Ethnobotanical Study of Wild Medicinal Trees and Shrubs in Benna Tsemay District, Southern Ethiopia

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Abstract

Assegid Assefa and Tesfaye Abebe 2014. Ethnobotanical Study of Wild Medicinal Trees and Shrubs in Benna Tsemay District, Southern Ethiopia..*Journal of Science & Developement* 2(1) 2014, 17-33.

Medicinal plants and knowledge of their uses provides a vital contribution to human and livestock health care needs throughout Ethiopia. Despite the wide role of medicinal-plant use by local communities, traditional utilization and management practices are not well documented. The objectives of this study were to identify wild medicinal trees and shrubs and document indigenous knowledge about their utilization and management practices. Ethnomedicinal data were collected using semi-structured questionnaires, key informant interviews and vegetation inventories. Ethnomedicinal uses of 23 trees and shrubs were identified and documented, of which 56% were used to treat human disease, 35% to treat livestock disease and 9% to treat both livestock and human disease. Root was the most frequently used plant part used to treat human disease, followed by leaf. Human diseases commonly treated using these substances were malaria, wound, tapeworm and stomachache. Oral applications were widely used, followed, in frequency of prescription, by dermal applications. The most commonly treated animal diseases were external parasites, constipation and anthrax. Expansion of agriculture was found to be a major threat to the existence of wild medicinal trees and shrubs in the study area. The study's results indicated that wild medicinal plants are valuable resources to the local community. Thus, more research needs to be carried out on medicinal efficacies and methods of domestication and propagation of medicinal trees and shrubs.

Keywords: Ethno-veterinary medicine, indigenous knowledge, semi-arid areas, South Omo, traditional medicine.

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INTRODUCTION

Traditional medicine has been defined as health practices, approaches, knowledge and beliefs incorporating plant-, animal- and mineral-based medicines, spiritual therapies, manual techniques and exercises to treat, diagnose and prevent illness or maintain well being (WHO 2001). Since ancient times plants have been indispensable sources of both preventive and curative traditional medicines for human beings and livestock (Dawit Abebe and Ahadu Ayehu 1993; Dery et al. 1999). More than 3.5 billon people in the developing world rely on medicinal plants as components of their health care regimes (Ruffo et al. 2002; Keirungi and Fabricius 2005; Endashaw Bekele 2007; Tesfaye Bekalo et al. 2009; Gidey Yirga 2010). Besides their use in fighting various ailments among local populations, certain medicinal plants are also export commodities, valuable as sources of considerable income for harvesters and for use as raw materials for modern bio-pharmaceutical industries (Endashaw Bekele 2007).

In Ethiopia, about 80% of the human population and 90% of livestock rely on traditional medicines (Getachew Addis et al. 2001; Haile Yineger et al. 2008; Ermias Lulekal et al. 2008; Fisseha Mesfin et al. 2009; Gidey Yirga 2010). Traditional medicine is an integral part of the culture, belief structure and lifestyle of Ethiopian peoples (Dawit Abebe and Ahadu Ayehu 1993; Tesfaye Bekalo et al. 2009). The issue of medicinal plant conservation in Ethiopia today calls for aggressive studies and documentation before accelerated ecological and cultural transformation distorts the habitats of these plants and culturally held knowledge bases (Endashaw Bekele, 2007). Since most traditional knowledge in Africa is transmitted orally, from generation to generation, knowledge of wild plants is in danger of being lost as habitats, value systems and natural environments change (FAO 1996; Haile Yineger and Delenasaw Yewhalwa 2007; Fisseha Mesfin et al. 2009). Thus, valuable indigenous knowledge associated with medicinal plants warrants proper documentation (Tesfaye Awas and Sebsebe Demissew 2009; Ermias Leulkal *et al.* 2008; Tesfaye Awas et al. 2012).

The major objectives of this study were to identify medicinal trees and shrubs and document local knowledge about their utilization and management in Benna Tsemay district of Southern Ethiopia. The study was intended to answer the following research questions: a) what different types of wild medicinal trees and shrubs are used for treatment of humans and livestock; b) which plant parts are formulated as medications; c) what traditional knowledge and practices for management and utilization of wild medicinal trees and shrubs is held by the study area's indigenous community; and d) what other roles might medicinal trees and shrubs have in land use systems?

MATERIALS AND METHODS

The Study Area

The study was conducted in Benna Tsemay district, South Omo zone of Southern Ethiopia (Figure 1). The district is located at $5^0.11' - 5.70'$ N latitude and $36^0.20' - 37^0.04'$ E longitude (BOFED 2007). The altitude of the district ranges from 500 to

1500 meters a.s.l. and the rainfall pattern is bimodal. The mean annual rainfall ranges from 400 mm to 920 mm and mean annual temperature ranges from 17.6^{0}C to 27.5^{0}C (SIM Alduba, unpublished report).

The dominant vegetation types in the district are *Combretum–Terminalia* and *Acacia-Commiphora* wood lands (Teshome Sormossa *et al.* 2004), and the major soil types are Eutric fluvisol and Chromic cambisols.

The livelihood of the local people in the district is based on mixed farming but pastoralism predominates over crop production. In addition, bee keeping and collection of wood and non-wood products (*e.g.*, wild edible and medicinal plants, incense, gum and *etc.*) are practiced. The human population of the district is 55,590 of which 28,087 are male and 27,503 are female (CSA 2007). The district is named after the two dominant local ethnic groups namely, Benna and Tsemay, which constitute 48.6% and 36.1% of the population respectively (CSA 2007). The remaining 15.3% of the population is composed of people of other ethnic groups.

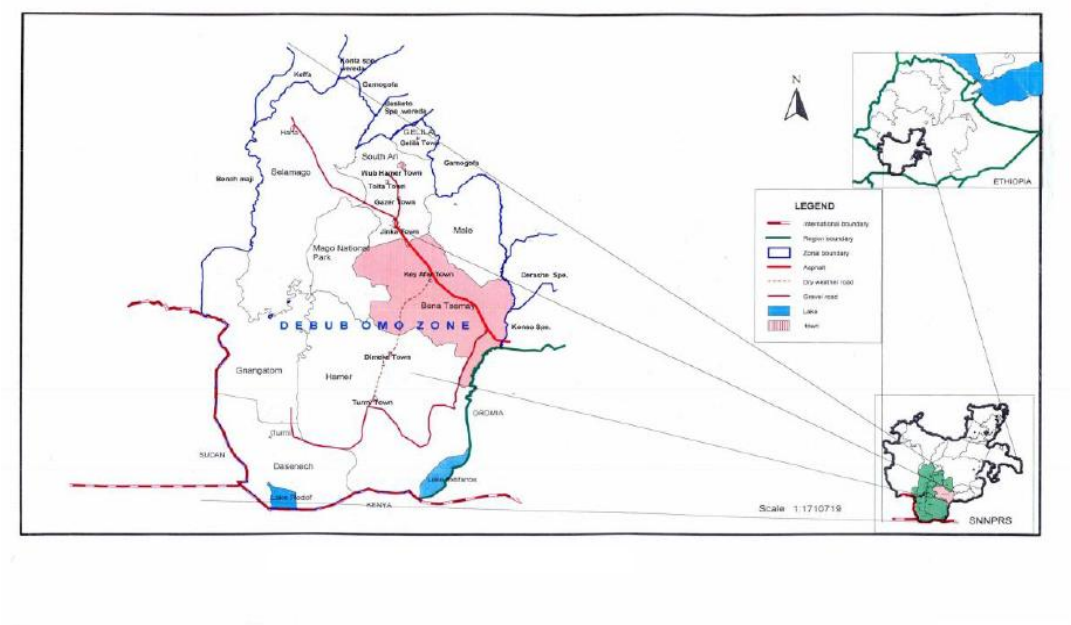

Figure 1. Geographical location of Benna Tsemay district, Southern Ethiopia

Ethnobotanical Data Collecton

Ethnobotanical data were collected using semi-structured questionnaires from randomly selected households, field observations and vegetation inventories. For the questionnaire survey, six *Kebeles*[1] were

[1] A *Kebele* is the lowest-level administrative unit in Ethiopia with an area of about 800 hectares, accommodating 400-800 households. However, the number of households in the sparsely populated pastoral and agro pastoral areas is often lower

selected from the 28 *Kebeles* of the Benna Tsemay district based on vegetation cover, altitude range and ethnic composition. Two *Kebeles* were located in lowlands (< 600 m.a.s.l) while the remaining four *Kebeles* had altitudes greater than 1200 m.a.s.l (Table 1). Semi-structured questionnaires were developed and interviews were conducted with 60 randomly selected households (ten households per *Kebele*). Data were collected on uses of medicinal trees and shrubs for humans and animals, types of trees and shrubs used, plant parts collected, diseases treated and preparation and utilization techniques.

Finally, information on other uses of these trees and shrubs, and on major threats to their continued existence, was collected using interviews and field observations. In addition to household interviews, 30 traditional herbalists (five per *Kebele*) were selected as key informants and interviewed to generate detailed information about traditional medicinal plants.

The key informants were selected using a snowball sampling method (Patton 1990) in which known traditional herbalists were contacted and each asked to name another person with similar knowledge and skills

Table1. Selected Kebeles, their vegetation type, altitude and dominant ethnic groups

No	*Kebele*	*Vegetation type*	*Mean altitude (meters)*	*Ethnic group*
1	Shala Kyayu	Desert and semi-desert scrubland	500	Tsemay
2	Luka	*Acacia–Commiphora* woodland	600	Tsemay
3	Alduba	*Combretum–Terminalia* woodland	1250	Benna
4	Shaba	*Combretum–Terminalia* woodland	1400	Benna
5	Olika Kibo	*Combretum–Terminalia* woodland	1500	Benna
6	Kako	*Combretum–Terminalia* woodland	1300	Benna

Source: Description of vegetation types is based on Friis, 1992

Vegetation Inventory

An inventory of the wild medicinal trees and shrubs was collected in order to assess the availability and abundance of trees and shrubs reported as being of medicinal value. In this paper the word 'shrub' is used to describe a woody perennial plant that remains of low height and produces multiple shoots from its base, whereas 'tree' refers to a woody perennial plant that produces one main trunk or bole and a more or less distinct and elevated crown (Huxley and van Houten 1997).

The inventory was carried out by means of systematic transect sampling. The major axis at sampling points was oriented in the same direction as the transect walk line. In each *Kebele* two transect lines were laid out 500m apart each extending for a distance of 600 m. Each transect was assigned either two 40 m×40 m (1600 m^2) or two 20 m×20 m (400 m^2) study plots depending up on the vegetation cover; *i.e.*, 40 m×40 m for the sparse vegetation of the lowlands (<600 m.a.s.l.), and 20 m×20 m for the dense vegetation found at higher altitudes (>1200 m.a.s.l.). Four study plots were assigned in each *Kebele* providing a total of 24 plots for the whole study. Out of these, eight plots had sizes of 1600 m^2 and the remaining 16 plots were 400 m^2 each. In each plot, all medicinal trees and shrubs were identified with the help of the key informants and documented by vernacular names. Voucher specimens of all species of interest were then collected, mounted, labeled and submitted to the National Herbarium at Addis Ababa University for identification and taxonomic classification.

Data Analysis

Collected data were analyzed using descriptive statistics. Microsoft Excel and SPSS (Statistical PPackage for Social Science) Version17 software were used for the analysis.

RESULTS AND DISCUSSION

Diversity of Wild Medicinal Trees and Shrubs

A total of 23 wild medicinal trees and shrubs were identified and documented, of which 56.6% were used to treat human disease, 30.4% to treat livestock disease and 13% for treatment of humans and livestock (Table 2). Medicinal trees and shrubs collected belonged to 15 families and 20 genera. The plant family with the largest number of trees and shrubs of the study area used for medicinal purposes was *Fabaceae,* which comprised 13% of the medicinal trees and shrubs identified. This is in agreement with earlier studies conducted in Ethiopia that indicated that the *Fabaceace* had the largest number of medicinal plants (Haile Yineger and Delenashaw Yewhalwa 2007;

Haile Yineger et al. 2008; Earmias Leukal et al. 2008; Tesfaye Bekalo et al. 2009). All documented medicinal trees and shrubs were wild and native, as has been reported elsewhere (Lange 1997; Endashaw Bekele 2007; Gidey Yirga 2009; Tesfaye Awas et al. 2012).

The local community assigned vernacular names to all of the documented medicinal trees and shrubs. This indicates the existence of a very close interaction between the people and their plant resources. According to Munishi et al. (2004), the importance of plants in local culture is usually shown by the proportion of plants that can be identified by local people and by local names.

Assessment of the growth forms of these plant species indicated that shrubs had the highest proportion with 12 of the species (52%) (Table 2). The studies conducted by Bayafer Tamene et al. 2000, Mark *et al.* 2008, Ermias Lulekal et al. (2008) ,and Fisseha Mesfin et al. (2009) also showed that shrubs made up the highest proportion of medicinal plants, representing respectively, 46.83%, 56%, 47.83% and 43.2% of the species of interest identified in those studies.

Table 2. Wild medicinal trees and shrubs in the study area

No	Scientific name	Local name		Family	Growth habit	Medicinal role
		Benna	Tsemay			
1	*Acacia hockii* DeWild	Chaqkent		Fabaceae	Tree	Livestock medicine
2	*Acacia mellifera* Benth.	Dille	Boytekko	Fabaceae	Tree	Human medicine
3	*Albizia anthelmintica* (A.Rich) Brogn.	Dheta		Fabaceae	Tree	Human medicine
4	*Aloe macocarpa* Tod.		Dheri	Aloaceae	Shrub	Livestock medicine
5	*Cadaba farinosa* Forssk.	Lagee		Capparidaceae	Shrub	Human medicine
6	*Carissa edulis* (Forssk)Vahl.	Akama		Apocynaceae	Shrub	Human medicine
7	*Croton macrsotachyus* Hochst.ex.A.Rich.	Betta		Euphoiaceae	Tree	Human medicine
8	*Echinops amplexicaulis* Benth		Kera	Asteraceae	Shrub	Human medicine
9	*Euclea divinorum* Hiern	Unsi		Ebenaceae	Shrub	Human medicine
10	*Euphoribia borensis* M. Gilbert		Kera	Euphoriaceae	Shrub	Livestock medicine
11	*Grewia velutina(Forssk)*Vahl.	Breza		Tiliaceae	Tree	Livestock medicine
12	*Leucas abyssinica* Briq.	Kero		Lamiaceae	Shrub	Livestock medicine
13	*Maerua crassifolia* Forssk		Qalklko	Capparidaceae	Tree	Livestock medicine
14	*Olea europea* L.	Remite		Oleaceae	Tree	Human medicine
15	*Rhus tenuinervis* Engl		Kupure	Anacariaceae	Shrub	Human medicine
16	*Salvadora persica* L.		Eakko	Salvodoraceae	Shrub	Both
17	*Solanum incanum*. L.	Grent		Solanaceae	Shrub	Human medicine
18	*Solanum somalense* Fracnch.		Cumo	Solanaceae	Shrub	Human medicine
19	*Tamarindus indica* L.	Roqo	Ruka	Fabaceae	Tree	Human medicine
20	*Terminalia brownii* Fresen.	Ara	Ara	Combertaceae	Tree	Human medicine
21	*Ximenia americana* L.	Moqolo	Moqolo	Oleaceae	Shrub	Livestock medicine
22	*Vernonia amygdalina* Del.	Geri		Asteraceae	Tree	Both
23	*Zanthoylum chalybeum*	Geddae		Rutaceae	Tree	Livestock medicine

Medicinal Trees and Shrubs in Study Area Used for Treatment Of Humans

A total of 15 wild medicinal trees and shrubs were identified and documented as being useful for treating human disease. The plant parts used to treat human disease varied from species to species and from disease to disease. Leaf, root, seed, bark and sap were widely used for treating human disease. Roots were the most frequently used plant parts (40%) followed by leaves (33%) (Figure 2). This finding is in agreement with those of certain others (Dawit Abebe and Ahadu Ayehu 1993; Munishi et al. 2004; Ermias Lulekal et

al. 2008; Fisseha Mesfin et al. 2009 and Emiru Birhane et al. 2011) but disagrees with the finding of Gidey Yirga (2010) who found that leaves were the most commonly used plant parts. This deviation is probably due to differences in plant resource sites. The present study was carried out in the wild, whereas that of Gidey Yirga (2010) was undertaken in home gardens. Obviously, medicinal woody plants grown in home gardens are expected to serve for long terms and, hence, garden owners might not harvest plant roots as that practice may cause the death of the whole plant.

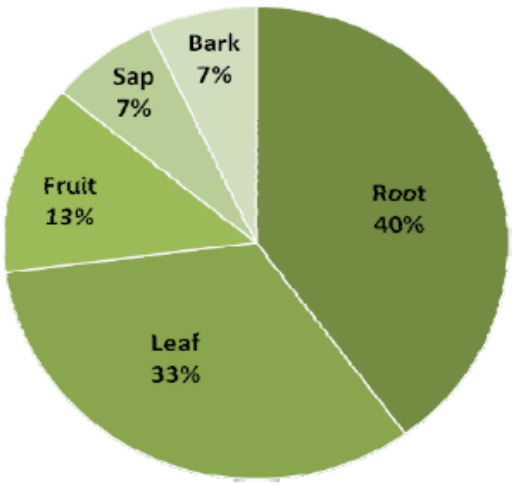

Figure 2. Percentage of plant parts used for treatment of human disease in Benna Tsemay district (n=60)

Disease Types, Preparation Techniques, Dosages and Routes of Application

Different disease types were reported as human health problems in the study area among which, malaria, skin infection, and diarrhoea were the most common. Wound, tapeworm and eye disease were treated by most people using traditional medicinal plants. However, only a few knowledgeable traditional herbalists treated some ailments, such as rabies and gonorrhoea.

Medicinal trees and shrubs in the study area were prepared in different forms. The most common mode of preparation was crushing (40%), followed by chewing (Table 3). This result is in agreement with the findings of Haile Yineger and Delenashaw Yewhalwa (2007) and Emiru Birhane et al (2011) who noted that the principal method of remedy preparation was through crushing.

Table 3. Methods of preparation of medicine trees and shrubs

No	*Mode of preparation*	*Number of species*	*Percentage*	*Rank*
1	Crushing	6	40.0	1
2	Chewing	4	26.7	2
3	Decortications	3	20.0	3
4	Tie and hold on	1	6.7	4
5	Dropping	1	6.7	4

There was no standard measure of dosage for herbal remedies in the study area. Dosage was determined in several ways including measurement of root length and leaf number. Various authors (Dawit Abebe and Ahadu Ayehu 1993; Endashaw Bekele, 2007; Tesfaye Bekalo et al. 2009 and Emiru Birhane et al. 2011) have also reported the absence of standardized dosing in the application of traditional medicines in Ethiopia and elsewhere. They noted that there were variations in the quantity of remedies, units of measurement and durations and times of application of traditional medicines prescribed by various healers for the same kinds of health problems. Application methods also vary by disease and medicinal plant species. Among the different routes of application utilized, oral application ranked first in frequency followed by dermal application (Figure 3). These results were similar to the findings of previous investigators (Dawit Abebe and Ahadu Ayehu 1993; Tilahun Teklehaymanot and Mirutse Gidey 2007; Haile Yineger and Delenashaw Yewhalwa 2007; Mark et al. 2008; Tesfaye Bekalo et al. 2009; Fisseha Mesfin et al. 2009 and Emiru Birhane et al. 2011) who noted that drinking (oral application) was the dominant method of administration.

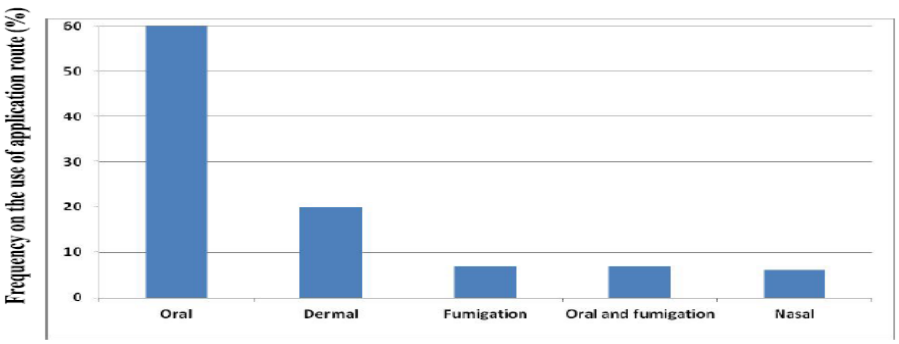

Figure 3. Route of application of traditional human medicinal trees and shrubs in Benna Tsemay district (n=60)

Techniques for Human Utilization of Wild Medicinal Trees and Shrubs

Most of the traditional medicinal trees and shrubs were used in fresh form (93%) while 7% were used after drying (Table 4). Gidey Yirga (2010) also reported that most traditional medicinal plants were used in fresh form.

Table 4. Utilization technique of human medicinal trees and shrub

No	Scientific name	Part used	Disease treated	Application	Utilization technique	Ingredient	Other uses
1.	*Acacia mellifera* Benth.	leaf	Body infection	dermal	- Shoot or young leaves are crushed and mixed with termite soil and the infected area is brushed with it.	Termite soil	Bee Forage
2.	*Albizia anthelmintica* (A.Rich) Brogn.	bark	Tape warm	oral	- Dry bark is grained decoction, used to prepare maize and sorghum bread and consumed.	Flour	
3.	*Cadaba farinosa* Forssk.	leaf	Malaria	oral	- Young leaves are crushed and the juice drank to treat malaria.	None	Fodder
4.	*Carisza edulis* Forssk Vahl.	root	Malaria	fumigation	- Roots are boiled. A decoction of the roots is used to treat malaria.	None	Edible
5.	*Croton macrostachyus* Hochst.ex.A.Ri.	leaf	Stomach distention	oral	- Young leaves are crushed, and the juice drank in small amount to treat stomach distention.	None	Firewood
6.	*Echinops amplexicaulis* Benth.	root	Stomach-ache Snakebite	oral dermal or fumigation	- Chewing the bark and swallowing the juice to treat stomach ache. - Crush and mix the root with butter and brush on the infected area.	None Butter	Firewood
7.	*Euclea divinorum* Hiern.	root	Gonorrhea	oral	- Roots of the shrub are crushed and the decoction of root drunk.	None	Edible
8.	*Euphoribia borenesis* Benth.	sap	Wound	dermal	- Sap from succulent stem is applied to newly injured body parts.	None	Fences
9.	*Olea europea* L.	leaf	Body weakness	oral	- The leaves are crushed and mixed with water and drank in small amount.	Water	Firewood
10.	*Rhus tenuinervis* Engl.	root	Rabies	oral	- The bark of the root are crushed and mixed with water and the decoction of the root is drank after 1 hour.	Water	Firewood
11.	*Salvadora persica* L.	leaf	Eye	nasal	- The leaves are squeezed and applied to the infected eye. It has burning effect.	None	Edible
12.	*Solanum incanum* L.	root	Stomachache	oral	- Root is chewed and juice swallowed the to treat stomach ache.	None	Fodder
13.	*Solanum somalense* Ffresen.	root	Stomach ache	oral	- The root is chewed. The resulting juice is swallowed to treat stomachache.	None	Fodder
14.	*Tamarindus indica* L.	fruit	Stomach ache	oral	- Collect the fruit and consume the pulps to treat stomach.	None	Edible
15.	*Terminalia brownii* Fresen.	bark	Wound	dermal	- Tie the tree bark to the injured area.	None	Bee Forage

Ethno-Veterinary Medicinal Trees and Shrubs

Failures of crop production are more common in pastoral areas of Ethiopia due to the high temperatures and low and erratic rainfall prevalent in those areas. Livestock production is therefore an indispensable component of land use systems employed for survival in those areas. According to the government agricultural office of the Benna Tsemay district, disease is the major constraint on livestock production and this is exacerbated by a critical shortage of veterinary services. Hence, the role of traditional medicinal plants for the protection of animal health is vital.

A total of 10 wild medicinal trees and shrubs were identified and documented for treatment of livestock diseases (Table 5). Medicinal trees and shrubs widely used to treat livestock diseases in the area included *Grewia velutina* ForsskVahl, *Leucas abyssinica* Brig and *Maerua crassifolia* Forssk. The most common livestock diseases in the study area were CCPP (contagious caprine pleuropnemonia), anthrax, and blackleg (Benna Tsemay district Agricultural office, unpublished report). Leaves (50%) were the plant parts most widely used to treat livestock diseases. Ethno-veterinary studies conducted by Bayafer Tamene *et al*. (2000) and Tilahun Teklehaymanot and Mirutse Gidey (2007) also indicated that leaves were the most commonly used plant parts for treatment of livestock disease. Crushing and harmonization of the plant part with water is the most common method of remedy preparation (Table 5).

Table 5. Utilization techniques of ethno-veterinary medicinal trees and shrub

No	Scientific name	Part used	Disease/para site treated	Mode of application	Utilization technique	Ingredient	Other uses
1.	*Acacia hockii* De Wild.	Leaf	Eye disease	nasal	- Shoot or newly growing leaf squeezed and directly applied to infected eye.	None	Bee forage
2.	*Aloe macocarpa* Tod.	Sap	Ticks	dermal	- Brush the yellowish sap of succulent stem on the thick infested area; the thick is removed immediately from the animal body.	None	Fence
3.	*Euphorbia borensis* M.Gilberts.	Sap	Wound	dermal	- Apply the sap of succulent stem to the injured body part (wound).	None	Fence
4.	*Grewia velutina* Forssk.Vahl.	Root	Anthrax	oral	- Root is crushed and the juice drank to animals when bleeding occurs in their ear.	None	Edible
5.	*Leucas abyssinica* Brig.	Leaf	Leech	nasal	- Dried leaves pounded and mixed with water and poured through the nose of animals to remove leech.	Water	Bee forage
6.	*Maerua crassifolia* Forssk.	Leaf	Tympany	oral	- Leaves are crushed and mixed with water and drank to animals to treat stomach constipation.	Water	Fence
7.	*Salvadora persica* L.	Leaf	Eye disease	nasal	- The leaves are chewed and the juice directly applied to the infected eye. It has a burning effect.	None	Edible
8.	*Vernonia amygdalina* Del.	Leaf	Tse-Tse fly	Oral	- Leaves are crushed and the juice drank by the animals.	Water	Bee forage
9.	*Xeminia americana* L.	Seed	External parasite	dermal	- Seed, roasted, and crushed; the powder mixed with animal butter and brushed to infected area to remove external parasites.	Butter	Edible
10	*Zanthoxylum chalybeum* Engl.	Bark	Constipation	oral	- The bark is crushed and boiled in water and the animal let to drink it, to treat stomach constipation.	Water	Fodder

Routes of Application Of Veterinary Medicines

Oral application is most frequently employed (50%), followed by dermal and nasal applications which account for 30% and 20% respectively of reported application methods (Figure 4).

This result is in agreement with the finding of Haile Yineger *et al.* (2007) who reported that an internal mode of administration was more common (72.41%).

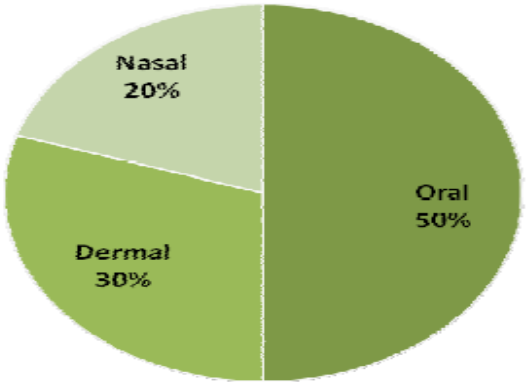

Figure 4. Route of application of veterinary medicinal trees and shrubs in Benna Tsemay district (n=60)

Threats to Wild Medicinal Trees and Shrubs in the Study Area

Various factors are considered as threats to existence of medicinal trees and shrubs in the study area among which expansion of agriculture and fire are the most important (Table 6). This result is similar to the findings of Endashaw Bekele 2007, Ermias Lulekal et al. 2008, Haile Yineger et al. 2008 and Fisseha Mesfin et al. 2009.

Table6. Priority ranking of factors perceived by the community as threats to Medicinal plants

Factors	Respondents(%)	Rank
Expansion of agriculture	25.0	1
Fire hazards	21.7	2
Overgrazing	18.7	3
Drought	13.3	4
Collection of wood for construction, tools and utensils	11.7	5
Collection of firewood	10.0	6

Other Uses of Medicinal Trees and Shrubs in the Study Area

In the study area, almost all of the interviewees indicated that their communities rely on natural vegetation for purposes such as medicine, construction material, farm tools, household utensils, firewood and charcoal. It was found that 96% of medicinal trees and shrubs have value other than as medicines. Analysis of the reported second most important uses of these trees and shrubs indicated that 26% of the species are edible and 22% are used for firewood (Table 4 and 5). This result is in agreement with the findings of Haile Yineger et al. 2008 and Ermias Lulekal et al. 2008.

CONCLUSIONS

A total of 23 wild medicinal tree and shrub species were recorded in the study area. The study revealed that the local community used traditional medicine widely, to treat both human and livestock diseases. This is likely due to lack of modern public health and veterinary services, in part, but also due to the availability of these low-cost locally sourced plant-based medicines. The study indicated that many wild species are under growing pressure from various anthropogenic factors and valuable indigenous knowledge is being lost along with species. These factors demand urgent attention, to conserve such vital resources so as to optimize their use in primary health care systems of humans and livestock, and for the benefit of the world's resource diversity and heritage.

Therefore, the following suggestions and recommendations are proposed for the better utilization and conservation of wild medicinal trees and shrubs in the study area:

- More research needs to be carried out on the medicinal efficacy and optimum dosages of medicinal trees and shrubs.
- Propagation and domestication of medicinal plants should be promoted through efforts of governments and nongovernmental organizations.
- Government and nongovernmental organizations should partner with the local community to enhance *in situ* conservation of wild medicinal trees and shrubs.
- Training and awareness creation should be given to traditional healers and the local community respecting the management of medicinal trees and shrubs, to encourage and permit their cultivation on a large scale.
- Wild medicinal trees and shrubs are open-access resources prone to overuse and degradation. Thus, community ownership of these resources needs to be strengthened with well-defined traditional institutions and bylaws to ensure their protection and sustainable utilization.

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ACKNOWLEDGMENTS

We are grateful to the agro-pastoralist community of Benna Tsemay district for sharing with us their wide knowledge of medicinal plants. Special thanks go to Hawassa University for its grant of research funds and Addis Ababa University's National Herbarium for species identification. Our sincere gratitude also goes to Dr. Thomas Roberts of the University of Saskachewan, Canada, for language-editing of the manuscript.