Research Article

Ethnoveterinary Medicinal Plants and Practices in Enarj Enawga District, East Gojjam Zone, Amhara Region, Ethiopia

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Abstract

Background: Plant based remedies were commonly used to cover the healthcare demand of the livestock population in Ethiopia. However, the medicinal plants and the associated ethnoveterinary practices were not studied and documented to a prominent level in Ethiopia. Hence, this study was initiated to identify and document the medicinal plants used in the management of livestock diseases in Enarj Enawga District, Amhara Region, Ethiopia.

Results: Ethnobotanical data were collected from February 1 to October 31, 2016 using semi-structured interviews, focus group discussions and field observations. Overall, 34 medicinal plant species belonging to 32 genera and 23 botanical families were documented. Solanaceae, the most dominant plant family, was represented by six species (17.65%). The majority of the medicinal plants belong to the herb (44.44%) and shrub (35.29%) categories and most of them were cultivated from the wild (52.94%) habitats. Roots (42.11%) and leaves (31.581%) were the most frequently used plant parts for the preparation of remedies. Oral (66.66%) was the principal route of remedy administration followed by dermal (15.75%) and ophthalmic (8.77%). The study also revealed *Calotropic procera* as the most preferred medicinal plant species for treating swelling in the District.

Conclusion: This study documented the most commonly used medicinal plant species to treat different livestock ailments in Enarj Enawga District. The majority of the recorded medicinal plants was shown to have high fidelity level (FL) and should be considered for further phytochemical and pharmacological investigations.

Introduction

Plants have been used for centuries in traditional healing systems and many indigenous communities around the globe manipulated them as ethnoveterinary medicines [1]. Ethnoveterinary medicine generally means the folks, beliefs, knowledge skills, method and practices pertaining to health of animals, which play a vital role in rural areas as a chief source of medicine to cure livestock diseases [2]. The use of ethnoveterinary medicine presents a cheaper and sustainable alternative to synthetic medicine [3]. Ethnoveterinary medicines, drawing upon centuries of traditional belief and use, are in practice over time by pastoralists and farmers for the treatment of different livestock diseases [4]. Ethiopia is among the countries in Africa with the highest livestock population [5]. Livestock production is an integral part of the Ethiopian agriculture and shares about 40% of the total agricultural output [6]. Despite its profound contributions for the economy, the livestock productivity is relatively poor, with lowest unit output in the world. The poor health condition of its livestock has partially been responsible for the low productivity [7,8].

Ethnoveterinary medicine is frequently used in the management of different livestock ailments in different cultural groups of Ethiopia [8-22]. Although the primary healthcare demand of 90% of the livestock populations in the country primarily hinged on plant based traditional medicines [23], the ethnoveterinary practice is affected by acculturation and depletion of plant habitats as a result of environmental degradation, deforestation and over exploitation of the medicinal plants themselves [14,24]. In addition, the ethnoveterinary knowledge and practices have been transferred from generation to generation through oral tales than in written form [25,26]. Thus, the ethnoveterinary practices will be lost unless the useful medicinal plants are conserved and the associated indigenous knowledge is properly documented and analyzed. Unfortunately, very little efforts so far been made to document and analyze the ethnoveterinary medicinal plants and practices in Amhara Region [26-32] and Ethiopia [8-20,24,25]. To the best of our knowledge, there is no ethnoveterinary medicinal plant study conducted in Enarj Enawga District. Therefore, the present study was designed to document and analyze the ethnoveterinary medicinal plants and practices in Enarj Enawga District, Amhara Region, Ethiopia.
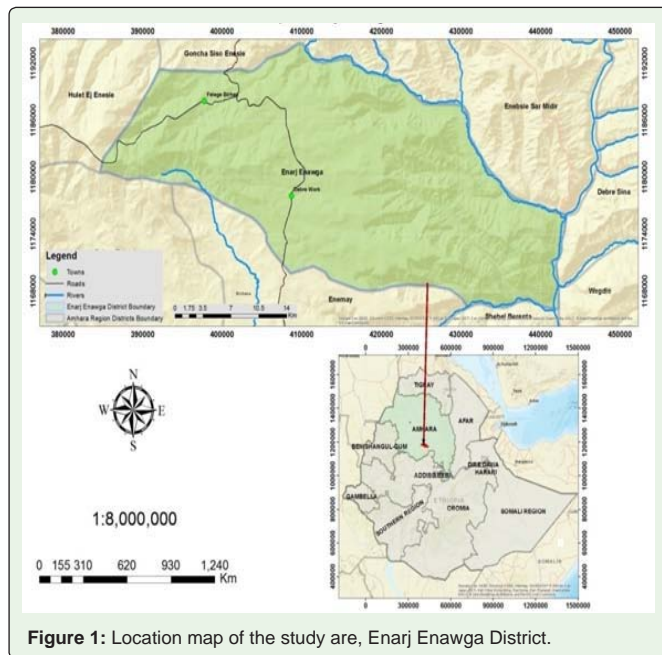
Figure 1: Location map of the study are, Enarj Enawga District.

Methods

Description of study area

The study was conducted in Enarj Enawga District (Woreda) found in East Gojjam Administrative Zone of the Amhara Regional State. Its capital, Debre Work town, is located at about 195 km south east of Bahir Dar, the capital city of Amhara Regional State and 291 km north of Addis Ababa, the capital city of Ethiopia (Figure 1). The District is bordered on the south by Enemay, on the southwest by Debay Telatgen, on the west by Hulet-Eju Enese, on the north by Goncha Siso-Enese, on the northeast by Enese Sar-Midir, on the east by Nile River that separate it from the South Wollo Zone, and on the southeast by Shebel Berenta. According to the 2007 national census conducted by the Central Statistical Agency (CSA), the District has a total population of 167,402 in 39,564 households, of whom 82,958 are men and 84,444 women; 13,623 (8.14%) are urban inhabitants. The indigenous people inhabiting the area belong to the Amhara ethnic group and speak Amharic language, the official language of Ethiopia. The majority of the inhabitants (97.36%) in the District practiced Ethiopian Orthodox Christianity and the remaining 2.34% of the population were Muslims [33].

Selection of study kebeles and informants

The ethnobotanical data were collected from 20 Kebeles (the smallest administrative unit in Ethiopia) of the study District that were purposively selected with the help of elders and local authorities based on better availability of traditional healers and knowledgeable informants. For the interview, 70 traditional healers and knowledgeable informants were selected using purposive sampling technique [34], of which 66 were men and four were women. The ages of the informants ranged between 25 and 78 years. Key informants for different ranking exercises were selected from those individuals previously sampled for the interview.

Ethnobotanical data collection

Data on plant parts used, method of preparation, dosage, route of administration, diseases treated, conservation status, cultivation practice and acquisition/transfer of indigenous knowledge were collected through semi-structured interviews and focus group discussions by following the standard methods [34,35]. Interviews and group discussions were held in Amharic, the mother tongue language of the people in the study area and the official language of Ethiopia. Field observations were also conducted to record the habit and habitat of each medicinal plant with the assistance of informants who participated during the interview. For each reported medicinal plant species, specimen was collected, pressed, dried, identified (by botanists at Debre Markos University (DMU)) and vouchers were deposited at DMU, College of Natural and Computational Sciences store.

Data analysis

The ethnoveterinary data were entered in to Microsoft Excel 2007 spreadsheet and organized for statistical analysis. Descriptive statistics was applied to compute the number and percentage of species, genera and families of ethnoveterinary medicinal plants, their growth forms, proportion of plant parts harvested, mode of remedy preparation and routes of administration.

Preference ranking exercise was used to identify the most preferred medicinal plant to treat swelling, the disease against which the highest number of medicinal plant species (eight) were prescribed by ethnoveterinary practitioners in Enarj Enawga District. For this purpose, ten individuals were selected randomly from the key informants and each individual was provided with fresh specimens of the nine medicinal plants and then asked to rank the plants according to their degree of preferences. Then, each medicinal plant was ranked based on the total sum of scores obtained [34,35].

Informants' agreement on cures for group ailments was estimated using ICF. The ICF value of each disease category was calculated as follows: number of use citations in each category (nur) minus the number of species used (nt), divided by the number of use citations in each category minus one [36].

$$ICF = \frac{nur \text{-} nt}{nur \text{-} 1}$$

The relative healing potential of each medicinal plant reported was estimated using an index called fidelity level (FL). It is computed as $FL = I_p/I_u \times 100$, where I_p is the number of informants who independently indicated the use of a species for the same major ailment and I_u the total number of informants who mentioned the plant for any major aliment [37].

Ethical considerations

The study was reviewed and approved by Research Evaluation Committee of Natural and Computational Sciences College, Debre Markos University before its commencement. Verbal consents, deemed appropriate by the committee for the study, were obtained from informants after brief introduction about the objective of the study prior to the interviews, field observations, ranking exercises. All verbal consents made with research participants were tape-recorded.

Table 1: Medicinal plant families with two or more plant species in the study area.

Family name	No of plant species	% of plant species	No of plant genera	% of plant genera
Solanaceae	6	17.65	4	12.5
Acanthaceae	2	5.88	2	6.25
Asteraceae	2	5.88	2	6.25
Boraginaceae	2	5.88	2	6.25
Cucurbitaceae	2	5.88	2	6.25
Euphorbiaceae	2	5.88	2	6.25
Fabaceae	2	5.88	2	6.25

Results

Medicinal plant knowledge among practitioners

In this study, most of the ethnoveterinary practitioners were men (66, 94.29%) and the remaining 4, 5.71% were women. Analysis was made to compare the knowledge of men and women practitioners in terms of number of medicinal plants cited, number of use citations, diversity of disease treated and their primary sources of medicinal plants; it was found that men informants were more knowledgeable than women in reference to the above parameters. Besides, the knowledge of women ethnoveterinary practitioners was restricted to the common disease types and familiar medicinal plants that grew in their home garden or nearby areas. As far as age groups are concerned, elder ethnoveterinary practitioners (above 45 years old) had established well defined procedures on how to collect plants, prepare remedies and about their mode of administration than the relatively younger informants (between 25 to 44 years old).

Acquisition and transfer of indigenous medicinal plant knowledge

Almost all the ethnoveterinary practitioners in the study area acquired their knowledge (regarding the method of diagnosis, type of medicinal plants used for specific ailment and remedy preparations) through oral tales from their father or grandfather with high level of secrecy. The practitioners didn't disclose information concerning medicinal plants even to all family members. Because they afraid of losing the pharmacological effectiveness of the medicinal plant remedy. This esteemed from their belief ''plants that are kept secret will have a pronounced efficacy''. Furthermore, some informants

also acquired the knowledge through systemic follow up and careful observation of knowledgeable individuals at the time of medicinal plant collection and preparation.

Ethnoveterinary medicinal plants reported and disease treated
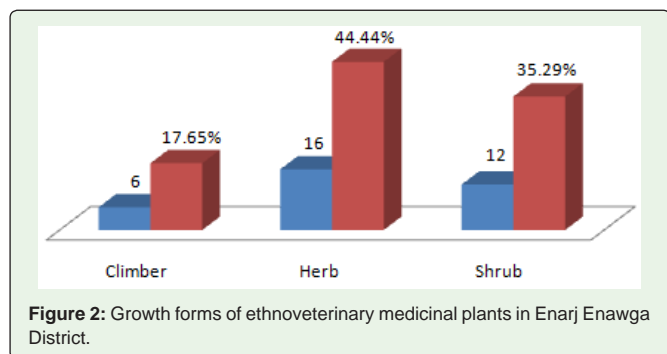
The study revealed that Enarj Enawga District harbor about 34 medicinal plant species used against 20 livestock ailments, which were distributed across 32 genera and 23 families (Appendix A). About 52.94% of these traditional medicinal plant species belong to seven families and the family, Solanaceae took the Lion's share with six plant species (17.65%). Acanthaceae, Asteraceae, Boraginaceae, Cucurbitaceae, Euphorbiaceae and Fabaceae each had two plant species (5.88%) (Table 1). The remaining 16 families were represented by one plant species each. The highest numbers of medicinal plants were used to treat swelling (8 species, 23.53%), anthrax (7 species, 20.59%), bloating, eye infection, rabies, trypanosomiasis, neck & shoulder pain/*YEKENBER MICH* with four species (11.76%) each. Blackleg, colic and thinning were the other livestock diseases treated with three medicinal plant species (8.82%) each (Table 2).

Habit, habitat and sources of medicinal plants

Analysis of the growth habits of medicinal plant species showed that herbs constitute the highest number of species (16 species, 44.44%) followed by shrubs (12 species, 35.29%) and climbers (6 species, 17.65%) (Figure 2). More than half of the medicinal plants reported, 18 (52.94%) were obtained from the wild, 8 (23.53%) from roadside, 2 (5.88%) from home gardens, 2 (5.88%) from croplands and 4 (11.76%) from both wild and roadside (Figure 3). Among the

Table 2: List of livestock diseases against which three or more medicinal plants were prescribed.

Disease name	Number of plant species used	Percent of plant species used	Number of plant genera used	Percent of plant genera used
Swelling	8	23.53	8	25
Anthrax	7	20.59	7	21.86
Bloating	4	11.76	4	12.5
Eye infection	4	11.76	4	12.5
Rabies	4	11.76	4	12.5
Trypanosomiasis	4	11.76	4	12.5
Neck & shoulder pain	4	11.76	4	12.5
Blackleg	3	8.82	3	9.38
Colic	3	8.82	3	9.38
Thinning	3	8.82	3	9.38

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Figure 2: Growth forms of ethnoveterinary medicinal plants in Enarj Enawga District.

Figure 4: Occurrence of ethnoveterinary medicinal plants in the study area.

total medicinal plants, 16 (47.06%) were rarely encountered, three (8.82%) were commonly found elsewhere and the remaining 15 (44.12%) were occasionally encountered (Figure 4).

Plant parts used and condition of remedy preparation

In ethnoveterinary remedy preparations, roots (42.11%) were the most frequently sought plant parts followed by leaves (31.58%), seeds (7.02%), whole plan (7.02%) and latex (3.51%) (Figure 5). Most of the plant remedies were prepared from fresh plant materials (73.68%). In addition, 12.28% of the remedies were prepared from dry plant materials and the remaining 14.04% were prepared from either dry or fresh plant materials (Figure 6). Different additives such as water, butter, salt, blood, and milk were frequently used in the preparation of plant remedies so as to improve the flavor, decrease the toxic side effects of remedies, to prepare suitable formulations and for ease of remedy administrations.

Routes of remedy administration and dosage

In the study District, the principal route of remedy administration was oral (66.66%) followed by dermal (15.75%) and ophthalmic (8.77%). Other routes such as anal and vaginal were also used when considered appropriate (Figure 7). Informants used local or traditional dosage measurements such as FAGA (made from *Lagenaria siceraria*), TASSA (water can), JOG (plastic bottle measuring around 3 Liters), FINJAL (coffee cup) and ATIQ (a third of finger sized) were used during remedy preparation and administration. It was observed that the dose of plant remedies differed among traditional healers (even in treating the same health problems) in Enarj Enawga District.

Figure 3: Sources of ethnoveterinary medicinal plants in Enarj Enawga District.
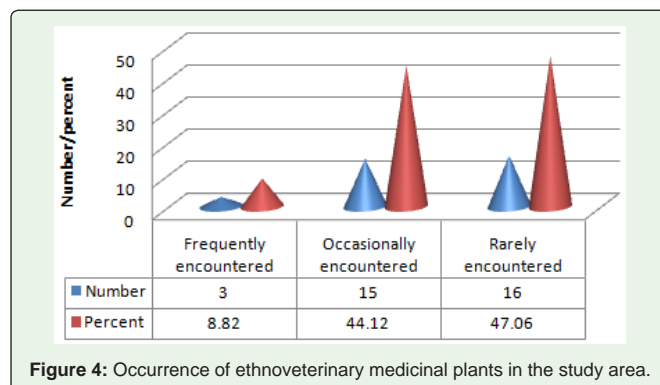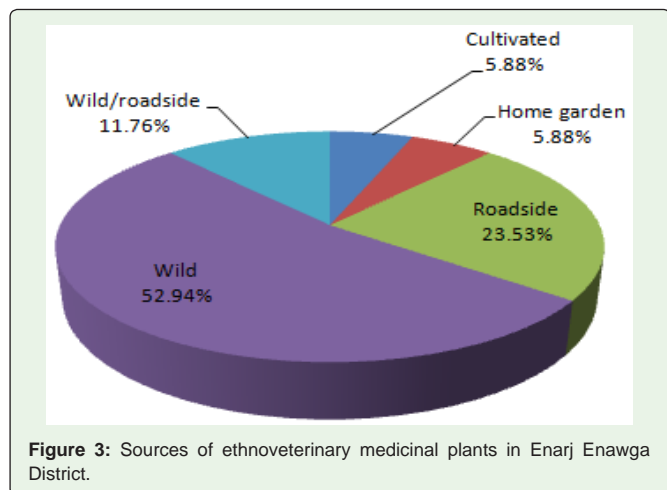
Marketability of medicinal plants

Survey of five prominent local markets in the study District did not show up plants solely sold for their ethnoveterinary medicinal purpose. Some medicinal plant species including *Lepidium sativum* (spice), *Lycoperisicum esculantum* (food) and *Trigonella foenum-graecum* (spice) were commercialized in Debre Work, Felege Birhan, Meaza Genet, Temguma and Gedeb local markets for their use as food and spice.

Informant consensus factor

Livestock diseases which are claimed to be cured by the ethnoveterinary practitioners of the study area were grouped in to eight diseases categories and higher ICF values were obtained for anthrax (0.88), swelling (0.87), *MICH* (0.85), rabies (0.84), internal diseases (0.84), eye disease (0.81), GIT diseases (0.78) and other livestock diseases (0.83) (Table 3).

Informants' preference on medicinal plants used to treat swelling

In the study District, eight medicinal plant species (*Calotrops procera*, *Cayratia gracilis*, *Cynoglossum amplifolium*, *Euphorbia ampliphylla*, *Kalanchoe petitiana*, *Mormordica foetida*, *Rubus steudnerii* and *Thunbergia alata*) were used in ethnoveterinary practices to treat swelling. The preference ranking exercise conducted on these medicinal plant species revealed that *Calotropis procera* is the most preferred medicinal plant species (for the management of swelling) followed by *Kalanchoe petitiana* and *Euphorbia ampliphylla* (Table 4).

Figure 5: Plant parts used for ethnoveterinary remedy preparation in Enarj Enawga District.
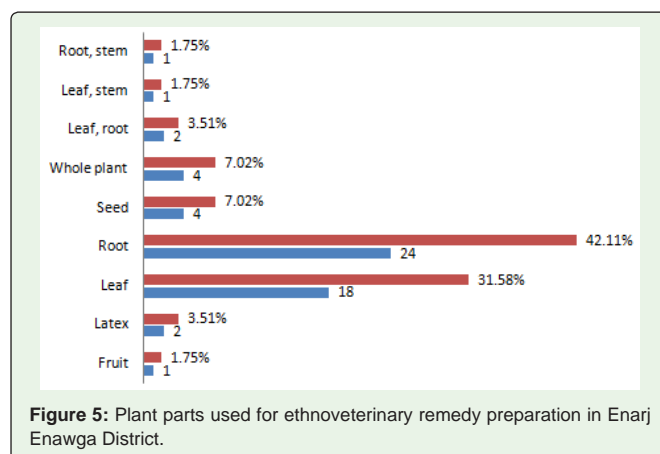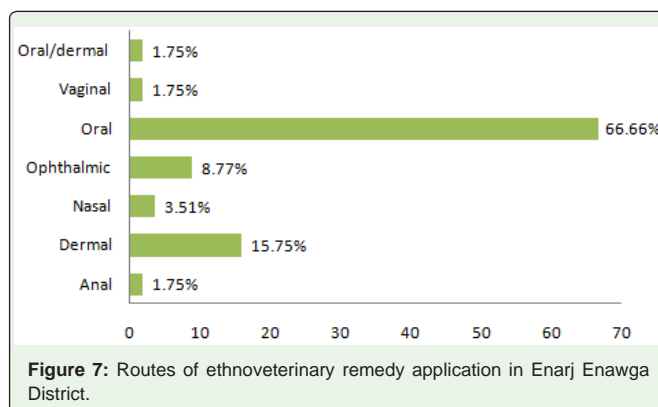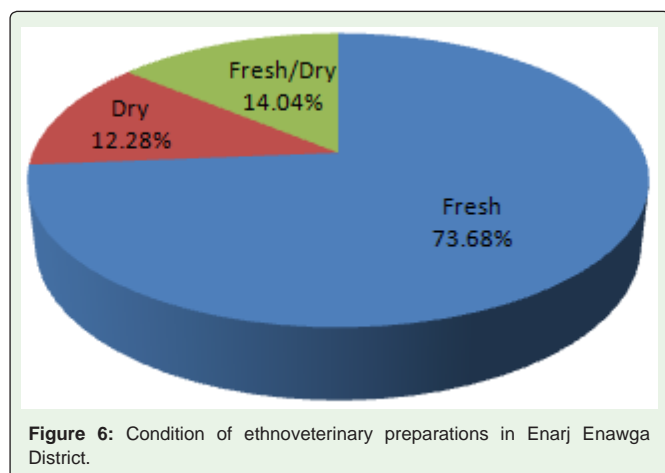
Figure 6: Condition of ethnoveterinary preparations in Enarj Enawga District.

Figure 7: Routes of ethnoveterinary remedy application in Enarj Enawga District.

Table 3: ICF values of traditional medicinal plants for treating livestock diseases in the study area.

Category of diseases	Diseases included	nt	nur	ICF
Anthrax	Anthrax	7	53	0.88
Swelling	Swelling	8	56	0.87
MICH	MICH and neck & shoulder pain	5	27	0.85
Rabies	Rabies and rabies vaccine	6	33	0.84
Internal diseases	Blackleg, trypanosomiasis and thinning	10	56	0.84
Eye disease	Eye infection and eye pain	5	22	0.81
GIT diseases	Bloating and colic	7	28	0.78
Other livestock diseases	Cough, hypolactatemia, leech infestations, Rh disease, urine retention, evil spirit and coccidiosis	9	25	0.83

Table 4: Preference ranking of medicinal plants reported for treating swelling in the study area.

Medicinal plant species	Respondents (R_1-R_{10})											
	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	Total score	Rank
Calotropis procera	8	7	8	8	8	7	6	8	8	7	75	1st
Cayratia gracilis	4	3	1	2	3	1	2	3	1	2	22	7th
Cynoglossum amplifolium	1	2	2	1	1	3	1	2	3	1	17	8th
Euphorbia ampliphylla	6	5	6	7	6	6	8	6	6	5	61	3rd
Kalanchoe petitiana	7	8	7	6	7	8	5	7	7	8	70	2nd
Momordica foetida	3	4	5	4	2	5	3	4	4	3	37	5th
Rubus steudneri	5	6	4	5	5	4	7	5	5	6	52	4th
Thunbergia alata	2	1	3	3	4	2	4	1	2	4	26	6th

N:B - Scores in the table indicate ranks given to the ethnoveterinary medicinal plants based on their efficacy. Highest number (8) given for the medicinal plant which informants thought most effective in treating swelling and the lowest number (1) for the least effective plant.

Table 5: FL values of ethnoveterinary medicinal plants against most frequently treated diseases.

Ethnoveterinary plant species	Diseases treated	Ic	Iu	FL (%)
Achyranthes aspera	Bloating	4	4	100
Aloe vera	Rh disease	3	3	100
Calotropis procera	Swelling	11	11	100
Cayratia gracilis	Swelling	7	7	100
Clerodendrum myricoides	Anthrax	4	4	100
Clutia abyssinica	Anthrax	5	5	100
Crotalaria karagwensis	Neck & shoulder pain	3	3	100
Datura stramonium	Trypanosomiasis	5	5	100
Euphorbia ampliphylla	Swelling	4	4	100
Gladiolus candidus	Anthrax	13	13	100
Inula confertiflora	Eye infection	6	6	100
Lycopersicon esculentum	Bloating	2	2	100
Plantago lanceolata	Trypanosomiasis	5	5	100
Rubus steudneri	Swelling	8	8	100
Solanum incanum	Leeches infestations	6	6	100
Solanum marginatum	Cough	6	6	100
Withania somnifera	Blackleg	6	6	100
Zehneria scabra	Thinning	3	3	100

Fidelity level of medicinal plants

FL is an important means to see for which ailment particular specie is more effective; accordingly, out of 34 medicinal plant species used for the preparation of ethnoveterinary remedies in the study area, 18 (56.25%) were used for the treatment of a single livestock ailments and shown to have 100% fidelity level (Table 5).

Discussion

Medicinal plant knowledge among informants

The gender distributions of medicinal plant knowledge among the practitioners showed most of the traditional healer in the District were males (94.29%) and there were very few females (5.71%) practitioners. This might be due to the attitude of traditional healers towards females where they often used to transfer their knowledge preferentially to males (elder son). Other ethnoveterinary studies conducted elsewhere in Ethiopia [10,17] come up with similar conclusion. Besides, the medicinal knowledge of females was found to be limited to plants which are found in the home garden or in nearby areas like *Achyranthes aspera*, *Cynoglossum amplifolium*, *Datura stramonium*, *Justicia schimperiana*, *Lepidium sativum*, *Plantago lanceolata* and *Zehneria scabra*. The bad habits and traditions which restricts females to domestic activities (like caring babies, cooking food, *etc*.) and hence their contact with the environment and

knowledgeable individuals might be responsible for the discrepancy in the gender distribution of medicinal knowledge. Similar trends were reported by Yigezu et al., [17] in four districts of Jimma Zone, Ethiopia. In addition, this study revealed that elders (above 45 years old) are more knowledgeable than younger ethnoveterinary practitioners in terms of number of medicinal plants cited, number of use citations, method of collection, method of preparation and remedy administration. Furthermore, the curative effects of remedies prepared by these experienced ethnoveterinary practitioners were by far better than the younger ones. This report is in line with different results documented in different parts of Ethiopia [16,38-40].

Indigenous knowledge transfer/acquisition

The major way of indigenous knowledge transfer on types of medicinal plants, traditional concepts of illness and method of diagnosis among the ethnoveterinary practitioners of Enarj Enawga District was by word of mouth to a family member (to an elder son or brother). Similar findings were reported for other communities in Ethiopia [16,27]. Furthermore, some practitioners acquired their knowledge secretly through systematic follow up and observation of knowledgeable individuals at the time of medicinal plant collection and preparation. It reflects the existence of high level of secrecy in the transfer or acquisition of medicinal knowledge among traditional healers of Ethiopia [25,26]. The practitioners also tend to avoid cultivation of medicinal plants in their home garden to keep the

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traditional knowledge secret enough. This in turn will have a profound negative effect on the conservation status of medicinal plants in the District.

Medicinal plants reported and their distribution

In general, the present study documented 34 medicinal plant species that have been used to treat 20 different livestock diseases by traditional practitioners in Enarj Enawga District, Amhara Region, Ethiopia. Similar ethnoveterinary surveys conducted in Ada'ar District, Afar Region, Ethiopia [8], Dabo Hana District, Borena Zone, Ethiopia [9], selected four Districts of Jimma Zone, Ethiopia [17], Ankober District, North Shewa Zone, Ethiopia [26] documented 49, 106, 74 and 51 medicinal plant species respectively. These findings clearly indicated the importance of plant based ethnoveterinary remedies in the management of livestock disease in different regions of Ethiopia.

Some of the ethnoveterinary medicinal plant species of the District were also reported from previous studies conducted elsewhere in Ethiopia. Among the total 34 medicinal plant species documented in this study, 6 species in Dabo Hana District of West Ethiopia by Tamiru et al., [9], 4 species in Wayu Tuka District of East Wollega by Megersa et al., [15], 7 species in Seharti Samre District of Southern Tigray by Araya et al., [16], 7 species in four selected Districts of Jimma Zone, Ethiopia by Yigezu et al., [17], 7 species in Ada'a District of East Shewa by Kefyalew et al., [18], 14 species in Kilte Awulaelo District by Teklay et al., [19], 7 species, Ankober District of North Shewa by Lulekal et al., [26], 9 species in Libo Kemkem District of South Gondar by Chekole et al., [27] were documented. These data showed the wide use of ethnoveterinary traditional remedies in the management of livestock diseases in Ethiopia and the presence of diverse ethnoveterinary knowledge among different communities in the country.

Solanaceae (6 species, 17.65%) was the most common plant family reported followed by Acanthaceae, Asteraceae, Boraginaceae, Cucurbitaceae, Euphorbiaceae and Fabaceae each had two plant species (5.88%). The dominance of these plant families (especially Solanaceae, Acanthaceae, Cucurbitaceae, Asteraceae, Euphorbiaceae and Fabaceae) in ethnoveterinary practices were documented in similar studies conducted elsewhere in Ethiopia [8,9]. This may be due to the abundance of these plant families in the Ethiopian flora. Moreover, the wide utilization of species from these families might relate to the presence of effective bioactive ingredients against livestock ailments [41].

Habit and habitats of medicinal plants

Most of the ethnoveterinary practitioners used to prepare remedies from herbs (44.44%) followed by shrubs (35.29%) and climbers (17.65%). This may be due to their relative better abundance, accessibility in nearby areas as compared to other life forms, which is in agreement with similar studies conducted in different corners or Ethiopia [19,27]. In contrast, other studies documented shrubs [8,26,42] and trees [17] as the most frequently used life forms in ethnoveterinary practices. Similar to other studies conducted in different parts of the country [11,12], the majority (52.94%) of the medicinal plants in the study district were collected from the wild. As

there was no strong tradition or observed practice by the local people to cultivate medicinal plants in their home garden, the ethnoveterinary medicinal plants were harvested and processed only when the need arose. The use of wild or uncultivated plants is a common practice in Ethiopia [8,15,20], such dependence on the wild habitats will have a long-term negative effect on the conservation statuses of medicinal plants besides to environmental degradation and deforestation.

Plant parts used and condition of remedy preparation

In our study, root was the most frequently used plant part accounting for 42.11% of the reported medicinal plant preparations which is in agreement with other results reported previously [13,20,26]. The collection of roots poses a significant threat to the survival of individual plants as compared to leaves [43], hence appropriate conservation measures should be taken for the sustainable use of medicinal plants in the study area. However, in studies conducted elsewhere in Ethiopia, leaf was indicated to be the most frequently sought plant part to treat livestock ailments [12,17,42], due to the presence of pharmacologically active phytochemicals which are capable of eliciting the intended biological activity. Most of the ethnoveterinary practitioners in the study District prefer fresh plant (73.68%) materials to prepare effective and efficient remedies. The use of fresh plant materials for remedy preparations is well documented elsewhere in Ethiopia [27-29] as most of the bioactive chemicals are retained in fresh plant materials as compared to dry ones. Yet, frequent collection of fresh plant materials in dry season has a devastating influence on the conservations statuses of medicinal plants.

Route of remedy administration and dosage

Oral was the most frequently used route of remedy administration accounting for 66.66% of the remedy preparations followed by dermal (15.79%) and ophthalmic (8.77%). Different studies from other parts of Ethiopia also reported oral as the preferred route of remedy application followed by dermal [12,17,44]. The dominance of oral route for remedy application could be due to its rapid onset of action and sustained physiological effects. Contrary to our findings, Yirga et al., [11] reported dermal as the principal route of ethnoveterinary remedy administration in Seharti Samre District (northern Ethiopia).

Plant based remedies are the first-choice weapons for the livestock healthcare demand of the local community, partly because of their affordability and accessibility as compared to modern medicine in the study area. Yet, lack of standard dosage and precise measurement are the common drawbacks of traditional herbal medicines [45]. According to the responses of the informants in the study District, the dose of remedies as well as frequency of administration varies depending on the age, size and type of animal treated. Relatively smaller amount of plant remedies (measured using FINJAL, TASSA, BIRCHIKO, etc.) were prescribed for sheep, goat, dog, etc., on the other hand FAGA and JOG were used to tailor the dose required for larger animals such as cow, ox, horse, donkey, etc. In addition, some remedies were administered once, while others were given until cure. Inconsistencies of doses have also been reported in similar studies conducted elsewhere in the country [8,20].

Most important medicinal plants and disease treated

Some of the medicinal plants were very popular and widely used in the study area. For instance, *Calotropis procera* was used to treat swelling and reported for the same purpose in other studies [16,19,26]. Similarly, the ethnoveterinary practitioners in the study District used *Kalancheo petitiana* for treating swelling. The use of this plant for the management of swelling was also reported in Ada'a District, East Shewa, Ethiopia by Kefyalew et al., [18]. These results revealed presence of active phytochemicals and the importance of the aforementioned plant species for the rural community to manage swelling in livestock.

Withania somnifera and *Momordica foetida* were the other important plants used in the management of blackleg in the study area. The ethnoveterinary use of *Withania somnifera* for the treatment of blackleg was also reported in Ada'ar District, Afar Region [8] and Ankober District, Amhara Region [26], Ethiopia. Similarly, Tolossa et al., [20] also reported the ethnoveterinary use of *Momordica foetida* in the management of blackleg in South Omo, Southern Ethiopia. The wide spread use of these medicinal plant species, in different cultural groups of Ethiopia, suggests their effectiveness in relieving blackleg and deserve pharmacological investigations.

Cucumis ficifolius was the other notable plant species used against rabies, blackleg, trypanosomiasis and cough in the study area. In agreement with this finding, other ethnoveterinary surveys conducted in different parts of Ethiopia witnessed the common use of *Cucumis ficifolius* for the treatment of blackleg [17] and rabies [46]. In addition, *Solanum incanum* and *Solanum marginatum* were implicated in the management of leech infestations and cough respectively, in the study area. Chekole et al., [27] suggested the similar use of these plant species in Libo Kemkem District of the Amhara Region, Ethiopia. The ethnoveterinary use of *Solanum marginatum* for cough/respiratory manifestation was also noted in reports of Yigezu et al., [17]. The use of *Inula confertiflora* for the treatment of eye disease was also reported by Kefyalew et al., [18] which is in line with our findings in Enarj Enawga District.

Marketability of medicinal plants

Almost all ethnoveterinary practitioners of the study District considered their knowledge and healing potentials as "a gift from God" to serve the community, thus, no one is obliged to pay money for the service they presented. Seldom, few practitioners recommend customers or users to pay one to five Birr (Ethiopian Dollar) for the nearby Orthodox Christian Church. They believe this will make the remedy ''blessed'' and thereby efficient in healing the disease. We noted that medicinal plants were not sold in the surveyed local markets (Debre Work, Felege Birhan, Meaza Genet, Temguma and Gedeb) especially for their intended medicinal purpose. Limited plant species such as *Lepidium sativum* (spice), *Lycoperisicum esculantum* (food) and *Trigonella foenum-graecum* (spice) were commercialized in the aforementioned local markets for their use as food and spice, which is in agreement with the findings reported by Teklay et al., [19] in Kilte Awulaelo District, Tigray Region, Ethiopia. In contrast, Lulekal et al., [26] documented the marketability of *Embelia Schimperi* and *Withania somnifera* plant species in some local markets of Ankober District, North Shewa, and Ethiopia.

Informants' consensus on herbal medicines

Best agreements among ethnoveterinary practitioners (higher ICF values) were observed for most disease categories in the study area: anthrax (0.88), swelling (0.87), MICH (0.85), rabies (0.84), internal diseases (0.84), eye disease (0.81), GIT diseases (0.78) and other livestock diseases (0.83). These high ICF values clearly indicate the incidence of livestock diseases in the study area and the efficacy of the medicinal plants for the disease categories as a whole. Moreover, these medicinal plant species are thought to be potential sources for chemotherapeutic agents and hence important assets in search for bioactive compounds [36].

Informants' preference on medicinal plants used to treat swelling

Among the eight medicinal plant species (*Calotropic procera, Cayratia gracilis, Cynoglossum ampliofolium, Euphorbia ampliphylla, Kalanchoe petitiana, Mormordica foetida, Rubus steudnerii* and *Thunbergia alata*) used in the management of swelling, *Calotropis procera* was found to be the most preferred plant species to treat swelling in livestock followed by followed by *Kalanchoe petitiana* and *Euphorbia ampliphylla*. In agreement with our findings, Teklay et al., [19] and Araya et al., [16] witnessed the use of *Calotropis procera* for the treatment of swelling in Kilte Awulaelo and Seharti Samre Districts, respectively. In another ethnobotanical study conducted in Ada'a District, East Shewa Zone, the use of *Kalancheo petitiana* for the treatment of swelling was well documented [18]. This indicated the ethnoveterinary importance of these plant species in the management of swelling in different regions of Ethiopia and the presence of active pharmacological scaffolds to treat swelling. Thus, we strongly recommend the pharmacological investigations of *Calotropis procera* using appropriate models.

Fidelity level of medicinal plants

FL value of 100% were observed for several medicinal plant species used against different types of livestock diseases, indicating relatively high healing potential of the plant species for treating their respective ailments [36,47]. Thus, it is worthy to consider these medicinal plants for phytochemical screening and biological activity tests.

Conclusion

34 medicinal plant species of veterinary importance were reported by the ethnoveterinary practitioners in Enarj Enawga District, Amhara Region, Ethiopia. Roots were the most frequently sought plant part for remedy preparation, which is threatening for the survival of the plant species. Besides, the people in the District do not have habit of documenting their indigenous knowledge and cultivating useful medicinal plants in their home gardens. Hence, efforts should be made to boost the awareness of the local community and to conserve the medicinal plants through *in situ* and *ex situ* conservation methods. Special attention should be given for medicinal plants with high ICF and FL values in the conservation program as well as in future pharmacological investigations.

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Appendix A: List of medicinal plants used for treating livestock ailments in the study area, Enarj Enawga District.

No.	Scientific name	Family	Local name	Habit	Parts used	Disease treated (English/ *AMHARIC*)	Animals treated	Preparation and application	Application route	Voucher number
1	*Achyranthes aspera* L.	Amaranthaceae	Telenj	Herb	Whole plant	Bloating	Cattles	The whole plant is washed with water, crushed, mixed with fresh butter and taken orally	Oral	YSB292
2	*Aloe vera*	Aloaceae	Eret	Herb	Root	Rh Disease/*SHETELAY*	All livestock	Dry roots are grounded, powder mixed with water, filtered and drenched	Oral	YSB236
3	*Argemone Mexicana* L.	Papaveraceae	Yeahiya eshoh	Herb	Root	Colic	All livestock	Roots are grounded, mixed with water and drenched without filtering	Oral	YSB257
					Leaf	Neck & shoulder pain/ *YEKENBER MICH*	Cattles	Leaves are crushed, mixed with fresh butter and applied paste on the affected part	Dermal	
4	*Calotropis procera* (Aiton) W.T.Aiton.	Apocynaceae	Kimbo	Shrub	Latex	Swelling	Donkeys	Latex is collected, mixed with fresh butter and smeared on the brisket after cutting with blades	Dermal	YSB223
5	*Cayratia gracilis* (Guill. Perr.) Suess.	Vitaceae	Aserkush	Climber	Root	Swelling	Cattles	Roots are crushed, mixed with salt and taken orally for three consecutive day	Oral	YSB250
6.	Centella asiatica L.	Apiaceae	Yeait joro	Herb	Root	Thinning	Cattles	Roots are crushed, mixed with water and drenched	Oral	YSB259
					Root	Rabies	Cattles, dogs	Roots are collected from seven different places, crushed, mixed with milk and drenched	Oral	
					Root	Rabies vaccine	Dogs	Roots are collected from seven different places, crushed, mixed with milk and taken orally	Oral	
7	*Clematis simensis* Fresen.	Ranunculaceae	Azo areg	Climber	Leaf	Colic	Cattles	Leaves are crushed, mixed with water and drenched	Oral	YSB252
					Leaf	Neck & shoulder pain	Oxen	Leaves are crushed and pasted on the affected part	Dermal	
					Leaf, root	Anthrax	Cattles	Leaves and roots are mixed with *Allium sativum* seed, crushed and pasted (after cutting the swelling)	Dermal	

#		Family		Type	Part	Disease	Animal	Preparation	Route	Voucher
8	*Clerodendrum myricoides* (Hochst) Vatke	Lamiaceae	Misirich	Shrub	Leaf	Anthrax	Cattles, donkeys	Fresh leaves are squeezed and fluid taken orally	Oral	YSB210
9	*Clutia abyssinica* Jaub. & Spach.	Euphorbiaceae	Fiyele fej	Shrub	Leaf	Anthrax	Cattles	Fresh leaves are crushed, mixed with water and drenched without filtering	Oral	YSB242
10	*Crotalaria karagwensis* Taub.	Fabaceae	Yeayit ater	Herb	Leaf	Neck & shoulder pain	Oxen	Leaves are roasted, grounded, powder mixed with butter and smeared on the affected part	Dermal	YSB263
11	*Cucumis ficifolius* A. Rich.	Cucurbitaceae	Yemdir embuay	Climber	Root	Rabies	Cattles, dogs	Roots are collected from seven different areas, crushed, mixed with milk and taken orally	Oral	YSB251
					Root	Rabies vaccine	Dogs	Roots are collected from seven different area, crushed, mixed with milk and taken orally	Oral	
					Root	Trypanosomiasis	Cattles	Roots are crushed, grounded, powder mixed with water and drenched	Oral	
					Leaf	Blackleg	Cattles	Fresh leaves are crushed, mixed with water, filtered and drenched for three consecutive days	Oral	
					Fruit	Cough	Sheep	Fruit is sliced, mixed with common salt and taken orally	Oral	
12	*Cynoglossum amplifolium* Hochst.	Boraginaceae	Shingug	Herb	Root	Swelling	Equines	Roots are crushed, mixed with water and drenched; rub the affected area with the crushed root	Oral/Dermal	YSB219
					Leaf	Neck & shoulder pain	Oxen	Fresh leaves are crushed and pasted on the affected part	Dermal	
13	*Datura stramonium* L.	Solanaceae	Astenagir	Herb	Root	Trypanosomiasis	Cattles	Roots are chopped, crushed and fluid taken orally with empty stomach for five days	Oral	YSB258
14	*Euphorbia ampliphylla*	Euphorbiaceae	Kokolchu	Shrub	Latex	Swelling	Equines	Latex is collected, mixed with fresh butter and smeared on the swelling	Dermal	YSB224
15	*Gladiolus candidus* (Rendle) Goldblatt	Iridaceae	Milas golgul	Herb	Root	Anthrax	All livestock	Roots are crushed, mixed with water and drenched without filtering	Oral	YSB213
16	*Hibiscus micranthus* L.f.	Malvaceae	Nacha	Shrub	Leaf	Anthrax	Cattles	Leaves are crushed and pasted on the affected part	Dermal	YSB234

17	*Impatiens rothii* Hook. F.	Balsaminaceae	Gishirit	Herb	Root	Eye infection	All livestock	Roots are grounded, mixed with fresh butter and applied in the form of ointment for five consecutive days	Ophthalmic	YSB270
18	*Inula confertiflora* A. Rich.	Asteraceae	Woynagift	Shrub	Leaf	Eye infection	All livestock	Leaves are crushed, dried, grounded, powder applied in the eye	Ophthalmic	YSB235
19	*Justicia schimperiana* (Hochst. Ex Nees) T. Anders.	Acanthaceae	Sensel	Shrub	Leaf	Bloating	Cattles	Leaves are crushed, mixed with water and drenched (without filtering)	Oral	YSB214
					Leaf	Evil spirit	All livestock	Leaves are chopped, soaked with water in bitter *Lagenaria siceraria* for a week and solution sniffed or taken nasally	Nasal	
20	*Kalanchoe petitiana* A. Rich	Crassulaceae	Andawula	Herb	Root	Swelling	Cattles	Roots are crushed and fluid drenched	Oral	YSB260
					Leaf, stem	Anthrax	Cattles	Leaves and stems are crushed and pasted on the affected part	Dermal	
21	*Lepidium sativum* L.	Brassicaceae	Feto	Herb	Seed	Urine retention	All livestock	Dry seeds are grounded, powdered and inserted *via* the anus	Anal	YSB245
					Seed	Coccidiosis	Hens	Dry seeds are grounded, powder mixed with oil and taken with flat bread/*ENJERA*	Oral	
22	*Lycopersicon esculentum* Mill.	Solanaceae	Timatim	Herb	Leaf	Bloating	Cattles	Fresh leaves are grounded, mixed with fresh butter and taken orally	Oral	YSB231
23	*Momordica foetida* Schumach.	Cucurbitaceae	Yekura hareg	Climber	Root	Swelling	Cattles	Roots are crushed, mixed with water and solution drenched for five days	Oral	YSB287
					Leaf	Blackleg	Cattles	Leaves are crushed, mixed with water and drenched for five days	Oral	
24	*Plantago lanceolata* L.	Plantaginaceae	Wondie gorteb	Herb	Root	Trypanosomiasis	Cattles	Roots are chopped and taken orally	Oral	YSB239
25	*Rubus steudneri* Schweinf.	Rosaceae	Amoch	Shrub	Whole plant	Swelling	Equines	The whole plant is washed, crushed, mixed with water and taken orally	Oral	YSB264
26	*Solanum incanum* L.	Solanaceae	Embuay	Shrub	Leaf	Leeches infestation	All livestock	Fresh leaves are crushed, mixed with water and drenched	Oral	YSB271
27	*Solanum marginatum* L.f.	Solanaceae	Geber embuay	Shrub	Seed	Cough	Sheep	Seeds are burned on fire and inhaled	Nasal	YSB272
28	*Solanum torvum* Sw.	Solanaceae	Emboyit	Shrub	Root	Rabies	Cattles, dogs	Roots are collected from seven different areas, crushed, mixed with milk and taken orally	Oral	YSB275

					Leaf	Leeches infestation	All livestock	Leaves are squeezed and fluid drenched	Oral	
29	*Thunbergia alata* Bojer ex Sims.	Acanthaceae	Hareg	Climber	Root, stem	Swelling	All livestock	Roots and stems are crushed, mixed with water and taken orally for five days	Oral	YSB205
					Whole plant	Anthrax	Cattles	The whole plant is washed, crushed, mixed with water and taken orally for three days	Oral	
					Root	Hypolactatemia/*GITMANES*	Cows	Roots are grounded with *Capsicum annum* and inserted through the vagina	Vaginal	
30	*Trichodesma zeylanicum* (Burm.f.) R.Br	Boraginaceae	Yewusha milas	Herb	Leaf, root	Colic	Cattles	Leave and roots are chopped, mixed with fresh butter and taken orally	Oral	YSB291
					Whole plant	Bloating	Cattles	The whole plant is washed, crushed, mixed with water and drenched	Oral	
					Root	Eye pain	All livestock	Roots are crushed, mixed with fresh water, filtered and eye washed with the solution	Ophthalmic	
31	*Trigonella foenum-graecum* L	Fabaceae	Abish	Herb	Seed	Eye infection	All livestock	Dry seeds are grounded with *Zingiber officinale* rhizome, powder inserted in to the eye	Ophthalmic	YSB281
32	*Verbascum sinaiticum* Benth.	Scrophulariaceae	Ketetina	Herb	Root	Thinning	Cattles	Roots are crushed, mixed with water and drenched for five days	Oral	YSB230
					Root	Rabies	Cattles, dogs	Roots are collected from seven different area, crushed, mixed with milk and taken orally	Oral	
					Root	Trypanosomiasis	Cattles	Roots are crushed, mixed with water and drenched without filtering	Oral	
					Leaf	Eye infection	All livestock	Leaves are chewed and spitted in the eye of the affected animals	Ophthalmic	
					Root	*MICH*	Sheep	Roots are roasted, grounded, powder mixed with water and taken orally	Oral	
33	*Withania somnifera* (L.) Dun.	Solanaceae	Gizewa	Shrub	Leaf	Blackleg	Cattles	Fresh leaves are crushed, mixed with milk and solution drenched	Oral	YSB278
34	*Zehneria scabra*	Asteraceae	Hareg ressa	Climber	Root	Thinning	Cattles	Fresh roots are crushed, mixed with water and drenched without filtration for three consecutive days	Oral	YSB206

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