	Woddeessa
13	*Cucumis ficifolius* A. Rich.	Cucurbitaceae	Fruit	Rabies, Abdominal pain, Poison, Mound	Hiddii
14	*Cucurbita maxima* Duchesne ex	Cucurbitaceae	Fruit	Tape worm	Baasqulaa
15	*Datura stramonium* L.	Solanaceae	Leaf	Rabies	Banjii
16	*Eucalyptus globulus* Labill	Myrtaceae	Leaf	Common cold (Cough)	Baargamoo adii
17	*Euphorbia abyssinica* Gmel	Euphorbiaceae	Milky exudate	Abdominal pain, wart	Hadammii
18	*Euphorbia candelabrum* Trem. ex Kotschy	Euphorbiaceae	Milky exudate	Wart	Hadaamii
19	*Euphorbia chumalis* S. Carter	Euphorbiaceae	Leaf	Fungus	Guurii

No.	Scientific Name	Family	Parts used	Disease treated	Local Name (Afan Oromo)
20	*Guizotia seabra* (Vis.) Chiov.	Asteraceae	Leaf	Blackleg	Hadaa
21	*Gloriosa superba* L.	Colchicaceae	Root	Liver infection	Sokorruu
22	*Hagenia abyssinica* (Bruce) J.F.Gmelin	Rosaceae	Fruit	Tapeworm, hookworm, endo- parasites	Heexoo
23	*Jasminum abyssinicum* Hochst ex Dc.	Oleaceae	Leaf	Nasal bleeding	Biluu
24	*Kalanchoe petitiana* A.Rich.	Crassulaceae	Root	Tonsillitis	Bosoqqee
25	*Lagenaria siceraria* (Molina) Standl.	Cucurbitaceae	Leaf	Snake poison	Buqqee
26	*Leonotis ocimifolia* (Burm. F) Iwarson	Lamiaceae	Leaf	Suntrock	Bokkolluu
27	*Lepidium sativum* L.	Brassicaceae	Fruit	Wart	Shuunfaa
28	*Lippia adoensis* Hochst.ex.Walp. Var. adoensis	Verbenaceae	Leaf	Ring worm	Sokonota/ Sukayee
29	*Myrsine africana* L.	Myrsinaceae	Bud	Tapeworm	Qamoo
30	*Ocimum gratissimum* L.	Lamiaceae	Leaf	Suntrock	Damakasee
31	*Ocimum lamiifolium* Hochst.ex Benth.	Lamiaceae	Leaf	Suntrock	Cabbii
32	*Olea europaea* subsp. cuspidata (Wall. ex G. Don) Cif.	Oleaceae	Leaf, Oil, Bark	Sharp pain, Goiter and Cough	Ejersa
33	*Olinia rochetiana* A. Juss.	Oliniaceae	Leaf	Evil spirit, eye infection, Dandruff, Abdominal pain, Skin itching	Gunaa
34	*Osyris quadriprtita* Decn.	Santalaceae	Leaf	Liver infection, Poison	Waatoo
35	*Polystachya tessehata* Lindl.	Orchidaceae	Root	Headache	Qoricha Bowwoo
36	*Prunus africana* (Hook.f) Kalkm	Rosaceae	Young shoot	Skin itching	Sukkee
37	*Pterolobium stellatum* Forssk.) Brenam	Fabaceae	Bud	Evil spirit	Gorxaa Dimaa
38	*Ranunculus multifidus* Forssk.	Ranunculaceae	Leaf	Liver infection	Qoricha dhibee Simbiraa
39	*Rhus vulgaris* Meikle	Anacardiaceae	Bud	Gonorrhoea	Qamoo

No.	Scientific Name	Family	Parts used	Disease treated	Local Name (Afan Oromo)
40	*Rosmarinus officinalis L.*	Lamiaceae	Leaf	Febrile illness	Foon waddittuu
41	*Rumex nepalensis* Spreng.	Polygonaceae	Root	Liver infection, abdominal pain	Shaabee
42	*Salix subserrata* Willd.	Salicaceae	Milk color exudate	Retained placenta, Mound	Alaltuu
43	*Sanicula elata* Ham. Ex. D.Don	Apiaceae	Leaf	Headache, Liver infection	Xuuxaa
44	*Satureja paradoxa* (Vatke) Engler ex Seybold	Lamiaceae	Leaf	Abdominal pain (sharp pain)	Sajjaabii
45	*Senna multiglandulosa* (Jacq) Irwin & Barneby	Fabaceae	Leaf	Measles	Birbirraa
46	*Setaria pumila* (Poir.) Roem. & Schult.	Poaceae	Leaf	Trachoma	Maxxnnee
47	*Sida tenuicarpa* Vollesen.	Malvaceae	Root	Diarrhoea	Camarrii
48	*Solanum campylacanthum* Hochst. Ex. A. Rich	Solanaceae	Fruit	Rabies, Abdominal pain, Poison, Mound	Hiddii
49	*Tapinanthus ziziphifolius* (Engl.) Dans.	Loranthaceae	Whole part	Skin rush	Harmoo Doddotii
50	*Terminalia brownie* Fresen.	Combretaceae	Leaf	Sun disease	Bir'eessa
51	*Tragia cinerea* (Pax) Gilbert & Radcl.- Smith	Euphorbiaceae	Root	Sexual disability	Laalessaa
52	*Verbascum sinaiticum* Benth.	Scrolophaceae	Root	Wart	Gurra Harree

Common human ailments and number of plant species claimed to treat them

It was observed and documented that the local communities had deep and adequate ethnobotanical knowledge to treat various human diseases with different types of plants. Among the medicinal plants reported, some of them were claimed to treat more than one ailment. The 42 human diseases recorded are said to be treated with a total of 52 plant species through use of 86 methods of preparations, where one species can treat a single disease or a number of diseases. Similarly, one ailment can be treated with combination of plant species or with a single plant. For example, rabies is treated with 12 species of plants, poisoning with 8 species, and diarrhoea with 4 species (Table 4).

Table 4
Common human ailments and number of plant species claimed to treat them in Tiyo District, Arsi Zone, Oromia, Ethiopia.

Health Problem	No. of plant species used	% of total medicinal plants used to treat human diseases
Rabies	12	23.08
Poisoning	10	19.23
Internal parasites	4	7.69
Diarrhoea	3	5.77
Evil eye	3	5.77
Hepatitis	3	5.77
Skin problem	3	5.77
Sunstroke	3	5.77
Abdominal distention	2	3.85
Abdominal pain	2	3.85
Bone fracture	2	3.85
Evil sprit	2	3.85
Fire burn	2	3.85
Gonorrhoea	2	3.85
Headache	2	3.85
Rosacea	2	3.85
Swelling	2	3.85
Teeth infection	2	3.85
Tonsillitis	2	3.85
Wart	2	3.85
Wound	2	3.85
Asthma	1	1.92
Bleeding	1	1.92
Cancer	1	1.92
Cough	1	1.92
Dandruff	1	1.92
Disorder of menstrual cycle	1	1.92
Eye infection	1	1.92

Health Problem	No. of plant species used	% of total medicinal plants used to treat human diseases
Febrile illness	1	1.92
Goitre	1	1.92
Herpes zoster	1	1.92
Influenza	1	1.92
Itching skin (sensation)	1	1.92
Liver problem	1	1.92
Male impotency	1	1.92
Mental illness	1	1.92
Nasal bleeding	1	1.92
Stomach problem	1	1.92
Syphilis	1	1.92
Tinea corporis	1	1.92

Medicinal Plants Used For Treating Livestock Ailments

Based on the ethnobotanical knowledge of local communities, a total of 20 medicinal plants used for treating livestock ailments were documented from the study area (Table 5). The informants revealed that in most cases they treat their livestock by traditional medication system and rarely look for modern medication.

Table 5

Medicinal plants and parts used for treating livestock ailments in Tiyo District, Arsi Zone, Oromia, Ethiopia.

No.	Scientific Name	Family	Part used	Disease treated	Local Name (Afan Oromo)
1	*Achyrospermum schimperi* (Hochst.) Perkins.	Lamiaceae	Leaf	Anthrax	Bala Diimessa
2	*Acokanthera schimperi* (A.DC) Schweinf. *L*	Apocynaceae	Root	Anthrax	Qaraaruu
3	*Agave sisalina* perrine ex. Engl.	Agavaceae	Leaf	Blackleg	Algee/Qaaccaa
4	*Aloe pubescens* Reynolds	Aloaceae	Root	Anthrax	Hargiisa
5	*Aspilia mossambicensis (*Oliv.) Wild.	Asteraceae	Leaf	Blackleg	Hadaa
6	*Calpurnia aurea* (Ait.) Benth.	Fabaceae	Leaf	Diarrhoea, Physical deterioration, Rabies, external parasites	Cheekataa
7	*Croton macrostachyus* Del	Eurphorbiaceae	Leaf	Sun disease, Abdominal distension,	Makkanniisaa
8	*Cymbopogon citratus* (Dc.) Stapf.	Poaceae	Leaf	Blackleg	Xajjiisaara
9	*Cynoglossum amplifolium* Hochst ex A.DC.	Boraginaceae	Leaf	Blackleg	Xoosinee Jaldeessaa
10	*Cyphostemma niveum (*schweinf.) Desc.	Vitaceae	Root	Anthrax	Laaluu
11	*Ficus capreaefolia* Del.	Moraceae	Leaf	Mound, Swelling	Luugoo
12	*Gnidia glauca* (Fresen) Gilg.	Thymelaceae	Bark	Foot and Mouth Disease (F.M.D)	Didiiysaa
13	*Helichrysum elephantinum* Cufod.	Asteraceae	Root	Blackleg, Rabies, Sun disease, Swelling, A.H.S.	Holotuu/Araddoo
14	*Hypericum revoltum* Vahl.	Hypericaceae	Leaf	Blackleg	Hindhee/Garambaa
15	*Nicotiana tabacum* L.	Solanaceae	Leaf	Blackleg, cough, internal parasites	Tamboo
16	*Phytolacca dodecandra* L Her.	Phytolaccaceae	Root	Cholera, Rabies&furee	Andoodee
17	*Satureja punctuata* (Benth) Bliq.	Lamiaceae	Leaf	Blackleg	Maxxannee baala bal'aa
18	*Sida schimperiana* Hochst	Malvaceae	Leaf, Root	AHS	Kottee gaangee

No.	Scientific Name	Family	Part used	Disease treated	Local Name (Afan Oromo)
19	*Stephania abyssinica* Dillon. & A.Rich.	Menispermaceae	Stem	Urine problem, Rabies	Kalaalaa
20	*Thymus schimperi* Ronn.	Lamiaceae	Leaf	Blackleg	Xooshinee

Common livestock ailments and plant species claimed to treat them

Twenty five livestock diseases were found to be treated with 20 plant species in which 38 preparations were involved. Rabies ranked first as it was treated by seven plant species and followed by diarrhoea and blackleg treated with three plant species each (Table 6).

Table 6
Common livestock ailments and number of plant species claimed to treat them in Tiyo District, Arsi Zone, Oromia, Ethiopia.

Common diseases	No. of plant species used	% of total medicinal plants used to treat livestock diseases
Rabies	7	35.00
Diarrhoea	3	15.00
Blackleg	3	15.00
External parasites	2	10.00
Cough	2	10.00
Mouse/nose wound	2	10.00
Eye infection	1	5.00
Bloating	1	5.00
Leech infestation	1	5.00
Lumpy skin diseases (LSD)	1	5.00
African horse sickness (AHS)	1	5.00
Sheep pox	1	5.00
Foot and mouth diseases (FMD)	1	5.00
Anthrax	1	5.00
Pasteurellosis of cattle	1	5.00
Pasteurellosis of Sheep	1	5.00
Actinomycosis	1	5.00
Avian cholera	1	5.00
Bloody urine	1	5.00
Dermatophilosis (Skin problem)	1	5.00
Glandular swelling	1	5.00
Epizootic lymphangitis	1	5.00
Retained placenta	1	5.00
Scabies	1	5.00
Physical deterioration	1	5.00

Medicinal plants used to treat both human and livestock ailments

The study reported that eleven plant species were commonly used to treat both human and livestock ailments. The species used to treat both human and livestock ailments were *Coccinia abyssinica*, *Kalanchoe lanceolata*, *Clerodendrum myricoides*, *Anethum graveolens*, *Azadirachta indica, Asparagus africanus*, *Diplolophium africanum, Solanum somalense, Vernonia amygdalina* and *Dodonaea angustifolia* (Table 7). In this study, 65 different human and livestock health problems were reported (40 of human and 25 of livestock). Most of these species were wild and harvested mainly for their leaves and the remedies were administered through oral and dermal routes.

Table 7
Medicinal plants and parts used for treating both human and livestock ailments in Tiyo District, Arsi Zone, Oromia, Ethiopia.

No.	Scientific Name	Family	Parts used	Disease treated	Local Name (Afan Oromo)
1	*Asparagus africanus* Lam.	Asparagaceae	root	Blackleg, Liver infection, Rabies, Dental infection	Sariitii
2	*Azadirachta indica* A. Juss	Meliaceae	Leaf	Blackleg, physical deterioration, Cholera, kill vectors	Niim/Miimoo
3	*Clerodendrum myricoides* (Hochst.) R.Br.ex vatke	Lamiaceae	Leaf	Evil eye, Evil spirit, Pasteurellosis	Maraasisaa
4	*Coccinia abyssinica* (Lam) Cong.	Cucurbitaceae	Root	Rabies, Abdominal pain	Hancootee
5	*Diplolophium africanum* Turcz.	Apiaceae	Whole part	Urine problem	Insilalaa
6	*Dodonaea angustifolia* L.f	Sapindacae	Leaf, bud	Cancer, external parasites, Bone fracture, Wart, Evil eye, Mound, Abdominal pain, Gonorrhoea	Dhittacha
7	*Justitia schimperana* (Hochst.ex Nees) T.Anders.	Acanthaceae	Leaf	Liver infection and Abdominal pain	Dhummuugaa
8	*Kalanchoe lanceolata* A.Rich.	Crassulaceae	Leaf	Rabies, Skin rash, Bone fracture, Tonsillitis	Hancuurraa
9	*Podocarpus falcatus* (Thunb.) Mirb.	Podocarpaceae	Bud	Rabies, Abdominal distension	Birbissa
10	*Solanum somalense* Franchet	Solanaceae	Root	Rabies, Evil spirit, Skin rash	Hidda bidoo
11	*Vernonia amygdalina* Del.	Asteraceae	Leaf	Diarrhoea, Physical deterioration	Ebicha

Plant Parts Used For Medicine

Based on summary of data collected and presented in Tables 3,5 and 7 regarding different plant parts used, leaves were the most commonly used part accounting for 51.81% of the total, followed by roots (20.48%), barks (2.41%). Figure 3 summarizes data on overall parts used for treating different ailments in the study area.

Preparation Of Medicine From Plants

Regarding the preparation of remedies from plants, informants reported various skills associated with preparation of herbal medicine. These include plant composition (whether single or combined), condition of plant used (fresh or dry) and methods of preparation such as crushing and pounding. The results of the condition of the plant parts used indicated that 27 plants (32.53%) were used in fresh state, 13 (15.66%) were used in dried state and 43 (51.81%) were used in fresh or dried state (Fig. 4). As these plants were used in both forms, the chance of using the medicinal plants under different seasons of the year was perceived to be high. The informants pointed out that they preserve the plant that they could not find in dry season in different ways like pounding and hanging the plant material in dry and safe place. Most of the remedies (64.33%) had additive like *Allium sativum*, sugar, honey, tea, coffee, pepper, while some (35.67%) were used alone to treat different human diseases.

There were various methods of medicine preparation from plants used by local people of the study area. The most popular modes of preparations were in the form of crushing, pounding and homogenizing in water, which accounted for about 24.62% followed by chewing (9.47%) and hold on (8.33%) as shown in Fig. 5.

Administration Of Herbal Preparations/formulations

The routes of administration of the prepared medicine were mainly internal applications 75 (70.75%), out of which oral application was the major one (Table 8). On the other hand, the external application was about 31 (29.25%).

Table 8
Route of administration and number of applications of herbal medicine in Tiyo District, Arsi Zone, Oromia, Ethiopia.

Route of administration	Total applications	Percentage
Internal	75	70.75
Oral	66	88.00
Nasal	3	4.00
Ear	1	1.33
Eye	2	2.67
Anal	3	4.00
External	31	29.25
Washing	3	9.68
Hold on	7	22.58
Smoking	9	29.03
Rubbing	4	12.90
Brushing	8	25.81
Total	106	100

Medicinal Plants Use Report (free Lists And Informants' Consensus)

The result of the study showed that some medicinal plants and their utilizations were more popular than others. Accordingly, plant species such as *Allium sativum* and *Asparagus africanus* were indicated relatively by higher

number (48 and 46 informants, respectively) for treating various human health problems such as liver infection, stomachache, common cold and intestinal parasites, sun disease, abdominal distension, tinea corporis, menstrual disorder, evil spirit and liver infection (Table 9).

Table 9
Informant consensus score in Tiyo District, Arsi Zone, Oromia, Ethiopia.

Plant species	No of informants	% of informants
Allium sativum	48	96.00
Asparagus africanus	46	92.00
Azadirachta indica	41	82.00
Calpurnia aurea	40	80.00
Croton macrostachyus	38	76.00
Datura stramonium	37	74.00
Dodonaea angustifolia	35	70.00
Helichrysum elephantinum	34	68.00
Kalanchoe lanceolata	33	66.00
Nicotiana tabacum	31	62.00
Rumex nepalensis	29	58.00
Solanum campylacanthum	28	56.00

Comparison of indigenous knowledge on medicinal plants use across age and sex

The study result revealed that the majority of traditional healers (knowledgeable informants) were older than 45 years. These healers identified 64 (77.12%) of the total medicinal plant species. Comparison of indigenous knowledge across sex showed that male and female informants identified 59 (71.08%) and 24 (28.92%) medicinal plants, respectively (Table 10). Out of the 50 knowledgeable informants (35 males and 15 females), 6 were in the age range of 18–31 age group, 8 respondents between 31 and 45; 14 were 46–60 and 22 were 60 and above age classes and cited 10.84%, 12.05%, 36.14% and 40.96% medicinal plants, respectively (Table 10). Furthermore, data collected from field observation and interviews revealed that informants in the first and second age group were not conversant enough in providing some ethnobotanical information clearly on the method of medicine preparation from plants, mode of application and plant parts used. Large numbers of key informants were found in the third and fourth age groups.

Table 10

Indigenous knowledge on medicinal plants across age and sex in Tiyo District, Arsi Zone, Oromia, Ethiopia.

Variables	Total respondents	No. of knowledgeable informants	Total plant identified	Percentage of the total
Age ranges	153	50	83	100.00
18–30	35	6	9	10.84
31–45	37	8	10	12.05
46–60	40	14	30	36.14
61–75	41	22	34	40.96
Gender	153	45	83	100.00
Male	84	35	59	71.08
Female	69	15	24	28.92

The results showed that the knowledge of medicinal plant increased as the age of the informant increased. The young generation particularly those in the age category less than 45 years have no or a little concept about herbal medicine when compared to population with age category above 45 years.

Preference Of Medicinal Plants

Preference ranking and paired comparison exercise based on key informant responses gave quantified ideas about the relative importance of some medicinal plants in Tiyo District.

Preferences of nine key informants on the medicinal plants used in treating rabies indicated that *Phytolacca dodecandra* stood first among twelve medicinal plant species followed by *Datura stramonium* and the entire data are as shown in Table 11.

Table 11
Results of preferences for twelve medicinal plants by nine key informants

Most preferred plant species	Key informants										Rank
	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	Total score	
Phytolacca dodecandra	5	5	4	5	5	4	5	5	5	43	1st
Datura stramonium	5	5	5	5	4	4	5	4	5	42	2nd
Podocarpus falcatus	5	4	5	5	4	4	5	3	4	39	3rd
Coccinia abyssinica	4	4	4	5	4	5	5	3	4	38	4th
Calpurnia aurea	4	5	5	5	4	3	4	4	3	37	5th
Solanum campylacanthum	4	3	4	4	5	3	4	5	4	36	6th
Asparagus africanus	5	5	5	3	3	4	4	5	3	35	7th
Helichrysum elephantinum	3	4	5	3	3	4	4	4	5	35	7th
Clematis simensis	4	4	5	4	3	4	4	4	2	34	8th
Kalanchoe petitiana	5	4	3	4	3	3	4	3	4	33	9th
Solanum somalense	4	4	3	3	4	3	3	4	4	32	10th
Stephania abyssinica	3	3	4	5	3	4	3	4	2	31	11th

Use Diversity Of Medicinal Plants

Among the medicinal plants documented in the study area, many were used for other different uses in additional to medicinal value. For example, *Carissa spinarum* was identified as top multipurpose species used for food, medicine, fodder, construction, firewood, charcoal making and fencing (Table 13). Other important multipurpose species included *Terminalia brownie, Croton macrostachyus, Eucalyptus globulus, Podocarpus falcatus, Hagenia abyssinica, Azadirachta indica* and *Vernonia amygdalina*.

Efficacy Of Medicinal Plants

About 10 disease categories were made from the total of 40 human ailments reported from the study area. Amongst these, the categories with the highest Informants Consensus Factor (ICF) values were Gastro-intestinal and parasitic diseases (0.92), followed by Respiratory diseases (0.80) and Febrile illness (0.79) as summarized in Table 14.

Table 13

Average scores of direct matrix ranking for eight medicinal plants with their use diversity in Tiyo District, Arsi Zone, Oromia, Ethiopia.

(The use values are from 0-5: 0=No use, 1=Least, 2=Less, 3, 4, 5 =highest/best) /div>

List of plant species	Use category								
	Food	Fodder	Medicine	Construction	Fire wood	Charcoal	Fencing	Total score	Rank
Carissa spinarum	5	3	5	4	5	1	1	24	1st
Terminalia brownie	0	3	5	4	4	1	4	21	2nd
Croton macrostachyus	0	2	4	5	4	1	4	20	3rd
Eucalyptus globulus	0	0	4	5	5	0	5	19	4th
Podocarpus falcatus	0	1	4	5	3	1	3	17	6th
Hagenia abyssinica	0	2	5	3	2	0	3	15	8th
Azadirachta indica	0	4	4	4	2	0	2	16	7th
Vernonia amygdalina	0	4	4	3	3	1	3	18	5th

Table 14
Informants Consensus Factor (ICF) values of traditional medicinal plants used to treat human ailments in Tiyo District, Arsi Zone, Oromia, Ethiopia.

List of plant species	Use category								Rank
	Food	Fodder	Medicine	Construction	Fire wood	Charcoal	Fencing	Total score	
Carissa spinarum	5	3	5	4	5	1	1	24	1st
Terminalia brownie	0	3	5	4	4	1	4	21	2nd
Croton macrostachyus	0	2	4	5	4	1	4	20	3rd
Eucalyptus globulus	0	0	4	5	5	0	5	19	4th
Podocarpus falcatus	0	1	4	5	3	1	3	17	6th
Hagenia abyssinica	0	2	5	3	2	0	3	15	8th
Azadirachta indica	0	4	4	4	2	0	2	16	7th
Vernonia amygdalina	0	4	4	3	3	1	3	18	5th

Relative Healing Potential Of Medicinal Plants

Fidelity level was performed for four categories of ailments treated by various medicinal plant species and the highest fidelity level was recorded for *Podocarpus falcatus* (44.44%) for treating rabies, *Cynoglosum amplifolium* (36.84%) for treating poison, *Euphorbia dumalis (*36.84%) for treating wart and *Carissa spinarum* (36.84) for treating evil eye and spirit among other medicinal plants used for the same services (Table 15).

Table 15

Fidelity Level value of medicinal plants commonly reported against a given ailment category

Disease category	Species used	% of all species	Use citations	% of all use citations	ICF
Gastro-intestinal & parasitic diseases	4	4.82	37	14.02	0.92
Respiratory diseases	6	7.23	26	9.85	0.80
Febrile illness	4	4.82	15	5.68	0.79
Oral, dental & pharyngeal	5	6.02	17	6.44	0.75
Evil spirit	9	10.84	32	12.12	0.74
Sexually transmitted diseases (STD)	7	8.43	22	8.33	0.71
Rabies, wart	12	14.46	35	13.26	0.68
Dermatological diseases	12	14.46	33	12.50	0.66
External injuries, bleeding & poison	12	14.46	29	10.98	0.59
Others	13	15.67	18	6.82	0.28
Medicinal plants	**Therapeutic category**	**NP**	**N**	**ICF value %**	
Podocarpus falcatus	Rabies	8	18	44.44	
Carissa spinarum	Evil eye	7	19	36.84	
Cynoglosum amplifolium	Poison	7	19	36.84	
Euphorbia dumalis	Wart	7	19	36.84	
Dodonaea angustifolia	wart	6	20	30.00	
Solanum somalense	Rabies	6	20	30.00	
Clerodendrum myricoides	Evil eye	5	21	23.81	
Lepidium sativum	Wart	5	21	23.81	
Osyris quadripartita	Poison	5	21	23.81	
Solanum campylacanthum	Rabies	5	21	23.81	
Croton macrostachyus	Evil eye	4	22	18.18	
Verbascum sinaiticum	Wart	4	22	18.18	
Cucumis ficifoliu	Poison	3	23	13.04	
Olea europaea	Evil eye	3	23	13.04	
Datura stramonium	Rabies	2	18	8.33	

Disease category	Species used	% of all species	Use citations	% of all use citations	ICF
Lagenaria siceraria	Poison	2	24	8.33	

Acquisition and transmission of knowledge of medicinal plants and perceived threats to Indigenous knowledge

The indigenous knowledge regarding the uses of medicinal plants of the study area have not been documented. The knowledge was transferred from generation to another generation verbally. In line with this, the informants of the study area reported that the previous culture on providing information on medicinal plants was top secret; not allowed to show or train others. This is because of many reasons as they stated:

1.
The medicine becomes cheap and the charges for service provision will be low if the medicine is known by many people.
2.
The medicine will lose its curative power if it is shown to patients
3.
Healers are hiding themselves because of the unfavourable attitude of the present generation toward the practice that consider it as backward. Though, it is not adequate, currently this situation is a little bit changed.

According to the explanation given by informants, the healers were supporting academic researches and at least transferring their knowledge to their elder sons. Accordingly, about 37 (74%) traditional healers have already trained their family and relatives, while 13 (26%) of them have a plan to do so in the future. In general, most knowledgeable informants 33 (66%) of the study area had acquired the traditional medication system from their parent and/or close relatives, 9 (18%) from both relatives and non relative healers, while 6 (12%) have gained the knowledge from other traditional healers, 2 (4%) through trial and error.

Healers show herbal medicine and transfer knowledge and skill to their family member at their later ages. A person trained by his family performs a strong oath locally called KAKU to keep the knowledge he/she obtained on medicinal plants and traditional medicine with maximum care and confidentially. According to the report of informants, although some people knew the medicinal plants and the methods to prepare the medicine, they did not exercise the knowledge. This was because they did not receive blessings from a well-known elder or he/she might not from a blessed family. Therefore, it was noted that these issues have reduced the chance of having new healers directly affecting sustainable continuity of knowledge and skill. On the other hand, most informants mentioned the lack of attention and assistants from educated professional, governmental and non-governmental sectors to encourage traditional healers. Few healers also mentioned lack of moral obligation to continue with the practice as a result of despair due to the general attitude considering the practice a backward activity by the current generation.

Discussions

Important medicinal plants used for treating human and livestock ailments

This study documented diverse medicinal plants and associated deep ethnobotanical knowledge. It was recorded that 52 (62.65%) plants were used for treating human ailments, 20 (24.10%) for treating health problems of livestock

and the remaining 11 (13.25%) for treating both human and livestock ailments. Species documented in this study and perceived to be used for human, livestock and both human and livestock ailments were also reported for their medicinal values from other parts of the country [30–33].

There were medicinal plants with higher informant consensus values that need to be seriously considered for further ethno-pharmacological studies. These species include *Allium sativum*, *Asparagus africanus* and *Azadirachta indica*. This high informant consensus values give good indication about particular species that serve for particular health problems, specific medicinal plants used for several health problems and the deep rooted indigenous knowledge maintained among local people in practicing and utilizing traditional medicine. Such information underlines the pharmacological significance of the medicinal plants in the area. This result was in agreement with several other ethnobotanical studies carried out elsewhere in Ethiopia [34–36, 10, 37].

Indigenous Knowledge Across Age And Sex

Ethnomedicinal knowledge involves traditional diagnosis, collection of plant materials and preparation of plant remedies in many countries including Ethiopia and is transferred from one generation to the other generation verbally with great secrecy. In the study area, it was noted that herbal medicine was not shown to others because; it was considered a professional secret, also essential for maintenance of the curative power of the medicine. This had great impact on the distribution of medicinal plants and associated traditional knowledge of the community. Previous study has reported similar practices describing the fact that such secret and verbal transfer make the indigenous knowledge or ethnomedicinal knowledge vulnerable to distortion and in most cases some of the lore may be lost at each point of transfer [8]. This has called for the high need for systematic documentation of such useful knowledge [8, 38].

The community in the study area had their own set of orally transmitted knowledge on health and medicinal use of many plant species. It was noted that the local communities had rich indigenous knowledge that was still beneficial to their livelihoods including health and food. Informants' consensus values obtained from this study were found to be high indicating the deep-rooted indigenous knowledge maintained among local people in practicing and utilizing traditional medicine.

However, some differences in this indigenous knowledge were noted across age and sex. Informants from the elder age group (greater than 45 years) were more knowledgeable than the youngsters. They could identify more medicinal plants and gave detailed descriptions related to the associated indigenous knowledge. This was expected as elders have developed better experiences and skills on the use and management of medicinal plants over years. In agreement with this result, members of the age group above 40 identified more medicinal plants than their younger counterparts (≤4 0 years) among the *Zay* people in East Shoa, Oromia, Ethiopia [6]. A similar observation was also reported by many others [10, 39, 33]. In general, the result obtained during this study showed that knowledge on medicinal plants increased as the age of the informants increased and it was directly proportional to age increment in agreement with previous reports [40, 41, 10, 42] but disagrees with reports by few in which elders at higher ages were found to have less indigenous knowledge on medicinal plants use than the younger age groups [e.g., 35]. The vivid reason for elders to be more knowledgeable than their younger counterparts could be due to the personal experience they developed in using these plants since old times. Traditional healers keep their indigenous knowledge as top secret for reasons related to curative power of the medicine and values. Furthermore,

Traditional healers show herbal medicine and transfer their knowledge and skill to their family member (most of the time to the oldest son) at their older ages. Many ethnobotanical studies from different parts of Ethiopia and other countries have reported similar challenges and lack of systematic documentation and transfer of the rich indigenous knowledge on medicinal plants including their management and use [41, 43, 6, 38, 30, 44].

The documented data in this study showed that male informants identified more medicinal species than female informants. This could be due to the fact that most of the time women spend more time at their home for keeping their children and taking care of activities near to homestead and therefore, have limited chance to visit far away wild ecosystems and learn about the diverse uses of medicinal plants found in such wild ecosystems. Similar finding was reported from Nagelle Arsi District in West Arsi zone in which women were found to be more knowledgeable on medicinal plants collected from home gardens and men had better knowledge on species collected from the wild [33]. Similarly, the average number of medicinal plants identified by females was less than that identified by males in Yalo District of Afar Regional State, Ethiopia [38]. On the other hand, there was no difference between indigenous knowledge of men and women informants on the use of medicinal plants in s in Ganta Afeshum District, Eastern Zone of Tigray, Ethiopia [45]. However, we believe that there exist differences in indigenous knowledge on management and use of medicinal plants across sex due to different occupations and exposures of men and women in rural communities of developing countries.

Plant Parts Used, Medicine Preparation And Application

The result of this study revealed that leaves were the most commonly used plant parts accounting for 51.81% of the total, followed by roots (20.48%). Previous study reports from different parts of Ethiopia [6, 46, 47, 48, 33] also documented that leaves followed by roots were the most common plant parts used to treat various health problems. On the other hand, in some studies roots were as the most widely used plant parts [10, 49, 37].

Community of the study area prepared most of the remedies from single plants which accounts for 63 (75.90%) and preparation from combined plant species accounting for 20 (24.01%) of the remedies. The result was in agreement with the findings [50, 10] in which the single plant preparations were reported to be high. However, this report disagreed with the other reports [6, 34] in which the combined plant materials were reported to have high proportion in herbal preparation. Among various popular methods of the herbal medicine preparation practiced by herbalists of the study area, crushing, pounding and homogenizing in water was the most common method accounting for about 24.62% preparations, followed by chewing 9.47% and tie on or hold on 8.33%. This result was different from the finding that reported 32 (36.4%) preparations were made in the form of powder, 29 (32.9%) crushed and pounded materials, and 12 (11.3%) in the form of chewing of plant parts for treatment of human health problems [49].

The most commonly used route of administration of herbal medicine in the study area was oral (62.3%) followed by dermal (20.7). Many studies agree with this finding of oral application as major route of application [51, 6, 32, 33]. For example, the most common (67.19%) route of administration of traditional remedies in Bule Hora District, Oromia, Ethiopia was oral [32]. Summary of studies in Ethiopia showed that the leading route of application of all the reported herbal remedies was oral accounting for about 42% [52].

Other Services Obtained From Home Garden Medicinal Plants

Local people obtain various services from the plants growing in their home gardens. According to this study 3 plant species in the home garden provided food and medicine, 4 were used as live fence, wind break and medicine and 2

used for medicine and construction purposes. This finding agrees with many previous studies [32].

Many of the home garden medicinal plants identified during this study were cultivated for other purposes but they were used as medicine when sudden sickness occurred. This observation was in agreement with previous study that reported only 6% of the plants maintained in home gardens in Ethiopia were primarily cultivated for their medicinal value even though many other plants grown for non-medicinal purposes turn out to be important medicines when some health problems are encountered [53].

According to the home garden owners, cultivation of home garden plants is their long-life practice. Even, some of them reported that they inherited their gardens from their parents. They also added that home garden has been very important source of their livelihood all the time particularly during the off set of rainy season. Practices of home garden were reported to be as old as agriculture in Ethiopia [54].

Conclusions

The local communities in the study area had rich indigenous knowledge on medicinal plants, types of both human and livestock ailments for which these medicinal plants had been used, methods of preparations and route of applications. The use of medicinal plants continued to play a significant role in meeting healthcare needs still today due to their accessibility, curing ability, manageable charges, existence of deep indigenous knowledge and other associated cultural values. The continuation of this knowledge was noted to be a clear indication of continued trust of the local communities on the efficacy of medicinal plants. However, this study showed that knowledge on herbal remedies was held by elder members of the community between 45–75 years of age. The decline in the use of medicinal plants by the younger generation may gradually lead to loss of indigenous knowledge associated with medicinal plant species.

Traditional herbal preparation mostly involved using single plant and the mode of administration was mainly internal in which oral administration was the leading route.

Indigenous knowledge of the local communities associated with the identification and use of medicinal plants should be encouraged, organized and promoted. Systemic documentation and protection of the rich knowledge of local communities and further research on selected potential medicinal plants were recommended as result of this study.

Declarations

Competing interests
The authors declare that they have no competing interests.
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Ethiopian Biodiversity Institute funded field data collection.
Authors’ contributions
MA involved in the study design, conducted interview, field work, literature review and general data collection and analysis and also wrote the first draft manuscript. GD secured funding for research work, supervised data collection and analysis, reviewed, revised and prepared the final manuscript. ZA gave guidance on data collection, supervised research work, data analysis and reviewed first draft. All authors read and approved the final manuscript.
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Ethics approval and consent to participate

Center for Environmental Science of Addis Ababa University approved the study. Furthermore, Tiyo District Agriculture and Rural development Office wrote supportive letter to all concerned bodies. Local communities in the study area gave verbal consent before the commencement of data and specimen collection.

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Figures

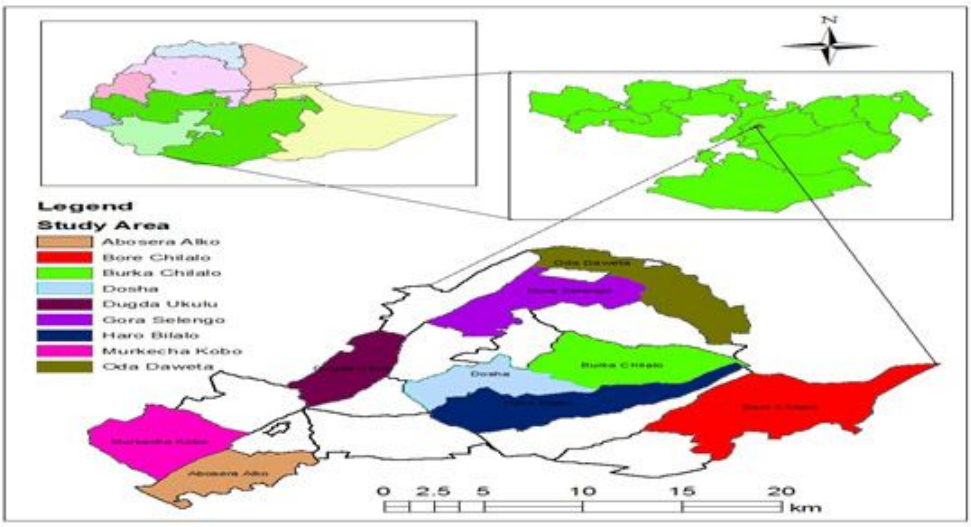

Figure 1

Map of Ethiopia showing the study area and the study sites (KEBELES).

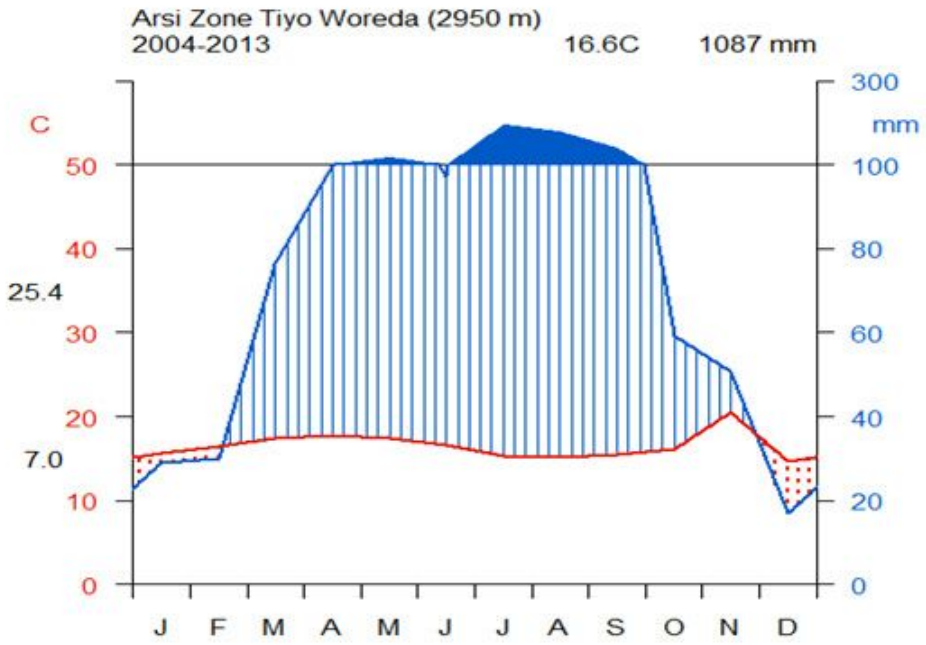

Figure 4

Ten years record of average monthly rainfall and Temperature of the study area

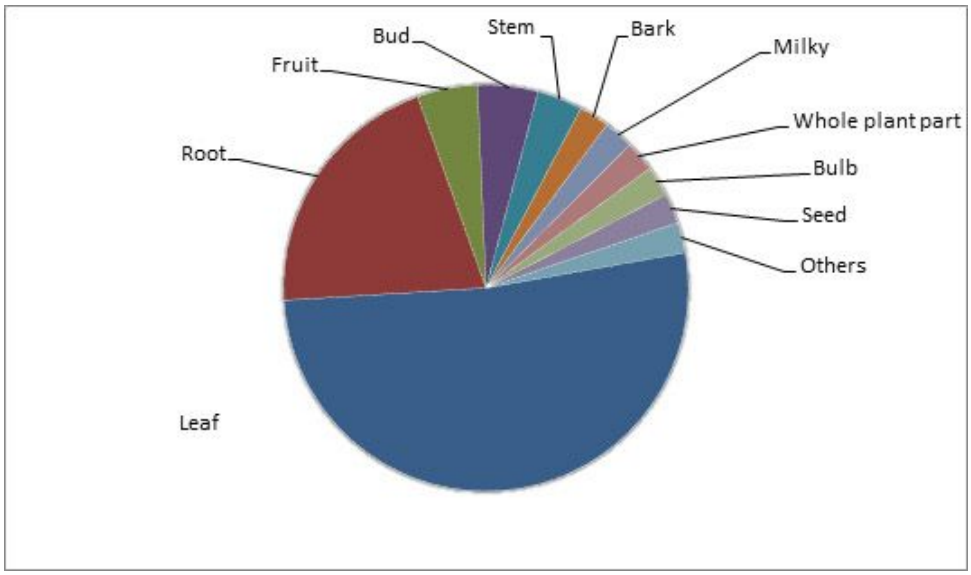

Figure 7

Proportion of plant parts used for human and livestock medicine in Tiyo District, Arsi, Oromia, Ethiopia.

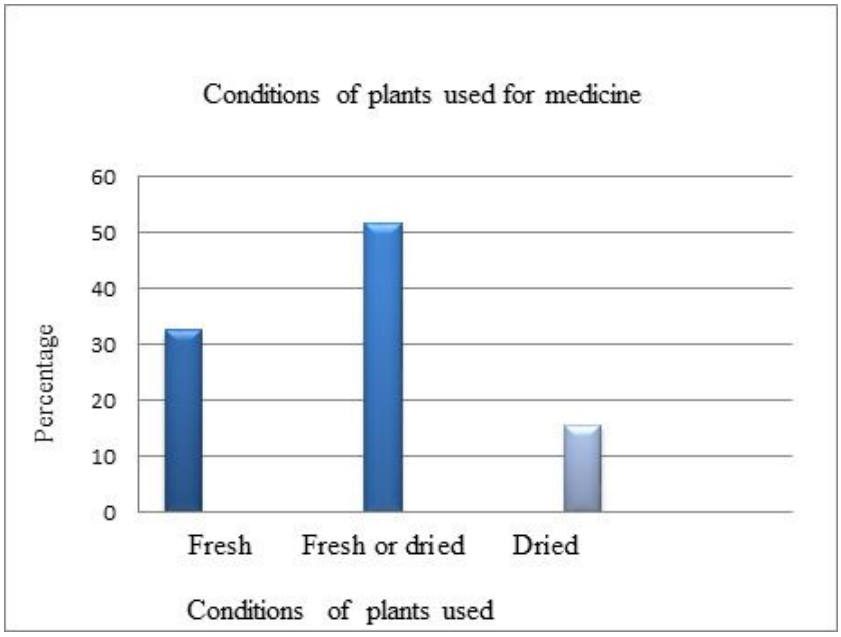

Figure 10

Conditions of medicinal plants used for human and livestock in Tiyo District, Arsi, Oromia, Ethiopia

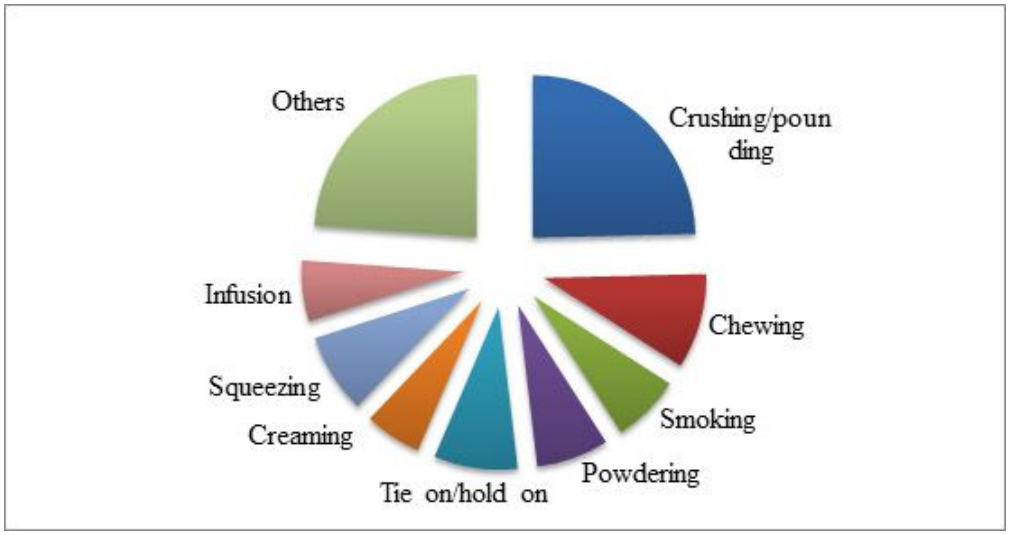

Figure 13

Methods of medicine preparation from plants in Tiyo District, Arsi, Oromia, Ethiopia.