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ORIGINAL RESEARCH

Ethnobotanical Study on Medicinal Plant Species Uses against Human Ailments in Lay Armachiho District, Northwest Ethiopia

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ABSTRACT

Indigenous peoples have developed their own knowledge of plant use and conservation strategies. But less emphasis was given on scientific studies of them. Therefore, ethnobotanical study on traditional medicinal plants was carried out in Lay Armachiho District to document their uses and management practices. Nine study kebeles with good vegetation cover and number of healers were purposively selected. Eighty informants, 18 key and 72 general informants were selected purposive and stratified random sampling technique, respectively. Ethnobotanical data were collected between February and March 2020 using semi-structured interviews, group discussion, and guided field walks with informants. Data were analyzed by descriptive statistical analysis and ethnobotanical data verification methods. A total of 78 plant species distributed in 47 families were documented. Majority of medicinal plants (47, 60.3%) were distributed in the wild habitat and shrubs were the dominant habit (28, 35.9%). About 66 human ailments have been identified that can be treated with many medicinal plants. The most commonly used plant part was leaf (41, 35.04%) and crushing (35, 31.8%) was the main preparation method. Most medicinal plants were used in fresh form (79, 71.8%) and administered orally 52(47.17%). *Allium sativum*, *Hagenia abyssinica* and *Croton macrostachyus* had high informant consensus value. *Ximenia americana* and *Croton macrostachyus* were the best scoring multipurpose species, and *Zehneria scabra* was with the highest fidelity level (98%) for treating febrile ailments. Agricultural expansion (29.82%) was the most important threatening factor to medicinal plants. The study area is rich in medicinal plant diversity and has a wealth of indigenous knowledge about its uses, which calls for prudent use and appropriate conservation measures.

Keywords/phrases: Armachiho District, indigenous plant knowledge, informants, human ailments, threatening factors

Introduction

Ethiopia is believed to be one of the six biodiversity rich countries in Africa and is home of 5,757 higher plant species from which 10% are endemic (Sebsebe and Ensermu, 2014). These plant resources provide materials to survive maintain ecological stability, preserve cultural heritage, biological information and indigenous knowledge of their usefulness. Hence, plants are sources for food, medicine, fuel, building materials, and tools for recreational and spiritual fulfillment. The country has many species of plants which are proven to be very effective in treating human and domestic animal diseases (Endeshaw, 2007). Edwards (2001) reported that woodland, grassland, and the evergreen scrub and rocky areas contain more medicinal plants with higher concentrations in woodland. Ethnobotanical studies are useful to document and disseminate knowledge on medicinal plants (Martin, 1995).

The widespread adoption of traditional medicine in Ethiopia is attributed to acceptance of its effectiveness and economic affordability compared to modern medicine (Edwards, 2001). However, medicinal plants and the indigenous knowledge associated with these plants are losing due to natural and anthropogenic factors, as well as the oral transmission system (Edwards, 2001; Ermias *et al*., 2008) that forcing traditional healers to travel long distances to collect them from wild habitats (Mesfin *et al*., 2005). Thus, most medicinal plants are currently under threat, causing many potentially beneficial plant species to disappear worldwide before they are even documented (WCMC), 1992). Kebu *et al*. (2004) agreed that the documentation of medicinal plant knowledge is still incomplete as there is not a complete inventory of medicinal plants traditionally used by indigenous peoples. Therefore, documentation of medicinal plant species with the associated wisdom is important in order to pass the knowledge to the next generation.

The Lay Armachiho District has diverse land features and vegetation distributions that have contributed to the wealth of indigenous knowledge of medicinal plants. However, the area is subjected to land degradation and deforestation due to unwise use of the natural environment for agricultural land and other uses. Such anthropogenic activities are eroding the medicinal plants with the associated indigenous knowledge. Before the total loss of plant resources, proper documentation is required for sustainable uses. Therefore, this work was initiated with the aim of documenting indigenous knowledge about the traditional use and conservation of medicinal plants before their total loss.

Materials and Methods

Description of the Study Area

Lay Armachiho is one of the 12 Districts of the Central Gondar Administrative Zone and is bordered by Tach Armachiho to the north, the city of Gondar to the south, Chilga to the west and Wegera District to the East (Figure 1). Tekeldengaye is the District capital and is located 22 km northwest of the city of Gondar. The total area of the District is 1,292.72 km^2. The district has 31 kebeles, of which 30 are rural kebeles and 1 urban kebele, with a projected population of 183,920 of whom 164,342 are rural and 19,578 are urban dwellers (CSA, 2015). Geographically, the District lies between the elevation ranges of 1000 to 3000 meters above sea level. The district has three agro-ecologies (climate zones), lowlands (32%), midlands (61%) and highlands (7%). The dominant soil types are eutric, leptosole and lithic leptosole (Lay Armachiho District Agriculture Office, 2019). Agriculture is the predominant activity, with a typical mixed economy (crop production and animal husbandry.

According to Ethiopian Metrological Agency, Tikle Dingay station data (2010-2019) mean annual precipitation for the area ranges from about 1300 mm to about 1500 mm. The District exhibits a unimodal precipitation pattern. The rainy months extend from June to the end of October. However, most of the

precipitation falls in July and August (Figure 2). The monthly annual temperature was between 11°C and 30°C. The mean annual temperature is 20°C.

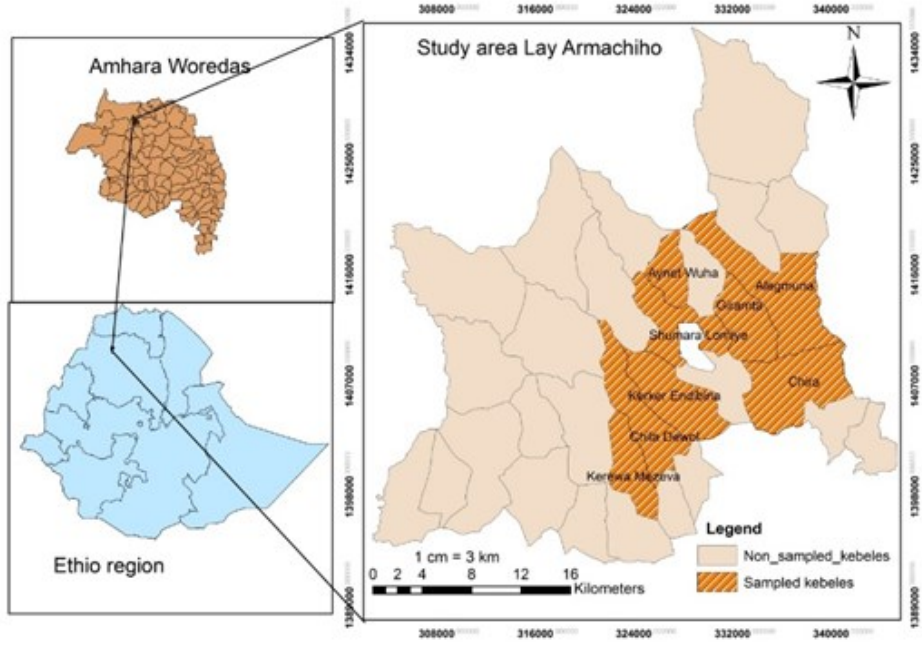

Figure 1: Location map of the study area

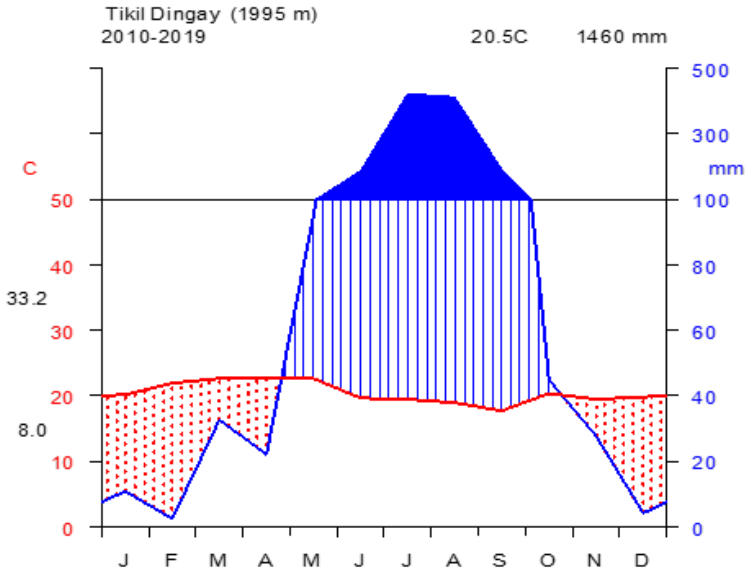

Figure 2: Climadiagram of the District

Most of the geographic arrangements of the district's lands are mountainous except for some plains. The vegetation of area is generally dry afromantane forest and grassland complex type. The dominant plant species grown in the study area are *Rhamnus prinoides*, *Olea europaea s*ubsp. c*uspidata*, *Cordia africana*, *Croton macrostachyus*, *Phytolacca dodecandra*, *Ficus sycomorus* and *Capparis tomentosa* (Friis *et al.,* 2010).

Sampling of respondents and study sites

Field surveys were conducted to gather information on the ethnobotanical uses of plants based on primary information sources. Therefore, a preliminary survey was conducted in February 2020 to gather information about the study area in terms of topographical features/agroecology/, vegetation distribution and availability of healers which were used as selection criteria for the study area. Accordingly, nine study kebeles (Alegmuna, Yanikev, Giramta, Aynet Wuha, Shumara Lomiye, Kerewa Mezeva, Chira, Kerker Endibina and Chila Dewol) were purposively selected based on the recommendation of local authorities, elders and development officers. A total of 90 informants (62 men and 28 women) above the age 18 were selected to collect data. From these, 18 key informants (two from each Kebele) were targeted purposively based on recommendations of local authorities and health advisors. So as to collect ethobotanical data, a total of 72 general informants (49 males and 23 females, eight from each Kebeles) were selected using stratified random sampling technique(based on sex and age).

Data collection

Ethnobotanical data were collected through individual /face-to-face/interviews, group discussions, and guided field walks with the informants. Semi-structured Questionnaires were prepared in English in advance and translated into Amharic during data collection. Questions were focused on local names of medicinal plants, their uses, habitat, habits, parts used, and ways of preparation, use, and administration. All data were collected using texts, photos and botanical preparations. In addition, focus group discussion was conducted before and during the ethnobotanical data collection according to Martin (1995) using 10 healers. These were conducted with members of the traditional medicine association, other local healers and knowledgeable members of the local community at specific times in each site. At the end of the interview, each informant's contribution was acknowledged, indicating the value of their knowledge in public health and biodiversity conservation. Furthermore, the interview was conducted during a guided field walk while walking through the study sites to collect the data on medicinal plants. Accordingly, a series of field observations were conducted with the help of guides and interviewed informants to collect plant samples. Complete records of collection type, landforms, soil types, nature of human activities and major threats, habits and habitats were recorded on site. After convincing the informants that the relevant information gained from them would be used for research purpose and for the recognition of the value of their indigenous knowledge, consent was made. Informants were, then, contacted at least two times within three weeks for the same ideas to check the validity of the information recorded. If the ideas of the informants contradict with the first information, it was rejected totally since it is considered as unreliable.

Data analyses

Descriptive statistics such as percentage, mean and frequency were used to analyze method of preparation, route of application, ailments treated, dosage, parts used, habit, threat and conservation of the medicinal plants. Ethnobotanical tools such as informant consensus, informant consensus factor, preference ranking, data matrix ranking and fidelity level were used to verify data.

Informant consensus was applied to calculate the number of informant reports for each plant species as traditional medicinal uses. Informant consensus factor (ICF) was calculated for each category of ailments to identify the agreements of the informants on

the curative power of plants and common ailments in the study area. The ICF was calculated as the number of use citation in each category (nur) minus the number of species used (nt), divided by the number of use citations in each category minus one (Heinerich, 1998). The factor provides a range of 0 to 1, where a high value acts as a good indicator for a high rate of informant consensus.

Preference ranking was done using eight experienced key informants to assess the degree of effectiveness of six medicinal plants against wound by following Martin (1995). The medicinal plants believed to be most effective to treat the illness was given the highest value (6), and the least effective got the lowest value (1). The value of each species was summed up and the rank for each species was determined based on the total score. This helped to indicate the most effective medicinal plants used by the community to treat the ailment.

Direct matrix ranking was conducted in order to compare multipurpose medicinal plants commonly reported by informants following Cotton (1996). Based on the relative benefits obtained from each plant, six multipurpose tree species were selected out of the total medicinal plants and six use diversities of these plants were listed. Five key informants were chosen to assign use values of each attributes (5=best, 4= very good, 3= good, 2= less, 1= least used, 0= not used). The six use values include construction, charcoal, fencing, firewood, medicinal and shade value. Based on data obtained from informants' average value of each use diversity for a species was taken and finally the values of each species summed up and ranked.

The fidelity level (FL) is the percentage of informants claiming the uses of a certain plant species to treat a particular ailment. FL was calculated as FL (%) = (Np / N) x 100 where Np is the number of informants that claim the use of a plant species to treat a particular ailments and N is the number of informants that use the plants as a medicine to treat any ailments as stated by Alexiades (1996). The total overall use and particular use reports informants were recorded and its fidelity level index was calculated and summarized.

Results and Discussion

Medicinal Plant Diversity and Distribution

In the study, 78 plant species distributed into 70 genera and 45 families were documented as having human medicinal value (Appendix 1).The result showed that local people living in Lay Armachiho District have a long and rich experience of interaction with their natural resources revealing traditional remedy preparation is considered as a routine task for the communities.

Ethnobotanical studies conducted by Gebeyehu *et al*. (2014), Mekuanent *et al*. (2015) and Getnet *et al*. (2015) came up with higher numbers of medicinal plants, 107, 101 and 163 species, respectively. However, Dereje (2018) and Messay *et al.* (2015) recorded 65 and 54 plant species, respectively which were lower than the current study. This showed that the use of local medicinal plants varies from place to place (Dereje, 2018).

The leading family was Solanaceae with five species followed by Euphorbiaceae, Lamiaceae and Malvaceae each with four species (Appendix 1). However in studies conducted by Mekuanint *et al*. (2015) and Yihenew *et al*. (2017) the dominant families were Fabaceae and Asteraceae, respectively. This reflects that their abundance (species richness) varies from place to place.

Shrubs were the dominant habit (28, 35.9%) followed by herbs (25, 32.1%) and trees (17, 21.8%) whereas climbers (8, 10.3%) were less used as traditional medicines in the study area. This could be due to the fact tree species are overused because of their diverse use values. The analysis of the data also showed that majority of medicinal plants in the homegardens is shrubs and herbs. It might be also associated with the abundance and year round availability of shrub species in the area. This finding agreed with the work of Alemayehu (2010) and Ermias *et al.* (2008)

indicating that shrubs were the most harvested forms for medicinal purpose in their ethnobotanical investigations. However, the finding of Endalew (2007) and Tizazu (2005) indicated that herbs were mostly harvested forms for medicinal purposes.

The result showed that most of the medicinal plants used by the communities were collected from wild (60.3%) followed by homegardens (29.5%) and both wild and homegarden (10.3%).This finding is in line with the general patterns seen in most medicinal plants inventories such as that of Bizuneh *et al*. (2018), Nigussie *et al*. (2018) and Mulugeta (2016). In a similar way, people in the study area exert less effort to cultivate medicinal plants in their homegardens rather go to the nearby or far places to harvest them in their wild environment, though, local people cultivate some popular medicinal plants such as *Allium cepa, Allium sativum*, *Zingiber officinale, Cucurbita pepo, Citrus limon, Rhamnus prinoides, Coffee arabica, Brassica nigra, Capsicum annuum, Carica papaya, Coriandrum sativum, Foeniculum vulgare, Lepidium sativum, Linum usitatissimum, Lycopersicon esculentum, Musa x paradisiaca, Nigella sativa* and *Ruta chalepensis* in their homegarden for other purposes like food, alcohol preparation and stimulant. Field observation during data collection clearly confirmed that some traditional healers do not have interest to grow some plant species in their homegarden that are used to treat specific ailments in order to keep the secret of their medicinal value.

Ailments treated

A total of 46 human ailments treated by medicinal plant species were identified. The practitioners of the area commonly diagnose each health problem by an interview and visual inspection of the patient. A single plant can treat a number of human ailments, and a single ailment can be treated by a number of plants (Table 1& Appendix 1). According to the informants the largest number of species was used to wound treated by 16 species. This disease is common in the area because most people engage in the farmland as a result they are susceptible to cut and wound; the next is cough, treated by 9 species. Evil eye and stomach ache are treated by 7 and 6 species respectively. Due to their accessibility, the local community prefers traditional healers for such ailments than modern medication. Edwards, (2001) reported that 80% of the Ethiopian people still use plant remedies for various ailments. Others also came with similar findings (Abiyu *et al.*, 2014; Mirutse *et al*., 2009).

Table 1: Common human ailments treated by more number of plant

No	Ailments	Local Name/ Amharic	No. of Plant Species Used
1	Wound	Kusil	16
2	Cough	Sal	9
3	Evil Eye	Buda	7
4	Stomach ache	Hod himem	6
5	Eczema	Asim	6
6	Diarrhea	Tekimat	5
7	Dandruff	Forefor	5
8	Malaria	Nidad /Woba	5
9	Swelling	Ebitet	5
10	Devil	Seytan	4
11	Head ache	Ras mitat	4
12	Poisoning	Merz	4
13	Taeniasis	Koso	4

Traditional knowledge of informants

Male informants reported more number of medicinal plant species indicating that they had better indigenous knowledge on medicinal plants than the female informants (Table 2). The common line of traditional medicinal knowledge acquisition or transfer, which favors males, especially elder sons, was responsible for the observed variation between sexes (Ermias *et al*., 2008). Boys have greater chance to gather knowledge on medicinal plants than girls because fathers have high interest to give their talent to their sons by allowing them to collect medicinal plants in the field whereas females are expected to spend their time at home. In addition, Tilahun (2009) came up with a similar result that females are expected to engage, mainly, in cooking food, giving care to family members and thereby limited interaction with their environment.

According to the data obtained from the study, more informants were not well educated. This indicated that illiterate informants handle much knowledge of traditional medicine than educated informants. With regard to age classes in the study area, majority of knowledgeable people were found between the ages of 61-80 followed by 41-60 age group members (Table 2). This finding clearly indicated that elders are more knowledgeable as far as the number of medicinal plant remedies, the method of collection, preparation of remedies and their mode of administrations were concerned. This report is in line with different results documented in different parts of Ethiopia (Solomon *et al*., 2015; Ermais *et al*., 2013; Miruts et *al*., 2009).

Regarding indigenous knowledge transfer, the highest source of knowledge on traditional medicinal plant was the father (42.22%) followed by mother (14.44%) and brother (12.22%), respectively (Table 3) revealing that knowledge acquisition by the healers was from parents or close relatives. The healers have a very high intention to keep their traditional knowledge secret and transmission is, largely, oral. Let alone the maximum secrecy that exist in the traditional knowledge acquisition or transfer, members of the young generations are lenient to acquire and conserve the practice

Table 2: Traditional knowledge of informants

	Sex		**Informant's Age groups**				**Educational status**			
Items	Male	Female	18 – 40	41 – 60	61 – 80	>80	Illiterate	1-8	9-12	>12
Frequency	62	28	21	24	31	14	23	51	9	7
Use report	332	128	45	97	247	71	121	266	42	31
Average	5.35	4.57	2.14	4.04	7.97	5.07	5.26	10.05	4.67	4.43

Table 3: Sources of informant's medicinal plants knowledge

Source	Number of informants	Percentage
Father	38	42.22
Mother	13	14.44
Brother	11	12.22
Sister	8	8.89
Friends	10	11.11
Other	10	11.11

Remedy preparation and application

Different parts of medicinal plants were reported to be used for medicines. The most frequently utilized plant part was leaves (41, 35.04%) followed by roots (20,25.64%) and fruit (13,11.11%) respectively (Figure 3).This might be due to their better accessibility during field collection, ease of preparation, and effectiveness due to bioactive components in their parts. Similarly, the detailed reason for leaves as the most potential sources of traditional remedy preparation was suggested by other studies (Dereje, 2018; Abiyu *et al.*, 2014).

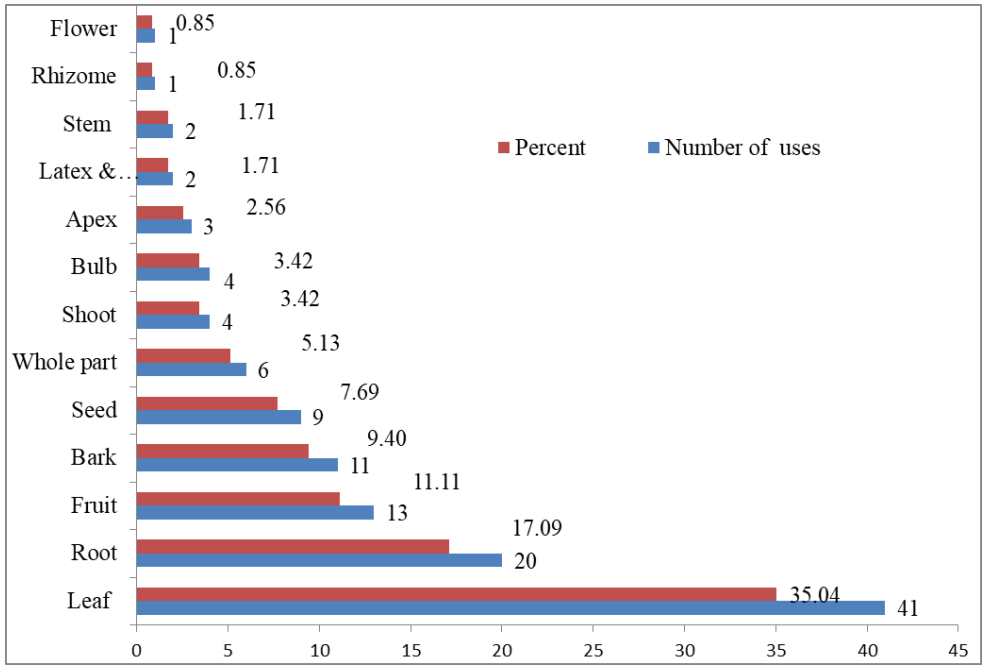

Figure 3: Plant parts used for remedy preparation

People in the study area employed various methods of preparations of remedies that the principal methods were crushing (35, 31.82%) followed by powdering (15, 13.64) and crushing and pounding (8, 7.27%)(Figure4). The methods of preparations depend on the types of ailments treated. In most cases, preparing plant remedies by crushing or squeezing is advantageous over using decoction since heat may affect the active constituents of the remedies. This finding was positively supported by the finding of Bizuneh *et al*. (2018) and Mulugeta (2016).

Informants reported various skills associated with herbal preparation. These include plant composition (whether single or combined), condition of plant material used (fresh or dry) and methods of preparation. The result showed, most remedies were prepared from a single plant (80.77%) and mixed forms accounted 19.23%.The findings also revealed that most medicinal plants used in fresh forms 79 (71.82%) of the total plants and 31 (28.18%) were used dry forms. The reason for preference of fresh plants over dried ones may be related to the fact that the biologically active principles present in the plant may decrease up on drying. Moa *et al*. (2013) also reported similar findings. Some of the remedies are taken with different additives, like butter, honey, sugar, tea, salt, food, water, coffee and milk. The additives are important to minimize the power of the medicines, improve the taste and minimize the discomfort of the medicines. For example, fruits *Allium sativum* pounded, powdered and then mixed with honey and taken orally as food are used to treat malaria.

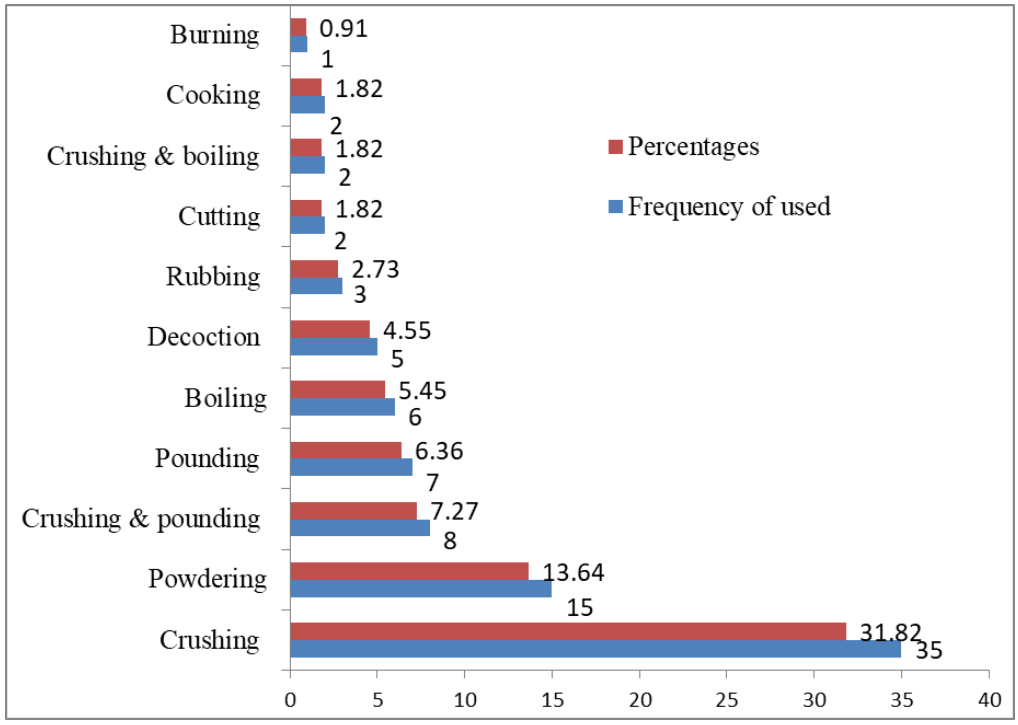

Figure 4: Methods of preparations of medicinal plants

Medicinal plants were applied through different routes of administration where oral administration covered the highest proportion (52, 47.27%) followed by dermal (40, 36.79%), nasal application (17, 15.09%) and Ear drops (1, 0.94% respectively. In the study area people are mostly affected by endo-parasites and this may be one of the reasons for the dominance of oral administration. Various ethnobotanical reports elsewhere in Ethiopia have indicated that oral administration is the predominant route (Gidey *et al*., 2011; Moa *et al*., 2013).

The traditional healers prepared medicinal plants in various ways and applied it using different methods to the patients. Creamed accounted for 42 (38.54%) followed by drinking 31(28.13%), smoking 15 (13.54 %), chew and swallowing 13 (11.46%), bandage 8 (7.29%) and tie/put on 1 (1.04%). People of the study area used various units of measurement and the duration of administration to determine the dosage. Local units such as finger length for bark, root, stem, different measuring materials such as spoon, coffee cup, tea cup and glass cups for decoction and numbers for leaves, seeds, fruits, and bulbs were used to estimate and fix the amount of medicine. For medicinal plants that were taken topically they do not have clear cut dosage. Generally, the dosages of remedies are not yet standardized and healers are using equipment which is available in their homes and consider patient age, physical and health conditions. Thus, this is expected to cause risk due to under dose and over dose during treatment of patients. Hence, Solomon *et al.* (2015) reported that lack of precision and standardization has been mentioned as drawbacks of traditional medication.

Ethnobotanical clustering and ranking results

Informant consensus result showed that *Allium sativum, Hagenia abyssinica*, *Croton macrostachyus*, *Datura stramonium* and others were reported with more number of informants (Table 4).

Table 4: Medicinal plants cited by greater than 30 numbers of informants

Plant species	Number of informants	Percent
Allium sativum	48	53.33
Hagenia abyssinica	47	52.22
Croton macrostachyus, Datura stramonium	45	50.00
Carissa spinarum	43	47.78
Embelia schimperi, Otostegia integrifolia	42	46.67
Zehneria scabra	41	45.56
Cucurbita pepo, Ocimum gratissimum, Zingiber officinale	40	44.44
Dodonaea angustifolia	39	43.33
Foeniculum vulgare, Nigella sativa, Ximenia americana	38	42.22
Euphorbia tirucalli, Eucalyptus globulus	37	41.11
Acokanther aschimperi	34	37.78
Capparis tomentosa, Carica papaya, Euphorbia abyssinica	31	34.44
Ruta chalepensis	30	33.33

Informant consensus factors result showed that the medicinal plants that were presumed to be effective in treating a certain disease had higher ICF values which indicated that these diseases were more common than those with low ICF (Table 5). Accordingly, Gonorrhea (0.98) had the highest ICF followed by Cancer and TB (0.96), and Cramp and impotency (0.96).

Table 5: Informant consensus factor by categories of diseases in the study area

Ailment category	Species	Use citations	ICF
Gonorrhea	3	97	0.98
Cancer and TB	3	78	0.97
Cramp and impotency	4	109	0.97
Animal causing (Rabies, poisoning and snake bite)	5	102	0.96
Goiter, tumor, wart and hemorrhoids	6	117	0.96
Diabetes, hypertension, gastritis and hepatitis	8	122	0.94
Malaria, head ache and febrile illness	11	141	0.93
Evil spirit and evil eye	11	124	0.92
Swelling and bleeding	11	130	0.92
Gastro-intestinal (Intestinal parasite, diarrhea, amoebiasis, giardiasis, taeniasis, ascariasis and vomiting)	18	152	0.89
Respiratory (tonsillitis, Influenza, common cold, asthma and cough)	16	137	0.89
Dermal (Wound, dandruff, eczema, itchy and impetigo)	30	229	0.87

Preference ranking exercise indicated that *Sida rhombifolia* ranked first and most effective medicinal plant to cure wounds whereas *Stereospermum kunthianum* and *Linum usitatissimum* were the least effective for treating the ailments (Table 6).Preference ranking exercise results are important parameters to identify the most effective plant species to treat wound. Ethnobotanical investigations done in different parts of the country (Yohannis *et al*., 2018; Abiyu *et al*., 2014 and Moa *et al*., 2013) also reported the use of *Sida rhombifolia*, *Rumex nervosus* and *Ximenia*

Table 6: Preference ranking of six medicinal plants used to treating wound

	Informants (I1- I8)									
Medicinal plants	I1	I2	I3	I4	I5	I6	I7	I8	**Total**	**Rank**
Centella asiatica	2	1	3	3	2	3	2	3	19	4th
Rumex nervosus	5	5	2	5	4	5	6	5	37	2nd
Sida rhombifolia	6	4	4	5	6	4	5	6	40	1st
Ximenia americana	4	6	6	4	3	4	3	3	33	3rd
Stereospermum kunthianum	3	2	5	1	2	1	1	2	17	5th
Linum usitatissimum	1	3	1	2	1	2	2	1	13	6th

Table 7. Direct matrix ranking of multipurpose medicinal plants

Use categories	Medicinal plants						Total	Rank
	Olea europaea	Cordia africana	Croton macrostachyus	Syzygium guineense	Ximenia american	Azadirachta indica		
Construction	22	23	23	24	23	21	140	3rd
Charcoal	23	26	22	27	24	22	150	1st
Fencing	15	21	19	17	18	19	109	6th
Firewood	24	22	25	22	28	23	144	2nd
Medicinal	10	14	24	19	26	23	116	5th
Shade	16	19	17	20	22	30	124	4th
Total	110	125	140	130	141	138		
Rank	6th	5th	2nd	4th	1st	3rd		

Direct matrix ranking finding showed most of the people in the study area rely on plants for various purposes such as agricultural tool, firewood, charcoal, construction material, fencing and medicine. *Ximenia american* was first ranked multipurpose species followed by *Croton macrostachyus* (Table 7). Of the six-selected use categories, charcoal and fuel wood were ranked first and second. Other studies conducted in different parts of Ethiopia, revealed *Croton macrostachyus* and *Olea europaea* subsp. *cuspidata* as the most preferred multipurpose medicinal plants (Yohannis *et al*., 2018; Abiyu *et al.*, 2014). These similar reports suggested their relative importance for the livelihood of the local residents and the burden posed on these plant species. Thus, appropriate conservation measures are before their total loss.

Regarding fidelity level value (Table 8), the medicinal plants that were widely used by the local people to treat one ailment have higher FL values than those treated more than one ailment. Thus, the result indicated that *Zehneria scabra* has the highest FL (98%) followed by *Hagenia abyssinica* (96%) and *Carissa spinarum* respectively. High FL could also be an indication of the efficacy of the reported plant to cure the specific ailment.

Table 8: Fidelity Level Index of some medicinal plants

Plant species	Treatment for	IP	Pu	FL	FL%
Allium sativum	Cough	39	48	0.81	81
Hagenia abyssinica	Taeniasis	45	47	0.96	96
Croton macrostachyus	Dandruff	37	45	0.82	82
Datura stramonium	Wound	31	45	0.69	69
Carissa spinarum	Evil eye	38	43	0.88	88
Otostegia integrifolia	Common cold	35	42	0.83	83
Zehneria scabra	Fibril illness	40	41	0.98	98

Threatening Factors of Medicinal Plants and Associated Knowledge

Agricultural expansion is the main cause for the loss of medicinal plants (Table 9) since community in the study area depends on mixed agriculture as the main economic activity so as to support their family. Similar studies have been reported by different scholars (Yihenew *et al*., 2018; Tadesse *et al*., 2015; Haile and Dilnesaw, 2007). Furthermore, the negative impact of deforestation on medicinal plants was also reported (Bizuneh *et al*., 2018).

Table 9: Threats to medicinal plants in the study area

Major treats	Frequency	Percentage
Agricultural expansion	34	29.82
Construction material	17	14.91
Charcoal making	16	14.04
Over grazing	29	25.44
Firewood collection	18	15.79

In addition to the threat posed on the medicinal plant species, the indigenous knowledge is also on the verge of extinction as lack of interest to use and acquire the traditional medicinal knowledge by the youths. Informants agreed that secrecy, informal transfer, influence of modern education and unwillingness of young generation are causes of indigenous knowledge loss. Elders mentioned less economic value of the practice, 'modernization', and associating traditional knowledge and practices with bad habits (such as witchcrafts) as negative factors during the discussions. Other studies also reported lack of interest to acquire the indigenous knowledge among the younger generations in different cultural groups in Ethiopia (Ermias *et al*., 2014; Miruse *et al*., 2009). Moreover, most of the traditional healers in the study area revealed the decline in their medicinal plant knowledge through time partly because they lacked a habit of properly documenting the ethnomedicinal knowledge. Hence, a great threat is posed on the future use of indigenous ethnomedicinal knowledge to fulfill the primary healthcare demand of the local people.

Conservation of Medicinal Plants

Some members of local community knew the importance of both *ex-situ* and *in-situ* conservation of plants. For instance, some people have started conserving the plants in fenced/protected pasture land; in different worship areas (churches, mosques), in their farms' field/farm margins and around their homegardens and live fences of the famers. *Olea europaea* subsp. *cuspidata* and *Euphorbia abyssinica* are found in church forest and also plants like *Allium cepa*, *Allium sativum*, *Hagenia abyssinica* and *Ocimum basilicum* are found in the majority of homegardens in the study area, as they need these plants in their daily life as spices, medicine, food or for other values. Homegardens are being used as informal experimentation plots for new varieties and exotic species (Mesfin *et al*., 2009). Plants such as *Acacia abyssinica* and *Cordia africana* are also left as remnants of forest in the agricultural field due to their uses as timber source, for construction and fuel wood. However, many of the informants who have knowledge on traditional medicine usage give priority to the immediate use of the medicinal plants than to its sustainable future uses, as a result their harvesting style is destructive.

Conclusion

Documentation of large number of medicinal plant species(78 species) and various methods of remedy preparation as well as route of applications proved that the local people in the study area have rich ethnobotnical indigenous

knowledge that could make them, largely, to depend on traditional plant medicine for their health care. The result also revealed that the source of traditional medicinal plants was largely from natural habitats indicating that conservation habit of medicinal plants by the local people is weak. Some medicinal plants that are preferred for their multipurpose use values will face risk of local extinction in the near future.

Recommendations

Based on the results of the study, the following recommendations are forwarded:

⇒ Local people in the District should be encouraged to grow highly proffered medicinal (such as *Sida rhombifolia, Ximenia americana*) and other multipurpose plants (*Olea europea,* subsp. *cuspidata Cordia africana*) in homegardens, mixing with crops in the farm lands and live fences.

⇒ Enhancing awareness of healers on the sustainable utilization and management of plant resources found in the wild habitats is required. For instance, a special care is needed when root is used for remedy preparation.

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Supplementary Table

List of medicinal plants for treating human ailments: Habit: T-tree, S-shrub, H-herb, and C-climber; Habitat: W- Wild, HG- Home Garden) Parts: Leaf(L); Stem(S); Bark(B); Seed(Sd); Root(R); Bulb(Bb); Fruit(F); Apex(A); Shoot(St); Sap(Sp);Flower(Fl) Rhizome(Rm); Stem bark(Sb);Root bark(Rb); Latex(Lx).

Scientific name	Family	Vernacular name	Habit	Habitat	Parts used	Ailment treated	Method of preparation and application	Collection No.
Acokanthera schimperi (A.DC.) Schweinf.	Apocynaceae	Mirez	S	W	L,Sb	Gonorrhea & Amoeba	Crush, pound with water, filter and drink	071
					Sd	Evil Eye	Tie the dry seed on the neck	
Acacia abyssinica Hochst. ex Benth	Fabaceae	Bazera gerar	T	W	B	Scorpion poison	Crush and cream	060
Acacia mellifera Benth.	Fabaceae	Girar	T	W	R, B	Tonsillitis	Crush and take orally	034
Allium cepa L.	Alliaceae	Qey shinkurt	H	H G	Bb	Hypertension	chopp, macerate in water, filter and drink	058
Allium sativum L.	Alliaceae	Nech shinkurt	H	H G		Cough	Crush, pound and eaten with honey	026
						Evil eye	The bulb mix with the roots of Withania sommifera, Solanecio gigas, Carissa spinarum, Verbena officinalis, Capparis tomentosa, Asparagus africanus, Clausena anisata, Justicias chimperiana, Verbasicum siniaticum, Jusminum grandiflorum, Cucumis ficifolius, and whole parts of Artemisia afra, Ruta chalepensis, are crushed and powdered then sniff& drink with coffee cup and fumigat.	
						Malaria	Crush and mix with honey then eat until recovery/ The bulb are chopped and smashed together in water for one day and drunk the decanted liquid every morning until recovery.	
					Bb	Hemorrhoids	Crushed, mix with the fruit juice of Citrus aurantifolia drink until recovery	
Aloe macrocarpa Tod.	Aloaceae	Eret	H	W	L	Dandruff	Mucilage mixed and paint the skin and hair	065
						Gastritis	Chopped and macerated in water for a night, a glass of the bitter solution is drunk every two hours.	
					R	Impotency	Crushed, powdered, mixed with butter then paint the whole part of penis	

Supplementary Table continued

Scientific name	Family	Vernacular name	Habit	Habitat	Parts used	Ailment treated	Method of preparation and application	Collection No.
Anogeissus leiocarpa (A. Rich) Guill. & Perr	Combretaceae	Kekera	T	W	Sb	Diarrhea & Stomach	Crushed, decoction and drunk two spoon until recovery	016
					L	Influenza	Crushed and taken Orally	
Argemone mexicana L.	Papaveraceae	Yahya eshoh	H	W	R	Rabies	Crushed, mix with water, give to all animals orally	058
Arundo donax L.	Poaceae	Shenbeko	H	W	R	Evil eye	Grounded with seeds of Allium sativum, leaves of	077
Azadirachta indicaA. Juss.	Meliaceae	Nim	T	W	L	Diabetes	Make juice, drink one cup until recovery	056
Bersama abyssinica Fresen	Melianthaceae	Abalo	T	W	F,R	Eczema (CHIFIE),	Pounded to powder, mixed with honey or butter and applied on the wound.	021
Brassica nigra L.	Brassicaceae	Senafich	H	W/ HG	L	Abdominal pain	Powdered with Lepidium sativum seeds, diluted with water , then drink	046
Brucea antidysenterica J.F. Mill.	Simarobaceae	Waginos	S	W	L	Wart	Crushed with Clematis simensis, Brucea antidysenterica and Oenanthe palustris, and put on the powder on the affected part	039
Buddleja polystachya Fresen.	Loganiaceae	Amfar	T	W	L	Wound & Dandruff	Crush the fresh & creamed	030
Calotropis proceraL.	Asclepiadaceae	Tobia	S	W	L	Swelling	Warm the leaf and rubbing the swelled part	042
						Tumor	Crushed with Cucumis ficifolius, Solanum incanum& Solanum marginatum then the powder is added to the affected part for 3 days.	
Capparis tomentosa Lam.	Capparidaceae	Gumero	S	W	R	Evil eye	The root is crushed with Allium sativum, Achyranthes aspera, Ruta chalepensis, Clematis simensis, Withtania somnifera, Cucumis ficifolius and Capparis tomentosa then suspend it on the neck	011
Capsicum annuum L.	Solanaceae	Berberie	H	HG	F	Tonsillitis	Crushed, fumigate by adding the fruit on an open fire till sneezing, the tonsil moves up while	032

Supplementary Table continued

Scientific name	Family	Vernacular name	Habit	Habitat	Parts used	Ailment treated	Method of preparatio and application	Collection No.
Carica papaya L.	Caricaceae	Papaya	T	HG	L	Intestinal	Boiled the fresh in water, cooled then drunk in the mornings	078
					S	Malaria	Dry/fresh seeds is pounded with water and drunk	
					F	Gastric	Fresh fruit taken orally	
Carissa spinarum L.	Apocynaceae	Agam	S	W	L,R, B	Evil eye, Gonorrhea,	Crushed parts, added on fire then inhaled the fumigate	069
					A	Insect/animal	Crushed, tied the affected body part	
					R	Evil spirit / MEFTHE SIRAY/	Washing by root juice of *Rumex nervosus, Rotheca myricoides*, *Asparagus africanus*, *Verbasicum sinaiticum*, *Verbena officinalis*, *Cucumisficifolius.*, *Plumbagozey lanicum*, *Euclea racemosa, Calpurnia aurea, Justicia schimperiana*, *Carisa spinarum*, *Ferrula*	
Catha edulis (Vahl) Forssk. ex Endl.	Celastraceae	Chat	S	HG	L	Evil spirit	Leaf is boiled with *Vernonia adoens is* root, then drink	028
Centella asiatica L.	Apiaceae	Yeayit joro	H	W	L	Wound	Crushed, mixed with cold water and decanted, then applying on the affected part	045
Cissus petiolata Hook. f.	Vitaceae	Alkie	C	W	R	Swelling, tumor	Inhaling its root powder on fire	057
Citrus limon (L.) Burm. f.	Rutaceae	Lome	S	HG	F	Common	Squeezed and added sugar and taken orally	035
						Athlete's foot	Its fruit is squeezed and creamed on affected part for continuous days.	
Clausena anisata (Willd.) Hook.f	Rutaceae	Limich	S	W	R	Evil spirit	Inhaling its root powder with roots of *Croton macrostachyus* and *Capparis tomentosa*on fire	073
Clematis simensis Fresen.	Ranunculaceae	YeazoAreg	C	W	S	Cancer (NEKERSA)	The smooth bark is removed, and the stem is chopped and applied on the swelling	055
					L	Swelling	Crushed & tied on swelling	

Supplementary Table continued

Scientific name	Family	Vernacular name	Habit	Habitat	Parts used	Ailment treated	Method of preparatio and application	Collection No.
Coffee arabica L.	Rubiaceae	Buna	S	HG	Sd	Wound, Spider	Roust the seed, mixed with honey and drink	031
Commelina latifolia Hochst. ex A Rich.	Commelinaceae	Yewhaenkur	H	W	St	Wound (GORMIT)	Crushed and tied with cotton cloth until recovery	018
Cordia africana Lam.	Boraginaceae	Wanza	T	W/ HG	L,B	Hepatitis	Crushed and then inhaled after boiling, Drinking the decoction	003
Coriandrum sativum	Apiaceae	Dinbelal	H	HG	Sd	Cough	Boiled mixed with butter and water and drunk.	020
Crinum abyssinicum (Hochst ex A. Rich)	Amaryllidaceae	Yejib shinkurt	H	W	L, Bb	Snake bite	Crashed and applied on the affected part	023
Croton macrostachyus Hochst.	Euphorbiaceae	Besana/ Mesana	T	W/ HG	L,	Acute blooding &Tetanus	Creamed latex of petiole or leaf	050
					Sb	Intestinal parasites, Amoeba, Gonorrhea& Pneumonia	Crushed the fresh, pounded with water, drunk filtrate after breakfast in the morning until recovery	
Cucurbita pepo L.	Cucurbitaceae	Duba	C	HG	F, Sd	Taeniasis	Dried fruit and seed is roasted and mixed with fruit of *Embelia schimperi*is given to eat; Dry, cooked and given to eat in empty stomach	067
Datura stramonium L.	Solanaceae	Astenagir	H	W	F	Intelligence/ enhance	Ground & eaten with WOT prepared from only garlic, paper and SHIRO with teff injera for 7days	002
					L	Scabies &	Crushed and creamed on head	
Dodonaea angustifolia L.f.	Sapindaceae	Kitkita	S	W	St/	Eczema	Charred with fire, mix ash with butter & creamed	036
					A	Bone broken	Crushed , tied with rope as bandage by bamboo stem	
Embelia schimperi Vatke	Myrsinaceae	Enkoko	C	W	F	Tape worm	Crushed and drunk mixed with tela (more alcoholic)	024
Eucalyptus globulus Labill.	Myrtaceae	Nech baharzaf	T	W/ HG	L	Common cold, Skin ailments	Boiling with water and drinking	019

Supplementary Table continued

Scientific name	Family	Vernacular name	Habit	Habitat	Parts used	Ailment treated	Method of preparatio and application	Collection
Euphorbia abyssinica Gmel.	Euphorbiaceae	Kulkual	T	W	Lx	Diabetes	Collected with cup and half is drunk three times a day before food (age, & physical appearance)	061
						Homorrhoids	Collected, cream swelling as it is fresh.	
						Ascaris	Add five drops latex on fresh Injera, eat before food in every morning till cure	
Foeniculum vulgare Mill.	Apiaceae	Ensilal	H	HG	R, L	Cough	Crushed, mixed with *Trachyspermumammi*& drink the decoction	038
Guizotia schimperi Sch. Bip.exWalp.	Astraceae	Mech	H	W	R	Stomach ache	Chewed & swallowed the liquid orally	029
Hagenia abyssinica (Bruce) J.F.Gmel.	Rosaceae	Koso	T	W	F	Tape worm, Vomiting & Diarrhea	Ground, mixed with milk and drunk before eat food in the morning	017
*Hibiscus macranthu s*Hochst. ExA.Rich.	Malvaceae	Nacha	S	W	L	Eczema (CHIFIE)	Chewed & creamed with cotton.	012
*Kalanchoe petitiana*A.Rich,	Crassulaceae	Andahula	H	W	R	Ascaris	Chopped on stone, mixed with water, squeezed, drink.	001
Laggeratomentosa (Sch. Bip. ex A.	Asteraceae	Keskesso	S	HG	L	Cancer (NEQERSA)	Crushed, squeezed, and applied on wound or add small drops water	051
					F	Sadden	drink bitter liquid for 8 days	
Lepidium sativum L,	Brassicaceae	Feto	H	W/ HG	Sd	Evil eye, sun stroke /	Crushed, mixed with water and sprayed on body parts.	068
						Dysentery	Pounded, mixed with Yoghurt, shacked well and drunk.	
Linum usitatissimum L.	Linaceae	Telba	H	W/ HG	Sd	Wound (GORMIT)	Mixed with honey, tie the wound.	033
*Lycopersicon esculentum*Mill.	Solanaceae	Tematem	H	HG	L	Spider poison	Chewed & put on the wound	025
Momordica foetida	Cucurbitaceae	Kura	C	W	L	Wound	Crushed and applied on the affected part	008
Musa x paradisiaca	Musaceae	Muz	H	HG	F	Cough	Eat every morning for five days before food	037

Supplementary Table continued

Scientific name	Family	Vernacular name	Habit	Habitat	Parts used	Ailment treated	Method of preparatio and application	Collection
Nigella sativa L.	Ranunculaceae	Awosda/	H	W/	Sd	Asthema	Pounded, powdered & drink with coffee	062
				W/		Stomachache	Crushed & pounded then taken before food.	
Ocimum basilicum L.	Lamiaceae	Zikakibe	H	HG	L	Headache	Crushed & Sniffed during pain	072
				HG		Malaria	Pounded with bulb of *Allium sativum,* eaten withhoney in the morning before malaria ailment happened.	
Ocimum gratissimum L.	Lamiaceae	Damakesse	S	HG	L	Febrileailments/ Mich/	Drinking its leaf tea	063
Olea europaea subsp. *cuspidata* L.	Oleaceae	Woira	T	W	L	Clean tooth, Tonsillitis, Deafness	Chewing, smoking	013
Otostegiai ntegrifolia Benth.	Lamiaceae	Tunjut	S	W	L,St	Common cold, Stomach	Smoking and fumigated the house	074
Pavonia urens Cav.	Malvaceae	Abelbalit	H	W	R	Impotency	Drinking 1 cup decoction	040
Phytolacca dodecadra L'Herit.	Phytolaccaceae	Mehan Endod	C	W	L,F, R	Abortion, Anthrax,	Crushed and taken orally	059
Premna schimperi Engl.	Lamiaceae	Chocho	S	W	L, B	Wound (CHIFIE)	Crushed and powder then creamed with butter or honey.	075
Pterolobium stellatum Forssk.	Fabaceae	Kentetifa	C	W	L	Tumor	Crushed with *Calotropis procera, Cucumis ficifolius* and *Solanuminc anum,* powder is added to the affected part	066
Rhamnus prinoides L. Herit,	Rhamnaceae	Gesho	S	HG	L	Wound (ALM AZBALECHIRA)	Crushed into powderand applied as bandage on the wounds until recover.	007
Ricinus communis L	Euphorbiaceae	Bulka/	S	HG	Sd	Eczema	Roasted, grounded, mixed with butter and cream the	014
Rosa abyssinica Lindley	Rosaceae	Kega	S	W	Bb	Cough	Grounded with water, filtered & taken orally	027
					Fl	Eczema	Squeezed and applied on the affected part	
					St	Stomachache	Squeezed& fluid taken orally	

Supplementary Table continued

Scientific name	Family	Vernacular name	Habit	Habitat	Parts used	Ailment treated	Method of preparatio and application	Collection No.
Rumex abyssinicus Jacq.	Polygonaceae	Mekmoko	H	HG	L, R	Hypertension, Vomiting.	Crushed, dried, pounded & drink with milk in the morning for two days	004
Rumex nervosus Vahl,	Polygonaceae	Ambacho	S	W	L	Wound (male circumcision)	Crushed, squeezed & applied on the wound.	015
Ruta chalepensis L.	Rutaceae	Tenaadam	H	HG	L	Evil eye	Crushed with roots of *CarissaspinarumAllium sativum, Achyranthes aspera, Securidaca*	041
Schinus molle L.	Anacardiaceae	Kundo	T	HG	F	Cough, Abdominal	Pounded, crushed and drink	064
Sida ovata Forssk.	Malvaceae	Chifrig	S	W	L	Skin infection	Rubbed on infected skin	076
						wound	Pounded and mixed with the leaf of *Vernoniaauriculifera*& parted on	076
Sida rhombifolia L.	Malvaceae	Gorgegit	S	W	L	Wound	Crushed and lied on the wound	053
						Dandruff	Crashed and washing with its decoction	
						Bleeding	Crashed and creamed on the affected part	
Solanum incanum L.	Solanaceae	YekollaEmbuay	S	W	F,	TB, cough	The fruit is washed, dried and crushed. It is boiled, and drunk with butter every morning till cured	010
						Wound (GORMIT),	The wound is washed with water, the fruit is squeezed and applied on the wound	
Stereospermum kunthianum Cham.	Bignoniaceae	Zana	T	W	L, A	Bleeding, Wound	Crashed and applied on affected part	047
Syzygium guineense (Willd.) DC.	Myrtaceae	Dokma	T	W	Sb,	Diarrhea, Evil sprit	Mix the powder with honey/ water and then drinking	070
Terminalia laxiflora Engl. &	Combretaceae	Wonbella	T	W	R	Snake bite	Warming and rubbing the affected part by the root	044
Vernonia adoensis Sch. Bip ex Walp	Astraceae	Eras abera	S	HG	R	Amoeba, Snake poison,	Crushed, root is chewed and juice is swallowed.	009

Supplementary Table continued

Scientific name	Family	Vernacular name	Habit	Habitat	Parts used	Ailment treated	Method of preparatio and application	Collection No.
Vernonia amygdalina Del.	Astraceae	Gerawa	S	HG	L, R	Dandruff, Malaria, Goiter,Impotence, Heart, Problem, Cough, Wound	♦ Crushed, Pounded is creamed fungus leg, ♦ Chewed and the sap is swallowed	052
Withania somnifera (L.) Dunal in DC.	Solanaceae	Kumo	S	W	L, R	Malaria,Cough, Impotence,Evil	Crushed and powdered, boiled, drunk juiced for 4 days; Squeezed leaves then cream the skin	048
Ximenia americana L.	Olacaceae	Enkoy	S	W	Sb	Wound	Crushing and Applying a spoonful of powder on the wound	005
Zehneria scabra (Linn. f.) Sond.	Cucurbitaceae	Haregresa	C	W/ HG	Le av	Fibril illness/ MICH/, Skin	The leaves are boiled in water and the patient is fumigated or the leaves are squeezed between palms and the juice is	022
Zingiber officinale Roscoe	Zingibiraceae	Zinjibil	H	HG	R m	Influenza, abdominal pain	The bark is removed, chopped, chewed and the liquid is swallowed, prepared as tea	006
Ziziphus spina-christi (L.) Desf	Rhamnaceae	Gava	S	W	L	Abdominal pain,	Crushed mixed with *Acacia oerfota* root or bark, oral drink water on the morning time in empty stomach	049