

Indigenous Knowledge of Local Communities in Utilization of Ethnoveterinary Medicinal Plants and Their Conservation Status in Dess'a Priority Forest, North Eastern Escarpment of Ethiopia

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Research

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Indigenous Knowledge of Local Communities in Utilization of Ethnoveterinary Medicinal Plants and Their Conservation Status in Dess'a Priority Forest, North Eastern Escarpment of Ethiopia

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Abstract

Background: Ethnoveterinary plant medicine plays indispensable role in many developing counties in treatment of livestock health problems. Dess'a priority forest is a bridge for small scale farming communities in Tigray and the Afar pastoralists, where both communities are rich in herds of domestic animals including camels. The study was aimed at investigating the utilization of ethnoveterinary medicinal plants and their conservation status in Dess'a priority forest, northeastern escarpment of Ethiopia.

Methods: A total of 22 key and 252 general informants were selected using purposive and random sampling technique respectively. Interview was conducted using pre-prepared semi-structured questionnaire following focus group discussion with elderly people. Guided field walk and direct observation were also used to collect the required data. Data were analyzed using Microsoft office word excel (2007), scoring and ranking.

Results: This study discovered that fifty-six ethnoveterinary medicinal plants distributed among 31 families and 49 genera, used by traditional healers for treatment of 37 livestock health problems, were identified in the study area. Wound (24%), Cough (15%) and abdominal bloat (12%) were the most prevalent ailments. Fabaceae (16%), Solanaceae (11%) and Amaranthaceae (7%) were wealthiest families. Majority of which (43%) were shrubs and principal sources of the medicinal plants were wild habitat (44.6%). major plant parts used were leaves (43%). In most cases, freshly harvested plant remedies (49%), were prepared by pounding (21%) followed by Crushing (12%). Oral (34%) was the principal route of remedy administration. *Nicotiana glauca* Graham & *Solanum marginatum* L. were most preferred ethnoveterinary medicinal plants. Uprooting (37%) were the leading harvesting method and majority of the plants were rarely encountered (53%). Deforestation (32%), Drought (27%) and climate change (18%) were major threats.

Conclusion: There is huge amount of indigenous knowledge of ethnoveterinary medicinal plants, but healers were secretive and did not share their knowledge freely, resulting in danger of information loss, and inappropriate utilization.

Keywords: Dess'a priority forest, Medicinal plant, Ethnoveterinary, Traditional healer

Introduction

Ethnoveterinary plant medicine plays indispensable role in pastoral and agro-pastoral communities that rely heavily on livestock for their livelihood and food security, in many developing and developed countries of the globe to treat their domestic animals.(1, 2) Rearing of domestic animal is a significant practice in Ethiopia and it plays an important role in the economy of the farmers(2). The utilization of ethnoveterinary medicinal plants for the treatment of various diseases has been part of human traditions since ancient times and still increasing in many developed and developing countries.(3-7) Ethiopian ethnoveterinary plant medications play a great contribution and the most important sources of therapeutics for more than 90% in the livestock population.(8-12) Ethiopia possesses about 213 families of flowering medicinal plants and of the 92 families, with one family of gymnosperm and one family of fern known to contain medicinal properties.(13)

Ethiopia is the largest and most popular country in the horn of Africa, with several topographies, climatic conditions and various ethnic cultures and one the six centers of biodiversity of the world(14). There are 6500 species of vascular plants in Ethiopia making the country one of the most diverse floristic regions in the world.(15) Ethnobotanists carry out ethnobotanical study with full of confidences in wealthy biological resources for ethnoveterinary medicinal plants, documentation, management and sustainable usage.(14) Dess'a priority forest area one of the oldest remnant dry Afromontane natural forests in Ethiopia, and the largest in Tigray and Afar regional states.(16-18) The Dess'a Forest has a high amount of species diversity and endemism that is threatened due to anthropogenic and natural factors.(19) Ethnoveterinary medicine is a system that is based on folk beliefs, indigenous knowledge, taboos, and skills that continue to the present day in Ethiopia.(11, 20) Demand and practice of Ethnoveterinary medication is highly increased from time to time because they are effortlessly available, cost effective and less expensive than the medicines

bought from an allopathic pharmacy, and valuable, especially in rural areas where veterinary services are absent or irregular and expensive.(20-22) However, traditional healers lack knowledge on the principles of harvesting medicinal plants, directing the users concerning the dosage and side effect, poor hygienic conditions.(23)

Conventional drugs are relatively expensive and sometimes high-priced to resource-limited farmers. Today, medicinal plants are still highly used in developing countries like Ethiopia.(15, 24) In such developing countries and rural societies, the use of Ethnoveterinary medicinal plants is both a valuable resource and a necessity, and furthermore it provides a real alternative for primary health care systems.(25) Although efforts have been made to document and compile medicinal plants in Ethiopia in general and in the study area in particular, information about ethnoveterinary plants and their conservation approach is still insufficient.(9, 26, 27) Therefore, this study was designed to investigate and document the indigenous knowledge, ethnoveterinary practice and problems associated with ethnoveterinary medicinal plants and their conservation status.

Materials and methods

Study area Description

The study was aimed at investigating the utilization of ethnoveterinary medicinal plants and their conservation status in Dess'a priority forest area, the northeastern escarpment of Ethiopia, which is located about 60 km northeast of Mekelle, the capital of the Tigray regional state. It is located between 130 56' N and 390 51' E having an area of 120,026ha at an altitude range of 900 and 2862 m.a.s.l.(17, 19, 28, 29) It falls within two regions of Ethiopia, namely the Tigray and Afar Regions. In Tigray Region, it touches three districts, Saesie Tsaedaemba, Atsbi-Wonberta, and Enderta. Administratively, the former two Woredas are found in the eastern zone of the region and the later one in the Southern zone of the region. Ab'ala, Berahle, and Kunoba are the three Woreda studied in the protected

area falling in the Afar Region. The forest is a representative of dry Afromontane forest conquered by *Juniperus procera* and *Olea europea ssp. cuspidata*.(28, 29). (Figure-1)

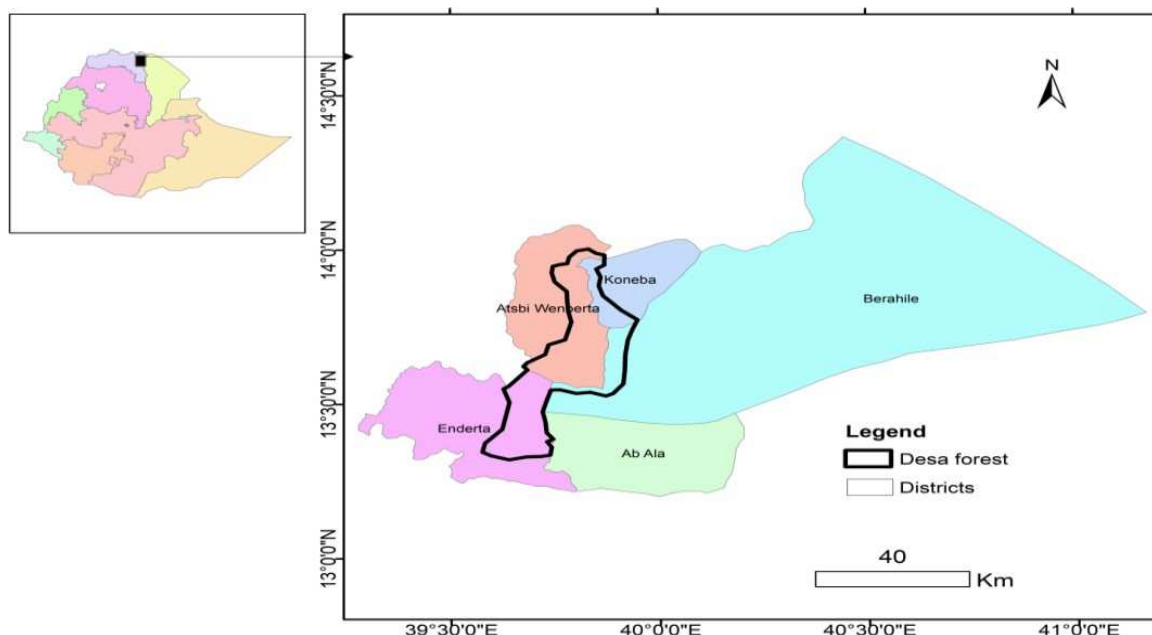


Figure 1: Map of the study area

Preliminary Survey, Forest Kushet and Informant Selection

Before we start an ethnobotanical study, we conduct preliminary survey and contacts were made with district and Kushet Administrators, Agriculture and Rural Development Bureau to seek permission and to carry out the study by informing those about the aims and significance of the study which is not for commercial purpose but for academic value. In order to have valuable information on ethnoveterinary medicinal plants and their conservation status of the Dess'a priority forest, it was decided to sample forest Kushet, within the forest and very close to the forest, based on community-forest interactions, accordingly a total of four Woredas (Berahle, Kunoba, Ab'ala, and Enderta) and six forest Kuhets (Wesema, Adkelo, Eruh and Edeghanu, Wahdist, Shahigubi, and Debrekibie) were selected.(30, 31) Following martin, (31-33) a total of 252 general informants were selected using a random informant sampling technique (from the list of inhabitants) during field and house visits (42

informants from each study forest Kushet). All interviews were administered after obtaining the voluntary consent of each informant and assuring them that the data going to be used only for academic purposes. With the help of traditional association leaders, local authorities, elderly people, and religious leaders, Twenty-two key informants (18 males and 4 females), who have the knowledge and ethnoveterinary practice were selected using a purposive sampling technique.

Ethnobotanical data collection

Semi-structured interview

A pre-prepared semi-structured interview method was used to collect quantitative and qualitative ethnobotanical data; we preferred this method of an interview because it allows a relaxed and free flow of dialogue with our interviewees.(33, 34)

Focus group discussion (FGD)

As shown in the figure below (Figure-2) after we get their consent to explain that their cooperation is a valuable contribution to the documentation and conservation of the ethnoveterinary medicinal plants, brief focus group discussion (in-depth interviews) was made to collect ethnobotanical data with a group of 5-8 individuals comprised of traditional healers, Kushet administrators, translators and forest guards from each forest Kushet were invited to authenticate the information get back avoid prejudice.(31, 35)



Figure 2 : Focus group discussion with traditional healers, Kushet administrators, translators and forest guards

Direct observation and Guided field walk

Direct observation and guided field walk interview were undertaken with key informants and all relevant data, including waypoint recording by using GPS, vernacular names, a tally of the plant, habit and habitat and parts used, harvesting methods as well as the strategies they use for the conservation of medicinal plants and preservation of indigenous knowledge on medicinal plants were recorded. Photographic records were also taken in the field to capture the plant specimens, field sites, and other useful memories.(31, 36)

Plant specimen collection and identification

The reported ethnoveterinary medicinal plants were collected from each forest Kushet, natural vegetation, and home gardens by collecting plant specimens of each plants species during guided field walks and direct observation. Then specimens were dried, deep-frozen, and determinations were made at Mekelle University, using taxonomic keys and descriptions given in the relevant volumes of Flora of Ethiopia and Eritrea. (33, 37-42) Finally, the accuracy of identifications was confirmed by senior botanists, and specimens are found deposited in Mekelle University.

Ethnobotanical data analysis

Microsoft office excel (2007), Simple preference ranking and direct matrix ranking and Proportions (percentiles), figures and tables were used to summarize the collected ethnoveterinary medicinal data.

Result and Discussion

Demographic characteristics

Majority of the traditional healers found in the study area were illiterate males, 18 (81.8%) and the remained 4(18.2%) were females, aged 20-70 years and with an average age of 56.55. This is due to traditions of indigenous people of Afar and being the natural case when the interviewer is passenger as in our case, Females are generally not surprising to come into view in any discussion with guest, both by society and family, even not seeing their face and not give hand for greeting by the opposite sex. Other studies conducted in different parts of Ethiopia also agreed that predominance healers that participated in sharing their healing knowledge were males.(43-45) Concerning marital status 15 (68%), 5(23%) and 2(9%) were married, divorced and unmarried respectively. According this result and respondents point of view most of traditional healers in the area were married, due to their wisdom in treating different livestock ailments and most of the society accept the question of appointment by the traditional healers.(44)

Source of healing wisdom and indigenous knowledge transfer

The highest source of healing wisdom was a family line (15, 68.18%) followed by “Qur’an”, 3, 13.64%), Neighborhood and observation (2, 9.09 %), traditional healers with payment (1, 4.545 %), “Bible” (1, 4.545%).This provide evidence that indigenous knowledge of the study area was transferred through family line, most of the healers need to share to their own family in general and to their young man in particular and they accepted that their reluctance in sharing their knowledge to others was due to income generation of that healing wisdom.

This shows a good agreement with different ethnobotanical studies conducted before, which reported that the most commonly cited source of healing was a family line.(3, 25, 46-48) Study conducted in Chifra district, Afar region, northeastern Ethiopia also cited the “Qur’an” as the source of healing wisdom; this indicates that religious books are one the sources of healing wisdom for utilization of plants in treating veterinary health problems.(49) The other methods were gained knowledge from traditional healers with payment; this means also indicates that healers of the study area gain their knowledge objectively by asking knowledgeable healers and pay money for the healers who told them about the practice and type of plant medicine. This finding also proved that “Bible “as source of healing wisdom from one religious leader and indicted that presence of close interaction of Christian, Islamic and indigenous religions with traditional medical systems. Even though there is a wealth of indigenous knowledge in the study area, most of the healers were reluctant in sharing their own knowledge and it is only transferred orally in a family line. This result is in line with some ethnoveterinary studies conducted before, which reported that there was secrecy of sharing indigenous medicinal knowledge to others. (43, 48, 50)

Diversity of Ethnoveterinary medicinal plants

A total of different 56 ethnoveterinary medicinal plants belonging to 31 families and 49 genera used by indigenous people of the study area to treat different veterinary ailments were identified. Dess’a priority forest area has rich ethnoveterinary medicinal plants compared to the studies conducted throughout the country before.(25, 44, 51-57) Although the study area was rich in its plant resource, ethnoveterinary medicinal plants were scanty due to natural and anthropogenic factors mainly the conflict on using the resource by both people of afar and Tigray regional states who shares border of the forest compared to other studies conducted before.(26, 27, 58-64) Exclusively, this current finding also documents two plant species (*Verbascum sinaiticum* & *Schinus molle*), which have a great importance

in beekeeping management practices, by preventing bee swarm from bad odor. (Table-6) In this study, the highest number of plant species having ethnoveterinary medicinal value were found in Fabaceae (9, 16%) followed by Solanaceae (6, 11%) and Amaranthaceae (4, 7%) (Table -1) *Acacia oerfota*, *Senna singueana*, *Indigofera spicata*, *Calpurnia aurea*, *Millettia ferruginea*, *Erythrina abyssinica*, *Acacia mellifera*. *Acacia etbaica* and *Senna alexandrina* were species of plants belonged to Fabaceae plant family utilized for their ethnoveterinary importance in the study area.(Table-6) In discrepancy to this finding, a previous ethnoveterinary medicinal plant study investigated that family poaceae were the most represented plant family(65), and a study in selected districts of southern Ethiopia,(64) also reported that *Euphorbiaceae* as leading plant family but were in agreement to the findings of Gakuubi and Wanzala.(66)

Table 1: plant families of the study area

Plant family	Frequency
Fabaceae	9
Solanaceae	6
Amaranthaceae	4
Asparagaceae ,Balanitaceae, Boraginaceae, Boraginaceae, Cactaceae, Caryophaylaceae, Celasteraceae, Commelinaceae, Ebenaceae, Asclepidaceae, Aloaceae, Malvaceae, Meliaceae Moraceae, Polygonaceae, Polygonaceae, Rhamnaceae, Salvadoracea, Scrophulariaceae Papaveraceae & Phytolaccaceae	1each
Apiaceae, Anacardiaceae Euphorbiaceae, Lamiaceae, Oleaceae, Rutaceae & Vitaceae	2 each
Asteraceae	3

Animals treated by traditional healers

Although the study area is rich in herds of domestic animals and bee keeping practice, ethnoveterinary disease and access to modern health services are a major problem in the

study area, especially in afar regional state. For this reason traditional ethnoveterinary healers of the study area treat their own domestic animals against various ailments using plant resource. Thirteen domestic animals were treated by the traditional healers of the study area. (Figure-3) Among Camels were cited (25, 22%) followed by Sheep (13, 12%). In fact, majority of the Afar people rear camel and goat compared to other domestic animals this is due to camels (“Ship of the desert”) are more adaptable to harsh conditions.(67) In disagreement with finding of (16) , people living around the forest rear a variety of domestic animals, but they give priority of rearing Goats and Camels. An Ethnoveterinary study in southern Aravali region, India also documented major domestic livestock species (Cows, Oxen, Goats, Sheep and Poultry) were treated using 27 ethnoveterinary medicinal plants belonging to 22 families uses for the treatment of bone fracture and wound recovery.(68)

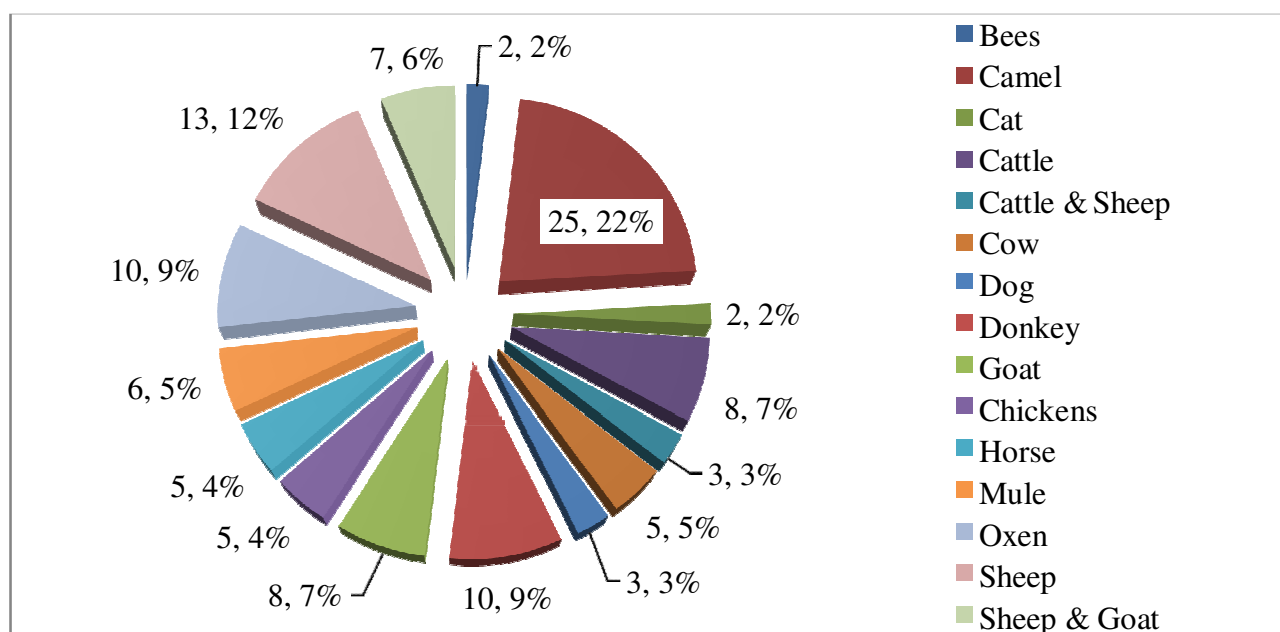


Figure 3: Domestic animals treated by traditional healers

Ethnoveterinary ailments

A total of 37 ethnoveterinary ailments were practiced and treated by healers of the study area.(Table-6) Among those ailments wound (16 times, 24%), followed by Cough (10 times,

15%), abdominal bloat (8 times, 12%) and dysentery (7 times, 11%) were the most frequently cited and most prevalent ailments of domestic animals in the study area. (Figure-4) Traditional healers of the study area were confident enough in treating this prevalent disease (wound) and mostly caused due to animal horn injuries, using cattle for plough (which cause neck wound), hyena bite and dermal ectoparasite. Inconsistent to this finding a previous ethnoveterinary study reported that blackleg followed by anthrax were among the major prevalent disease.(69)

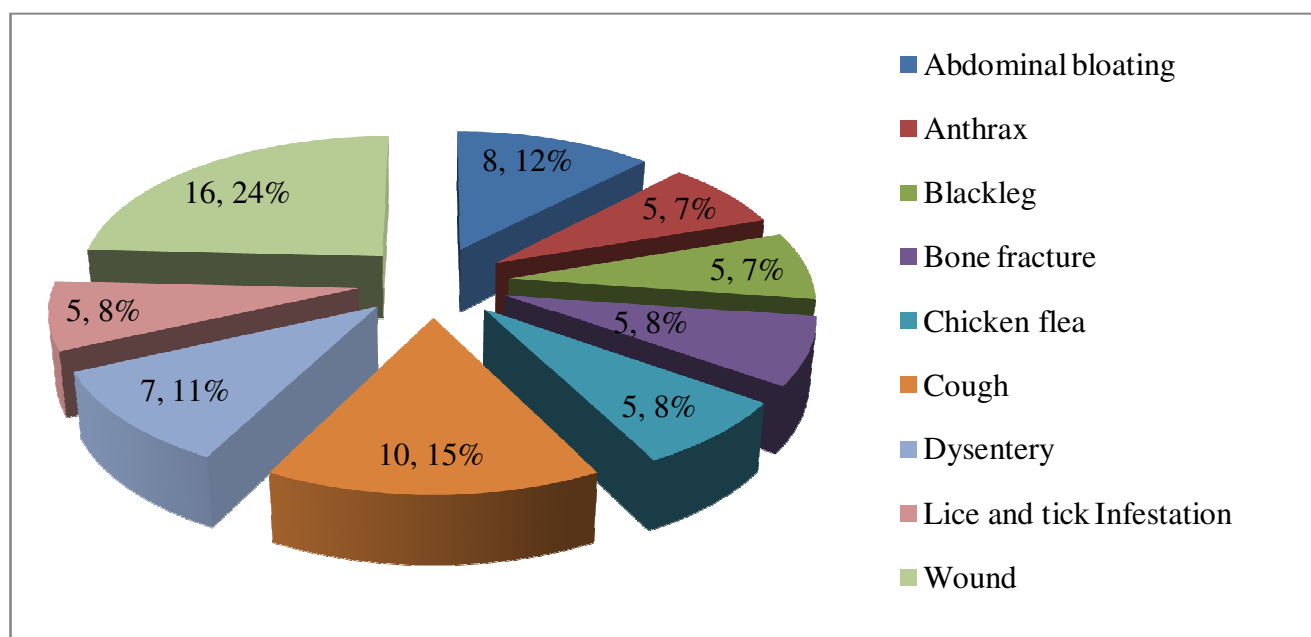


Figure 4 : Top 5 cited ethnoveterinary ailments of the study area

Habit of ethnoveterinary medicinal plant

Shrub, 24 (43%) was the most commonly used habits of the plants by traditional healers followed tree, 20 (36%), herbs, 9 (16%) and climbers, 3(5%). (Figure-5) This finding showed an indication of abundance of shrubs, 43% and trees, 36% , which could be due to survival to rain fall fluctuation and recurrent drought than seasonal herbs and climbers in the study area. Inconsistent to this finding a number of studies conducted before reported the dominance of herbs in their identified ethnoveterinary medicinal plants.(52, 64, and 70)

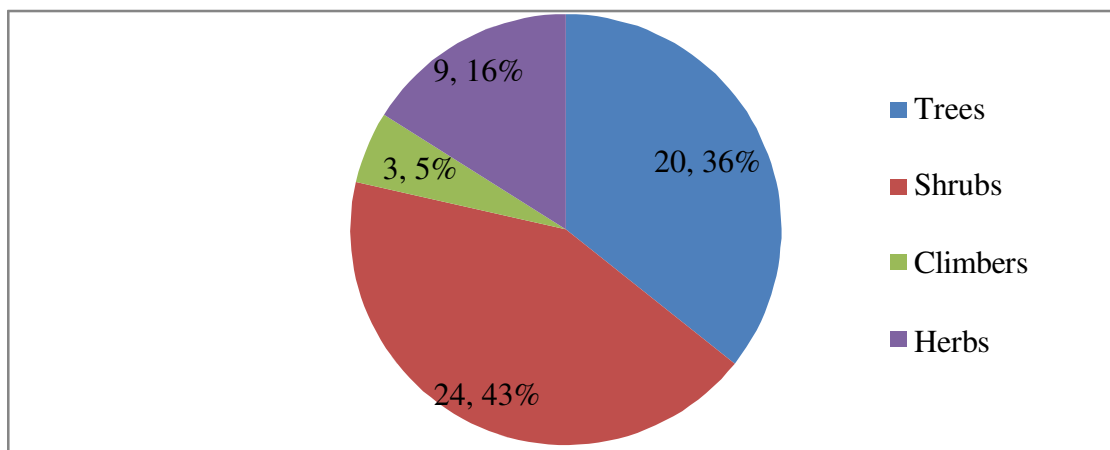


Figure 5: Habit of the reported Medicinal plants.

Habitat (Source) of ethnoveterinary medicinal plant

The principal sources of the medicinal plants were from wild, Ubiquitous and both home garden and agricultural field with proportion of (25 species, 44.6%), (8 species, 14.3%), (8 species, 14.3), respectively. (Table-2) This was pinpointing overwhelm on the wild plant resource in the study area and dess'a priority forest in particular and traditional healers of study area have less effort to cultivate ethnoveterinary medicinal plants in their home gardens rather; they go to nearby forests or far places to harvest wild plant resource. Consistent to our finding, previous findings (44, 69-72), reported that wild habitat as a major source and practice of cultivation of plants for their ethnoveterinary medicinal purpose in home gardens in most of the country is low though many plants are cultivated for purposes animal fodder, shade, charcoal production and mainly for source of human food.

Table 2: Source of the ethnoveterinary medicinal plants in the study area

Source of ethnoveterinary medicinal plants	Frequency	Percent (%)
Home garden and wild	8	14.3
Crop and agricultural fields	3	5.4
Forest floor	2	3.6
Home garden	3	5.4
Slope	4	7.0
Ubiquitous(Everywhere)	8	14.3
Wild	25	44.6
Wild, crop and agricultural field	3	5.4
Total	56	100

Parts of plant remedies used for the preparation

The results of study illustrated that the major part of the medicinal plants were leaf, root, fruit, latex, and whole part with proportion of 48 (43%), 16(14%), 8(7%), 8 (7%) and 8 (7%), respectively in the study area. (Figure-6) Finding of this study confirmed that majority of the plant's parts used to treat ethnoveterinary ailments were leaf, root, fruit, latex and whole part with highest share of leaf 48 (43%), and showed in conformity with findings of (25, 26, 52, 53, 70) , which indicated excessive harvest of leaves damaging plants, the extent of damage of medicinal plants due to fragile nature of plant parts, particularly the young leaves bearing few leaves, collected for the purpose of medicine seems to be high in the area.

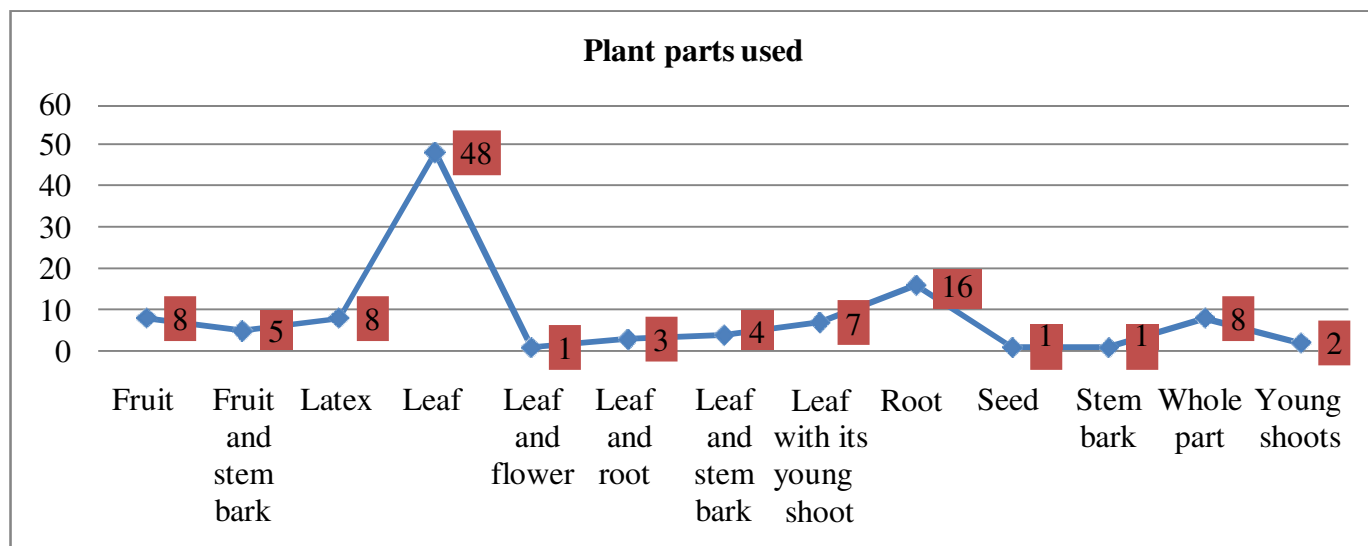


Figure 6: Parts of the ethnoveterinary medicinal plants used in the study area

Harvesting methods of plant parts

Traditional healers of the study area possess eleven different harvesting methods of ethnoveterinary medicinal plant parts, among those uprooting the whole plant was the leading method 42(37%) followed Collecting leaves with its young shoots 39 (34%). (Table-3). Harvesting leaves compared to harvesting roots has less harmful manipulate on the continued existence of medicinal plants.(44) Although collection of plant parts for medicinal purpose is an important aspect, traditional healers of the study area have poor knowledge on harvesting and utilizing the plant resource, which evidenced that the share of roots, leaves with its young shoots, good looking and high quality fruits and stem bark, totaling (76%) which may lead to decrease in species abundance and, finally, even to local extinction. In other words, through extreme or weak harvesting follow, plant species may be put endanger. An ethnoveterinary study in Eastern Harerghe Zone, Eastern Ethiopia also investigated that whole removal 23(33.8%), debarking 23(33.8%) and uprooting 22(32.4%) and such harvesting techniques are the major threatens for conservation.(70)

Table 3 : Harvesting methods of plant parts

Harvesting methods of plant parts	Frequency	Percent (%)
Collecting good looking & high quality fruits	5	4
Exude or latex collection	8	7
Collecting lateral root without damaging main root	4	4
Collecting leaves with its young shoots	39	34
Collecting leaves with its young shoots & Peeling stem bark	1	1
Plunk individual leaves	6	5
Peeling stem bark	1	1
Shake down fruit & peeling stem bark	2	2
Shake down fruit	3	3
Uprooting the whole plant	42	37
Uprooting the whole plant & Collecting leaves with its young shoots	2	2

Form of remedy preparation

Freshly harvested plant parts were the dominant ones 55(49%) used in remedy preparation whereas the remaining 39(34%) and 19(17%) of remedies were reported to be prepared from dried parts and both dried and freshly parts of medicinal plant species respectively. (Figure-7) traditional healers of the study area realize that freshly harvested remedies were most effective and in healing almost all ethnoveterinary health problems than other forms of remedy preparations. Traditional healer also evidenced for their preference to use freshly harvested plant remedies that shrubs and trees were simply harvested from the forest area. Similar work also reported(25) for traditional healers in the study districts to make use of freshly harvested plant parts (85.7%) for remedy preparation over dried forms. This current finding disagrees with the finding of an ethnoveterinary survey conducted in woredas of Tigray region; Northern Ethiopia that accepted traditional healers sell and advertized the

dried form of plant medicine in the market and also store even for long time in different containers in their homes.(26)

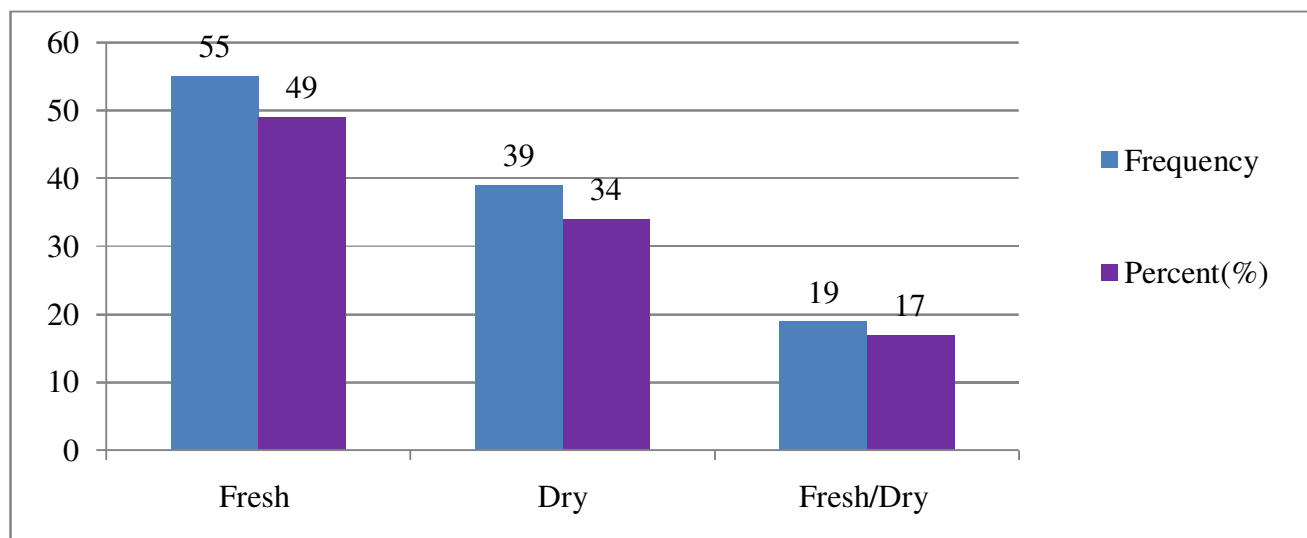


Figure 7: Form or remedy preparations

Methods of preparation and route of administration

Twenty methods of ethnoveterinary medicinal plants preparations were documented in this study. (Figure-8) The proportions vary based on the type of disease treated and the actual site of the ailment. The major method of remedy preparation was pounding, 24(21%), followed by crushing, 13 (12%). Dissimilar patterns were reported by some ethnoveterinary studies (46, 58, 73) where pounding and crushing, (79.2%), crushing (62.7%) and chop and soak in water with salt overnight then squeezed, (97.8%) found that the main mode of preparations respectively. The majority 39(34%) of medicinal plants preparations were revealed to be administered orally, and 19 (17%) were administered dermal, 10(9%) taken topically.(Figure-9) This finding was consistent with findings of (45, 52, 56, 58, 73) who reported as most of medicinal plants used by pastoralists administered through 76.2%, 64 %, 80%, 58.2% and 71% oral route respectively.

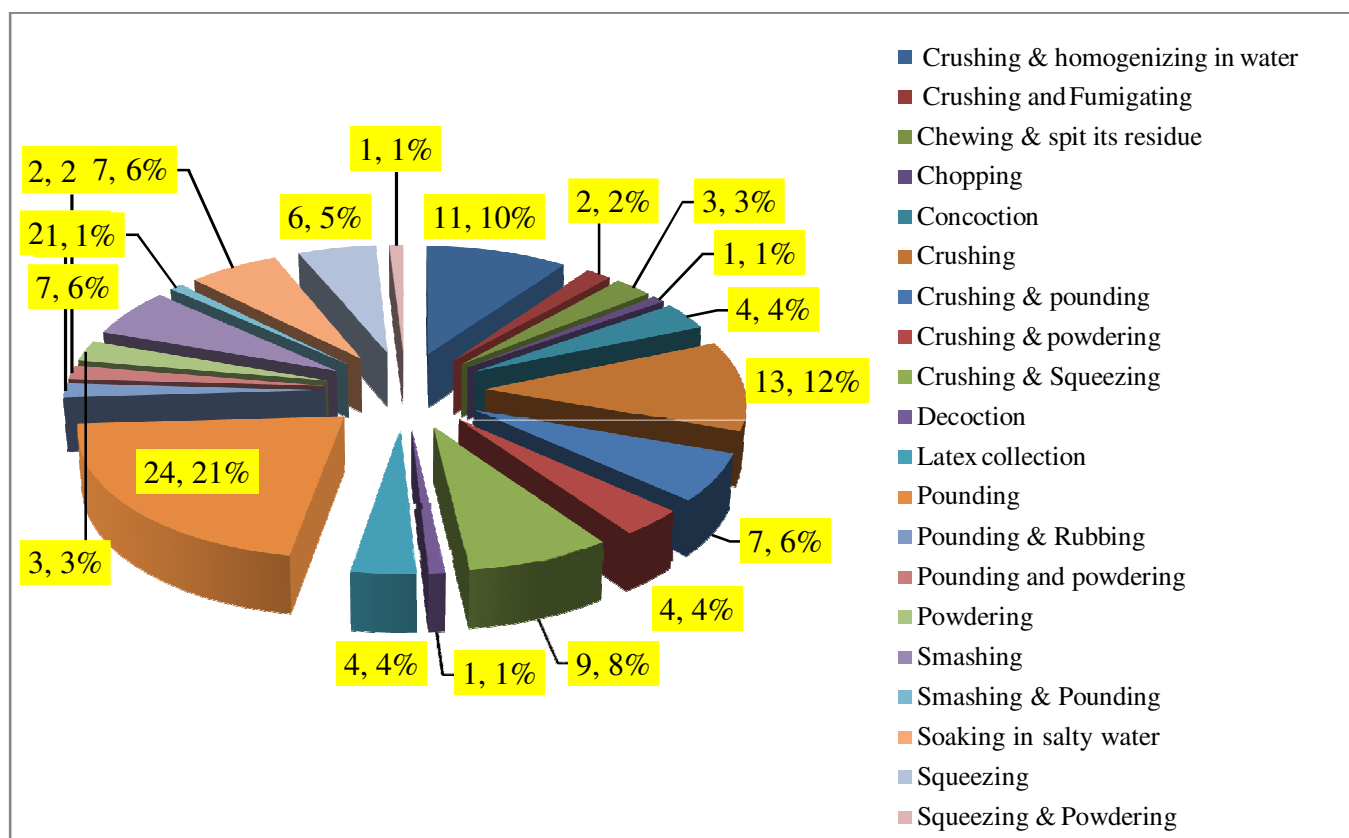


Figure 8: Route of preparations of ethnoveterinary medicinal plants

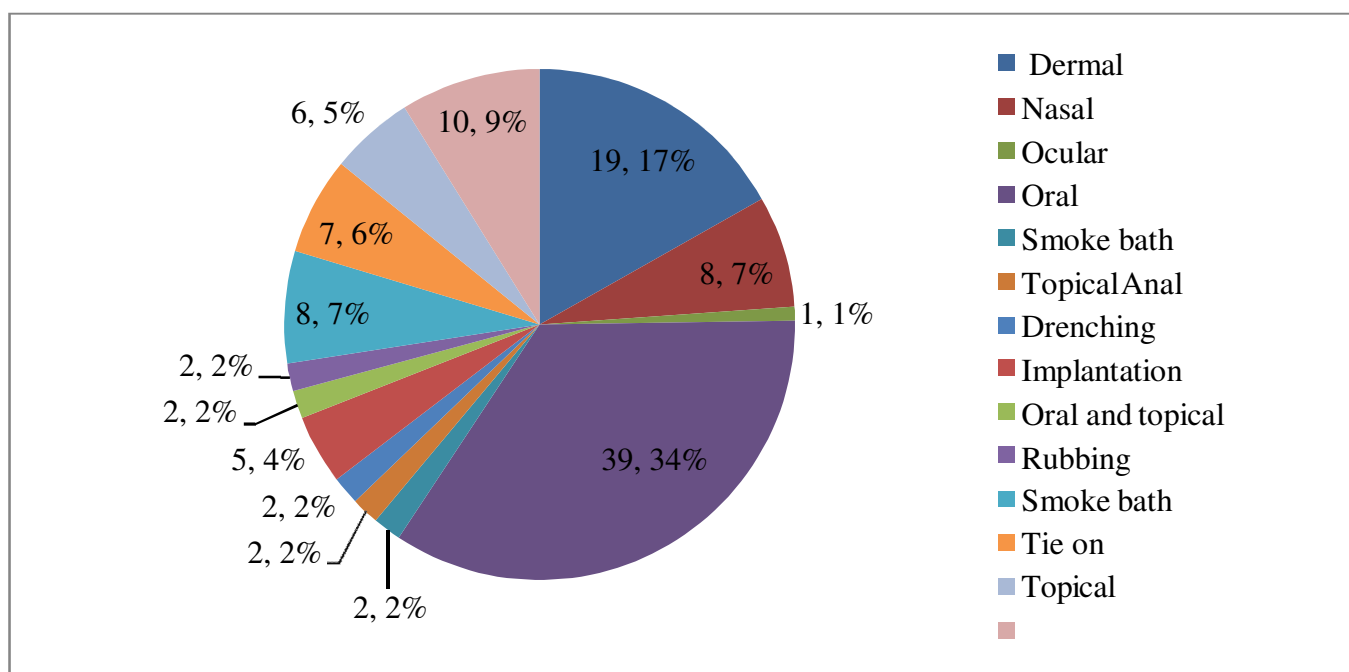


Figure 9 : Route of administrations of ethnoveterinary medicinal plants

Abundance of ethnoveterinary medicinal plants

Analysis of abundance of ethnoveterinary medicinal plants revealed that 30 (53%), 16 (29%), 6 (11%) and 4(7%) were encountered rarely, moderately, seasonally and commonly respectively. (Figure-10) Water and salt were frequently used substances added in the preparation of remedies to increase demand and decrease toxicity of the prepared remedy. This result revealed that traditional healers of the study area required long time and traveled long distance for searching most of the ethnoveterinary medicinal plants in general and herbs and climbers in particular. In consistent to our finding an Ethnoveterinary study in East Gojjam Zone, Amhara Region, Ethiopia also indicated that most of the plant remedies were prepared from fresh plant materials (73.68%).(74)

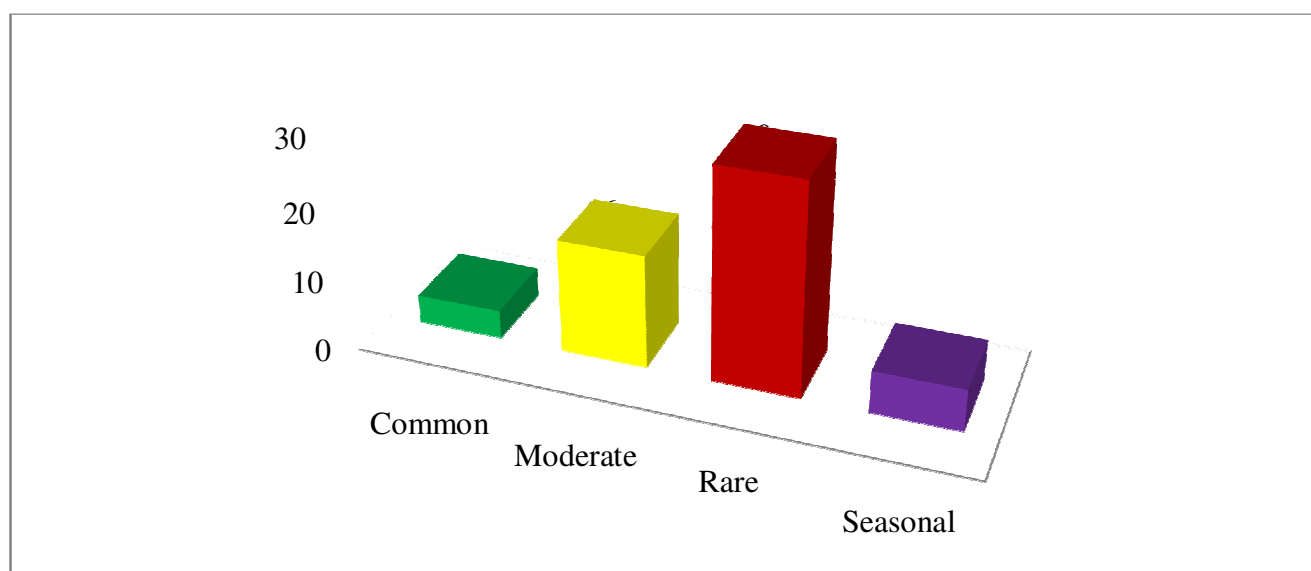


Figure 10: Abundance of ethnoveterinary medicinal plants

Preference ranking Dess'a priority forest

following to Martin and Cotton, (31, 33) preference ranking was also computed using twelve key informants to assess the overall effectiveness of ethnoveterinary medicinal plants used for treating the reported ailments in the area. 5=best, 4= very good, 3=good, 2 =less used and 1=least used were the use values of each species assigned by all the key informants. Then values given to each ethnoveterinary medicinal plant were summed and ranked. (Table- 5)

Preference ranking of top ten medicinal plants that were reported with overall effectiveness, in treating most prevalent disease in the study area was conducted after selecting 12 key informants (2 from each forest kushets). When there are the different species prescribed for different health problem, healers show preference in overall effectiveness and preference of one over the other. *Nicotiana glauca* (56) followed *Solanum mariginatum* (54), were ranked as the most preferable ethnoveterinary medicinal plants in overall effectiveness of treating veterinary ailments of the study area. In opposition to this finding, A study conducted in Wolmera district, Oromia Region, Ethiopia *Agenda abyssinica* (Bruce) J. F. Gmel, followed by *Vernonia amygdalina* Del was the most preferred plant species for the treatment of internal parasite.(56)

Table 4: Preference ranking (Overall effectiveness) of ethnoveterinary medicinal plants of Dess'a priority forest area

Scientific name	Key informants coded (1-12)												Total score	Rank
	1	2	3	4	5	6	7	8	9	10	11	12		
<i>Acacia etbaica</i> Schweinf.	3	4	5	3	4	5	1	4	4	3	4	3	43	4 th
<i>Achyranthes aspera</i> L.	3	3	3	4	3	4	5	2	3	4	1	5	40	7 th
<i>Rumex nepalensis</i> Spreng.	3	5	4	2	3	4	1	2	3	4	2	3	36	10 th
<i>Solanum mariginatum</i> L.	4	4	5	4	4	5	5	5	4	5	4	5	54	2 nd
<i>Foeniculum vulgare</i> (Mill.)	3	5	4	2	5	4	2	3	2	4	5	2	41	6 th
<i>Nicotiana glauca</i> R.Grah	5	4	5	5	4	5	4	4	5	5	5	5	56	1 st
<i>Dobera glabra</i> . (Forssk.) Juss. Ex Poir.	1	3	4	3	4	2	5	5	4	1	2	3	37	9 th
<i>Acacia oerfota</i> (Forssk.) Schweinf.	4	3	2	4	3	5	2	5	4	3	4	3	42	5 th
<i>Calotropis procera</i> (Ait.)Ait.f.	3	2	4	3	5	4	2	4	5	4	2	1	39	8 th
<i>Withania somnifera</i> L.	5	4	3	2	5	4	5	3	5	4	3	5	48	3 rd

Threats of ethnoveterinary medicinal plants

According to the information obtained from the informants of each study forest Kushet, and our field observation, majority of ethnoveterinary medicinal plants were under threat. Accordingly deforestation was the most cited threat (7 respondents, 32%); due to community of the study area was mostly active in fire wood and charcoal production (*Acacia etbaica*, *Olea europea*, and *Euclea racemosa*), followed by Drought (6, 27%), climate change (4, 18%), they supposed by fluctuation and shortage of raining season (Figure-11). This result indicated that intense deforestation (for the purpose of fire wood and charcoal production) became the major threat to ethnoveterinary medicinal plants. Other studies of ethnobotanical medicinal Studies in Ethiopia (75, 76) reported that Agricultural expansion (55%), Deforestation as the major threat to medicinal plants respectively. An ethnobotanical study in Shinle Zone, Somali Regional State, and Eastern Ethiopia also reported that invasive plant (*Prosopis juliflora*) as a principal threat of ethnoveterinary medical plants.(73)

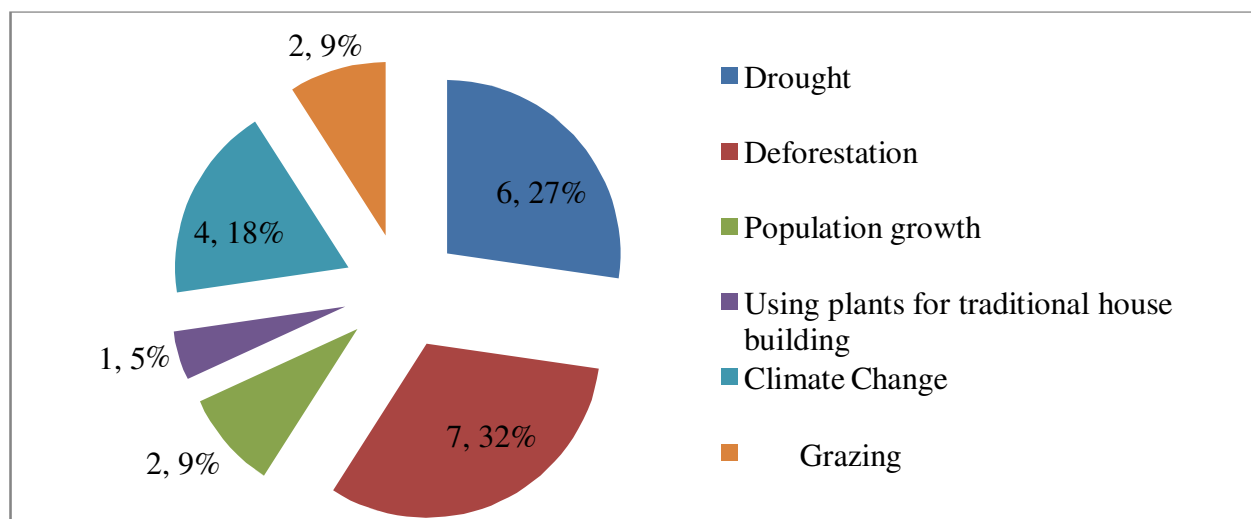


Figure 11: Major threats of ethnoveterinary medicinal plants

Conclusion

Our finding suggests that there is a huge amount of indigenous knowledge of ethnoveterinary medicinal plants in the study site. The majority of the population was illiterate, but they had powerful indigenous knowledge of ethnoveterinary medicine and more ethnobotanical information was found from the elderly male population. This survey has revealed fifty-six ethnoveterinary medicinal plants used to treat 37 veterinary diseases. Most ethnoveterinary medicinal plants were under threat because of several natural and anthropogenic factors, which calls special attention for conservation.

As the study area is partially owned by pastoralists, the serious gap in information transfer to the next generation needs to get attention and mobilization for such documentation.

Domesticating and planting of medicinal and multipurpose plants is one method for ensuring their sustainability. In addition, conservation effort and the utilization of modern drugs by the local people were very small. People of the study area have poor methods for harvesting and utilizing the medicinal plant resource, for example totally uprooting the whole plant for just a leaf or one root, stripping leaves, and removing all the fruits with plant damaging harvesting methods making up seventy-six percent of the mentioned harvesting methods. This may lead to the decline of species abundance and even finally to local extinction. Therefore, there is a need to train the plant collectors on sustainable and ethical methods of harvesting the plants.

The forest lies at the border of Tigray and Afar regional states, which may result in negligence in ownership and fierce competition for the resources. Hence, the conflict of the people in the borders of the forest in using resources is common. , To create a system of security and accountability equitable benefit sharing and governance is in demand. The healers were secretive and did not share their knowledge freely, resulting in the danger of information loss, and inappropriate utilization. Therefore, encouragement of the local

traditional healers to use traditional medicine wisely, through licensing, recognition and other motivating actions are needed.

Recommendations

The Regional and Woreda Administration, the Regional and Woreda Bureau of Agriculture and Natural Resources, Information Media, organizations working in awareness creation, research and education organizations, and Ethiopian Biodiversity Institute should work on raising awareness to conserve these important species and to document and pass on the indigenous knowledge to the next generation. Woreda agricultural office needs to promote domestication and planting of medicinal and multipurpose plants where possible also raise and distribute such plants to both people and the planting activities in the forest of the study area. The Afar and Tigray Regional State Governments; Regional and federal Bureaus of Agriculture and Natural Resources; Ethiopian Biodiversity Institute; Forest and Climate Change and the Ethiopian Environment and Forest Research Institutes at the Regions need to work to find a working legal framework for conflict resolution, benefit sharing and resource administration for the sustainability of the forest.

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Authors' contributions

The authors have made substantive intellectual contributions to this study in carried out field work, data entry, collection, identification of plants, preparation of the manuscript and proof reading.

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Availability of data

All data generated or analyzed during this study were included in this Manuscript.

Declaration of competing interests

The author(s) declare that they have no competing interests.

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Table 5: Ethnoveterinary medicinal plants used to treat ethnoveterinary disease

Key: (Hg= home garden, HgW= home garden and wild, CAf=crop and agricultural fields, Ff= forest floor, Sl=slope, Ubi=Ubiquitous, W=wild, WCAf= wild crop and agricultural fields, Sh =Shrub, T=Tree, H=Herb, Cl=Climbers), WP=Whole part of plant, Fr=fruit R =Root, L=Leaf, Ysht=Young Shoots, Sb =Stem Bark, Fl=Flower, Se=Seed, La=Latex, F=Fresh, D= dry, D/F= Both dry and fresh M=Moderate, Common=Seasonal, R=Rare HK=Haftom Kahsay, Tig –Tigrigna and Afa=Afarigna

Vernacular name (Afarigna or Tigrigna)	Scientific name , Family name, Habitat	Harvesting methods, Habit and Part used	Animal and Aliment treated	Form of remedy preparation , Route of preparation and administration	Abundance & Voucher specimen
Abyi Engule[Tig], Karahtihara[Afa]	<i>Solanum mariginatum</i> L. Solanaceae, WCAf	Sh, R	Cough, Camel	D/F, Pounding, Tie on	M, HK-01
		Sh,L	T B, Camel	F, Crushing & Squeezing, Nasal	
		Sh,L	Ecto-parasite, Goat	D, Soaking in water, Topical	
		Sh, L & Ba	Cutaneous Streptothricosis , Sheep	D/F ,Pounding, Dermal	

Agol [Tig] Shekayto[Afa]	<i>Withania somnifera</i> L. Solanaceae, Sl	Sh, L	Neck Wound, ox	F, Crushing, Topical	M, HK-02
		Sh, Leaf & Ysht	Foot-mouth Disease, Cattle	Crushing, Oral	
		Sh, L	Leg wound, Goat	F, Crushing & Squeezing, Rubbing or smearing,	
Alayto [Afa]	<i>Aerva javanica</i> (Burm. f) <i>Juss. Ex Schult.</i> Amaranthaceae, HgW	Sh, L	Equine Influenza, Horse	D, Crushing & pounding, Rubbing or smearing	R, HK-03
		Sb & FL	Blackleg, Sheep	F, Smashing, Oral	
Alie'to [Afa]	<i>Cissus quadrangularis</i> L. Vitaceae, W	Cl ,Wp	Lice and tick, Cattle	F, Soaking in water, Topical	R, HK-04
Atat [Tig]	<i>Maytenus arbutifolia</i> (Hochst. ex A.Rich.) R.Wilczek Celasteraceae, W	Sh, L & Ba	Expelling delayed placenta, Cow	F, Crushing & pounding, Oral	M, HK-05
			Anthrax, Cattle	F, Crushing, Topical	
Atamiti [Afa]	<i>Rhus natalensis</i> Bernh. <i>ex Krauss</i> Anacardiaceae, Ubi	Sh, L	Snake bite prevention, Goat	F, Smashing, Tie on	R, HK-06

Awhi [Tig]	<i>Cordia africana</i> Lam. Boraginaceae, Hg	T, L	Wound due to hyena bite, Sheep	D/F, Crushing & pounding, Rubbing	R, MU-07
		T, L & R	Tetanus, Horse	D, Pounding, Rubbing	
Bara Bangi [Afa]	<i>Argemone mexicana</i> L. Papaveraceae, W	UWp, H, Se	Anthrax, Cattle	F, Crushing & homogenizing in water, Smoke bath	C, HK-08
Askento [Afa]	<i>Solanum hastifolium</i> <i>Hochst. Ex Dunal.</i> Solanaceae, W	UWp, H, Wp	Cutaneous Streptothricosis , Sheep	D, Smashing, Rubbing	R, HK-09
Enkaetihara [Afa]	<i>Nicotiana glauca</i> <i>R. Grah.</i> Solanaceae, Ubi	UWp, Sh, L	Expelling leeches, Cattle	D, Soaking in water, Dermal	M, HK-10
		Sh, L & R	Rabies, Dog	F, Crushing & Squeezing, Rubbing	
		Sh, R	Cough, Camel	F, Crushing & pounding, Orally	
		Sh, L & Ysht	Wound Bloat, Camel	D, Pounding, Rubbing or smearing	
		Sh, L	Wound due to hyena bite, Sheep	D, Crushing & homogenizing in water, Dermal	
		Sh, L & Ysht	Cough, Mule	D/F, Pounding, Nasal	
		Sh, L & Ysht	Donkey's wart, Donkey	D, Crushing & homogenizing in	

				water, Oral	
Dankakebis [Afa]	<i>Capsicum annuum L.</i> Solanaceae, W	UWp, H, L	Liver disease, Camel	D, Crushing, Oral	R, HK-11
Danshel [Tig]	<i>Ferula communis L.</i> Apiaceae, W	Sh, L & Ysht	Lice and tick Infestation , Goat	F, Exudation form, Dermal	M, HK-12
Dengele [Tig]	<i>Rumex nepalensis</i> <i>Spreng.</i> Polygonaceae, WCAf	UWp, H, Wp	For Cow hates their calf, Cow	D, Pounding, Implantation	R, HK-13
Disayto [Afa]	<i>Celosia polystachya</i> (<i>Forssk.</i>) Amaranthaceae, SI	Sh, L	Anthrax, Sheep and cattle	D/F, Powdering, Topical	R, HK-14
		Sh, L & Ba	Expel delayed placenta. Camel	F, Smashing, Tie on	
Ere [Tig], Ureyta [Afa]	<i>Aloe elegance</i> Aloaceae, WCAf	UWp, Sh, La	Tick infestation, Goat	F, Crushing, Oral	R, HK-15
		Sh, L & Fl	Chicken flea, Chicken	D, Crushing, Smoke bath	
Etse zewye[Tig]	<i>Cyphostemma junceum</i> (<i>Webb</i>) <i>Desc. Ex Wild &</i> <i>R.B.Drumm.</i> Vitaceae, HgW	Sh, L & Ysht	Cough, Goat	D/F, Pounding, Oral	M, HK-16
		Sh, Fr	Cough, camel	D/F, Powdering, Oral	
		Sh, L	Anthrax, Sheep	F, Crushing & powdering, Oral	
Galae'to [Afa]	<i>Calotropis procera (Ait.)</i> <i>Ait.f.</i> Asclepidaceae, W	Sh, Ysht	Wound Bloat, Goat	D/F, Pounding, Dermal	R, HK-17
		UWp, Sh,	Rabbis, Dog	F, Exudation form,	

		L		Oral	
		Sh, La	Bone fracture, Camel	D, Crushing , Orally	
		UWp, Sh, La	Tick infestation, Goat	F, Squeezing, Dermal	
Habi tselim(Tig)	<i>Jasminum gratissimum</i> Deflers. Oleaceae, Ubi	UWp, Cl, Wp	Malaria, Camel	D, Crushing & homogenizing in water, Oral	M, HK-18
Garsayto[Afa]	<i>Dobera glabra. (Forssk.)</i> <i>Juss. Ex Poir.</i> Salvadoracea, HgW	T, R	Breast Swelling, cat	D/F, Pounding, Dermal	M, HK-19
Gerento[Afa]	<i>Acacia oerfota (Forssk.)</i> <i>Schweinf.</i> Fabaceae, W	T, L	Vomiting, Cat	D/F, Pounding , Oral	R, HK-20
Hambohambo [Tig]	<i>Senna singueana</i> <i>(Delile) Lock</i> Fabaceae, HgW	Sh, L	Sleeping Sickness, Horse	F, Smashing, Tie on	R, MU-21
		Sh, R	Equine Influenza, Horse	F, Crushing, Smoke bath	
Tsediyet [Tig]	<i>Indigofera spicata</i> Forssk. Fabaceae, HgW	H, L	Dysentery, Sheep & Goat	F, Chopping , Oral	S, HK-22
Hitsawuts[Tig]	<i>Calpurnia aurea (Ait.)</i>	Sh, L	Cough, Mule	D/F, Pounding, Oral	R, HK-23

	Fabaceae, W	Sh, L	Bone fracture, Sheep	F, Chewing & spit its residue, Dermal	
Hohot[Tig]	<i>Rumex nervosus Vahl.</i> Polygonaceae, CAf	Sh, L	Expelling leeches, Cattle	D, Squeezing , Oral	R, HK-24
Kastanisto[Tig]	<i>Asparagus africanus Lam.</i> Asparagaceae, Ubi	UWp, Cl, R	Cow hates their calf, Cow	D/F, Pounding ,Oral	R, HK-25
Khokhitsi [Afa],Girawa[Tig]	<i>Vernonia amygdalina Del.</i> Asteraceae, HgW	Sh, L	Expelling leeches, Ox	F, Crushing & Squeezing, Oral	M, HK-26
		Sh, L	neck swelling, Camel	D, Squeezing, Dermal	
Qolqual [Afa], Belles [Tig]	<i>Opuntia ficus-indica (L.) Mill.</i> Cactaceae	Sh, La	Malaria, Donkey	F, Crushing & homogenizing in water, Topical	R, HK-27
		Sh, R	Dislocated bone, Sheep & Goat	F, Crushing, Oral	
Komidere Bereka[Tig]	<i>Lycopersicon esculentum Mill.</i> Solanaceae, W	UWp, H, Fr	Dysentery, Sheep	F, Crushing & homogenizing in water, Oral	R, HK-28
		UWp, H, L	Abdominal bloating, Sheep	D/F, Pounding, Oral	
Kusrayto[Afa]	<i>Ziziphus spina-christi (L.) Desf.</i> Rhamnaceae, W	T, Leaf	Wound Bloat, Camel	F, Crushing & homogenizing in water, Dermal	R, MU-29
		T, Ysht	Devil sickness, Sheep & Goat	D/F, Powdering, Tie on	

Laynoyta[Afa]	<i>Millettia ferruginea</i> (Hochst) Baker. Fabaceae, W	T, L	Rabies, Dog	F, Crushing & homogenizing in water, Oral	S, HK-30
Lemon [Tig]	<i>Citrus aurantifolia L.</i> Rutaceae, Hg	Cglf, T, Fr	Wound due to hyena bite, Donkey	D, Squeezing, Dermal	R, HK-31
Libay [Afa]	<i>Erythrina abyssinica</i> Lam. Ex DC. Fabaceae, W	Pil, T, L	Abdominal bloating, Camel	F, Chewing & spit its residue, Topical	R, HK-32
Limo [Tig]	<i>Melia azedarach L.</i> Meliaceae, Hg	Pil, T, R	Cough, Sheep	F, Squeezing, Oral	M, HK-33
Mearkak[Tig]	<i>Helichrysum sp.</i> Asteraceae, W	UWp, H, Wp	Wound, Cattle	Smashing, Tie on	R, HK-34
Meda'eto [Afa]	<i>Euclea racemosa subsp. schimperi (A.DC.)</i> F. White. Ebenaceae, Sl	Pil, Sh, L & Ysht	Chicken flea, Chicken	F, Smashing & Pounding, Smoke bath	R, HK-35
		Pil, Sh, L	Neck Wound, Ox	F, Squeezing & Crushing, Topical	
		Pil, Sh, L	Blackleg, Cattle	D/F, Pounding and powdering, Oral	
Merka'eto[Afa]	<i>Acacia mellifera (Vahl).</i> (Benth.) Fabaceae, Ubi	Pil, T, L	Dysentery, Sheep	D, Pounding, Oral	R, HK-36
		Lrwmr, T, R	Malaria, Camel	F, Concoction, Oral	

Misrar[Afa],Siwa kerni[Tig]	<i>Leucas abyssinica</i> (Benth.) Lamiaceae, CAf	Pll, Sh, Sb	Dislocated bone, Sheep & Goat	F, Crushing & homogenizing in water, Dermal	R, HK-37
		Pll, Sh, L	Tetanus, Horse	F, Squeezing, Topical	
Engada'eto[Afa]	<i>Euphorbia abyssinica J.</i> <i>F. Gmel.</i> Euphorbiaceae, W	T, L & Sb	Abdominal Bloat, Ox	D, Pounding and powdering, Oral and topical	R, HK-38
		El, T, La	Blackleg ,Sheep	D/F, Pounding, Nasal	
		El, T, La	Diarrhea, Camel	F, Latex collection, Oral	
Saeri saero [Tig]	<i>Silene macrosolen</i> Steud. Ex A.Rich. Caryophyllaceae, Ff	UWp, H, L	Lice and tick infestation, Donkey	F, Crushing and powdering, Dermal	R, HK-39
Semed [Afa], Shbtsi [Tig]	<i>Phytolacca dodecandra</i> L'Herit. Phytolaccaceae, W	El, T, La	Dysentery, Camel	F, Latex collection, Oral	M, HK-40
Serawto[Afa],Seraw [Tig]	<i>Acacia etbaica</i> Schweinf. <i>Fabaceae</i> , HgW	Sd & PSt, T, Fr & Sb	Urine retention, Donkey	D/F, Pounding, Oral and topical	R, HK-41
		T, L	Abdominal bloating, Sheep	D, Crushing & homogenizing in water, Drenching	
		T, L & R	Neck Wound, Ox	F, Chewing & spit its residue, Drenching	

		T, L	Disease of hunger, Camel	F, Concoction, Oral	
Shlan[Tig]	<i>Foeniculum vulgare</i> (Mill.) <i>Apiaceae</i> , W	Sh, L	Abdominal bloating, Ox	D, Crushing & Squeezing, Drenching	M, HK-42
		Sd & , Sh, Fr & Sb	Cough, Donkey	F, Crushing, Nasal	
		Sh, R	Chicken flea, Chicken	D, Crushing , Smoke bath	
Zengi-adgii [Tig]	<i>Verbascum sinaiticum</i> <i>Benth.</i> <i>Scrophulariaceae</i> , W	Sh, Wp	Anti bad odor, Bee	D, Pounding , Smoke bath	S, HK-43
Soneyta[Afa]	<i>Senna alexandrina</i> Mill. <i>Fabaceae</i> , Ubi	UWp, Sh, L	Abdominal bloating, Sheep & Goat	D/F, Pounding, Topical	R, HK-44
		UWp, Sh, R	Blackleg, Cattle & Sheep	D, Squeezing & Powdering, Anal	
Sublayto[Afa]	<i>Ficus sycomorus</i> Forssk. <i>Moraceae</i> , Sl	Cglf, T, Fr	Cow hates her calf, Cow	D, Crushing, Rubbing	R, HK-45
Te'aer [Afa]	<i>Euphorbia</i> sp. <i>Euphorbiaceae</i> , W	UWp, H, L	Disease of hunger, Camel	F, Concoction, Oral	S, HK-46
		UWp, H, La	Wound, Donkey	D/F, Pounding, Dermal	

Tsfirarya [Tig]	<i>Sida schimperiana</i> <i>Hochst.</i> Malvaceae, Ff	Sh ,R	Anthrax, Cattle & Sheep	D, Crushing & pounding, Drenching	M, HK-47
		Sh, L	Wound, Donkey	D, Soaking in water, Dermal	
Tskur berbere[Tig]	<i>Schinus molle</i> L. Anacardiaceae, HgW	T, L	Abdominal bloating, Camel	F, Concoction, Topical	R, HK-48
		T, Fr & Sb	Anti bad odor, Bee	F, Crushing & Squeezing, Drenching	
		T, L	Sex stimulants in female , Sheep and Goat	F, Crushing & pounding, Implantation	
Udayto [Afa]	<i>Balanites aegyptiaca</i> (L.) <i>Del.</i> Balanitaceae, W	T, , Fr & Sb	Dysentery, Ox	D, Pounding, Oral	C, HK-49
		Sd, T, Fr	Wound due to hyena bite, Ox	F, Crushing & homogenizing in water, Dermal	
Waraabekala) [Afa]	<i>Amaranthus caudatus</i> L. Amaranthaceae, Ubi	UWp, Sh, L	Disease of hunger, Cattle	D, Soaking in water, Nasal	S, HK-50
		UWp, Sh, L	Dysentery, Camel	D, Pounding, Oral	
Wegerto[Afa]	<i>Olea europaea</i> L. <i>subsp</i> <i>cuspidata</i> (Wall. ex G.	T, L	Expel delayed placenta, Cow	F, Crushing & powdering, Anal	M, HK-51

	<i>Don) Cif.</i> Oleaceae, W	T, R	Neck Wound, Ox	D, Pounding, Dermal	
Wegiesera[Afa],Muche le[Tig]	<i>Achyranthes aspera L.</i> Amaranthaceae. W	UWp, H, L	Urine retention, Donkey	F, Crushing , Nasal	M, HK-52
		UWp, H, R	Foot rot, Ox	F, Crushing & Squeezing, Dermal	
		UWp, H, L	Chicken flea, Chicken	F, Crushing and Fumigating, Smoke bath	
		UWp, H, Wp	Cough, Camel	D, Pounding, Nasal	
Wekerikoqous [Afa]	<i>Solanum incanum L.</i> Solanaceae, W	Sd, Sh, Fr	Chicken flea, Chicken	D, Crushing and Fumigating, Smoke bath	M, HK-53
		Sd, Sh, Fr	Eye inflammation, Mule	F, Crushing, Ocular	
		Sd, Sh, R	Trypanosomose ss, Camel	D, Soaking in water, Oral	
Chiendog [Tig]	<i>Otostegia fruticosa</i> (<i>Forssk.</i>) Schweinf. Ex Penzig. Lamiaceae, CAf	Sh, L	Diarrhea, Camel	F, Crushing & Squeezing, Smoke bath	S, HK-54
		Sh, L	Wound due to hyena bite, Sheep and Goat	D, Smashing , Dermal	

		Sh, R	Blackleg, Cattle & Sheep	D, Pounding, Oral	
		Sh, L	Disease of hunger, Donkey	D, Pounding, Oral	
Elisurae[Afa]	<i>Commelina sp.</i> Commelinaceae, W	UWp, H, R	Bone fracture, Camel	D, Soaking in water, Topical	C, HK-55
		UWp, H, Wp	Cough, Donkey	F, Crushing & Squeezing, Nasal	
		UWp, H, L	Abdominal bloat, Camel	D, Pounding, Oral	
		UWp, H, L	Dysentery, Mule	F, Decoction, Oral	
Sukuhto[Afa]	<i>Teclea nobilis</i> Delile. Rutaceae, W	UWp, H, Fr	Strangles, Mule	D, Pounding, Oral	C, HK-56

Figures

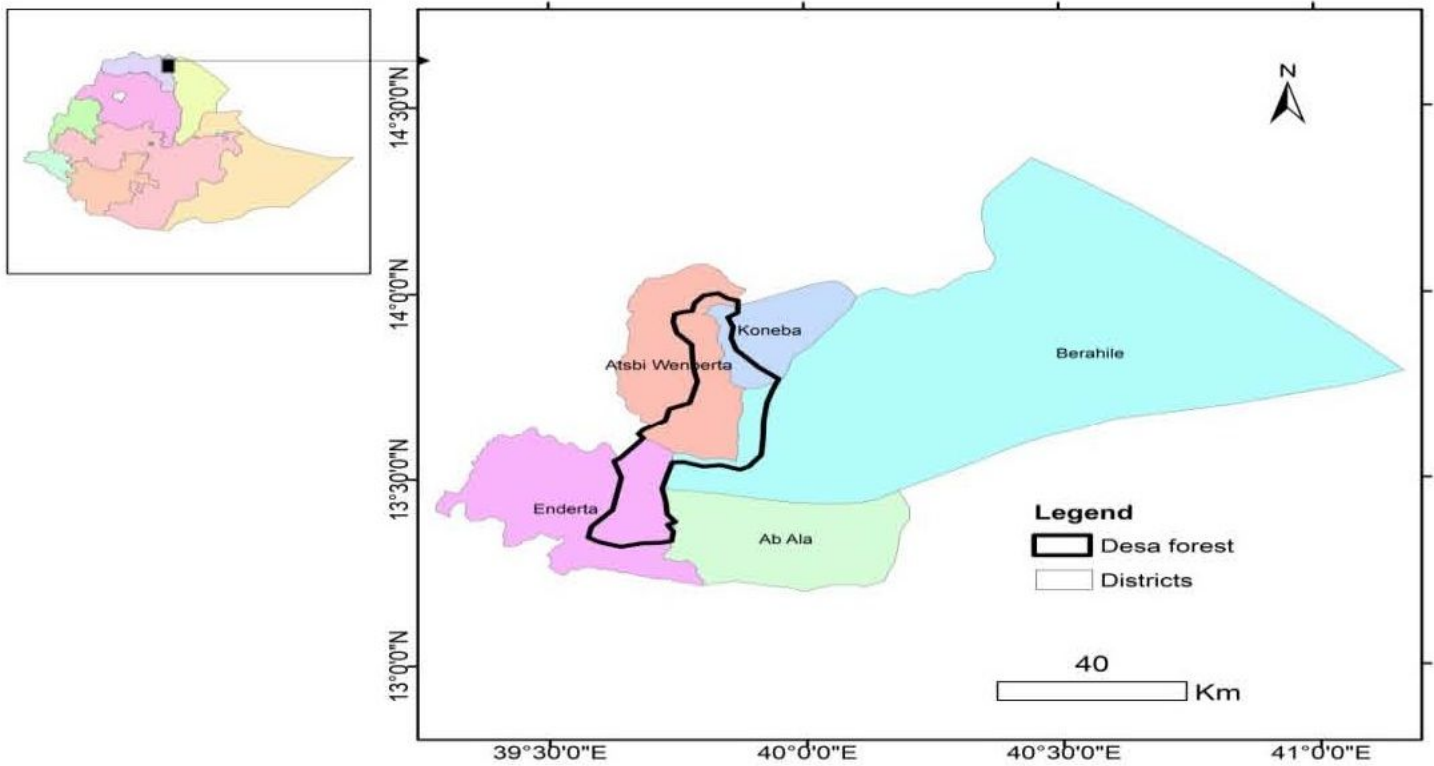


Figure 1

Map of the study area



Figure 2

Focus group discussion with traditional healers, Kushet administrators, translators and forest guards

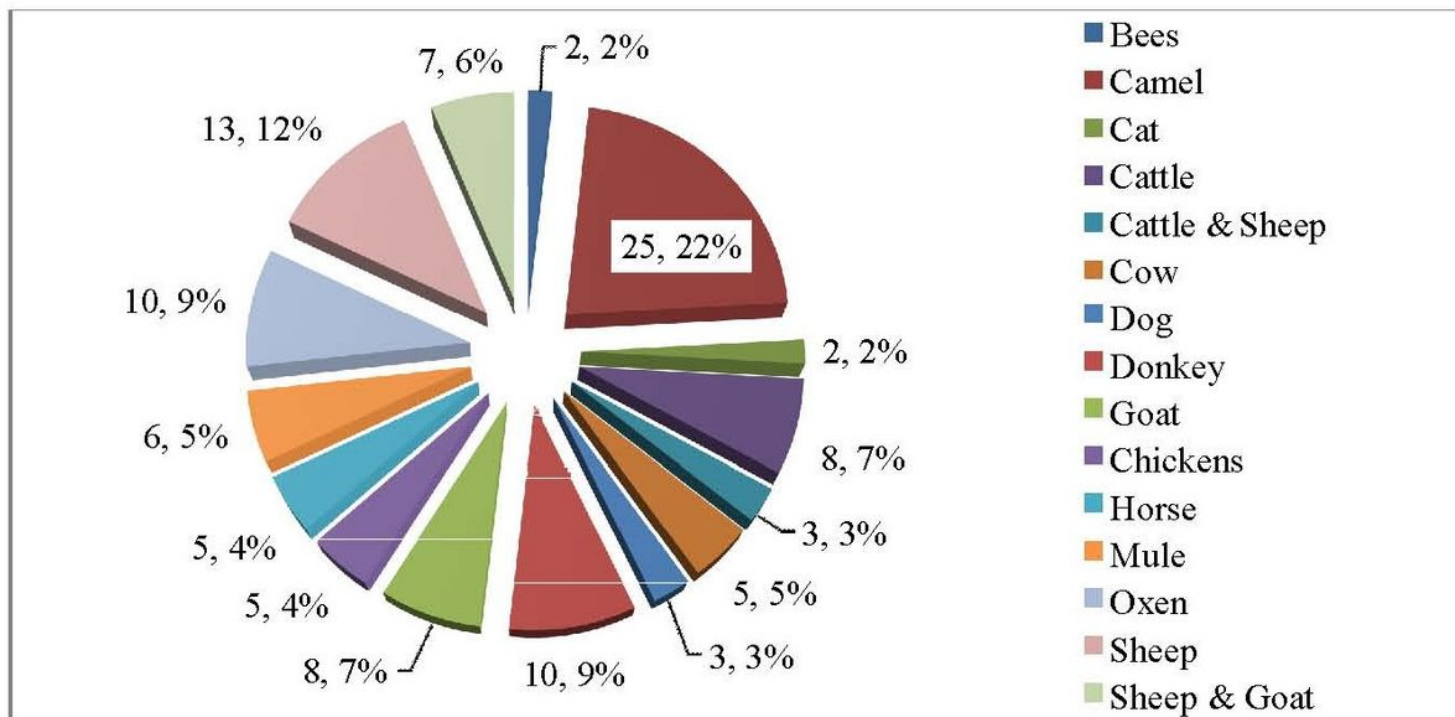


Figure 3

Domestic animals treated by traditional healers

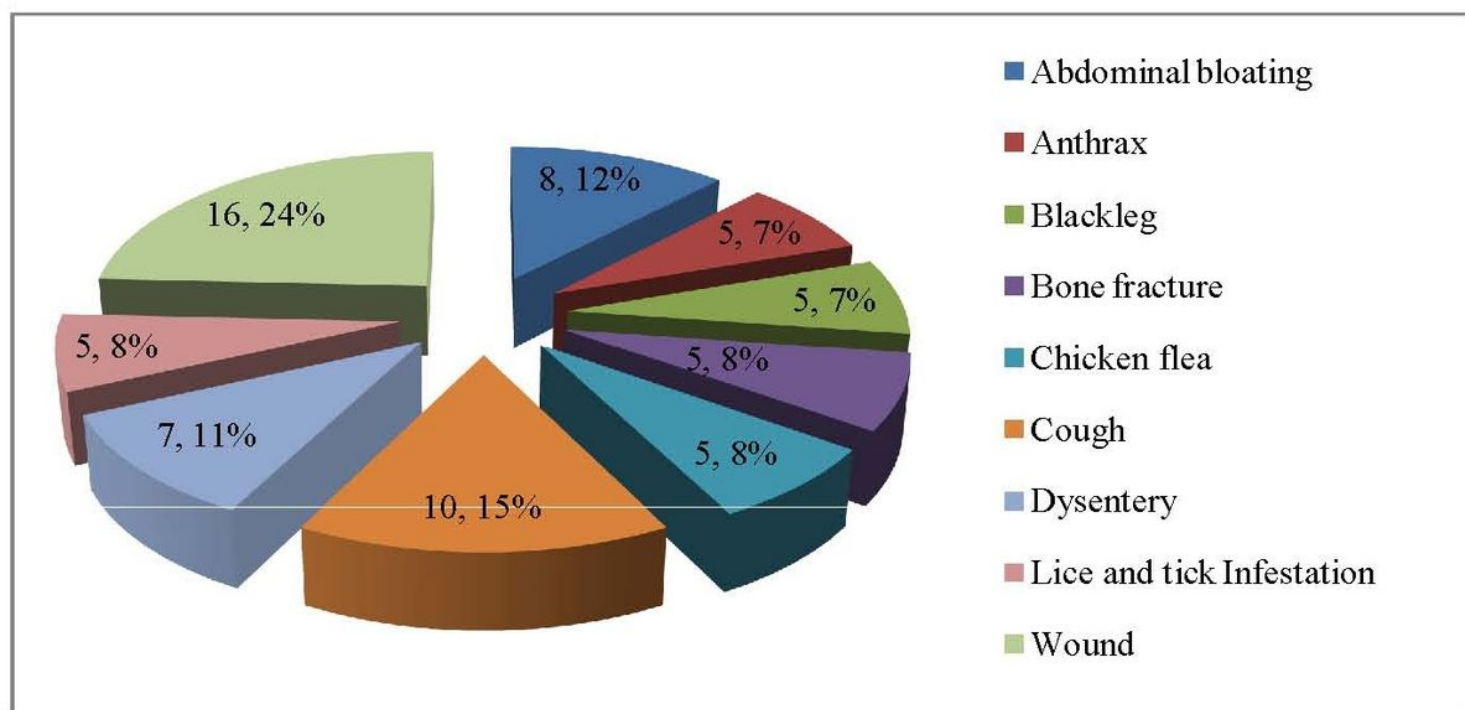


Figure 4

Top 5 cited ethnoveterinary ailments of the study area

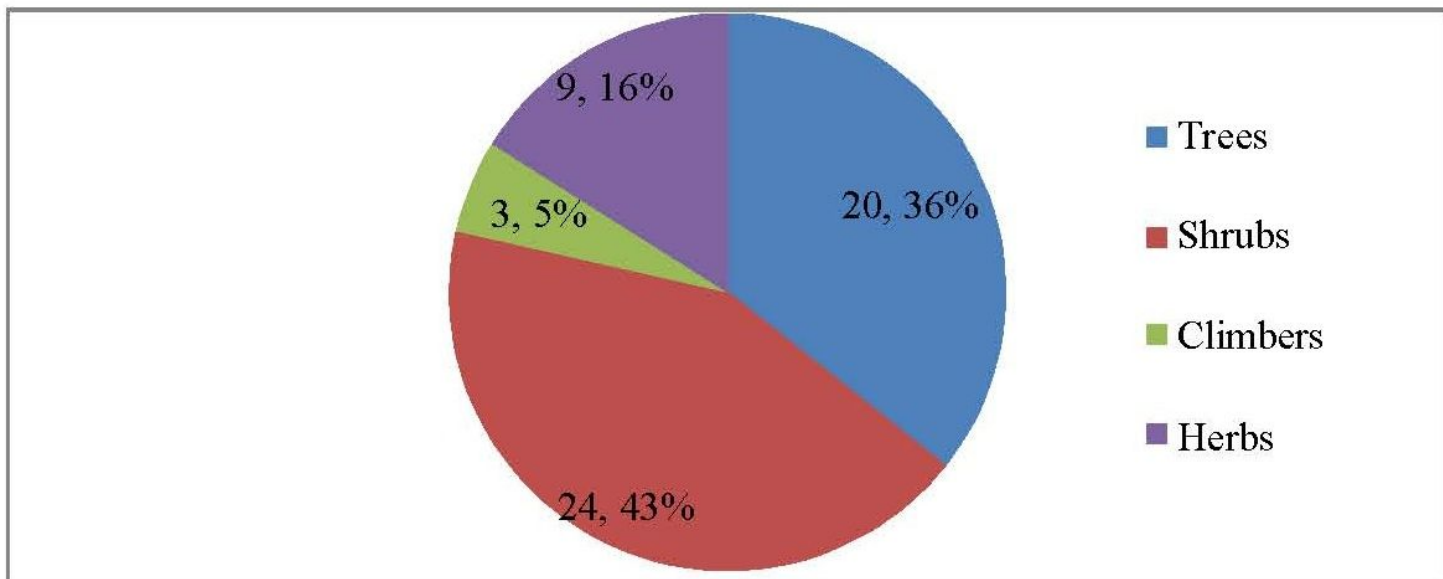


Figure 5

Habit of the reported Medicinal plants.

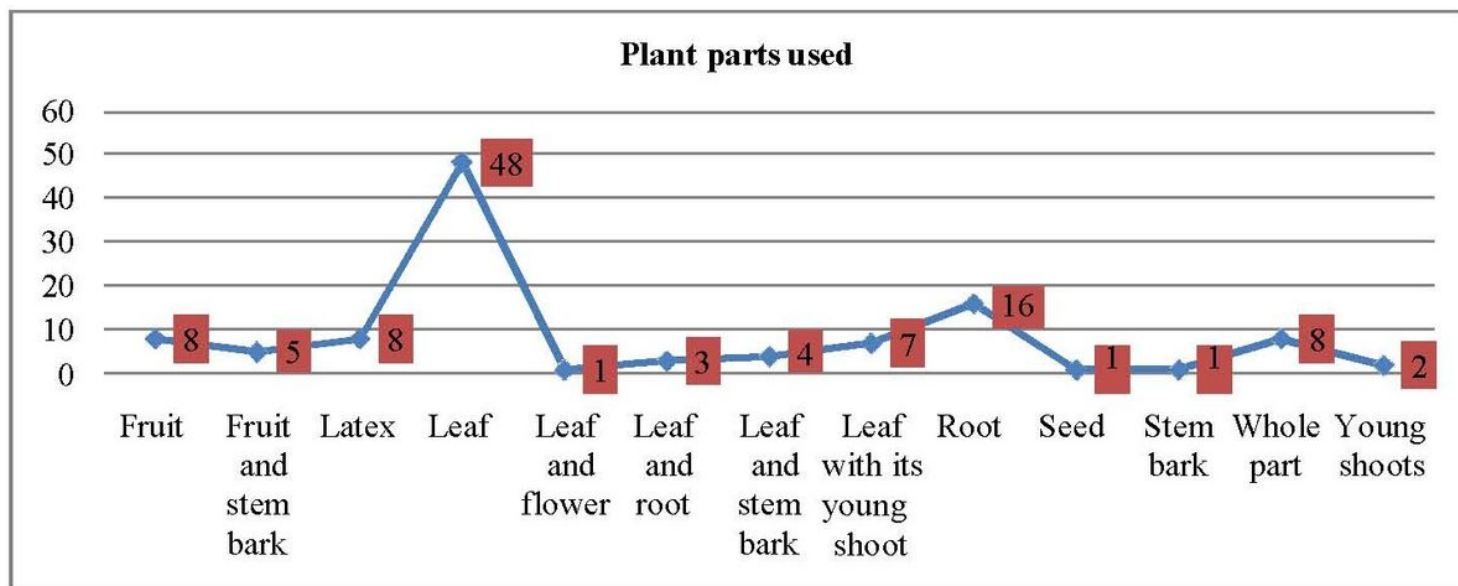


Figure 6

Parts of the ethnoveterinary medicinal plants used in the study area

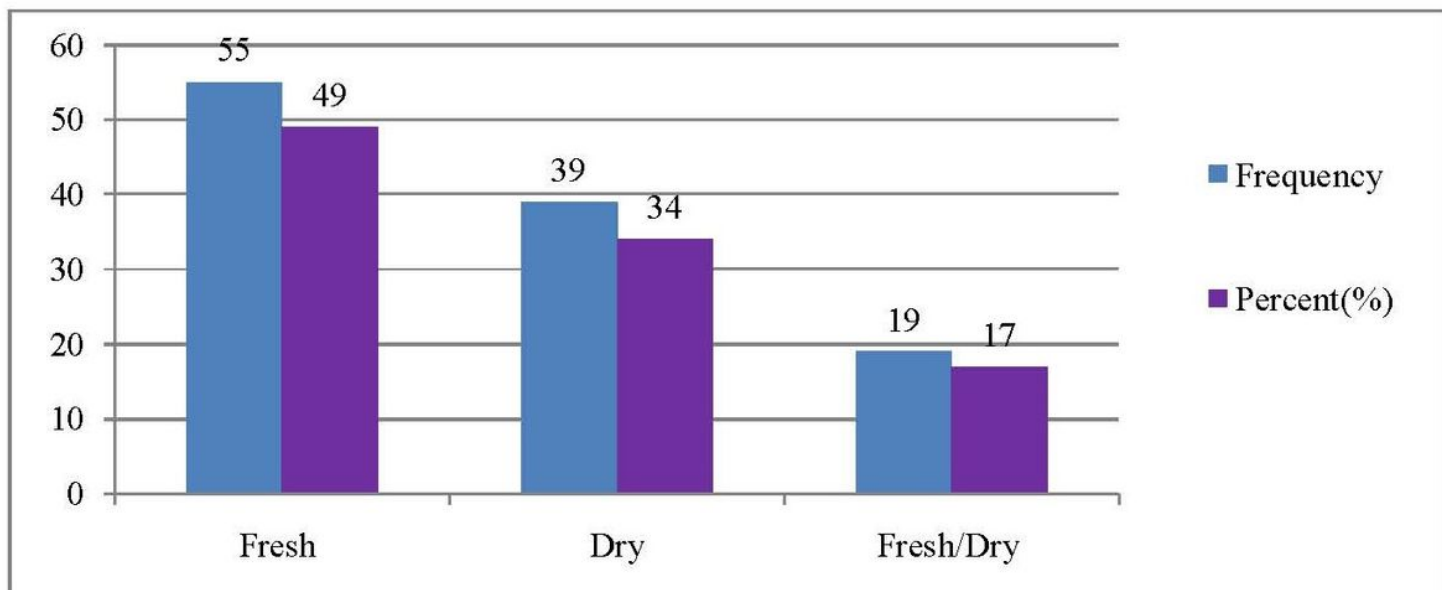


Figure 7

Form or remedy preparations

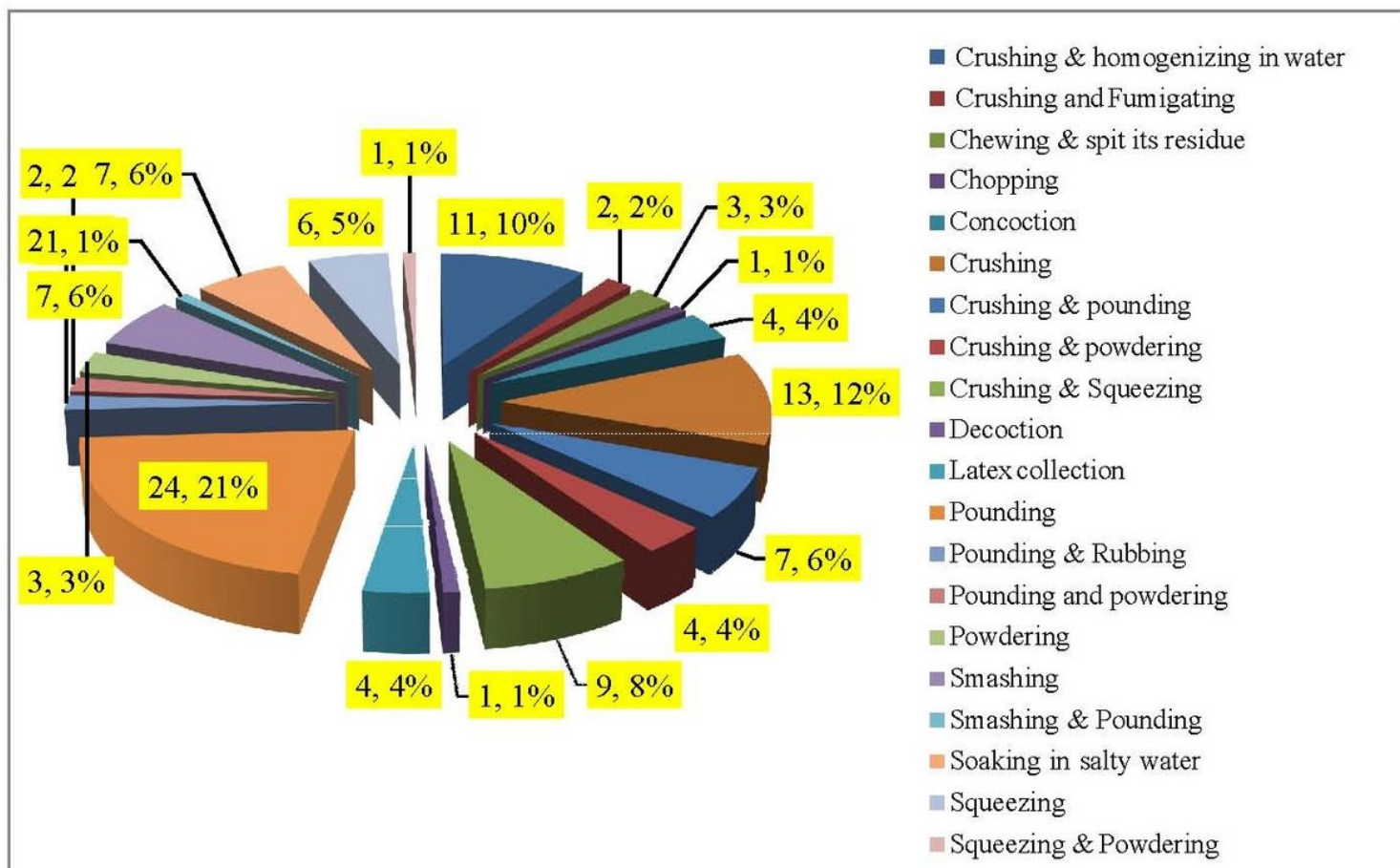


Figure 8

Route of preparations of ethnoveterinary medicinal plants

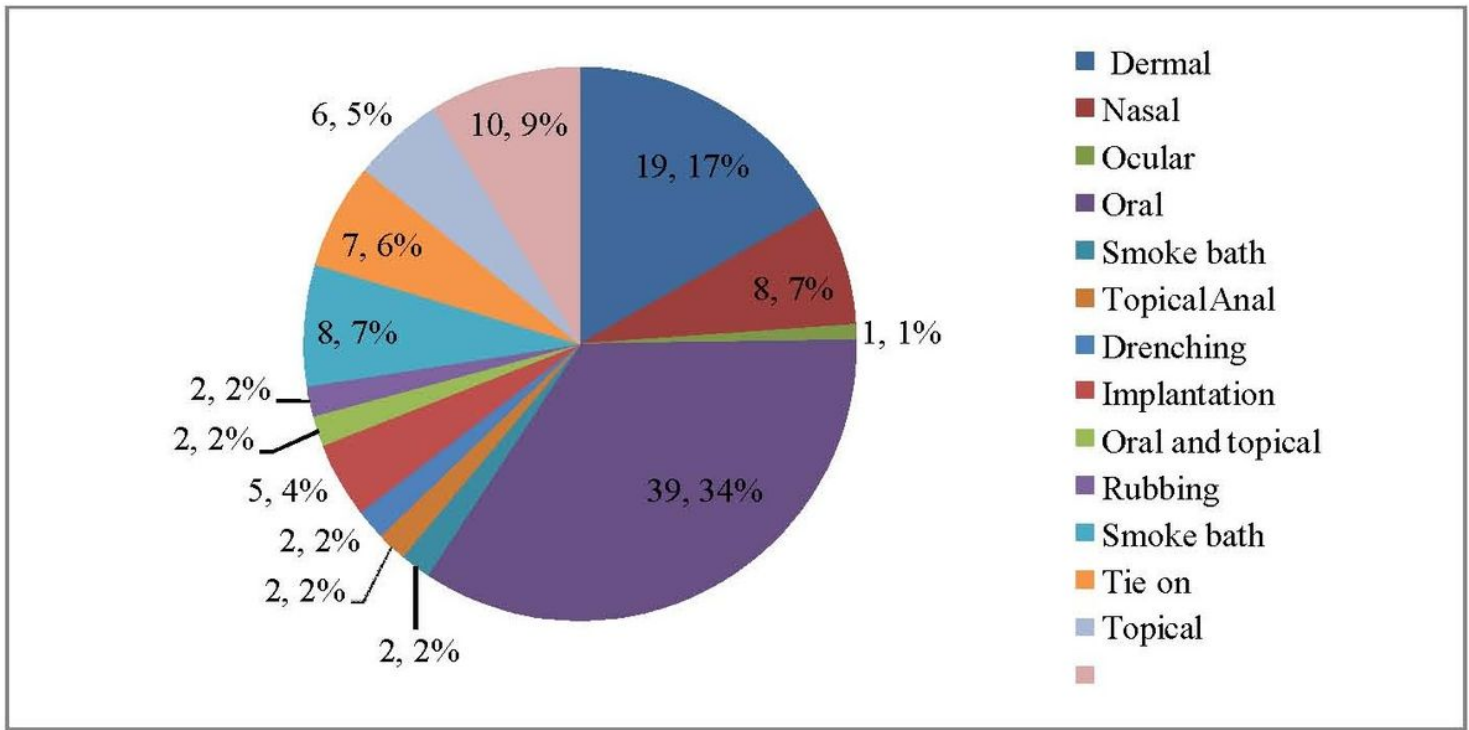


Figure 9
Route of administrations of ethnoveterinary medicinal plants

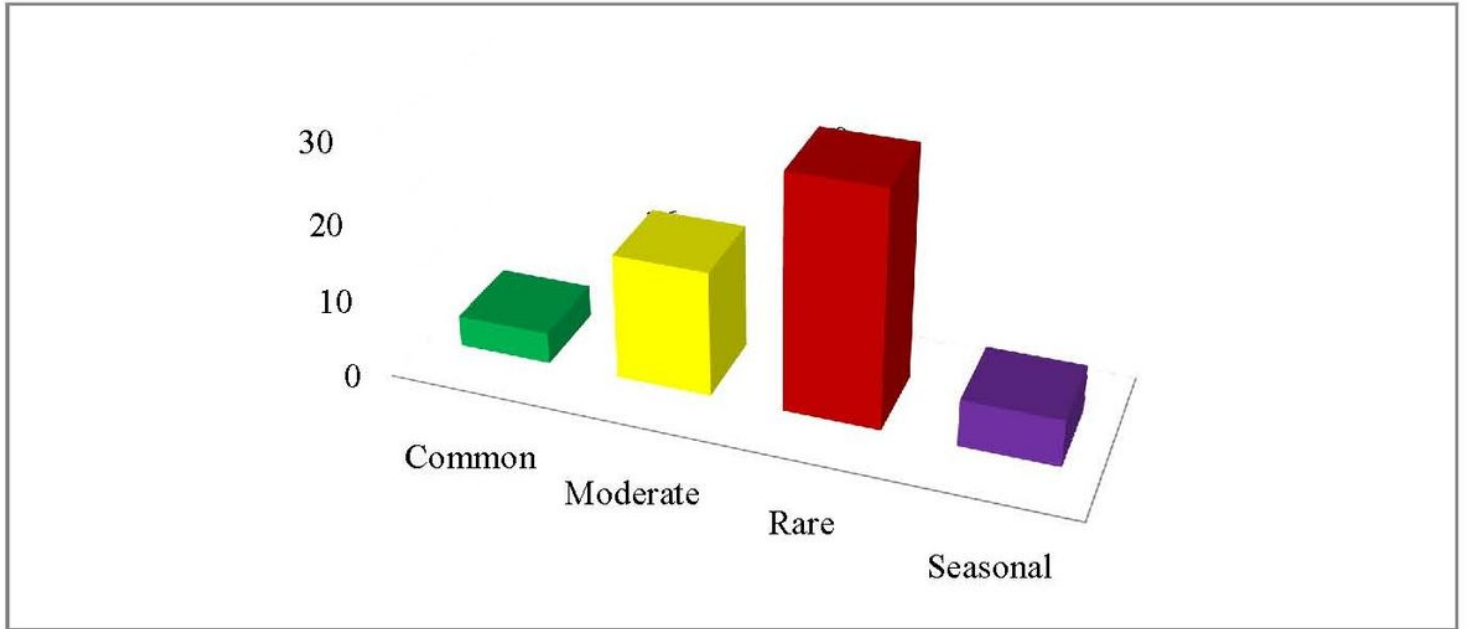


Figure 10
Abundance of ethnoveterinary medicinal plants

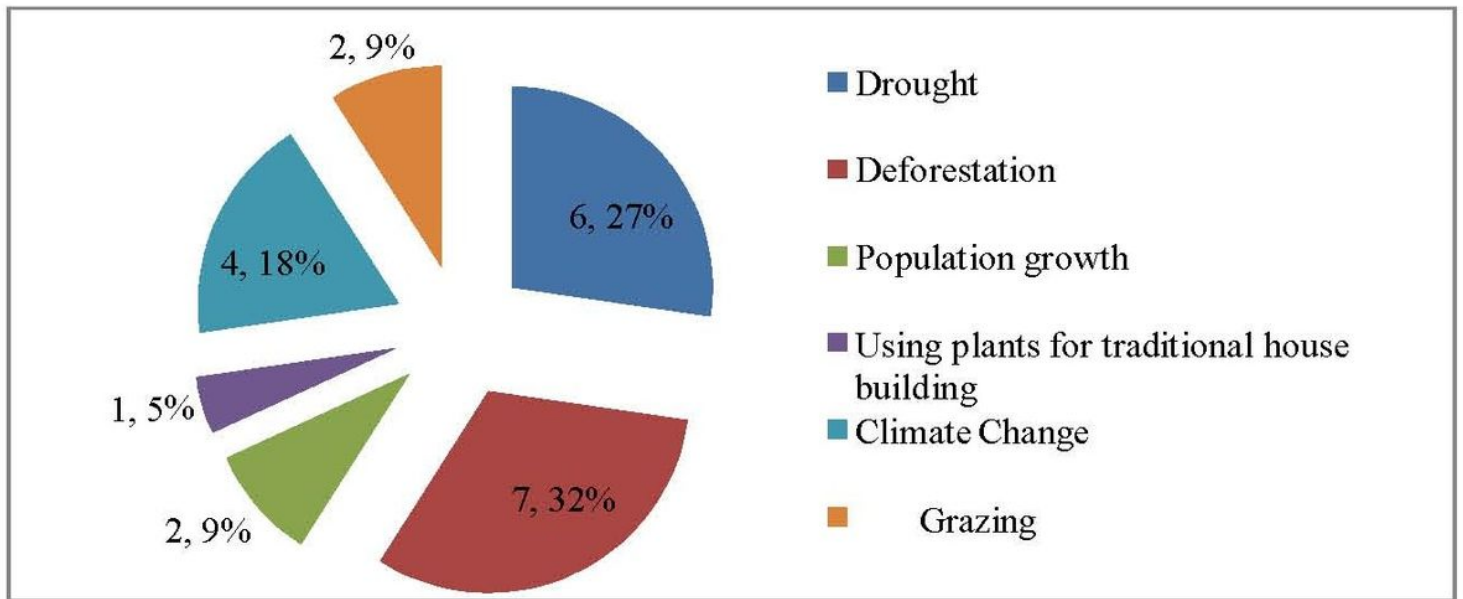


Figure 11

Major threats of ethnoveterinary medicinal plants