# Ethnobotanical Study of Medicinal Plants used for the treatment of domestic animal diseases in Yilmana Densa and Quarit Districts, West Gojjam Zone, Amhara Region, Ethiopia

Derebe Alemneh

**Correspondence**

**Derebe Alemneh**

Department of Biology, College of Natural and Computational Sciences, Assosa University, Assosa, Ethiopia.

*Corresponding Author: saintma333@gmail.com

**Ethnobotany Research & Applications 22:28 (2021)**

## Research

## Abstract

*Background:* In Ethiopia, about 90% of the animal population has been treated by traditional medicine derived from medicinal plants. Thus, for the sustainable use of the species there should be an exploration of unexplored areas of the country to present an output data for conservation planners and policy makers. The current study districts were one of the unexplored areas of the country.

*Methods:* Reconnaissance survey was conducted from September 2015 to June 2016. General informants were selected systematically. Data were collected with semi-structured interviews, and observation. Consensus factor, fidelity level and ranking exercises were calculated to analyze the data.

*Results:* Thirteen medicinal plants were recorded in the districts. Most of the species were herbs, non-cultivated, and used to treat cattle diseases. Leaves were the primary source of remedy. Most remedy was prepared by crushing from non-dried parts. Most of the remedy was administered through oral routes and used to treat gastrointestinal diseases. *Stephania abyssinica* showed the highest fidelity level for the gastrointestinal disorders whereas *Phytolacca dodecandra* was the most preferred. Overharvesting and agricultural land expansions were the major identified threats.

*Conclusion:* Medicinal plants of the districts are under serious threats, and thus the species should be conserved by taking an immediate conservation action.

*Keywords:* Healing potential, informant agreement, marketability, respondents

## Background

Like human diseases, animal diseases have been the major threats for animal husbandry throughout Ethiopia (Tekle 2007; Yimer et al. 2012; Abunna et al. 2018; Chaburte 2019). Though livestock husbandry is a pillar in the livelihood of more than 70% of Ethiopians (MOA 2010), animal diseases have led the livestock population of the country to be low in productivity (Duguma 2013). The communities living in different parts of Ethiopia especially the rural people living far from the urban areas have not access to modern medicine for the treatment of their domestic animal population. Because of this most of the communities of the country still now depend on traditional medicine

Manuscript received: 21/07/2021 – Revised manuscript received: 08/10/2021 - Published: 16/10/2021
http://dx.doi.org/10.32859/era.22.28.1-16

derived from medicinal plants to treat their domestic animals. In congruent to this, recent studies conducted in different parts of the country showed the presence of the highest dependency on traditional medicine / remedy derived from medicinal plants to treat the livestock diseases (Gidey and Ameni 2003; Sori et al. 2004; Yineger et al. 2007; Woldegerima et al. 2008).

In the current study districts, there is an ample vegetation cover which is the rich source / home for veterinary medicinal plants. Nowadays, this resource is dwindling from time to time mainly by human driven factors. This has been a major threat for medicinal plants of the areas. Similarly, the indigenous knowledge which is interrelated with the medicinal plants of the districts has been threatened because of the loss of medicinal plants of the areas. Thus, well planned, and designed strategies are needed for the conservation of the medicinal plants and the interrelated indigenous knowledge of the areas.

This also requires a complete output data regarding the type of the medicinal plants and their threats found in the areas. In addition, to transfer the indigenous knowledge of the areas for the future generation, it should be recorded and documented. Otherwise, it vanishes from the areas. Therefore, the purpose of the study was to record and document veterinary medicinal plants in Yilmana Densa and Quarit Districts of West Gojjam Zone of Amhara Region, Ethiopia, to provide an output data for future conservation of medicinal plants and preservation of indigenous knowledge.

## Materials and methods

### Location

Yilmana Densa district (Wereda) is located at 11° 30′ N and 37° 20′ E in West Gojjam Zone, Amhara Regional State, Ethiopia. It is bordered on the south by Kuarit, on the southwest by Sekela, on the west by Mecha, on the north by Bahir Dar Zuria, on the southeast by Gonji Kolela districts, and on the east by Abay River which separates the district from the South Gondar Zone. The major town of this district is Adet which is 42 kilometers from Bahir Dar (the capital of Amhara Region). The second district, Quarit, is located at 11° 10′ N and 37o 15′ E and it is one of the districts in the same zone, West Gojjam. It is bordered in the Southwest by Jabi Tehnan, on the West by Sekela, on the North by Yilmana Densa, on the Southeast by Dega Damot districts, and on the east-by-East Gojjam Zone. The major town is Gebeze Maryam (Dabi) (Figure 1). Even if the two districts are parts of a single zone, they were chosen for the purpose of increasing the study area coverage.

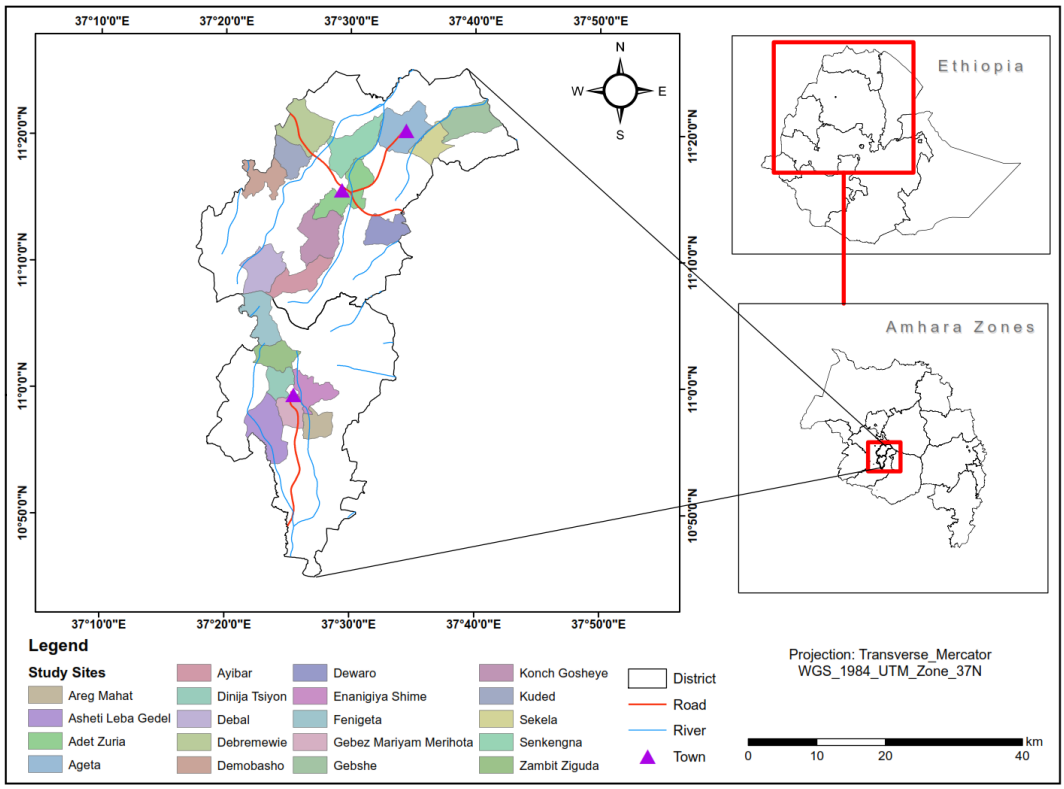


Figure 1. Location of the study kebeles (smallest administrative units or sub-districts) in the district of West Gojjam Zone, Amhara Region, Ethiopia (Drawn by using Arc GIS ver. 10.5).

**Climate**

Both districts have two agroclimatic zones namely Weyna Dega and Dega zones. Weyna Dega ranges from 1500 m to 2300 m above sea level and Dega ranges from 2300 m to 3200 m above sea level (Hurni 1998). Total annual rainfall is comparatively high with a long term mean of 1366 mm per annum. The rainy season is relatively long and lasts from May to October (Figure 2).

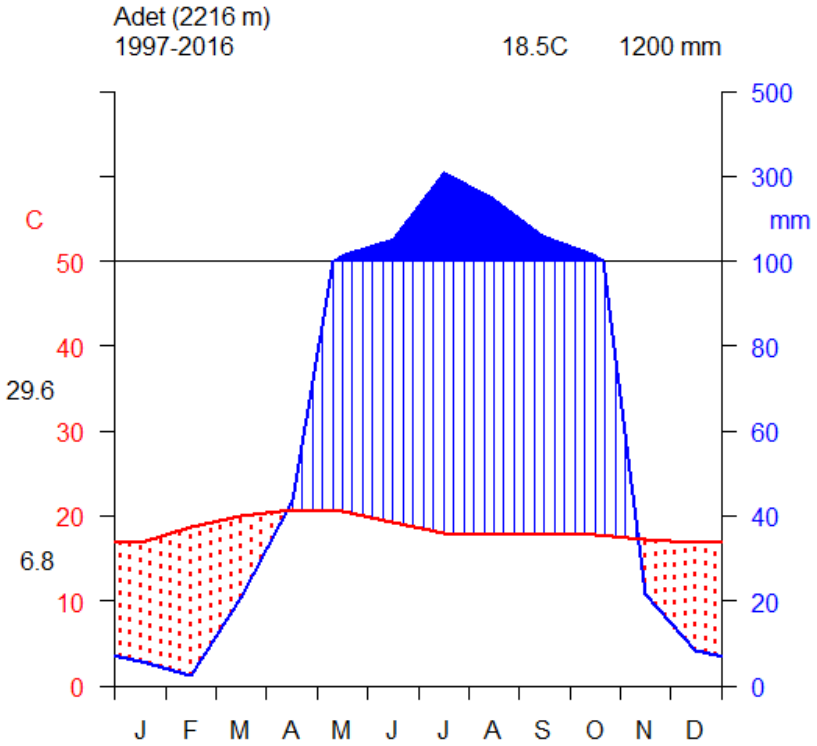


Figure 2 Climate diagram of Adet

**Soil, topography, geology and vegetation**

Both districts have plains, mountains, valleys, and undulating areas. Most of the district areas are covered by undulating areas and mountains respectively. The soils are traditionally classified into black soil, red soil and brown soil that consist of 20, 65 and 15% of the soil of the districts respectively (Tassew *et al.* 2011; Agricultural Office of the Districts 2016). Scientifically, the major soil types of the districts are eutric vertisols which are the subdivisions of vertisols. They are one of the soil categories found in West Gojjam Zone (Gebey and Mekuriaw 2013).

According to Kazmin (1975) and Mohr (1962) the basement complex of the higher lying areas of Amhara Region fundamentally composed of various grades and types of schist and gneiss as well as almost unaltered sedimentary rocks and igneous intrusions. They underlay the whole of the region, forming an intensively folded and foliated metamorphic basement. This is the Precambrian basement rock underlying Mesozoic marine sediments and Tertiary flood basalt type to which the present study of the research falls under this type of geology.

The mainland covers in the study areas are settlements surrounded by Eucalyptus trees, cultivated land, grassland, woodland, and shrub/bushland. It also includes evergreen and semi-evergreen, small trees, and occasionally larger trees. Besides, there are a few scattered trees such as *Acacia* spp., *Cordia africana* and *Croton macrostachyus* in the farmlands whereas *Eucalyptus camaldulensis* is grown around the homestead (ALP 2005).

**Demographic features and livelihoods**

According to CSA (2007), Yilmana Densa district has a total population of 214,852, of whom 107,010 are males and 107,842 females whereas Quarit district has a total population of 114,771, of whom 56,767 are males and 58,004 are females respectively. The majority (98.19%) of the inhabitants of Yilmana Densa district practiced Ethiopian Orthodox Christianity. Most of the population resides in rural areas whereas the least number are urban inhabitants. The districts are inhabited by 99.9% of Amhara people and Amharic was spoken as a first language by 99.96%.

The populations of the districts have several livelihoods. The first one is traditional farming by using oxen rarely by using heifers, cows, horses, and mules. Crop production is entirely rain fed, except in a small number of kebeles (sub-districts) where small scale water harvesting practices have been recently introduced by the office of agriculture and rural development (ALP 2005). The main crop types of the districts are cereal crops, oil crops, pulses, vegetables and spices (Agricultural Office of the Districts 2016). The other alternative sources of livelihood include off-farm and non-farm activities. Non-farm activities such as pottery, metalwork, weaving, carpentry, and basket making are practiced as a result of shortage of agricultural land (BoFED 2006). Off-farm activities (micro and small enterprises) are used as the second poverty reduction and include animal husbandry, poultry, honey production and construction (BoFED 2004). According to Gebey and Mekuriaw (2013), livestock is the most valuable resource for the livelihood of the rural people. Especially, cattle are the best source of income (ALP 2005).

**The status of human and livestock health**

The main human diseases occurred in the districts are malaria, tuberculosis, lung diseases, intestinal parasites, diarrheal diseases, gastritis and duodenitis, eye diseases, skin wounds (infections) and epilepsy. The transmission of malaria increases between September and November which are the major transmission seasons of it (ALP 2005). The seasons are associated with the amount of rainfall and relative humidity. The average monthly rainfall for malaria transmission was recorded to be 86.6-316.3 mm and that of average monthly relative humidity was 50-78%. The other major disease type is tuberculosis whose consequences are particularly serious and potentially weakens patients and their families (Emiru 2015).

The districts have also several economically important livestock diseases which are mentioned as the main problem for livestock rearing. The major livestock diseases occurred in the districts are anthrax (which infects cattle and goat), goat pox, black leg, and internal and external parasites (infects both cattle and goats), skin disease, pasteurellosis, trypanosomiasis and fasciolosis. Morbidity rates in indigenous sheep breeds of the district can be 70 to 90% and mortality can be from 5 to 10%. Both morbidity and mortality highly influence productivity and they reduce commercial value (ESGPIP 2009). Fasciolosis is one of the major parasites of domestic animals in Quarit district. It imposes direct and indirect economic impact on ruminants (cattle and sheep) which are the natural hosts for Fasciola (liver flukes) infestation (Urquhart *et al.* 1996).

**Site selection**

The representative study kebeles (sub-districts) were selected after the reconnaissance survey of Yilmana Densa, and Quarit districts from September to November 2015 and February to June 2016. The sites were selected by discussing with the local people. Following the discussion, a total of 19 representative rural kebeles (12 from Yilmana Densa and 7 from Quarit) were selected (Figure 1).

**Sample selection**

The total respondents participated in the study were 395 (268 males and 127 females) whereas the total number of key informants were ninety-five. The key informants were selected because of reserving better amount knowledge than the general respondents / informants. The recommendation for the selection of key informants was given by elderly and knowledgeable inhabitants of the districts. Representative general and key informants were selected using systematic random and purposive sampling approaches, respectively, as described by Albuquerque *et al.* (2014). The age of the informants ranged from 20 to 81 years (207 were from 20 to 50, whereas 188 were >50 years old). Most of the informants (290 informants) were illiterate whereas the remaining 105 informants were literate including those who were educated in traditional schools.

**Data collection**

The data collection methods were following the ethno-botanical methods of Albuquerque *et al.* (2014). Data were collected in different seasons over different years to collect plant specimens during the respective flowering and fruiting seasons. Semi-structured interviews, with focus group discussions, participant and field observation, were used to collect the data. The informants were asked about local names, habitats, parts used, collecting households, the threats and traditional conservation practices of veterinary medicinal plants. The informants were also asked about the diagnosis methods of diseases, mode of remedy preparation and dosage, application, routes of remedy administration and ingredients used sources of knowledge about veterinary medicinal plants and method of indigenous knowledge transfer.

All semi-structured interviews were followed by independent walk - in - the - woods exercises to pave the way for a detailed discussion with the informant and the practical identification of traditionally used veterinary medicinal

plants of the districts. Field observations were performed with the help of local guides, as well as some respondents of the local community. Moreover, one focus group discussion (consisting of 7 participants) per kebele was undertaken to gain detailed data on veterinary medicinal plants of the districts.

**Plant Specimen identification**
Veterinary medicinal plant specimens were collected, numbered, pressed, dried, and identified. Identification of specimens was performed both in the field and by using Flora of Ethiopia and Eritrea. Plant specimen collection and preparation were made using the methods of Alexiades (1996).

**Use diversity study**
All informants of the study were interviewed at the same time for their knowledge of the additional local use or use diversity of veterinary medicinal plants cited for one or more uses of medicinal and other useful plants following the method of Martin (1995), Cotton (1996) and Albuquerque *et al.* (2014).

**Market survey**
Market surveys were conducted at three marketplaces, namely Adet and Bir Gebeya (from Yilmana Densa district) and Dabi (from Quarit district). The purpose of market survey was to record and document the availability of veterinary medicinal plants found in the markets following the method of Alexiades (1996).

**Data analysis**
Like the data collection methods, most of the data analysis methods were done based on the methods of Albuquerque *et al.* 2014.

**Informant consensus factor**
Informant consensus factor (ICF) was computed to measure the level of homogeneity of the information collected and the degree of overall agreement on the treatment of each animal health disorder and to identify the most effective medicinal plants used for the traditional treatment of domestic animal diseases in the districts. The informants were contacted three times for the same ideas to assure the reliability of the information recorded during the first interview, and the information that was repeated in the same manner by the informants at three contact times was recorded. ICF was computed as follows: ICF = Nur - Nt / (Nur - 1), where Nur = number of use reports from informants for a particular plant use; Nt = number of species that are used for that plant use for all informants. ICF values range between 0 and 1, where '1' indicates the highest level of informant consent.

**Fidelity level**
The relative healing potential of each reported medicinal plant used against domestic animal disease was evaluated using an index of fidelity level (FL) and it was calculated as follows: FL (%) = (Ip / Iu) X 100, where Ip is the number of informants who independently cited the importance of a species for treating a particular disease and Iu the total number of informants who reported the plant for any given disease.

**Preference ranking**
Sixteen key informants were selected for the preference ranking of 9 medicinal plants used to treat gastrointestinal diseases, and the scores were provided by the informants based on their preference. In this exercise, the medicinal plant which participants thought to be the most effective in treating the reported disease got the highest value (9), whereas the one with the least effective got the lowest value (1). Based on the total score of each species, the rank was determined (Martin 1995).

**Direct matrix ranking**
Data on the diversity of 5 multipurpose medicinal plants was evaluated by direct matrix ranking exercise as described by Alexiades (1996). This involved six (four men and two women) key informants. The purpose of the direct matrix ranking exercise was to identify whether which the multipurpose medicinal plants were most widely used in the districts for the purpose of identifying the major threats of medicinal plants (Martin 1995).

**Descriptive statistics**
The method of descriptive statistics was also applied to identify the number and percentage of species, genera, and families of medicinal plants used, their growth forms, proportions of parts used.

## Results and discussions

### Diversity of reported medicinal plants

A total of 30 medicinal plants were reported by the respondents to be used as a source of traditional medicine for the treatment of domestic animal diseases. The species were recorded to be grouped under 30 genera and 22 families (Table 1). Four species were endemic to Ethiopia. The highest number of species was recorded for Asteraceae and Euphorbiaceae (3 species, 10% each). Regarding their growth form, most species were herbs (12 species, 40%) followed by shrubs (8, 26.7%), trees and climbers (5, 16.7% each). About 76.7 % (23 species) were non-cultivated, whereas 23.3% (7 species) were cultivated for different purposes. The reported parts to be used as a source of traditional medicine for the treatment of domestic animal diseases were bulb, fruit, flower, leaf, root, seed and stem. The exudates (latex both milky and watery) derived from the different parts mainly from leaves and stems of the medicinal plants were also the other source of remedy. Out of these parts, the leaves were the primary source of traditional medicine to cure animals (Figure 3).

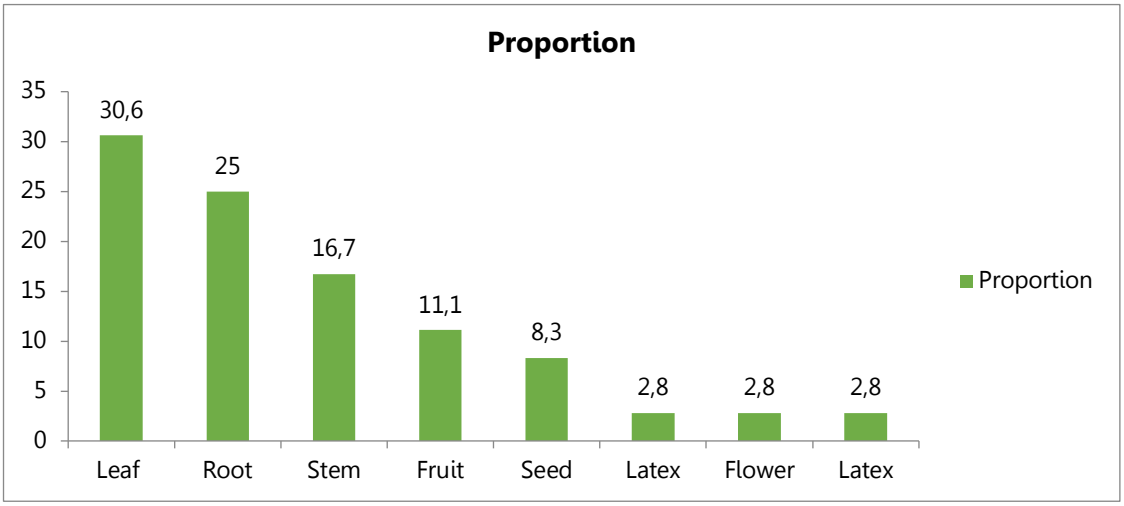


Figure 3. Proportion of the parts as resource of remedy

The study showed that the current study districts of West Gojjam Zone, Amhara Region are rich with veterinary medicinal plants compared to some parts of the country (Table 2). However, as some research findings showed, there are other areas which are richer with veterinary medicinal plants compared to the current study districts (Table 1). The variation in the number of veterinary medicinal plants record in these areas of the country might be determined by many different factors. These might be the study area coverage i.e. as the study area increases the number of record might increase. For example, South Omo and Gamo Gofa have more record of species than the present study districts because of the study was undertaken at Zone (including many districts) level.

Similarly, four districts in southern Ethiopia and the same number of districts in Jimma zone have more record of medicinal plants. This is as mentioned before because of the variation in study area coverage and the variation in the vegetation (forests, woodlands, shrub lands and others) cover of the study areas. For example, the southern and southwestern parts of the country have higher vegetation cover than the northern parts of the country. This is because of the presence of the highest land degradation and continuous deforestation of the vegetation resources in the northern parts. The reason is that the livelihoods of the local people of the southern, southwestern parts of the country are interconnected with vegetation especially with forests. Because they have wild coffee found in forests, thus they have to protect the forest for the sake of the coffee found in.

In the contrary, such types of activities are not observed in the northern parts of Ethiopia. Thus, the areas got a chance to be rich with vegetation and in turn help the areas to be richer with veterinary medicinal plants than other parts of the country. For example, most of the areas such as Tehuledere district, Kilte Awulaelo district, Dabat district, where are found in Northern Ethiopia are the least in veterinary medicinal plants record (Table 2). While areas found in southern and southwestern parts of the country such as Omo, Gamo Gofa, Jima Zone, and areas with dense forest such as Ankober district, north Shewa are richer than the northern parts of the country. Thus, since veterinary medicinal plants are parts of the vegetation of the country, and in addition most of the species are non-cultivated which are found in from their wild habitats the existence of vegetation cover determines the existence of veterinary medicinal plants.

Table 1. Ethno-veterinary medicinal plants used for the traditional treatment of domestic animal diseases

| Scientific name | Family | Local name | Parts used | Used to treat | Used for | Mode of preparation | Application | Administration |
|---|---|---|---|---|---|---|---|---|
| *Acmella caulirhiza* Del. | Asteraceae | Yemedirberbere | Flower | Eye disease | Bull, cow, heifer, ox, | Crushing | Painting | Optical |
| *Aloe pulcherrima* Gilbert & Sebsebe | Aloaceae | Ret | Jell | Hair disease | Cow, ox, | Cutting | Painting | Dermal |
| *Arisaema schimperianum* Schott | Araceae | Yejibageda | Stem | Gastrointestinal disorder | Cow, ox, | Crushing | Drinking | Oral |
| *Brucea antidysenterica* J. F. Mill. | Simaroubaceae | Waginos | Leaf | Gastrointestinal disorder | Cow, ox | Crushing | Drinking | Oral |
| *Calotropis procera* (Ait.) Ait. f. | Asclepiadaceae | Tobia | Latex | Rashes | Cow, ox | Squeezing | Drinking | Oral |
| *Calpurnia aurea* (Ait.) Benth. | Fabaceae | Zigta | Leaf | Lice | Cow, ox | Crushing | Washing | Dermal |
| *Clausena anisata* (Willd.) Benth. | Rutaceae | Limich | Leaf, root | Swelling on the body | Cow, ox | Crushing | Drinking | Oral |
| | | | | | Donkey, horse, mule | Crushing | Drinking | Oral |
| *Coriandrum sativum* L. | Apiaceae | Dinbilal | Seed | Cough | cow, donkey, horse, ox | Roasting, pounding | Eating | Oral |
| *Crinum abyssinicum* Hochst. ex A. Rich. | Amaryllidaceae | Yejibshnkurt | Bulb | Gastrointestinal disorder | Cow, ox | Crushing | Eating | Oral |
| *Croton macrostachyus* Del. | Euphorbiaceae | Bisana | Bud | Gastrointestinal disorder | Cow, ox | Crushing | Drinking | Oral |
| *Cucumis ficifolius* A. Rich. | Cucurbitaceae | Yemidirembuay | Root, fruit, leaf | Swelling, rabies, Gastrointestinal disorder, sneezing | cow, ox | Crushing | Drinking, eating | Oral |
| | | | | | Cow, goats, ox, sheep, | Crushing | Dropping | Nasal |
| | | | | | Dog | Crushing and mixing with meat | Eating | Oral |
| *Echinops kebericho* Mesfin | Asteraceae | Kebericho | Root | Swelling, Gastrointestinal disorder, cough | Cow, ox | Crushing with the root of *Phytolacca dodecandra* | Eating | Oral |
| | | | | | Donkey, horse, mule | Pounding with *Coriandrum sativum* | Eating | Oral |
| *Erythrina brucei* Schweinf. | Fabaceae | Korch | Leaf | Eye disease | Cow, ox | Crushing | Painting or dropping | Optical |
| *Euphorbia abyssinica* Gmel. | Euphorbiaceae | Kulkual | Latex | Emaciation, rabies | Cow, ox | Squeezing | Drinking | Oral |
| *Justicia schimperiana* (Hochst. ex Nees) T. Anders. | Acanthaceae | Sensel | Leaf | Swelling, Gastrointestinal | Cow, donkey, horse, mule, ox | Crushing | Drinking | Oral |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | disorder, chicken disease | Chicken | Crushing | Eating | Oral |
| *Laggera siceraria* (Molina) Standley | Cucurbitaceae | Qil | Fruit | Gastrointestinal disorder | Cow, ox | Crushing | Drinking | Oral |
| *Lepidium sativum* L. | Brassicaceae | Feto | Seed | Febrile illness, cough | Cow, ox | Pounding | Drinking | Oral |
| *Myrica salicifolia* A. Rich. | Myricaceae | Shinet | Leaf, bark | Febrile illness | Ox | Crushing | Washing | Dermal |
| | | | | | Cow, ox | Crushing and squeezing the bark | Dropping | Optical |
| *Nicotiana tabacum* L. | Solanaceae | Tinbaho | Leaf, fruit | Leech | Cow, ox, bull | Crushing | Eating | Oral |
| *Nigella sativa* L. | Ranunculaceae | Tekur Azemud | Seed | Leech | Cow, ox | Mixing with water | Drinking | Oral |
| *Olinia rochetiana* A. Juss. | Oliniaceae | Tifie | Bud | Eye disease | Cow, ox | Crushing | Dropping | Optical |
| *Phytolacca dodecandra* L'Her. | Phytolaccaceae | Endod | Root, leaf | Rabies, swelling, Gastrointestinal disorder | Cow, dog, ox | Crushing | Drinking, eating | Oral |
| *Ricinus communis* L. | Euphorbiaceae | Chakima | Root | Gastrointestinal disorder | Cow, ox | Crushing | Drinking | Oral |
| *Rumex nepalensis* Spreng. | Polygonaceae | Yewushamilas | Root | Gastrointestinal disorder | Cow, ox | Crushing | Drinking | Oral |
| *Solanum marginatum* L.f. | Solanaceae | Gebreembuay | Fruit | Sneezing | Cow, goat, ox, sheep, | Squeezing | Dropping | Nasal |
| *Stephania abyssinica* (Dillon & A. Rich.) Walp. | Menispermaceae | Engochit | Root | Gastrointestinal disorder | Cow, ox, sheep, goats | Crushing | Drinking | Oral |
| | | | | Rabies | Puppy | Crushing and mixing with milk | Drinking | Oral |
| *Thalictrum rhynchocarpum* Dill. & A. Rich. | Ranunculaceae | Sirebizu | Root | Weight loss, Gastrointestinal disorder | cCw, ox, sheep, goats | Crushing | Drinking | Oral |
| *Urera hypselodendron* (A. Rich.) Wedd | Urticaceae | Lankuso | Leaf | Swelling on the body | Donkey | Crushing and squeezing | Drinking | Oral |
| *Verbascum sinaiticum* Benth. | Scrophulariaceae | Dabakeded | Root | Back bleeding, weight loss | Cow, ox | Crushing | Eating | Oral |
| *Vernonia amygdalina* Del. | Asteraceae | Grawa | Leaf | Gastrointestinal disorder | Livestock | Crushing | Drinking | Oral |

In addition to these two factors which might determine the number of veterinary medicinal plants record, the presence of cultural and traditional medicinal knowledge difference among Ethiopian communities might also be other determinant factors. The southern part of Ethiopia has the highest cultural diversity because of inhabited by different communities with multiple cultures. This led the areas to be one of the richest in veterinary medicinal plant record.

The results showed that most of the veterinary medicinal plants in the two districts were herbs and leaves are the primary sources of remedy out of the other seven mentioned parts. The use of herbaceous species as the primary source of traditional medicine in the study districts might be related to their availability compared to trees and shrubs (Lulekal *et al.* 2013; Getaneh and Girma 2014). It might also be associated with their abundance with a relatively high amount of rainfall in the area. In agreement with the present study, leaves were recorded as the primary source of remedy for veterinary diseases in other findings (Tolossa *et al.* 2013; Yigezu *et al.* 2014; Tekle 2014; Romha *et al.* 2015; Simegniew *et al.* 2017).

It might be also because of possessing strong phytochemicals like alkaloids and flavonoids that have strong antibacterial and antifungal properties (Trotter and Logan 1989). In addition, the use of leaves as source of traditional medicine might be twofold. This is because of cutting the leaves from medicinal plants does not damage the plant unlike that of using roots by digging and cutting the plants. On the other hand, preparation of remedy from leaves is easily for crushing unlike that of roots, stems. These might be the reasons for the dominance of leaves as source of remedy as recorded in many other research findings (Woldegerima *et al.* 2008; Adefa and Abraha 2011; Lulekal *et al.* 2013; Getaneh and Girma 2014; Birhanu *et al.* 2018).

Asteraceae and Euphorbiaceae were also recorded to be the dominant families in consisting of more veterinary medicinal plants. The dominancy of Asteraceae in the areas might be because of its highest distribution in the country. Thus, because of the species under this family have highest distribution; thus, they might have highest availability in the areas for use. The dominancy of Euphorbiaceae also might be because of the species under this family possess highest phytochemicals that used to cure especially gastrointestinal ailments. It might be the reason why these families are recorded to be one of the dominant families of the veterinary medicinal plants in most areas of the country. For example, both families were recorded as dominant families by Lulekal *et al.* 2014 and Tekle 2014 whereas Asteraceae was recorded as dominant family by Tolossa *et al.* 2013.

Table 2. Comparison in the richness of medicinal plants in different parts of Ethiopia

| **Study areas** | **Number of records** | **Citations** |
|---|---|---|
| The present study districts | 30 species | |
| Chiro district, Hararge, Ethiopia | 12 species | Bekele and Musa 2009 |
| Dabat district, North Ethiopia | 18 species | Woldegerima et al 2008 |
| Tehuledere district, south Wello | 19 species | Adefa and Abraha 2011 |
| Kilte Awulaelo district, Tigray | 19 species | Teklay *et al.* 2013 |
| Horro Gudurru districts, western Ethiopia | 25 species | Birhanu and Abera 2015 |
| Wonago district, south Ethiopia | 28 species | Mesfin *et al.* 2009 |
| Goma district, south Ethiopia | 29 species | Mesfin *et al.* 2009 |
| Kochore district, Gedeo Zone | 29 species | Tekle 2014 |
| Enarji Enawga district, East Gojjam Zone | 34 species | Simegniew et al 2018 |
| Four districts, southern Ethiopia | 49 species | Romha *et al.* 2015 |
| Ankober district, north Shewa zone | 51 species | Lulekal *et al.* 2014 |
| Babile district, Eastern Ethiopia | 51 species | Belayneh *et al.* 2012 |
| Four districts, Jimma zone | 74 species | Yigezu *et al.* 2014 |
| Gamo Gofa, south Ethiopia | 89 species | Adefa and Getaneh.2013 |
| South Omo, southern Ethiopia | 91 species | Tolossa *et al.* 2013 |

Euphorbiace also recorded as dominant veterinary medicinal plant family by Simegnew *et al.* 2017. In addition, it was also recorded as a dominant veterinary medicinal plant family in Bagerhat district, Bangladesh (Rahmatullah *et al.* 2010). The results further showed that the majority veterinary medicinal plants have been harvested from their wild habitats in agreement with other research findings (Adefa and Abraha 2013; Yigezu1 *et al.* 2014; Simegniew *et al.* 2018). This indicated that most species are under various threats.

**Proportions**

The majority (70%) of veterinary medicinal plants (21 species) were reported to be used for the treatment of a single disease type, whereas 9 species (30%) were used for the treatment of more than one disease type (Table 1). Moreover, most species (63.6%) were used for the treatment of cattle diseases. This might be because of the rearing of the highest number of cattle than other domestic animals. This might be because of cattle rearing is one of the major livelihoods for the population of the areas as mentioned in the methods part. Thus, the local people might focus on these groups.

**Diagnosis of diseases**

It was reported that usually veterinary remedy was administered after the animal was visually examined by a traditional healer for any symptoms on its mouth or foot parts, throat, eyes, nose, and ear as well as through the occurrence and status of wounds on its skin. The animal diseases were identified based on the observation of diseased animals. Moreover, they were identified based on the information obtained from the owner of the animal by interviewing about the major symptoms shown by the animals.

**Mode of preparation, application, and routes of administration**

It was reported that most of the remedy (94.3%) was prepared from freshly harvested veterinary medicinal plants whereas the remaining from the dried parts of plants. Most of the preparation was done by crushing, whereas the remaining was given by chewing (the owner of the cattle first chews the plant part with his mouth and then painted the infected part), pounding, and cutting. The seeds were the only dried parts to be used as a source of veterinary remedy. Most (70%) remedy was prepared from medicinal plants without a need of plant ingredients or mixtures. Thus, of the remedy was reported to comprise remedial parts of a single medicinal plant. However, 30% of the remedy was prepared by combining two or more veterinary medicinal plants. The use of the majority of the species without plant ingredient was also recorded in other research (Belayneh *et al.* 2012).

After the veterinary remedy / traditional medicine were prepared, it was applied by rubbing and pasting of the remedy for the treatment of dermatological diseases, whereas oral administration was applied for the treatment of internal diseases. These types of application methods were recorded in other parts of Ethiopia. As it was reported, the prepared remedy was administered through four routes (dermal (10%), optical (6.7%), nasal (3.3%), and oral (80%)). In agreement to the present study, oral administration was also recorded as the major administration routes in many research findings (Adefa and Abraha 2011; Tolossa *et al.* 2013; Yigezu *et al.* 2014; Birhanu and Abera 2015).

More to the point, the dosages of the remedy did not usually have standard traditional measurement scales but rather given by rough estimation. However, it was reported that cups and glasses were rarely used as traditional standards of measurement. The most veterinary remedy was applied orally, indicating most of the diseases are internal parasites. In agreement with the current findings, oral routes were reported as the major routes in other research findings (Giday and Teklehaymanot 2013; Regassa 2013; Getaneh and Girma 2014).

What is more, the results showed that freshly harvested parts of medicinal plants were dominantly used for the preparation of the traditional veterinary medicine. This might be the main reason for preferring crushing as the main preparation method. Furthermore, it might be for achieving high efficacy in using active ingredients of fresh plant parts which they could suspect to be lost on drying. According to Woldegerima (2008), freshly harvested materials have better efficacy than dried plant materials. This is due to some compounds or molecules inside the fresh materials that might be evaporated when they are exposed to intense sunlight and hence might result in the loss of their efficacy level (Giday and Teklehaymanot 2013). The other reason might be due to the unsuitability of the species' parts to preserve in dried form.

**Informants' agreement**

The highest informants' consensus factor (ICF) values were recorded for rabies (0.97). As well, the highest plant use citation (49%) was recorded for gastrointestinal diseases (17.7%) (Table 3). Regarding their uses, most species (40.22%) were reported to be used for the treatment of gastrointestinal diseases followed by those used to treat dermatological ones (11 species, 29.1%). Amongst all plants reported, the highest proportion of species was claimed to treat gastrointestinal diseases (12 species, 40%), followed by rabies, cough, and eye diseases (3 species, 10% each). The results of the study agreed with other findings (Lulekal *et al.* 2013). This indicated that diseases under this group might have the highest frequency and risk (most lethal for domestic animals) in the areas (Regassa 2013). Therefore, local people might focus on such diseases resulting in practicing repeated traditional tests on most

species to protect their domestic animals. This might be experienced with most species of veterinary medicinal plants.

The prevalence of dermatological diseases also mentioned in second order in the areas. This might be because of the presence of poor treatment of domestic animals in both feeding and shelter provision. For example, as it was reported, there is a scarcity of fodder which results in weight loss that might lead the body of the animal to be exposed to dermatological parasites such as animal lice. Most livestock also might be reared in the fields (outside houses) resulting exposed to blood-sucking birds. It also resulted in a lesion which is a dermatological disease. Furthermore, the rearing places of domestic animals might lack purity. Thus, it might cause and contribute to such types of diseases to prevail (Getaneh and Girma 2014).

Table 3. Informants' agreements on livestock diseases

| Disease categories | Nur | Nt | ICF |
|---|---|---|---|
| 1. Rabies | 33 | 2 | 0.97 |
| 2. Eye disease | 23 | 3 | 0.9 |
| 3. Gastrointestinal diseases | 119 | 16 | 0.87 |
| 4. Dermal diseases | 13 | 9 | 0.3 |

**Relative healing potential of veterinary medicinal plants**

*Stephania abyssinica* showed highest fidelity level value (93.3%) for gastrointestinal disease category followed by *Justicia schimperiana* (64.3%) under miscellaneous disease category. *Cucumis ficifolius* also showed relatively high healing potential (16%) under respiratory disease category (Table 4). The results showed that *Stephania abyssinica* and *Justicia schimperiana* have highest fidelity level of 93.3% and 64.3% respectively. It also showed that infective disease categories have highest informant agreements. Highest fidelity values indicate the correlated highest healing potential of the species. Furthermore, it reveals that the distribution of most important knowledge of the species in the local community (da Silva *et al.* 2014).

Table 4. Fidelity level of 5 veterinary medicinal plants

| Scientific name | Family | Disease treated | Ip | Iu | FL (%) |
|---|---|---|---|---|---|
| *Stephania abyssinica* (Dillon & A. Rich.) Walp. | Menispermaceae | Gastrointestinal disorder | 28 | 30 | 93.3 |
| *Justicia schimperiana* (Hochst. ex Nees) T. Anders. | Acanthaceae | Chicken disease | 9 | 14 | 64.3 |
| *Cucumis ficifolius* A. Rich. | Cucurbitaceae | Sneezing | 21 | 131 | 16.0 |
| *Phytolacca dodecandra* L'Her. | Phytolaccaceae | Rabies | 20 | 220 | 9.0 |
| *Echinops kebericho* Mesfin | Asteraceae | Cough | 7 | 97 | 7.2 |

**Preference of medicinal plants**

*Phytolacca dodecandra* was recorded to be the most preferred (by total score of 129) medicinal plant to treat gastrointestinal disorder while *Cucumis ficifolius* (by total score of 117) was the second for the same purpose (Table 5).

Table 5. Preference ranking of 9 medicinal plants reported to treat gastrointestinal disorders

| Medicinal plants for gastrointestinal disorders | Informants labeled A to P | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | TS | R |
| *Arisaema schimperianum* Schott | 7 | 3 | 8 | 7 | 8 | 2 | 1 | 3 | 6 | 8 | 6 | 3 | 9 | 5 | 7 | 3 | 86 | 4th |
| *Brucea antidysenterica* J. F. Mill. | 4 | 6 | 4 | 4 | 7 | 4 | 3 | 4 | 5 | 2 | 2 | 5 | 1 | 7 | 6 | 2 | 66 | 6th |
| *Crinum abyssinicum* Hochst. ex A. Rich. | 1 | 2 | 3 | 5 | 3 | 1 | 2 | 1 | 2 | 3 | 5 | 6 | 2 | 4 | 3 | 1 | 44 | 8th |
| *Croton macrostachyus* Del. | 2 | 1 | 5 | 3 | 5 | 5 | 4 | 2 | 3 | 4 | 7 | 1 | 7 | 6 | 5 | 8 | 68 | 5th |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cucumis ficifolius* A. Rich. | 8 | 8 | 7 | 6 | 6 | 8 | 9 | 8 | 4 | 7 | 9 | 7 | 6 | 8 | 9 | 7 | 117 | 2nd |
| *Justicia schimperiana* (Hochst. ex Nees) T. Anders. | 3 | 5 | 1 | 8 | 1 | 3 | 6 | 5 | 1 | 5 | 1 | 2 | 3 | 2 | 4 | 9 | 59 | 7th |
| *Phytolacca dodecandra* L'Her. | 9 | 7 | 9 | 9 | 9 | 9 | 8 | 9 | 7 | 9 | 8 | 9 | 5 | 9 | 8 | 5 | 129 | 1st |
| *Rumex nepalensis* Spreng. | 5 | 4 | 2 | 1 | 2 | 6 | 6 | 6 | 8 | 1 | 3 | 4 | 4 | 3 | 1 | 6 | 59 | 7th |
| *Stephania abyssinica* (Dillon & A. Rich.) Walp. | 6 | 9 | 6 | 2 | 4 | 7 | 7 | 7 | 9 | 6 | 4 | 8 | 8 | 1 | 2 | 4 | 89 | 3rd |

**Note:** Scores indicate ranks given to medicinal plants based on their efficacy. Highest number (9) is given for medicinal plant which informants thought most effective in treating gastrointestinal disorders and lowest number (1) for the least.

The preference of a species and its parts might be a threat for that particular species (Ramos et al., 2014) since preference of use might result in overharvesting of the species. *Cucumis ficifolius* was reported to be rare in the areas because of overharvesting of the species since they are the most preferred species by the communities. In agreement to other reports done in other parts of Ethiopia (Fassil 2003), the roots of the species have been harvested for veterinary medicinal purposes as a result such types of activities are the most dangerous for the sustainability of the species (Yirga 2010; Lulekal *et al.* 2013). The result of direct matrix ranking on multipurpose veterinary medicinal plants *Croton macrostachyus* was ranked first (most threatened) (Table 6).

Table 6. Average direct matrix ranking score of six key informants for 5 species with additional uses (5 = best; 4 = very good; 3 = good; 2 = less used; 1 = least used and 0 = no value)

| | *Calpurnia aurea* | | | | | | *Croton macrostachyus* | | | | | | *Justicia schimperiana* | | | | | | *Olinia rochetiana* | | | | | | *Phytolacca dodecandra* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Informant (I)(1-6) | | | | | | I | | | | | | I | | | | | | I | | | | | | I | | | | | |
| Agricultural tool | 5 | 5 | 5 | 4 | 3 | 4 | 4 | 5 | 5 | 4 | 4 | 5 | 1 | 2 | 2 | 1 | 3 | 4 | 1 | 2 | 2 | 3 | 3 | 2 | 0 | 0 | 2 | 0 | 0 | 0 |
| Fence | 3 | 2 | 1 | 3 | 4 | 5 | 3 | 1 | 4 | 1 | 3 | 1 | 5 | 5 | 4 | 5 | 5 | 5 | 2 | 3 | 3 | 4 | 4 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| Firewood | 4 | 3 | 4 | 2 | 1 | 3 | 5 | 4 | 3 | 5 | 5 | 4 | 1 | 3 | 3 | 1 | 2 | 3 | 4 | 5 | 4 | 5 | 5 | 5 | 1 | 1 | 2 | 1 | 1 | 1 |
| Washing purpose | 3 | 1 | 2 | 1 | 2 | 1 | 1 | 3 | 2 | 2 | 1 | 2 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 5 | 5 | 5 | 5 | 5 | 5 |
| Informant total | 15 | 11 | 12 | 10 | 10 | 13 | 13 | 13 | 14 | 12 | 13 | 12 | 10 | 11 | 9 | 8 | 10 | 12 | 7 | 10 | 9 | 13 | 14 | 8 | 7 | 7 | 11 | 7 | 7 | 7 |
| Grand total | 71 | | | | | | 77 | | | | | | 60 | | | | | | 61 | | | | | | 46 | | | | | |
| Rank | 2nd | | | | | | 1st | | | | | | 4th | | | | | | 3rd | | | | | | 5th | | | | | |

Medicinal species with highest use diversity might be under pressure. The result also showed that multipurpose species such as *Calpurnia aurea*, *Croton macrostachyus* and *Phytolacca dodecandra* are the most threatened species. This is because multipurpose species are the most threatened than the other medicinal plants with least additional uses (Alemayehu *et al.* 2015; Kidane *et al.* 2018).

**Marketability**

Limited numbers of species (6 species, 20%) of veterinary medicinal plants were available in the local markets (Adet and Dabi local markets) of the areas. Out of the marketable species, three species namely *Nigella sativa*, *Coriandrum sativum* were sold in mass for the purpose of spice. These species were cultivated in farmlands for this purpose whereas *Lepidium sativum* was sold in small amount as it was needed in small quantity for the treatment of human gastrointestinal ailments. The species was cultivated as intercrops usually with *Eragrostis tef* in farmlands. As it was reported, the species is nowadays scarce as farmers ignored the cultivation of the species in their farmlands because of the traditional medicinal plants have been replaced by modern medicine.

*Echinops kebericho* an expensive species since nowadays the species has been dwindling because of overharvesting, and the harvesting system kills the species. Because the usable part of this species is root, so to harvest its roots the root must be cut down. *Laggera siceraria* was sold and cultivated for its large fruits that used to prepare house utensil which is used as a container of dough. But the local people who did not grow the plant, they bought the large-matured fruit and they use the internal flesh part of the plant as a source of veterinary medicine used for the treatment of veterinary diseases/ ailments. *Ricinus communis* is a home garden plant which is grown by farmers as the shelter of their house. But the main purpose of growing the species was for its oily seeds. The seeds were sold in large amount for traditional tanners for painting their leathers and as leathery substances to make them smooth. However, when their domestic animals become ill they used the seeds of the species as source of veterinary medicine.

**Threats and conservation status**

The major reported threats of veterinary medicinal plants were overharvesting of available species, agricultural land expansion, and less attention to traditional medicine due to modernization. The root of *Echinops kebericho* was reported to be overharvested for fumigation purposes to avoid evil spirits, especially during childbirth. The root of the species was also reported to be sold in local markets. Similarly, *Cucumis ficifolius* was reported to be highly overharvested for the treatment of both human and animal diseases.

The habitats where the species were reserved were also reported to be lost in need of extra agricultural land. Thus, the threats were both direct (killing the species by uprooting through digging) and indirect (clearing their major habits).On the other hand, some indirect conservation practices were reported in the study areas. These were cultivating veterinary medicinal plants for sale, food, firewood, shade, and fences as well as there was a reported seasonal protection of forest patches, which were the major reported habitats of the species.

The results showed that agricultural land expansion is the primary threat to the veterinary medicinal plants of districts as it is reported as a primary threat in other parts of Ethiopia (Mesfin *et al.* 2009; Lulekal *et al.* 2013). It further showed that the use preference is the other threat, in agreement with other findings (Balemie 2008). For example, *Cucumis ficifolius* and *Echinops kebericho* were overharvested for their roots and such activities also might kill the roots of the species. This might result in a severe threat to the survival of rare and slowly reproducing medicinal plants, in agreement with other findings (Zenebe *et al.* 2012; da Silva *et al.* 2014).

Moreover, multipurpose species were the most threatened as multipurpose species are the most threatened (Birhanu and Abera 2015). The results also showed that there are low conservation activities done by the local people in the districts. The conservation activities were also done indirectly rather than their primary role (medicinal plant conservation role) in agreement with other research findings done in other parts of Ethiopia (Ramos *et al.* 2014; Alemayehu *et al.* 2015).

## Conclusions

The study districts are rich with veterinary medicinal plants as they are the major sources of traditional veterinary medicines in other parts of Ethiopia. Thus, the local people of the district have reserved indigenous knowledge of medicinal plants. Nowadays, low attention has given to ethno-veterinary medicinal plants in using and conserving the species even if there are still rich sources of indigenous knowledge on ethno-veterinary medicine. Moreover, most ethno-veterinary medicinal plants are non-managed and non-marketable. Therefore, extensive awareness creation is needed regarding their conservation and management. More to the point, the extraction of veterinary remedy should be conducted on ethno-veterinary medicinal plants. In relation to this, healer associations should be established and there should be coordination with the district's health offices for the successful provision of traditional veterinary medicines. Finally, priority of conservation should be given to veterinary medicinal plants.

## Declarations

**Ethics approval and consent to participate**: The data were collected with respect to confidentiality and consent. All respondents were informed about the aim of this study.
**Consent for publication**: Not applicable.
**Availability of data and materials**: The data was included within the article.
**Competing interests**: The author declares no conflict of interest.
**Funding:** Not applicable.
**Authors' contributions:** The author read, reviewed, and approved the manuscript.

## Acknowledgements

The author is very much indebted to all local respondents who shared their veterinary medicinal plant knowledge with the author. The author also kindly acknowledges the local people giving hostility during data collection.

## Literature Cited

Abunna F, Merid B, Goshu G, Waktole H, Mammo G. 2018. Assessment of major reproductive health problems, their effect on reproductive performances and association with brucellosis in dairy cows in Bishoftu town, Ethiopia. Journal of Dairy Veterinary Animal Research 7(1):14-20.

Abebe D, Ayehu A.1993. Medicinal Plants and Enigmatic Health Practices of Northern Ethiopia Addis Ababa. B. S. P. E: Ethiopia.

Adefa M, Abraha B. 2011. Ethnobotanical survey of traditional medicinal plants in Tehuledere district, South Wollo, Ethiopia. Journal of Medicinal Plants Research 5(26):6233-6242.

Adefa M, Getaneh S. 2013. Medicinal Plants Biodiversity and Local Healthcare Management System in Chencha District; GamoGofa, Ethiopia. Journal of Pharmacognosy and Phytochemistry 2(1):284

Albuquerque P U C, da Cunha F V L, de Lucena P F R, Alves, N. eds. R R. 1995. Methods and Techniques in Ethnobiology and Ethnoecology. Springer Protocols Handbooks, New York.

Alemayehu G, Asfaw Z, Kelbessa E. 2015. Plant diversity and ethnobotany in Berehet district, North Shewa Zone of Amhara region (Ethiopia) with emphasis on wild edible plants. JMPS 3(6):93-105.

Alexiades M. 1996. Collecting ethnobotanical data.An introduction to basic concepts and techniques. In: (Alexiades, M. and Sheldon, J.W.eds.). Selected Guideline for ethnobotanical research: A Field Manual, The New York. Botanic Garden, USA: 58-94.

Balemie K. 2008. Some ethno-veterinary plants used by Kerreyu pastoralists in ORS, Ethiopia. Biodiversity Newsletter.

Bekele A, Musa A. 2009. Ethnoveterinary practice in Chiro District, western Hararge, Ethiopia. Pharmacologyonline 1:128-139.

Belayneh A, Asfaw Z, Demissew S and Bussa N. 2012. Medicinal plants potential and use by pastoral and agro-pastoral communities in Erer Valley of Babile Wereda, Eastern Ethiopia. Journal of Ethnobiology and Ethnomedicine 8:42.

Birhanu T, Abera D. 2015. Survey of ethno-veterinary medicinal plants at selected HorroGudurru districts, western Ethiopia. African Journal of Plant Science 9(3):185-192.

BoFED (Bureau of Finance and Economic Development) 2004. Rural households socioeconomic baseline survey of 50 districts in Amhara Region (phase II), 7. Bahir Dar, Ethiopia.

BoFED. 2006. Development Indicators of Amhara region. Bahir Dar: BoFED.

Chaburte C, Endabu B, Getahun F, Fanta A, Asefa Z, Aragaw K. 2019. Health and welfare problems of pack donkeys and cart horses in and around Holeta town, Walmara district, Central Ethiopia. Journal of Veterinary Medicine and Animal Health 11(1):17-25.

Central Statistical Agency (CSA) 1994.1994 Population and Housing Census of Ethiopia: Results for Amhara Region, 1 (1). Tables 2.1, 2.7, 2.10, 2.13, 2.17, Annex II.2.

Central Statistical Agency (CSA)).2007. 2007Population and Housing Census of Ethiopia: Results for Amhara Region1 (1). Tables: Amhara Region. Tables 2.1, 2.4, 2.5, 3.1, 3.2 and 3.4.

Cotton MC. 1996. Ethnobotany: Principles and Applications. Roehampton Institute London.

da Silva VA, do Nascimento VT, Soldati GT, Medeiros, M F T, Albuquerque U P. 2014. Techniques for Analysis of Quantitative Ethnobiological Data: Use of Indices.

Demissew S, Dagne E. 2001. Basic and applied research in medicinal plants. In Proceedings of the National Workshop on Biodiversity Conservation and Sustainable Use of Medicinal Plants in Ethiopia: 28 April-1May 1998. Edited by Zewdu M, Demissie A. Addis Ababa, Ethiopia: Institute of Biodiversity Conservation Research 29-33.

Duguma B. 2013. Smallholder livestock production and marketing systems in the Haramaya district, Eastern Ethiopia. Basic Research Journal of Agriculturalñ Science Review 2:122-129.

ESGPIP (Ethiopia Sheep and Goat Productivity Improvement Program), 2009.

Fassil H. 2003. "We do what we know": Local health knowledge and home-based medicinal plant use in Ethiopia. PhD Thesis. International development center Queen Elizabeth House Green College, Oxford University.

Gebey T., Mekuriaw Z. 2013. Diagnosis and intervention plans for west Gojjam zone, Amhara region.

Getaneh S, Girma Z. 2014. An ethnobotanical study of medicinal plants in Debre Libanos district, Central Ethiopia. African Journal of Plant Science 8(7):9.

Giday M, Teklehaymanot T. 2013. Ethnobotanical study of plants used in management of livestock health problems by Afar people of Ada'ar District, Afar Regional State, Ethiopia. Journal of Ethnobiology and Ethnomedicine 9:8.

Gidey M, Ameni G. 2003. An Ethnobotanical Survey on plants of Veterinary Importance in two Woredas of Southern Tigray, Northern Ethiopia. SINET: Ethiopian Journal of Sci*ence* 26(2): 123-136.

Hurni H. 1998. Agroecological Belts of Ethiopia: explanatory notes on three maps at a scale of 1:1,000,000. Soil conservation research programme (scrp) research report no. 43. Addis Abeba, Ethiopia and Bern, Switzerland: Ministry of Agriculture and Centre for Development and Environment (CDE).

Kidane L, Gebremedhin G, Beyene T. 2018. Ethnobotanical study of medicinal plants in Ganta Afeshum District, Eastern Zone of Tigray, Northern Ethiopia. Journal of Ethnobiology and Ethnomedicine 14:64.

Lulekal E, Asfaw Z, Kelbessa E, Van Damme, P. 2014. Ethnoveterinary plants of Ankober District, North Shewa Zone, Amhara Region, Ethiopia. Journal of Ethnobiology and Ethnomedicine 10:21.

Lulekal E, Kelbessa E, Bekele T, Yineger H. 2008. An ethnobotanical study of medicinal plants in Mana Angetu District, southeastern Ethiopia Journal of Ethnobiology and Ethnomedicine 4 10.

Martin J G.1995. Ethnobotany: A methods manual. Chapman and Hall, London.

Mesfin F, Demissew S, Teklehaymanot T. 2009. An ethnobotanical study of medicinal plants in Wonago Woreda, SNNPR, Ethiopia. Journal of Ethnobiology and Ethnomedicine 5:28.

MOA, Ethiopia Animal Health Year Book (2009/10). 2010. Addis Ababa: Federal Ministry of Agriculture Animal and Plant Health Regulatory Directorate (APHRD).

MPGRD (Ministry of Provincial Government and Rural Development). 2008. Constituency Development Profile and Action Plan: Hograno/Kia/Havulei. A Report prepared for the Provincial Government Development Unit, Ministry of Provincial Government and Rural Development, Honiara, the Solomon Islands.

Rahmatullah M, Mollik A, Alam J, Ahmmed B, JahanIsrat, Sintaha M, KhalequeHimel, Chowdhury M, Noor F, Rahman S, Jahan R, Seraj S. 2010. An Ethnoveterinary Survey of Medicinal Plants Used by Folk Medicinal Practitioners to Treat Cattle Diseases in Randomly Selected Areas of Bagerhat District, Bangladesh. American-Eurasian Journal of Sustainable Agriculture 4(3):386-396.

Ramos AM, de Medeiros MP, Albuquerque PU. 2014. Methods and Techniques Applied to Ethnobotanical Studies of Timber Resources.

Regassa R. 2013. Assessment of indigenous knowledge of medicinal plant practice and mode of service delivery in Hawassa city, Southern Ethiopia. Journal of Medicinal Plants Research 7(9):517-535.

Romha G, Dejene TA, Telila LB, Bekele DF. 2015. Ethnoveterinary medicinal plants: Preparation and application methods by traditional healers in selected districts of southern Ethiopia. Veterinary World 8(5):674-684.

Simegniew Y, Leshe S, Abebe Y, Minuye N. 2018. Ethnoveterinary Medicinal Plants and Practices in Enarj Enawga District, East Gojjam Zone, Amhara Region, Ethiopia. International Journal of Animal Science 2(1):1014.

Sori T, Bekana M, Girma A, Ensermu K. 2004. Medicinal plants in the ethno-veterinary practices of Borana pastoralists, Southern Ethiopia. International Journal of Applied Research in Veterinary Medicine 2(3):220-225.

Tassew A, Teffera B, Jafar E, Ashagrie E, Mulugeta G, Tesfaye G, Adimasu S, Limenih S, Genet T, G. Selassie Y, Leyew Z. 2011. Comprehensive study on research, development and management interventions in Birr sub-watershed, Quarit district, West Gojjam zone, Amhara national regional state.

Teklay A, Abera B, Giday M. 2013. An ethnobotanical study of medicinal plants used in KilteAwulaelo District, Tigray region of Ethiopia. Journal of Ethnobiology and Ethnomedicine 9:65.

Tekle Y. 2014. An ethno-veterinary botanical survey of medicinal plants in Kochore district of Gedeo Zone, Southern Nations Nationalities and Peoples Regional State (SNNPRs), Ethiopia. Journal of Scientific and Innovative Research 3(4):433-445.

Tolossa K, Debela E, Athanasiadou S, Tolera A, Ganga G, Houdijk JGM. 2013. Ethno-medicinal study of plants used for treatment of human and livestock ailments by traditional healers in South Omo, Southern Ethiopia. Journal of Ethnobiology and Ethnomedicine 9:32.

Trotter, R.T. and Logan, M.H. 1986. Informant Consensus: A New Approach for Identifying Potentially Effective méDicinal Plants. Ed. Bedfore Hills, New York: 91-112.

Urquhart NS, Van Leeuwen MD, Murray W L. 1996.A mixed model with both fixed and random trend components across time. Journal of Agricultural, Biological and Environmental Statistics 1(4):435-453.

USDA, Giving Livestock Feed a Boost in Ethiopia. http://feedthefuture.gov/article/giving-livestock-feed-boost-Ethiopia.

Wabe TN, Mohammed AM, Raju JN. 2011. An ethnobotanical survey of medicinal plants used in the Southeast Ethiopia used in traditional medicine. Spatula DD 1:153-158.

Woldegerima B, Teferra A, Ragunathan M. 2008. Ethno-veterinary Use of Medicinal plants by Traditional Healers in Dabat District, Northwestern Ethiopia. Pharmacognosy Magazine 4(15).

Yigezu Y, Berihun D, and Yenet W. 2014.Ethnoveterinary medicines in four districts of Jimma zone, Ethiopia: cross sectional survey for plant species and mode of use. BMC Veterinary Research 10:76.

Yimer E, Mesfin A, Beyene M, Bekele A, Taye G, Zewdie B, Alemayehu T. 2012. Study on knowledge, attitude and dog ownership patterns related to rabies prevention and control in Addis Ababa, Ethiopia. Ethiopian Veterinary Journal 16(2):27-39.

Yineger H, Kelbessa E, Bekele T, Lulekal E. 2007. Ethno-veterinary medicinal plants at Bale Mountains National Park, Ethiopia. Journal of Ethnopharmacology 112:55-70.

Yirga G. 2010. Ethnobotanical study of medicinal plants in and around Alamata, southern Tigray, northern Ethiopia. Journal of Biological Sciences 2(5).

Zenebe G, Zerihun M, Solomon Z. 2012. An ethnobotanical study of medicinal plants in AsgedeTsimbila district, northwestern Tigray, northern Ethiopia. Ethnobotany Research and Applications 10:305-320.