Indigenous Knowledge on the Use and Management of Medicinal Trees and Shrubs in Dale District, Sidama Zone, Southern Ethiopia

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Research

Abstract

Plants (both wild and cultivated) are essential to alleviate human health problems and food insecurity especially in the developing world. The present study was conducted in Dale District, Sidama Zone, Southern Nations, Nationalities, and People's Region, Ethiopia, from February 2012 to June 2012, with an objective to (1) identify tree and shrub species used as medicines for the treatment of human and livestock diseases and sources of these medicinal species and (2) document factors associated with indigenous knowledge on their utilization and conservation. A total of 63 informants were involved. Data were collected using semi-structured interviews, field observations, and farm inventories. Forty-two medicinal tree and shrub species were used to treat 34 human diseases and 15 livestock diseases. The most frequently used part was leaves. The most widely used method of remedy preparation is crushing. The common route of administration is oral which is applied through drinking. Agricultural land expansion, wood for construction, timber production, and firewood collection are the major threats to those species. Except for some cultural and spiritual beliefs supporting conservation, efforts to conserve and cultivate medicinal species are limited in the area. Therefore, participation of the local people, awareness-raising through training on judicious utilization, and conservation of these species is important.

Introduction

Plants represent a constant interest as sources of novel foods and medicines (Motlhanka & Makhabu 2011). Fruit and leaves of different tree species (both wild and cultivated) are essential to alleviate human health problems and food insecurity especially in the developing world. Jeambey *et al*. (2009) have reported that using fruit from trees improves blood circulation, prevents diabetes, and reduces obesity, cancer, and chances of being affected by heart diseases. Medicinal plants form the basis of traditional healthcare systems for the majority of the population of developing nations. About 500 million people in south Asian countries alone are reported to seek health security from plants (Abebe 2001, Mesfin *et al*. 2014). Demand has been increasing as a result of growth of human populations and the frequently inadequate provision of modern medicine (Marshall 1998, Mesfin *et al*. 2014).

In Ethiopia, there is a long history of using medicinal plants to treat a variety of diseases (Kibebew 2001, Mesfin *et al*. 2014). Eighty percent of the human population and 90% of livestock in Ethiopia rely on traditional medicine, as many plants species have displayed medicinal value for some diseases of human and livestock (Abebe 2001). According to Bekele (2007), the major reasons why medicinal plants are demanded in Ethiopia are due to culturally linked traditions, the trust the communities have in traditional medicine, and relatively low cost in using them.

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Ethiopia is believed to be home for about 6,500 species of higher plants, with approximately 12% of these endemic (Bekele 2007, Mesfin *et al*. 2014, UNEP 1995). The greater concentrations of medicinal plants are found in the south and southwestern parts of the country following the concentration of biological and cultural diversity (Belayneh *et al.* 2012, Mesfin *et al*. 2014). Despite the use of traditional medicine over many centuries, relatively small numbers of tree and shrub species (TASS) have been studied for possible medical applications, and the spread of this knowledge is mostly limited to indigenous societies (Cunningham 1993). Thus, the need to perform ethnobotanical research to document the medicinal TASS and the associated indigenous knowledge (IK) must be an urgent task (Hamilton 2003, Martin 1995, Pankhurst 2001). Moreover, the conservation of ethnobotanical knowledge as part of living cultural knowledge and practice between communities and the environment is essential for biodiversity conservation.

Research on sustainable utilization of medicinal TASS is inadequate in Ethiopia (Hunde Feyssa *et al*. 2011). Nevertheless, limited professionals have made an attempt to document medicinal TASS and traditional knowledge in some parts of Ethiopia. These include Giday (2001), Hunde (2001), Seifu (2004), Hunde *et al*. (2006), Amenu (2007), Yineger and Yewhalaw (2007), Teklehaymanot and Giday (2007), Lulekal *et al*. (2008), Yineger *et al*. (2008), Mesfin *et al.* (2009), Awas and Demissew (2009), Hailemariam *et al.* (2009), Tamene *et al*. (2009), Yirga (2010), Etana (2010), Hunde Feyssa *et al*. (2011), Yirga *et al*. (2011), Addisie *et al*. (2012), Belayneh *et al.* (2012), Megersa *et al*. (2013), and Mesfin *et al*. (2014) among others. Indeed, there is a need to do more in parts of the country where such studies have not been conducted due to the cultural diversity and the diverse flora of Ethiopia. There is traditional knowledge of medicinal plants in the Southern Nations, Nationalities and Peoples' Region (SNNPR), but the knowledge has not been systematically documented in the region in general and in the study area (Dale District) in particular. Therefore, the present study was initiated with an objective (1) to explore TASS that are used as medicines for the treatment of human and livestock diseases and sources of these TASS, and (2) to document the associated indigenous knowledge on utilization and conservation of medicinal TASS and threatening factors on these species in Dale District, Sidama Zone, southern Ethiopia.

Materials and Methods

Description of study area

The study was conducted in Dale District in Sidama Zone of the SNNPR, Ethiopia. Dale District is located at 6°39' to 6°50'N and 38°18' to 38°31'E (Figure 1). The district covers a total area of about 30,212 ha and an elevation range of 1,600–2,800 masl. This district is comprised of 36 **kebeles** (the smallest administrative units next to district in Ethiopia) with a total population of about 228,638.

The mean annual temperature ranges between 9.6°C and 29.2°C. The area has a bimodal rainfall pattern with the first peak from April to May and the second peak from August and October. The lowest rainfall was recorded between November and February. The mean annual rainfall of the area is 1102 mm per year. Agroforestry practices appear to be the major features of the land use systems in the area.

Sampling techniques

A reconnaissance survey was first conducted to gain an overview of the demographic, socio-economic, and biophysical conditions of the study area. A multistage sampling technique was employed whereby in the first stage, **kebele** administrations (hereafter **kebeles**) involved in the study were selected using a stratified sampling technique. Altitude was used to stratify the **kebeles** in the district. In the second stage, proportional allocation techniques were used to determine the number of sample **kebeles** from each stratum. Accordingly, a total of five **kebeles** (14% of the total **kebeles**) were selected and separated by altitude: high altitude (2401–2800 masl) (Gajamo), medium altitude (2001–2400 masl) (Tula, Soyama, Bera Tedicho), and low altitude (1600–2000 masl) (Semen Kege) (Figure 1). The reason why three **kebeles** were included for medium altitude is because most of the **kebeles** in Dale District are at medium altitude. In the third stage, informants were selected to participate in the ethnobotanical study from the selected five **kebeles** using lottery methods. This was done by considering a list of households in each study **kebele** as a sampling frame (from which sample informants were selected).

Sampling of informants

The sample size for the study was determined by estimating minimum sample size based on a number of accuracy factors following an equation used by Watson (2001). Hence, the following equation was used in determining the number of sample informants included for this study:

$$n = \left(\frac{P[1-P]}{\frac{A^2}{Z^2} + \frac{P[1-P]}{N}} \right) / R$$

Where:

n = sample size required

N = number of people in the population (in this case, 5000)

P = estimated variance in population, as decimal: (i.e., 0.3 for 30%)

A = precision desired, expressed as a decimal (i.e., 0.95 for 95%)

Z = based on confidence level: 1.96 for 95% confidence

R = estimated response rate, as decimal (i.e., 0.8 for 80%)

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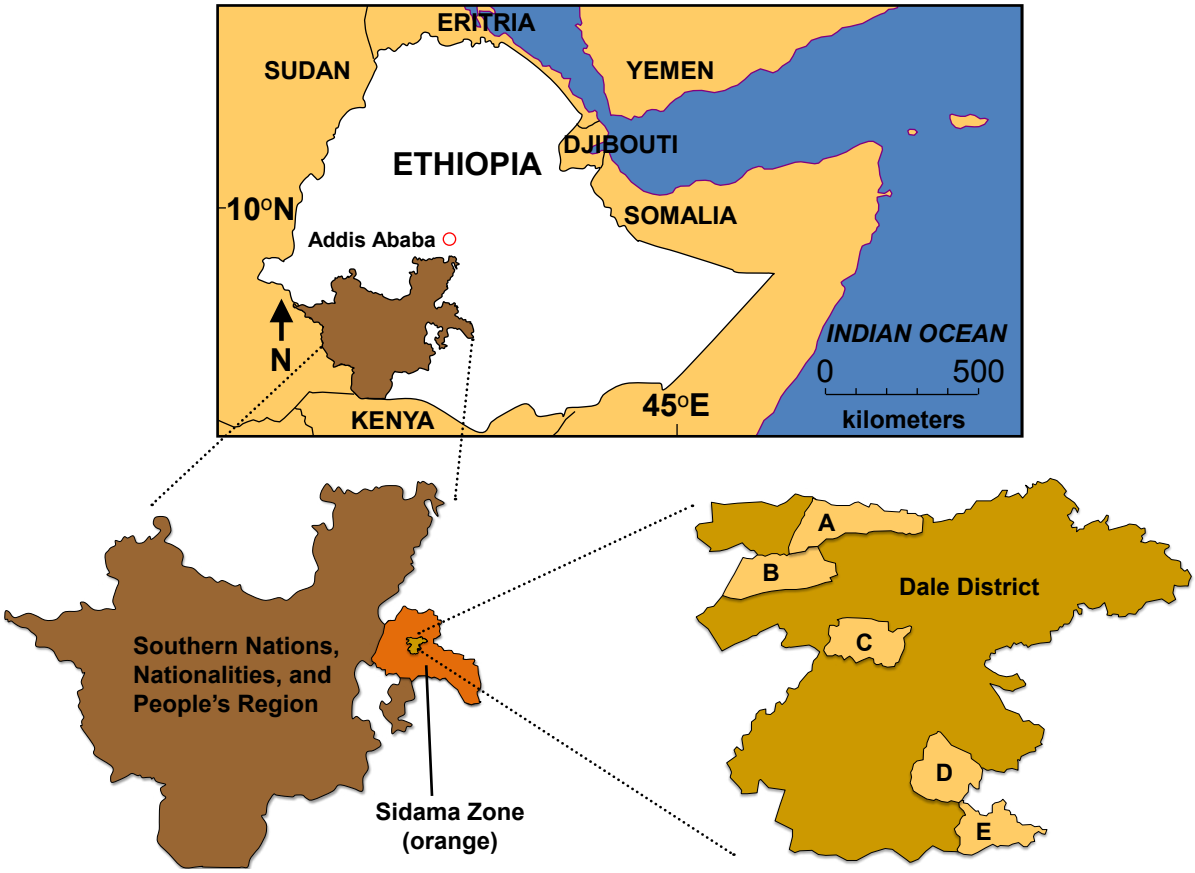

Figure 1. Study **kebeles** (**A**) Soyama, (**B**) Semen Kege, (**C**) Tula, (**D**) Bera Tedicho, and (**E**) Gajamo in Dale District, Sidama Zone, Southern Nations, Nationalities, and People's Region, Ethiopia.

Accordingly a sample size of 63 informants was obtained. A total of 63 informants were involved (12–13 informants from each **kebele**) out of all those who volunteered to participate in the study. Moreover, 23 key informants (4–5 from each **kebele**) were purposively selected based on recommendations from local people (elders) and local authorities (agricultural technicians and **kebele** leaders) who were confirmed to be more knowledgeable about cultural uses of TASS and other aspects of rural life. Such choice of key informants is following the suggestion made by Martin (1995). In the identification of informants and key informants, age and gender were considered. Accordingly informants aged 20 and above were included in this study.

Data collection

Before collecting data, all sample informants were informed of the study's objectives, giving their consent and cooperation on the exploration of medicinal TASS of the area. For the purpose of data collection, five enumerators—one for each **kebele**, familiar with socio-economic and cultural aspects of the society, and proficient in the local language (Sidamigna)—were selected, oriented, and trained for a day.

Ethnobotanical data were collected from February 2012 to June 2012 following techniques described in Martin (1995) and Cotton (1996). Semi-structured interviews, field observations, and farm inventories were used to record types of medicinal TASS, part(s) used, diseases treated, preparation methods, form used (fresh/dried), ways of application, conservation practices, and threats to the species. Moreover, field observations with key informants in each **kebele** were used to identify medicinal TASS, their distribution in the different land uses, use, and conservation practices and threatening factors on site.

Inventory of medicinal TASS

The presence of the reported medicinal TASS in the area were also assessed using 20 randomly chosen informant's farms (4 informant's farms in each study **kebele**). A total of 40 sample plots were established, 20 of which were in homegardens (4 plots in each study **kebele**) and another 20 plots outside homegardens, i.e. for boundary

plantings and live fencing (4 plots in each study **kebele**). The size of the plots in homegardens was 5 × 5 m, and in each homegarden, three plots were taken from right, left, and back side (one each) of the homegarden in order to assess the whole TASS species following the technique employed by Hailemariam *et al*. (2009). For inventory of medicinal TASS in boundary plantings and live fencing, their length and width were determined using a method adopted from Lauriks *et al*. (1999) but modified to suit this study. Accordingly, in each selected 60-m sample section, length and width of the boundary and live fencing were measured at 0, 15, 30, 45, and 60 m (central measuring line). Those medicinal TASS that are found in boundary plantings and live fencing were enumerated in 4 × 4 m sub-sample plots along the central measuring line at 0, 15, 30, 45, and 60 m. When the assumed length became less than 15 m or greater than 60 m, the central measuring line was either reduced or increased accordingly. Medicinal TASS at the border of the sub-sample were included if 50% of the canopy fell within the sub-sample. With respect to the front yards, complete counts were made for medicinal TASS occurring in front yards because of their limited number.

All medicinal TASS encountered during this inventory and reported by sample informants were collected and recorded using two Ethiopian languages (Sidamigna and Amharic). Preliminary identification was carried out in the field by the help of a field identification expert. Further, species identification was made using the published modern *Flora of Ethiopia and Eritrea* (Volume 8) (Demessew & Friis 2009). TASS names were also checked for their current recognition in www.tropicos.org. A few species which were used by key informants who were unwilling to show the species for others were not botanically identified due to secrecy concerns. Thus, those TASS were documented in Sidamigna only limiting the information to the local people. It was also assumed that further identification could be made when such individuals open their door regarding this secrecy for outsiders.

Data analysis

Triangulation was employed to evaluate the cultural validity of information collected using different surveying methods (Mintsa-Mi Nzue 2009, Zenebe *et al*. 2012). The data collected through semi-structured interviews and field observations were organized, entered, and analyzed using descriptive statistics like frequency distribution and percentage by using Microsoft Excel (Zenebe *et al*. 2012).

Results and Discussion

Medicinal TASS

A total of 42 medicinal TASS were identified that are used for the treatment of human and livestock diseases (Table 1). Of these, 17 species (40.5%) were used for treatment of only human diseases, six (14.3%) were used to treat only livestock diseases, and the remaining 19 species (45.2%) were used for treating both human and livestock diseases. These medicinal TASS are distributed in 32 genera and 26 families. The family Fabaceae was represented by six species followed by Boraginaceae and Euphorbiaceae represented by two species each, and the remaining 21 families were represented by one species each.

Most of the medicinal TASS identified here were also medicinally used in other parts of Ethiopia. Of the 42 plants in this study, 4 were reported by Giday (2001) from the Zay people, 6 by Seifu (2004) from Chifra District of Afar region, and 16 were indicated in Tesfaye (2005) from southern Ethiopia. Other studies that reported medicinal uses of these species include Hunde *et al*. (2006) with 4 species, Amenu (2007) with 15, Mesfin *et al.* (2009) with 12, Awas and Demissew (2009) with 11, Hailemariam *et al.* (2009) with 7, Tamene *et al*. (2009) with 2, Yirga (2010) with 6, Etana (2010) with 11, Megersa *et al*. (2013) with 17, and Yirga *et al*. (2011) with 3 species. In short, of the 42 medicinal TASS found in this study, 24 of them were previously reported by other investigators. Hence, this widespread reporting on the use of these medicinal TASS by different groups of the societies in different localities could be attributed to different cultural groups, which could validate the medicinal properties of these species. People of Ethiopia over a wide area therefore may have the tendency to use the same medicinal species as a result of the wider distribution of medicinal TASS in the country and to a certain extent their usefulness.

TASS parts used to treat human diseases

In this study the most utilized part of the TASS reported was leaves (41%), followed by bark (17%) and roots and fruit (12% each) (Figure 2). Other ethnomedicinal studies such as Amenu (2007), Yineger and Yewhalaw (2007), Yineger *et al*. (2008), Mesfin *et al*. (2009), Etana (2010), and Addisie *et al*. (2012) also reported that leaves were the most commonly used plant parts in remedy preparations. This finding is inconsistent, however, with the result of Lulekal *et al*. (2008) where roots were most used.

Preparation, routes of administration, and application of human medicine

The principal methods of remedy preparation were crushing (30%) followed by chewing (25%) and harvesting (20%), with the remaining methods being boiling, squeezing, crushing and burning, and crushing and boiling (Figure 3). This finding is consistent with the result of others (Megersa *et al.* 2013, Yineger & Yewhalaw 2007) that indicated crushing as the lead preparation method. Remedies are mostly prepared from single TASS (87%) as opposed to mixtures of different TASSs species (13%). Similar studies by Hunde (2001)

Table 1. Medicinal tree and shrub species (TASS) used for the treatment of human and/or livestock diseases in Dale District, Sidama Zone, Southern Nations, Nationalities, and People's Region, Ethiopia. Habit (**Ha**): Tree (T), Shrub (S); Parts used (**PU**): Bark (B), Latex (La), Root (R), Leaf (L), Fruit (Fr); Use: Human (H), Livestock (L). *TASS that were not identified by their botanical names because of the unwillingness of the traditional healers to show the species, on the spot, during field data collection. These species were thus documented only by their local Sidamigna names.

Scientific name	Local name	Family	Ha	PU	Use	Disease treated
Afrocarpus falcatus (Thunb.) C.N.Page	**Dagucho**	Podocarpaceae	T	L	H	rheumatism
				L	H	hepatitis, stomachache, gastritis, cancer
				L	H	swelling
				L	H	liver problem
				L	L	stomachache
Albizia gummifera (J.F.Gmel.) C.A.Sm.	**Matticho**	Fabaceae	T	B	H	stabbing pain
				B	H	sudden sickness
				B	L	stabbing pain
				B	L	sun problem
Bersama abyssinica Fresen.	**Xewerako**	Melianthaceae	T	B	H	liver problem
				L	L	mastitis
				L	L	blackleg
Brucea antidysenterica J.F.Mill.	**Hatawao**	Simaroubaceae	S	R	H	fever
Buddleja polystachya Fresen.	**Bulancho**	Scrophulariaceae	T	L	H	fibril illness
Capparis tomentosa Lam.	**Gaho**	Capparaceae	S	L	H	diarrhea
Calpurnia aurea (Aiton) Benth.	**Cheketa**	Fabaceae	S	L	H	gonorrhea
				L	H	dandruff
				L	L	mastitis
Carissa spinarum L.	**Otilaa**	Apocynaceae	S	Fr	H	tuberculosis, cancer, cough
Cassipourea malosana (Baker) Alston	**Kincho**	Rhizophoraceae	S	B	H	muscle fatigue
Celtis africana Burm.f.	**Shisho**	Cannabaceae	T	L	L	stabbing pain
Commiphora campestris Engl.	**Hamessa**	Burseraceae	S	L	H	weight loss in children
				R, L	H	disability
Cordia africana Lam.	**Wadicho**	Boraginaceae	T	B	H	indigestion
				B	H	"evil eye"
				B	L	stabbing pain, cancer, cough
Croton macrostachyus Hochst. ex Delile	**Masincho**	Euphorbiaceae	T	R	H	stomachache
				B, R	H	tuberculosis
				La	H	wound
				L	H	itching
				L	L	cancer
Dodonaea viscosa subsp. *angustifolia* (L.f.) J.G.West	**Itancha**	Sapindaceae	S	L	L	anthrax
				L	L	cancer, sun problem, stabbing pain
Ehretia cymosa Thonn.	**Gidincho**	Boraginaceae	T	L	H	"evil eye"
				L	L	stabbing pain, cough

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Scientific name	Local name	Family	Ha	PU	Use	Disease treated
Ekebergia capensis Sparrm.	**Olonchoo**	Meliaceae	T	B	H	weight loss in children
				B	L	stabbing pain
				B	L	bovine tuberculosis
Entada abyssinica Steud.ex A.Rich.	**Galchacha**	Fabaceae	S	B	H	toothache
Erythrina brucei Schweinf.	**Woleko**	Fabaceae	T	B	L	bovine tuberculosis, cancer
Euphorbia candelabrum Trémaut ex Kotschy	**Karicho**	Euphorbiaceae	T	L, La	H	rheumatism, sharp pain, diarrhea
Fagaropsis angolensis (Engl.) Dale	**Godicho**	Rutaceae	T	L, Fr	H	stomachache
				Fr	H	rheumatism
				L, Fr	L	diarrhea
				Fr	L	cough, cancer
				Fr	L	stomachache
				L	L	stabbing pain
Gardenia ternifolia subsp. *jovis-tonantis* (Welw.) Verdc.	**Gambela**	Rubiaceae	T	B	H	weight loss in children
				B	L	stomachache
Juniperus procera Hochst. ex Endl.	**Honcho**	Cupressaceae	T	L	H	stomachache
Maesa lanceolata Forssk.	**Gowacho**	Primulaceae	T	B	H	diarrhea
				B, L	H	stomachache
				B	L	blackleg
				L	L	retained feces
				B	L	skin rash
				B, L	L	stomachache
Millettia ferruginea (Hochst.) Baker	**Hengedich**	Fabaceae	T	B	L	cancer
Olea europaea subsp. *cuspidata* (Wall. ex G.Don.) Cif.	**Ejersu**	Oleaceae	T	L	H	rheumatism
				B	H	tuberculosis
				B	H	kwashiorkor
				B	L	stomachache
Olinia rochetiana A.Juss.	**Nolee**	Penaeaceae	S	L	H	headache
				L, B	H	toothache
				L	H	common cold
				L	L	cough
				L	L	common cold
Pittosporum abyssinicum Delile	**Boncho**	Pittosporaceae	T	B	H	cancer
				B	H	sharp pain
Prunus africana (Hook.f.) Kalkman	**Dongicho**	Rosaceae	T	B	H	sunken fontanel
				B	L	skin rash
				B	L	wound
Schefflera abyssinica (Hochst. ex A.Rich.) Harms	**Gatamo**	Araliaceae	T	L	H	stomachache
Syzygium guineense (Willd.) DC.	**Duwancho**	Myrtaceae	T	B	H	indigestion, stomachache
				B	H	liver problem, tuberculosis
				B	L	tuberculosis, skin rash

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Scientific name	Local name	Family	Ha	PU	Use	Disease treated
Terminalia brownii Fresen.	**Rukessa**	Combretaceae	T	L	H	stabbing pain, diarrhea, constipation
Vernonia amygdalina Delile	**Hecho**	Asteraceae	S	L	H	stomachache
				L	H	rheumatism, swelling
				L	H	malaria
				L	L	cough
				L	L	stabbing pain
Unidentified*	**Chabicha**		T	L	H	fibril illness, rheumatism
Unidentified*	**Gedda**		S	L, B	H	toothache
				L	H	gonorrhea
				R	H	cancer
				L	L	shivering
				L	L	sun problem
				L, Fr	L	stabbing pain
				L	L	tuberculosis, cancer
Unidentified*	**Gidicho**		T	L	H	cancer
Unidentified*	**Gufaricho**		S	L	L	diarrhea
Unidentified*	**Laluntee**		S	R	L	stomachache
Unidentified*	**Huroo**		T	Fr	H	gastritis, gonorrhea
Unidentified*	**Ifaticho**		S	R	H	swelling
				R	L	swelling
Unidentified*	**Sololsa**		S	B, Fr	H	male sexual impotency
Unidentified*	**Malansicho**		T	R	H	swelling
				L	L	tuberculosis, blackleg
Unidentified*	**Shishonee**		S	R	H	hepatitis, liver problem

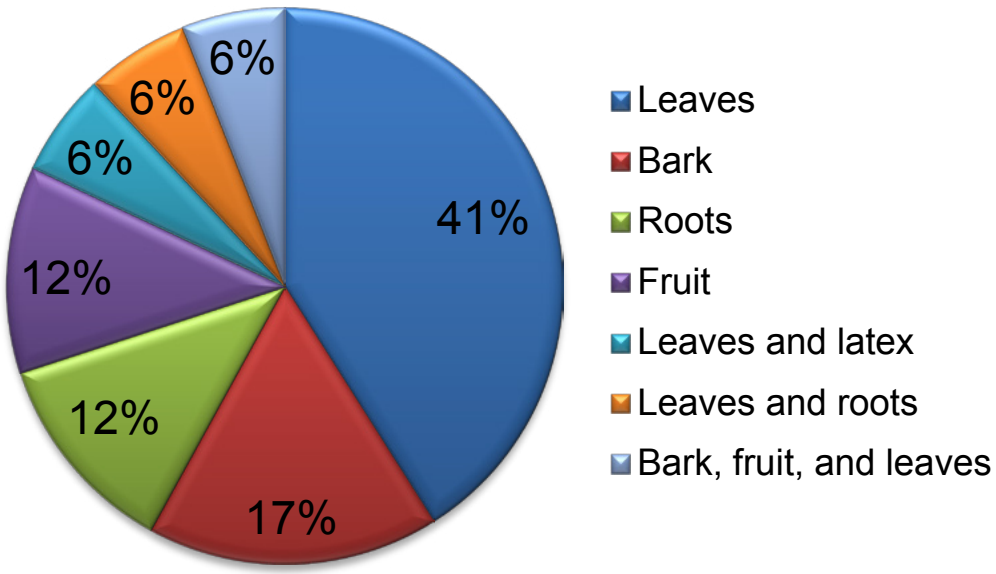

Figure 2. Part(s) of medicinal tree and shrub species used for human treatment in Dale District, Sidama Zone, Southern Nations, Nationalities, and People's Region, Ethiopia.

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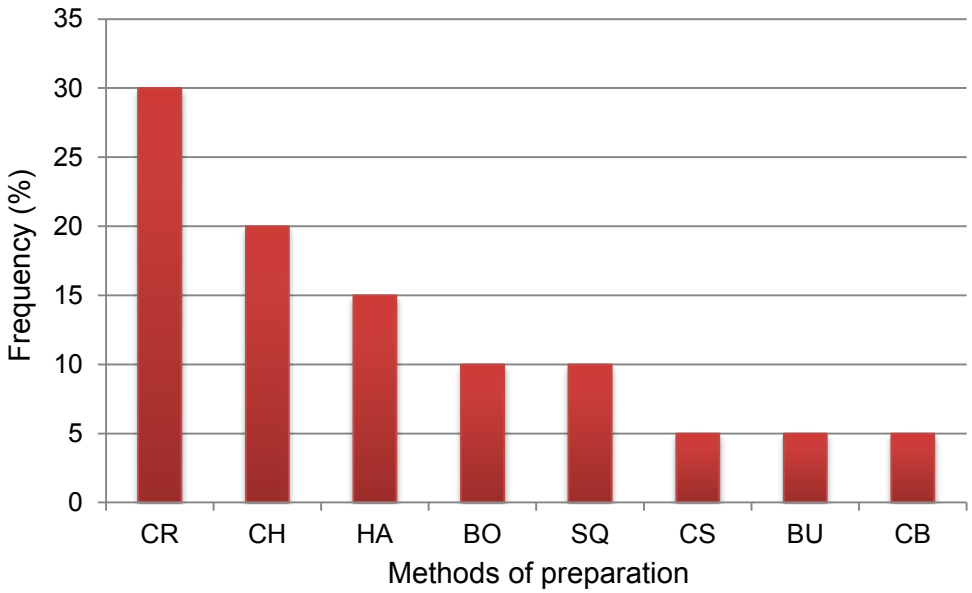

Figure 3. Preparation methods of human medicinal tree and shrub species in Dale District, Sidama Zone, Southern Nations, Nationalities, and People's Region, Ethiopia. CR = Crushing; CH = Chewing; HA = Harvesting; BO = Boiling; SQ = Squeezing; CS = Crushing and Squeezing; BU = Burning; CB = Crushing and Boiling.

and Etana (2010) also indicated that a single species remedy was more common, while previous works of Yineger and Yewhalaw (2007) indicate that multi-species remedies were more often used. Oral administration was the dominant route in this study with 76% of the cases, followed by nasal (10%), dermal (9%), and nasal-oral (5%). Similar results were obtained by other investigators (Addisie *et al*. 2012, Lulekal *et al*. 2008, Mesfin *et al*. 2009, Yineger & Yewhalaw 2007, Yineger *et al*. 2008, Yirga *et al*. 2011) who also indicated oral administration as the dominant route of administration. Prepared traditional medicines are applied in a number of ways; for example drinking was most reported (55%) followed by eating and swallowing sap (15% each), sniffing (10%), and drinking-sniffing (5%).

Parts of TASS used to treat livestock diseases

Parts of TASS used for livestock health treatment in the study area were leaves (50%), followed by bark (33.3%), and roots (16.7%). This finding agrees with the reports of Lulekal *et al*. (2008) and Etana (2010) but disagrees with Amenu (2007) in which roots are the major plant parts used for livestock remedy preparation followed by leaves.

Preparation, routes of administration, and application of livestock medicine

The preferred preparation techniques used for livestock medicine involve crushing (50%) followed by crushing and squeezing (25%), while squeezing and pounding together account for 25%. For example, the leaf of *Bersama abyssinica* Fresen. is burned, and the remaining ash is mixed with butter and creamed on cows' udders to treat mastitis. Oral application was the highest route of administration (83.3%) followed by dermal and oral (16.7%), similar to the findings of other (Amenu 2007, Etana 2010, Mesfin *et al*. 2009). Application methods of ethnoveterinary medicinal TASS mostly involve drinking (83.3%) while painting and adding to ear, nose, and eye together account for 16.7%.

Condition of medicinal TASS during preparation

About 92% of the TASS were prepared in fresh form and 2% in dried forms while the remaining 6% were prepared either in fresh or in dry forms. Preparation of traditional medicines from fresh materials has exposed the species to serious threat in comparison to dried forms, which can be stored for longer periods of time, and preservation of remedies from either form was not reported. Similar findings were also reported by other researchers in Ethiopia (Addisie *et al*. 2012, Mesfin *et al*. 2009) who reported that the majority of the remedy preparations were in fresh form.

Acquisition of traditional medicinal knowledge

Traditional medicinal knowledge was mainly acquired from parents (62%), followed by healers (15%) and self-trial and error (13%), with the rest of the informants (10%) claiming no knowledge of traditional medicinal knowledge. This finding agrees with other investigations in other parts

of Ethiopia (Etana 2010, Mesfin *et al*. 2009) that revealed the highest source of traditional medicinal knowledge was from parents.

Distribution of medicinal TASS in different land uses

Those identified and documented medicinal TASS were obtained from homegardens (25 species, 59.5%), in live fencing (9 species, 21.4%), in boundary plantings (6 species, 14.3%), and along river banks and from forest areas (2 species, 4.8%). This proportioning is partly due to low coverage of wild vegetation in the area, and those species retained in homegardens, live fences, and boundary plantings are done so because of their use as shade for coffee and live fencing for protection of farms and/or gardens from animal damages.

Threats to medicinal TASS

It was found that the most threatening factor to the medicinal TASS in the area was agricultural land expansion (32.5%) followed by construction (22.5%), timber production (15%), drought (12.5%), fire wood collection (10%), and expansion of *Eucalyptus* plantation and grazing (7.5%). Other investigators like Abebe (2001), Mesfin *et al*. (2009), and Hunde Feyssa *et al*. (2011) also indicated that agricultural land expansion and construction severely threatened different TASS in other parts of Ethiopia.

Conservation of medicinal TASS

Sample informants were asked to comment on the fate of medicinal TASS in the area. Of 40 selected sample informants, 87.5% indicated possible ways of conserving medicinal TASS and 12.5% replied that it was impossible to save these medicinal TASS from threats (Table 2).

During field observations, it was noted that there are some cultural and spiritual beliefs that somehow helped in the conservation of the medicinal TASS. For instance, the claim by traditional healers that "medicinal TASS are effective only if collected and administered by knowledgeable persons and healers" is a helpful attitude relative to the conservation of medicinal plants. Moreover, collecting of TASS from graveyards, which are commonly found at the front side of the home compound, is highly prohibited by the local people of the area. There are also ritually or spiritually protected big trees locally known as **budee** (Sidamigna language) where people praise a god known as Magano and ask their needs concerning peace, health, production, and good weather (e.g. sufficient rain or reduced drought).

Table 2. Strategies for preventing threats to medicinal tree and shrub species in Dale District, Sidama Zone, Southern Nations, Nationalities, and People's Region, Ethiopia (n = 40).

Strategies	Responses
Increase awareness of wise uses of native medicinal TASS	14 (35%)
Encourage tree plantings (also protecting natural regeneration)	14 (35%)
Formulation of rules	7 (17.5%)
No suggestions	5 (12.5%)
Total	40

Conclusions and Recommendations

The main perceived threat to medicinal TASS in the area arises from agricultural land expansion, construction, timber production, and firewood collection. Threats to medicinal TASS due to their utilization for medicinal purpose are likely negligible. Likely threats that erode indigenous knowledge (IK) emanate from the secrecy of oral-based knowledge transfer, i.e. absence of documented sources of this knowledge, reluctance of young generations to gain the knowledge, disappearance of the species, influence of modernity, and lack of awareness. Based on the findings of this study the following recommendations are offered:

1. Since some of the traditional healers might have given much attention to the IK transfer while others have little concern, there is a need for governmental and non-governmental organizations to participate in awareness-raising for healers to minimize the loss of IK and to create an appropriate forum for transfer of knowledge on medicinal TASS.

2. The IK of traditional medicine practitioners must be encouraged and protected. This could be the way through which such people could exercise their skill broadly and benefit from it.

3. There is a need for coordination of traditional healers of the area—together by certification or by organizing them at district level—to popularize their IK on medicinal TASS. Establishing Traditional Healers Association by (1) providing funds and land for cultivating medicinal plants and (2) assisting their activities with professional guidance helps to conserve the fast-eroding medicinal TASS of the area.

4. The traditional medicinal TASS of the area were used for treatment of diseases from simple to fatal diseases. Hence, these traditional remedies need to be confirmed through scientific investigations to identify those that may provide alternatives for modern drugs.

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5. *Circa situm* conservation activities should be practiced in the district through training model farmers to ensure the continuity of threatened medicinal TASS. This can be achieved by:

    - encouraging people to grow medicinal plants in homegardens, mixed with crops in farmlands, and as live fences;
    - promoting the establishment of local botanical gardens at least at the district level; and
    - encouraging people to protect and enclose ritual and spiritual areas with higher distribution of medicinal TASS in the locality.

6. Biological studies need to be conducted on the reported medicinal TASS of the study area to generate information that could be used in future drug development and possibilities to improve plant qualities through breeding.

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