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Ethnobotanical Study of Medicinal Plants in Heban Arsi District, Oromia, South Eastern Ethiopia

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Abstract
Ethnobotanical study of medicinal plants in Heban Arsi district was conducted to document medicinal plants, parts used for medicinal purposes, modes of preparation and routes of administration for remedies. Ethnobotanical data were obtained using Household Survey, Key informant interview and market survey from October 12, 2014 to January 12, 2015. Data were analyzed by descriptive statistics using Microsoft Excel and Statistical Package for Social Science. Ethno medicinal use of 130 medicinal plant species belonging to 112 genera and 61 families were identified and documented. The highest number of medicinal plants was used in Degaga (midland) district (54 species). Out of total medicinal plants 55 (44.35%) species were reported to treat human aliments only. Most of the medicinal plants harvested were herbs (37.50%), followed by trees (36.76%) and the least was lianas 1(0.74%). The root (25.74%) parts of medicinal plants were frequently used, followed by leaves (24.26%), both roots and leaves (9.56%) and seeds (8.82%). The most widely used mode of preparation in study area was crushing (17.65%), followed by pounding (16.91%), powdering (13.97%) and squeezing (5.88%). The most commonly used route of administration was oral (30.88%), followed by dermal only (14.71%), nasal and dermal (11.76%), and nasal only (8.09%). Most of the medicinal plants were reported to be used in fresh (52%) condition to treat diseases. Market survey indicated that most of the medicinal plants were not widely sold in market for medicinal purposes, but for other purposes. Ocimum lamiifolium species was cited by the highest proportion of informants (27.68%) and, Anemia disease category scored the highest number informant consensus factor (0.84) value. Preference ranking indicates that Ocimum lamiifolium ranked first in treating febrile illness human disease and Croton mycrostachyus ranked first in treating blackleg livestock disease in the study area. Simple pairwise comparison indicated that Calpurnia aurea ranked first to treat snake bite disease. Direct matrix ranking revealed that Cordia africana ranked first as a multipurpose medicinal plant.
Keywords/Phrases: Heban Arsi, Medicinal Plants, Ethnobotany, Human disease, Livestock disease

INTRODUCTION

Background

Ethnobotany is an extensive sense referring to the study of the relationship between peoples, plants and the environment involving wide range of disciplines with particular emphasis on traditional cultures (Martin, 1995; Cotton, 1996). Over centuries, local peoples of different localities have advanced their own specific knowledge on plant resource uses, management and conservation (Cotton, 1996). Indigenous knowledge (IK) of medicinal plants (MPs) and their use by indigenous cultures are not only beneficial for conservation of cultural traditions and biodiversity, but also healthcare and drug development in the present and upcoming day (Tamiru *et al*., 2013).

The world primary means of treating diseases and fighting infections has been based on the use of MP species. From ancient times, plants have been rich sources of effective and safe medicines (Russell *et al*., 2006). Globally, about 64% of the total world population is reliant on traditional medicine (TM) for their healthcare needs (Phondani *et al*., 2016). According to the World Health Organization (WHO), nearly 3.5 billion people in developing countries believe in the efficiency of plant remedies and use them regularly (WHO, 2003).

In Ethiopia, over 80% of the population was relies on TMs (traditional medicines) (Abebe and Ayehu, 1993; Tadesse *et al*., 2005; Bekele, 2007). In Ethiopia, plants have shown very effective medicinal value for some diseases of humans and livestocks. The major reasons why MPs are demanded in Ethiopia are due to culturally associated traditions, the trust of communities on medicinal values of TMs and relatively low cost in using them (Tadesse *et al*., 2005; Bekele, 2007).

Ethiopia is a country with various types of climatic, topographic, soil features and agro ecological zones (Institute of Biodiversity Conservation, 2005). This makes the country to have a rich and diverse fauna and flora.

But little emphasis has been given to ethnobotanical studies over the earlier periods (Dawit, 2001), while there is some attempt in investigating MPs and indigenous knowledge (IK) on sustainable use and management of plant resources.

In Ethiopia, TM is faced with the problem of sustainability and continuity mainly due to the loss of taxa of MPs (Kelbessa *et al*., 1992; Asfaw, 2001). According to Abebe *et al*. (2001), the diversity of plants in Ethiopia is on the process of being eroded mainly due to human induced pressures.

The study stated that habitat destruction and deforestation for commercial timber, encroachment by agriculture and other land uses have resulted in the loss of some thousand hectares of forest that harbor MPs, annually over the past several decades. In view of these, documentation of the traditional uses of MPs is an issue that is important to preserve the knowledge (Teklehaymanot and Giday, 2007). According to Lulekal *et al*. (2008), the current loss of MPs in the country due to natural and anthropogenic factors linked with the loss of valuable indigenous knowledge (IK) associated with the plants. Hence, there exists an accelerated destruction of plant resources with loss of IK. Thus, this study attempts to identify and document MPs and associated knowledge of management and use as well as threats that hamper sustainable management and use of MPs.

Figure 1. Hygenia Abyssinia and Bamboo

Statement of the Problem

Among natives of various countries, knowledge of traditional medicine has been passed orally from one generation to the next. The same is true in Ethiopia where written records in this field are almost absent even though the country has had a written language for over two thousand years. The method is crude and highly conducive to distortion in an area where much accuracy is needed. Some of the lore is lost at each point of transfer or otherwise modified and thereby becomes erroneous and dangerous to use (Amare, 1976). Almost all rural community of our country uses many indigenous plants as an alternative to disease treatments until today.

The broad-based cultural diversity and the diverse flora of Ethiopia, studies conducted on the traditional MPs in Ethiopia are very limited (Giday *et al*., 2009).

Many traditional remedies are remaining hidden due to movement of people, urban expansion, influence of modern medicine and exotic cultures (Mesfine and Lema, 2001).

There are natural and manmade forests that are protected by the community or by the government in the zone. Heban Arsi district is one of the west Arsi zone in which ethnobotanical study has been not conducted yet. The local communities living in the study area have unique cultural interactions with plants. They use many wild and domesticated species for the fulfillment of cultural and spiritual needs.

Over utilization of Medicinal Plants from the wild and the lack of knowledge about proper conservation practices result in the loss of biodiversity. In addition to this, the rapid economic growth and alteration of culture threaten the traditional lifestyle of local communities. As a result, there is a high threat for the loss of Medicinal Plants together with IK. Awas (2007) noted that detailed information on Medicinal Plants of Ethiopia could only be acquired when studies are undertaken in several parts of the country where little or no botanical and ethnobotanical explorations have been conducted. Lack of documentation and under reporting of ethno medicinal plant knowledge are some of the major problems of TM in Ethiopia (Yineger and Yewhalaw, 2007; Birhanu, 2013).

In the Heban Arsi district there is gap in the documentation of Medicinal Plants and related IK. Moreover, it is necessary to find solution that the new generations underutilization of Medicinal Plants through emphasizing on modern medicine. Lack of integration of IK with modern science for continuity, and transfer of IK from elder

to young generation also needs due attention.

Scope of the Study

This study is only limited to investigate MPs and related IK in Heban Arsi district, south Eastern, Ethiopia. The study does not include population structure of MPs and other ethnobotanical study such as Commercial, food, spices and recreational uses of plants.

MATERIALS AND METHODS

Description of the Study Area

Geographical location

Heban Arsi is one of the West Arsi Zone district's that is located in Oromia regional state of west Arsi zone. The district Capital "Goljota" is located at distance of 226 km from Addis Ababa along south east part of the country. The district embraces 9 rural districts and 3 urban districts which characterized by diversified agro ecological zones. The total area of the District is 35,613.6 hectares. Exorbitantly, geographical location is between 7^0 9'N-7^0 42'N latitude and 38^0 25' E - 38^0 54'E longitude (Fig. 2). The altitude of the study area ranges between 1500-3000masl (HADADO, 2016).

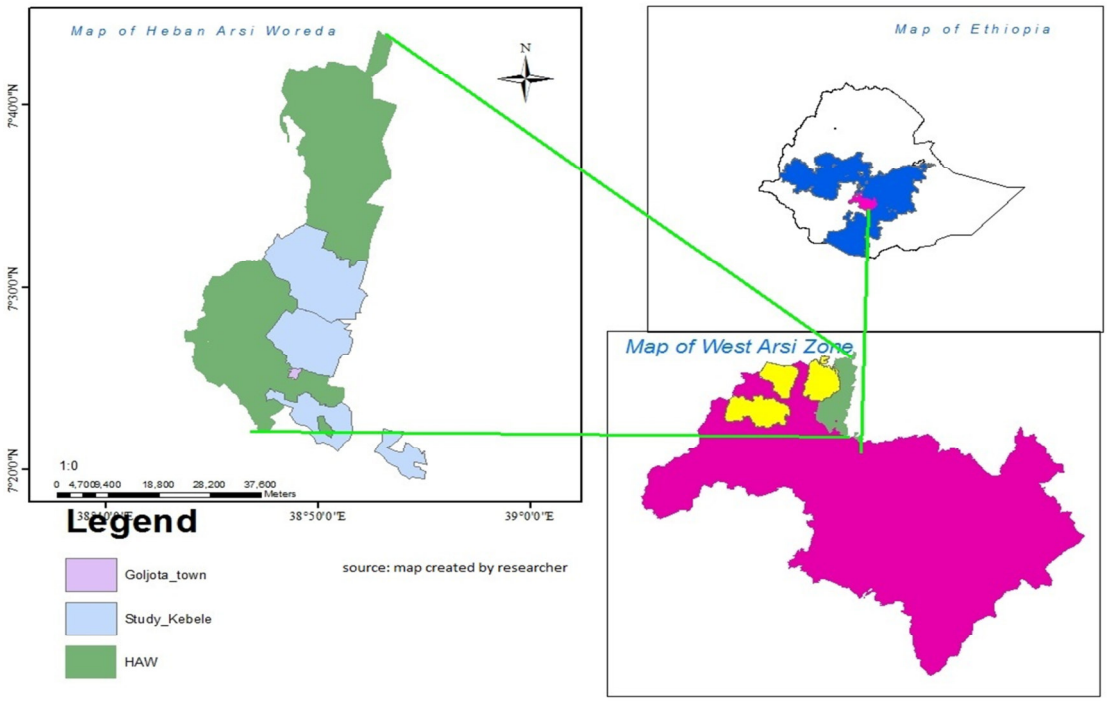

Figure 1: Map of the study area

Relief, Drainage, Climate and soil

The topographic feature of Heban Arsi District is mostly flat and undulating landscape. This District is characterized mostly by major three local climatic zone such as *badda-daree* (is the immediate zone where huge number of the population settled), *baddaa* (cool highland area) and rarely coverage places of *gammoojjii* (kola or lowland) agro-climatic zones. These agro-ecological zones differ in altitude and in rainfall distribution.

The rainfall distribution is bimodal type, with the short rainy seasons that starts from March to May while long rainy season starts from July to October.

The annual average rainfall of the study area is 825mm (ranges from 500 to 1150 mm) and the mean annual temperature is 19^oC (ranges from 10^0c to 27^0c) (HADADO, 2016). The dominant soil type of the District (study area) is largely derived from volcanic activities in the rift valley. The soils of the study area are characterized as Mollic Andosols (Mulugeta, 2004).

Relief: - the known mountains in the district are Kuke (1,815m), Chorora (1,455m) and Bultum (1,140m). The highest elevation is 1,815m while the lowest elevation is about 1,300m (HADADO, 2016).

Drainage: - The known rivers draining in the district are Gedemso, Guracho, Delale and Lepis also pass through the district). Lake Langano also found in the district (HADADO, 2016).

Soils

The dominant soil type of the District is largely derived from volcanic activities in the rift valley. The soils of the study area are characterized as Mollic Andosols (Mulugeta, 2004). Principally there are two types of soils in the district. These are nitosoil "*Biyyee Diimaa*" and vertisol "*biyyee" guraacha'* (HADADO, 2016).

Nitosoil: - Found on sloppy areas as well as flat areas and less fertile as compared to vertisols. It is suitable for growing crops such as teff, wheat, maize, barley, pea, bean and sorghum. It has got a good drainage and gives good yield with fertilizers. It is moderately susceptible to erosion. Nitosoil covers about 40% of the total area of the district (HADADO, 2016).

Vertisols: - Mostly found on flat areas. It has got high percentage of organic matter. It has no as such water logging problem. It is suitable for growing crops such as teff, vetch and chick pea.

Vegetation

The physical conditions and variations in altitudes have resulted in a great diversity of climate, soil and vegetation which in turn caused the evolution of different plant species with large diversity. Before 20 years ago, the District was substantially covered with natural forests (HADADO, 2016). But today, that is only history and much of the area, including farmlands and home gardens are covered by planted forests and woodlots. The District is covered by 19.19% forest area out of the total land area including natural forest, community forest and private forest (HADADO, 2016).

Population and Agricultural activities

Heban Arsi District has a total of 75831 people who are settled and organized under 12 Districts. From those 41103 of them are male and 34728 females (CSA, 2007). The population density of Heban Arsi District is about 213 persons per square kilometer (CSA, 2007). The major agricultural activities in the district are crop production and livestock rearing in the form of mixed farming system. Maize, wheat and barley are the most widely grown cereal crops in the district (HADADO, 2016).

Livestock and health services

In 2012, Heban Arsi district had livestock population of 165,846 heads, out of which 43,812 were cattle, 60,980 were goats, 19,102 were sheep, 982 were horses, 619 were mules and 62,143 were poultry (HADADO, 2016).
The major livestock feeds in this district are natural grazing, hay, crop residues and local beer by-products. The known livestock diseases that exist in the district are blackleg, pasteurellosis, anthrax, rabies, and lamp, external and internal parasites of cattle, internal parasites of sheep and goat, pox, anthrax and rabies of equine. Concerning the availability of veterinary services, up to the end of 2012, there was 1 clinic and 3 health post in the district. The number of health personnel in the district was 3 health assistant and 6 technicians in 2012 (HADADO, 2016).

Methods of Data Collection

Site selection and sampling design

In order to get appropriate and relevant information, the structured questionnaire was developed and translated in local language (Afan Oromo). Then structured questionnaire interview, field observation and focused group discussion was used to collect data by the investigators and field assistants on the identification of medicinal plants, current conservation status, local name of medicinal plants, factors affect the conservation status of medicinal plant species, management techniques and parts of plants mainly collected (used to treat disease).

The key informants were selected using a snowball sampling method (Patton, 1990 as cited in Assegid Assefa and Tesfaye, 2014) in which known traditional healers were contacted and each asked to name another person with similar knowledge.

Field visits were carried out with the traditional healers to observe and collect medicinal plant species reported. Sample specimens of each medicinal plant species were collected during the field visits.

The collected specimens was identified through flora of Ethiopia and Eritrea (Hedberg *et al*., 2006), useful trees and shrubs for Ethiopia (Azene *et al*., 1993), researcher experience and by asking other experts.

Household Survey

It is survey technics where a semi- structured interview was used with both closed and open-ended questions. So that producing relevant information from respondent's regarding demographic data, traditionally known medicinal plant, species of plants' responsible treatments, parts of plants mostly used as medicine and conservation practiced. An interview was administered by two assistants and one researcher.

Focused group discussion (FGD)

In order to summarize household survey, Focus group discussion is essential and support to obtain valuable and

detail information, because it is difficult to collect information only through household survey regarding overall information. It was held with randomly selected informants in each district through appropriate Checklists.

Market Survey

For identification and record medicinal plants values beyond medicine market survey was carried out and medicinal plants sold in the market was observed. Then the detail information was gathered from buyer and seller of traditional medicinal plants and described economic benefits that indigenous people obtained from medicinal plants in the Study area

Figure 2: Market survey in Goljota and Shopa market (Researchers, 2017)

Sample Size

To carry out the present study, three districts out of nine rural districts, namely Degega, Argada-Shaldo and Shopa-guenet was selected as representatives by the purposive sampling techniques based on vegetation cover, ethnic composition and Indigenous knowledge of the traditional medicinal plants.

Following to the study site selection, Total households of each districts around most vegetation cover area or forest was selected based on the following formula; $n = \frac{NP(1-p)}{(N-1)(d/Z\alpha/2)^2 + P(1-P)}$

Where, n = number of sample size;

N= Total number of households in selected districts,

Z α/2 = from the table of standard normal distribution (Scheaffer *et al*., 2012).

α = level of significance;

P= expected proportion (80%, P=0.8, Abebe and Ayehu, 1993; Tadesse *et al*., 2005; Bekele, 2007) and

d= precision (10% of p, then d= 0.08, Suresh and Chandrashekara, 2012).

Then calculated representative sample size were 102 households, when non-respondent 10% (10), this means out of total respondents 10% not respond to ethnobotanical information, and the actual sample size were 112. Selected key informants were 18 from selected districts. Totally 130 informant households were selected for the study.

Out of house hold, key informants were selected by the snowball method in order to identify the traditional healers (key informants) from the total selected informants (Patton, 1990 as cited in Assegid and Tesfaye, 2014). Key informant is a person who is knowledgeable about the previous and current conservation status of traditional medicinal plants of the area, well experienced and well known by local community. During the selection, 6 farmers was selected from each districts through snowball method and individual farmer was asked to give the name of six (6) KIs depending on the above definition. Out of the mentioned thirty six (36) KIs, the top ranking 6 KIs was selected from the total informants (n=36, where $n_{=KI}$). Finally, 12 informants from each district and totally thirty six (36) informants were selected as a representative for the present study.

Table 3 Household population and Sample size of the study area

Districts	Total number of households	Sampled households	Sampled key informants	Total of informants
Shopa bultum	1131	45	6	51
Degega	848	34	6	40
Argada	823	33	6	39
Total	**2802**	**112**	**18**	**130**

Ethnobotanical data collection

Ethnobotanical data were collected from December 20, 2016 to February 20, 2017 on two field trips made to the site. First field trip was to collect primary ethnobotanical data. The second field trip was conducted in order to confirm ethnobotanical information and to request people participated in study to indicate the wild plants they used to treat human and livestock aliments (Martin, 1995; Cotton, 1996). Accordingly, semi-structured interviewees, focus group discussions, and guided field walks with informants were employed to obtain IK of the local peoples on health, vegetation, land forms and soil types.

Semi-structured interviews were conducted based on a checklist of questions prepared beforehand in English, and translated to local language "*Afaan Oromoo"* Semi-structured interviews were held in "*Afaan Oromoo*" directly.

Information regarding local names of MPs, plant part(s) used, methods and conditions of preparation, diseases treated, dosage used, route of administration, and uses other than medicinal values, threats and conservation practices to MPs were recorded at the spot (Figure 4). Observations were made on the morphological features and habitats of each MP species in the guided field walk.

Three focus group discussions undertaken in three agro climatic zones with household respondents which have 6 members were conducted to understand indigenous classification of agro climatic zones, MP uses; factors threaten MP species and conservation practiced.

Figure 3: Interview with key informants in study area (Researchers, 2017).

Plant specimen collection and identification

At the end of the interview, the reported MPs were collected from natural vegetation and home garden. Plant identification was performed both in the field, and Preliminary identification was done in the field and collected, numbered, pressed and dried. Identification of plant specimens with experts was done using identification keys

and published materials such as the Flora of Ethiopia and Eritrea.

Data Analysis

Descriptive statistics

Descriptive statistics such as percentage and frequency were employed to summarize the data on MPs use and associated IK. The information gathered from local people such as medicinal value, application, methods of preparation, routes of administration, disease treated, parts used and growth form, the indigenous agro climatic variation of MPs and associated IK were summarized using descriptive statistics. To make summary calculation, to draw bar graphs and pie-charts MS Excel spreadsheet 2010 Used.

Statistical Package for Social Science (SPSS) Version 20 was used to summarize Pearson correlation relationship between age of respondents and levels of education in relation with number of species cited and compare mean t-test between male and female, and traditional healers and household respondents.

Informant consensus

Informant consensus factor (ICF) was calculated for each category to identify the agreements of the informants on the reported cures for the group of ailments. The ICF was calculated as follows: 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 (Heinrich *et al*., 1998). ICF values range from 0.00 to 1.00. High ICF values are obtained when only one or a few plant species are reported to be used by a high proportion of informants to treat a particular ailment. Low ICF values indicate that informants disagree over which plant to use (Canales *et al*., 2005).

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

Where: ICF: Informant consensus Factor
nur: number of use citation
nt: number of species used

Preference ranking

Preference ranking was conducted to rank some selected MPs based on degree of their effectiveness in treating febrile illness human disease and blackleg livestock disease. Following the methods of Martin (1995), key informants were asked to think; order and rank the MPs based on their personal preference, community importance, or any other criteria set by him/her and this helps to indicate the most effective MPs used by the community to treat diseases.

Each rank was given an integer value ranging from 1-7 and the most effective one was given the highest value seven, while the least important was assigned a value of one. Finally, all these values were summed up and ranks given to each plant species accordingly.

Paired comparison

Paired comparisons can be used for evaluating the degree of preference or levels of importance of selected plants. This method was used to find out the efficacy and popularity of MP species used to treat disease following the procedure described by Martin (1995). Key informants were showed their responses independently for pairs of MPs that were noted for treating snake bite disease. A list of the pairs of selected MPs with all possible combinations were made and sequence of the pairs and the order within each pair were randomized before every pair is presented to selected key informants. Then their responses were recorded. The total value summed and the rank was made based on the total score of the key informants. Accordingly, the plant that gets the highest score was the most popular for treating a snake bite disease.

Direct matrix ranking

Direct matrix ranking was conducted in order to compare multipurpose MPs commonly reported by informants following Cotton (1996). Based on the relative benefits obtained from each MP, multipurpose MPs species were selected out of the total MPs and use diversities of these plants were listed. Key informants were chosen to assign use values to each attribute (5=best, 4=very good, 3=good, 2=less used, 1=least used and 0=not used). Based on information gathered from key informants, average value of each use-diversity for a species was taken and the values of each species were summed up and ranked.

RESULTS AND DISCUSSION

Characteristics of Sampled Households in Heban Arsi District

Sample household respondents selected from three different agro climatic zones highland (29.41%), midland (30.39%), and lowland (40.19%) proportion to number of households in districts. Out of the total samples, 80 of

them were male and 22 were female headed household respondents selected randomly from households of districts. Concerning age, 29 household respondents were in the age ranges (<40 years) while 73 household respondents were in the age category of (≥40 years) age. Most of household respondents were married (85.29%) and Illiterate (unable to read and write) (80.39%) as shown in Table 2. Age classification was similar with Giday *et al*. (2003).

Table 4 Characteristics of household's respondents

Characteristics	Class	Frequency	Percentages (%)
Agroclimaitc zones	Highland	30	29.41
	Midland	31	30.39
	Lowland	41	40.19
Gender	Male	80	78.43
	Female	22	21.57
Ages	<40	29	28.43
	≥40	73	71.57
Marital Status	Single	2	1.96
	Married	87	85.29
	Widowed	7	6.86
	Divorced	6	5.88
Educational level	Illiterate	82	80.39
	Literate	20	19.6

Knowledge of Local People on Agroclimatic Zones, Vegetation's and Landscapes

Local classification of agro climatic zones and associated indigenous knowledge

Local people in Heban Arsi district classified the agro climatic zones of the district into three major categories based on climate and elevation characteristics. These agro climatic zones were:

Baddaa /Highlands/- This agro climatic zone was found between altitude ranges of 2400masl to 2900masl in the study area. It was characterized by relatively cool and dry climate with unimodal type of rain fall where rain fed agricultural production were reported the main economic activity. The major crop varieties reported in this agro climatic zone were wheat, barley, peas, beans and potato.

*Badda Daree/*Midlands/- This agro climatic zone lay within altitudinal range of 2100maslto 2400masl in the study area. It was characterized by relatively warm and dry climate with unimodal rainfall where both rain fed agriculture and small scale irrigation based production systems were the main agricultural activities. The reported main crop varieties of this agro climatic zone were wheat, teff, beans, peas and maize.

Gammoojjii/Lowlands/- Refers to agro climatic zone lying between altitude ranges of 1600masl to 2100masl in the study area. The climate of this agro climatic zone was relatively hot and dry. Rain fed agriculture and cattle rearing were the main agricultural activities of the area. The dominant crop varieties in this zone were teff, sorghum and maize.

Local categories of vegetation and associated knowledge

Locally wild vegetation classified as: *Marga (Citaa), Hadaa, Hamoocaa, Bosona* and *Caffaa* depending on the size, growth form of the plants as well as the services they provide.

Marga (Citaa) - Grass and its associated herbaceous plants that were fed by grazing animals.

Hadaa- Small shrubby or non-shrubby plants usually in farmlands and associated habitats

Bosona- Forests with herbaceous and woody layers understory. Such vegetation category was at decreasing rate and scattered forest available in district.

Hamoocaa- herbaceous and woody vegetation category refers to impenetrable complex plant associations usually in the wild seen around valley.

Caffaa- Refers to herbaceous and grassy types of wetland vegetation that is evergreen throughout the year as well as those lands that become swampy following rainy season.

Local categories of landscapes and associated knowledge

The local people also classified landscapes based on the topography and elevation of the land. The major classes of landscapes were: *watara* (Plain), *Sulula* (Valley), *Ilaala* (Hill), *Tulluu* or *Gaara* (Mountain), *Hallayyaa* (Cliff), *Caffaa'aa* (Swampy), *Ededa* (River banks).

Depending on the soil characteristics and fertility of land the local people categorize land as: *Diimilee* (red soil), *Cirracha* (sandy soil) and *kosii* (fertile soil). Lands were also classified based on the services they provide as *Lafa Qonnaa* (agricultural land), *Lafa Margaa* (grazing land) *a*nd *Lafa coccodhaa* (infertile land or unproductive).

Medicinal Plants in Heban Arsi District

A total of 124 MP species (Appendix 6) belonging to 117 genera and 63 families were identified in study the area. The number of MP species reported were higher than that of recorded to the Debre Libanos district by Getaneh and Girma (2014) where 83 MPs were identified but, less than the studies carried out around Fiche district by Enyew *et al*. (2014) who reported 155 MP species. This observation shows that the local peoples in Heban Arsi district have relatively extensive knowledge of how to use plants as medicine against different diseases. Out of the reported MPs, 59 species were also reported by Enyew *et al*. (2014) and 37 species were reported by Getaneh and Girma (2014).

Table 5 Distributions of MP species in different family

Families	Number of MP species	Percentages (%)
Fabaceae	13	9.56
Asteraceae	11	8.09
Lamiaceae	8	5.88
Solanaceae	8	5.88
Euphorbiaceae	6	4.41
Asparagaceae	3	2.21
Brassicaceae	3	2.21
Malvaceae	3	2.21
Moraceae	3	2.21
Myrtaceae	3	2.21
Polygalaceae	3	2.21
Ranunculaceae	3	2.21
Rubiaceae	3	2.21
Rutaceae	3	2.21
Verbenaceae	3	2.21
Others 48 families	1 or 2 each	44.28

Sources: Researcher's Data

With regard to plant family, Fabaceae was the most popular to the area and, were represented by 13 species (9.56%) and followed by Asteraceae 11 species (8.09%), Laminaceae 8 species (5.88%) and Solanaceae 8 species (5.88%) as shown in (Table 3).

The finding agrees with other studies in Ethiopia and other countries (Lulekal *et al*., 2008; Assefa and Abebe, 2014; Awang *et al*., 2014; Kewessa *et al*., 2015; Mekuanent *et al*., 2015; Alebie and Mehamed, 2016; Kebebew, 2016; Tugume *et al*., 2016), in which Fabaceae was the dominant.

Other than the listed MPs, local people in Heban Arsi district responds that they have cultural and spiritual related MP harvesting day, starting first September they believe that all plant species harvested in this day used for treatment of ailments. They call MPs harvested in this day as "*Qorichaa Birraa*" especially reported to be used to treat febrile illness. MPs collected on this day are kept under the roof of house and used for one year. According to study by Enyew *et al*. (2013) is that those plants are harvested in same period and sold in market. However, in Heban Arsi district not traded, every household harvest it and reported to share between neighborhood households.

Out of the total identified MPs 55 (44.35%) species were reported to be used to treat human ailments only, 19 (15.32%) species used to treat livestock ailments only and 50(40.32%) species to treat both human and livestock (Table 4). This result indicates that most of MPs used for human's ailments as reported by different authors in MP studies carried out elsewhere (Lulekal *et al*., 2008; Bekalo *et al*., 2009; Mesfin *et al*., 2009; Enyew *et al*., 2014; Getaneh and Girma, 2014; Kassa *et al*., 2016).

Table 6 Medicinal plants used to Cure Humans, Livestock and both exclusively.

Types of Animals Cure	**Number of medicinal plants used**	**Percentages (%)**
Human	55	44.35
Livestock	19	15.32
Both	50	40.32

Sources: Researchers data

Use of diverse number of MPs reported from different agro climatic zones of the district. The highest number of MPs were reported in Degega District (54 species), followed by shopa_Bultum (40 species) and the least number of MPs in Argeda district (27 species) were used (Table 5).

Most of MPs were collected from the wild (especially from border of kuke and Shopa_Bultum district particularly those species favorable for high rainfall and low temperature) that collection of MPs not limited to the districts they live in, they also harvest from other districts in the district. MPs collected from Argada mainly collected in the morning because in most cases the plants were obtained from far distances, secondly early in the

morning snakes could not be encountered due to low temperatures and thirdly they believe that those medicinal plants effective only when they were collected in the morning and they reported that they culturally prefer only Tuesday and Saturday morning and this contrast with work of (Okello *et al*., 2010).

Table 7 Number of MPs used in the three agroclimatic zones in Heban Arsi district

Name of Districts	Number of plants	Percentages(%)
Argeda	27	22.31
Degega	54	44.63
Shopa_Bultum	40	33.06

Sources: Researchers data

Habitat and Growth form of Medicinal Plants in Heban Arsi District

Of the total 124 MP species (77 species, 62.09%) were collected from wild alone, (20 species, 16.13%) were collected from both home garden and wild, (15 species, 12.09%) were collected from home garden alone and (12 species, 9.7%) were collected from farmland. This finding agrees with the Kassa *et al*. (2016); Fenetahun and Eshetu (2017) in which most of MPs were collected from the wild than home garden and farmland (Figure 5). The finding shows that local people in study area mostly depends on wild sources than home garden and farmland to obtain MPs.

This indicates that negative influences on MP species that consequence to over-harvesting from wild and less conservation done for them and not as that of MPs in home garden, finally cause to shrinking MP species. But, the activity of cultivating MPs in home garden and farmland was also not bad because the number of MPs obtained in home garden and farmland was also satisfactory

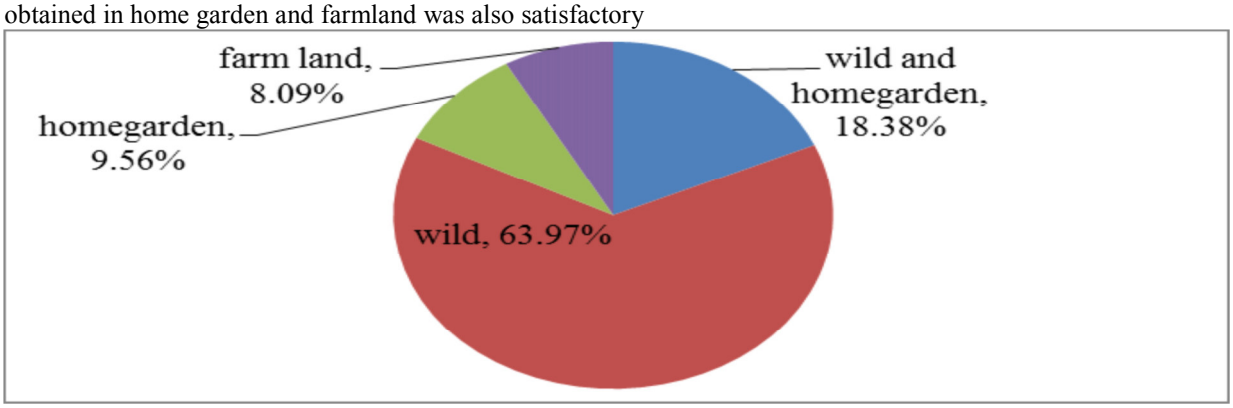

Figure 4: Habitat of MPs in the study area

Among the 124 MP species recorded from the study area the highest representation was for herbs, which accounts for 51 (37.50%) species, followed by trees 50 (36.76%) and the least was liana, which for 1(0.74%) species. This finding agrees with previous studies by Awas and Demissew (2009); Enyew *et al*. (2014); Kebede *et al*. (2016) who reported dominance of herbs for medicinal purpose (Figure 6).

This could be related to the fact that these species exhibit high level of abundance and easy to obtain them, because herbs form of MPs easily available in home garden and forest patches.

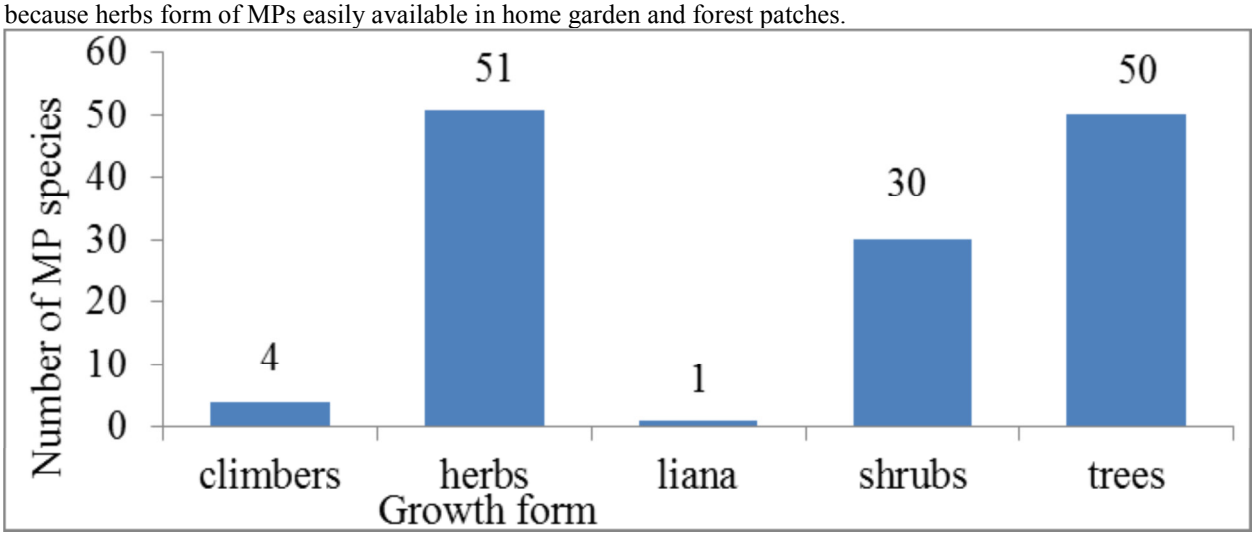

Figure 5: Growth form of MPs in the study area.

Parts used, Mode of Preparation, Routes of Administration and Dosage of Medicinal Plants

Medicinal plant parts used

Indigenous People in Heban Arsi district were used different part(s) of MPs for preparation of medicines to treat human and livestock aliments. Root parts were of MPs was the most frequently reported to be used in study area (35 species, 25.74%), followed by leaves (33 species, 24.26%), roots and leaves (13 species 9.56%), seeds (12 species, 8.82%) and others (Figure 7). Other finding in Ethiopia and other countries also approve that root parts of MPs mostly used for TM preparation (Lulekal *et al*., 2008; Limenih *et al*., 2015; Okello *et al*., 2016). However, the uprooting of plants effect mother plant, it finally causes totally death of plants. Excessive use of leaves also has negative affect on survival and regeneration of MPs, but not as much serious as that of damaging as such plant species their root, bulb, stem and bark used.

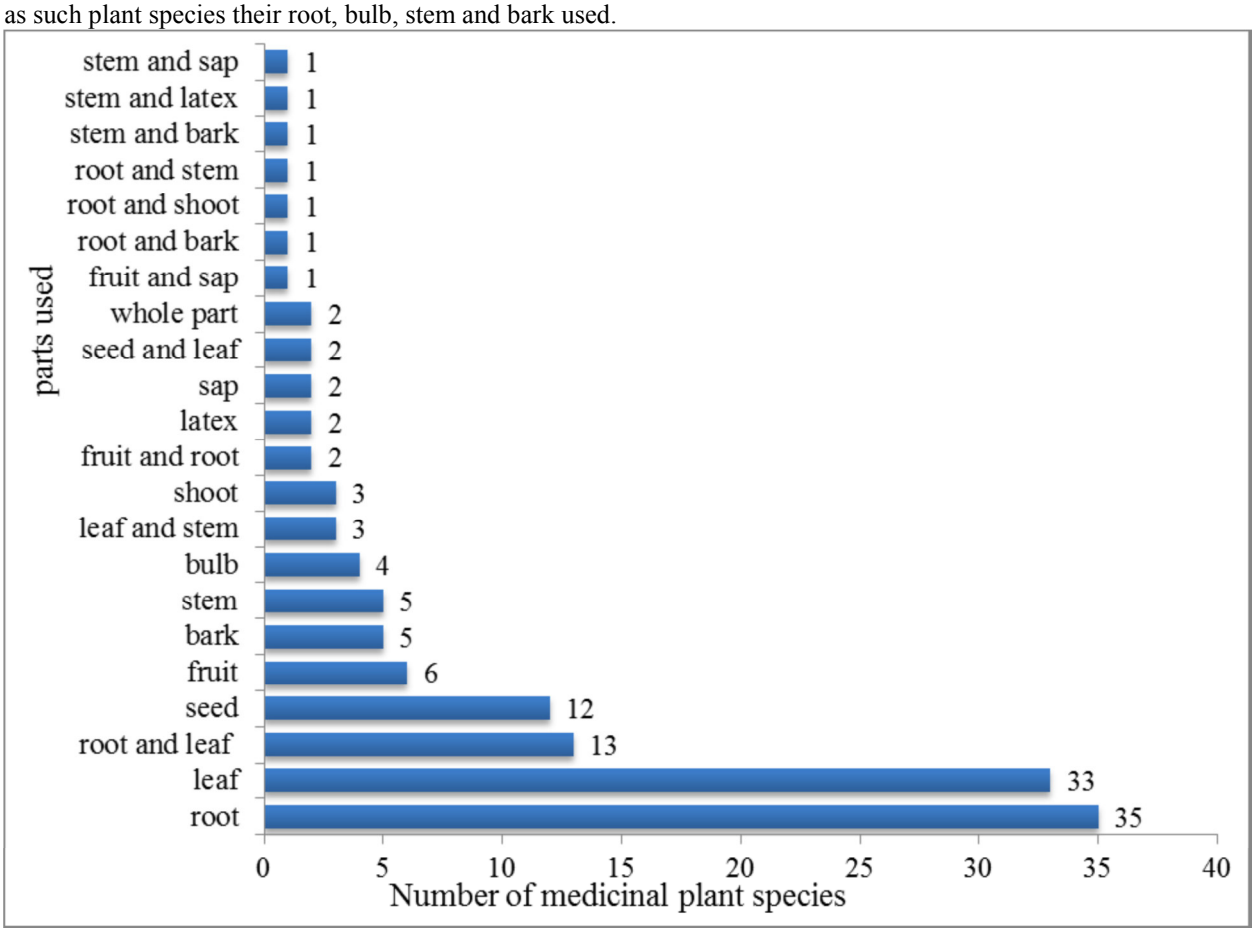

Figure 6: Plant parts used for preparation of medicine in the study area.

Mode of preparation of medicinal plants for remedies

In Heban Arsi district, diversified modes of preparation were used to remedy human and livestock aliments. The major modes of preparation were crushing (17.65%), pounding (16.91%), powdering (13.97%), squeezing (5.88%), chewing (5.15%), pounding and powdering (4.41%) (Figure 8) This is similar with the works of Yirga (2010) that most of the preparation was done by crushing. The preparation and application methods vary based on the types of diseases treated and the actual site of ailments. The majority of the preparations were made from the mixtures of different plant species with water and different additive substances like honey, sugar, butter, salt and milk. These additive substances have different functions i.e. to reduce poisons, improve flavor and as antidotes during adverse effects such as vomiting, skin rash and diarrhea.

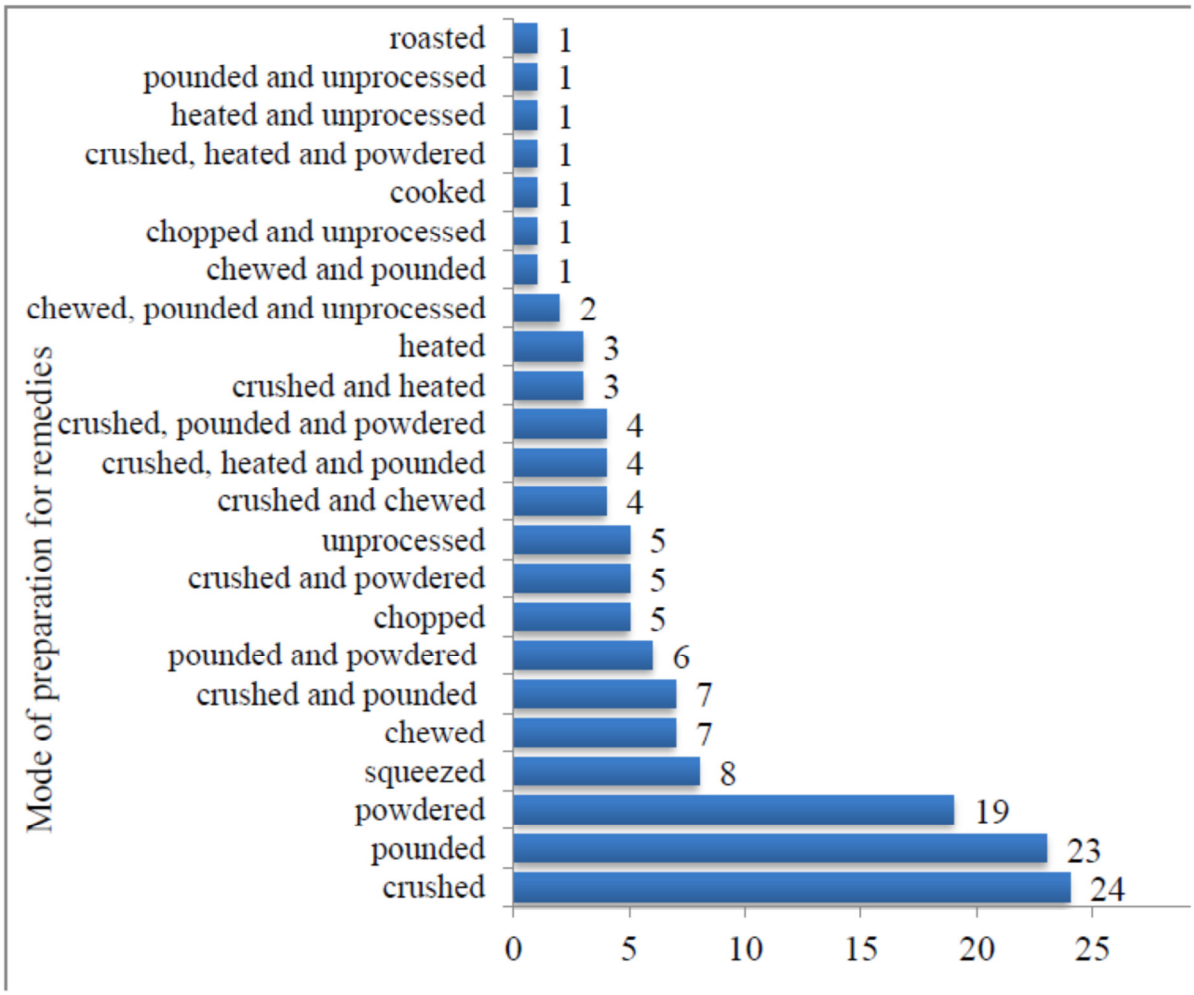

Figure 7: Mode of preparation of medicine to treat both human and livestock in the study area

Routes of administration

There were various routes of administration of herbal remedies to treat human and livestock aliments. The major routes of administration used in the study area were oral only (30.88%), dermal only (14.71%), nasal and dermal (11.76%), nasal only (8.09%), dermal and oral (5.88%), dermal, nasal and oral (4.41%). Oral application of remedies was popular as others finding reported by (Mesfin *et al*., 2009; Zerabruk and Yirga, 2012; Alebie and Mehamed, 2016).

Both oral and dermal routes permit quick physiological reaction of the prepared medicines with the pathogens and increase their curative powers.

Conditions of preparation and dosage of medicinal plants

The conditions of preparation of MPs for remedies in the study area were fresh (71 species, 52%), dry (37 species, 27%) and fresh or dry (28 species, 21%) shown on Figure 9. This finding similar with other ethnobotanical studies in Ethiopia by Yineger *et al*. (2007); Mohammed *et al*. (2016), that most of MP species prepared in fresh condition. The frequent use of freshly processed remedies could imply the accessibility of MPs in the locality and high curative power of fresh preparations.

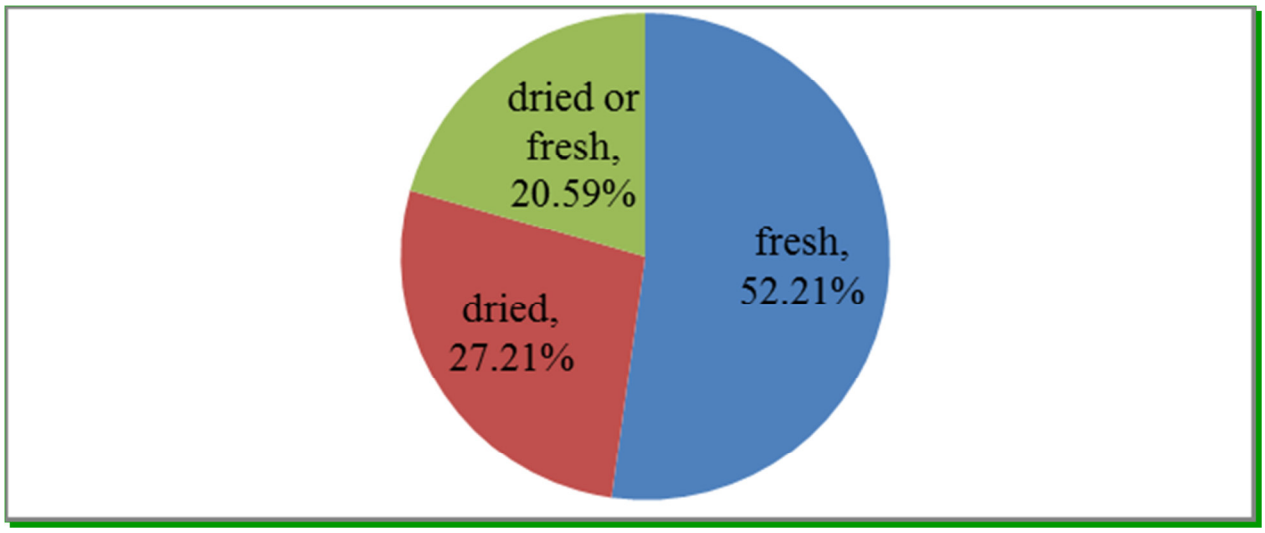

Figure 8: Form of preparation of medicine to treat human and livestock in the study area

In the Heban Arsi district different units of measurements and the duration of administration used to determine the dosage. There is no uniformity with regard to the dosage of the medicine between the different THs and local peoples (use by themselves) for same disease, though all the THs and local peoples agree on the point that the dosage given for patients vary with age and physical strength. They do also agree that some medicines are not allowed to be taken by women when pregnant. In general, the dosages of TM to be administered for certain duration were given by estimating the age, physical strength of the patient and the severity of the diseases. Amounts to be administered was estimated by the use of measurements such as length of a finger (for bark, root and stem), coffee and tea cup (for powdered plant material) and number count (for sap/latex drops, leaves, seeds, fruits and bulbs). Recovery from the disease, which usually is determined by the disappearance of disease symptoms, is a criterion that the local peoples of the study area consider to determine the duration of using the medicine.

This agrees the other ethnobotanical studies in Ethiopia Lulekal *et al*. (2008); Kalu and Seid (2014) that the major drawback in practicing traditional MP for human and livestock aliments is lack of precision and standardization.

Marketed Medicinal plants

Table 8 reported marketability of MP species.

Botanical Name	Uses	Botanical Name	Uses
Aframomum corrorima	Spice	*Hordeum vulgare*	Food
Allium sativum	Spice and food	*Juniperus procera*	Furniture
Brassica carinata	Food	*Lepidium sativum*	Medicine
Brassica nigra	Medicine	*Linum usitatissimum*	Food
Capsicum annuum	Food	*Nicotiana tabacum*	Psychoactive
Catha edulis	Psychoactive	*Nigella sativa*	Spice
Citrus limon	Food	*Olea europaea subsp. Cuspidate*	Firewood and medicine
Coffea Arabica	Drinking	*Pisum sativum*	Food
Cordia Africana	Furniture	*Rhamnus prinoides*	Spice
Croton macrostachyus	Furniture	*Ruta chalepensis*	Spice and medicine
Eucalyptus globulus	Firewood and construction	*Sesamum angustifolium*	Food
Ficus vasta	Furniture	*Vicia faba*	Food
Guizotia abyssinica	Food	*Zingiber officinale*	Spice

Sources: Researchers data.

Market survey results obtained from Goljota (Saturday) and Lammaffoo (Tuesday) market indicates that MPs were not widely sold at market for medicinal purposes, but for other purposes as shown on Table 6. This finding was similar with that of Giday *et al*. (2009); Mesfine *et al*. (2014) who reported that most of the MPs are not traded at market rather collected from environment when needed. The likely reasons behind that the local people prefer either immediately collecting these plants by themselves from the available areas in the district to prepare the medicines or they prefer to go directly to the THs to get treatments instead of buying the MPs from the market.

Ranking of Medicinal Plants

Informant consensus

In Heban Arsi district medicinal plants (MPs) which were popular due to the wide range of diseases they treat and commonly used are well known by the local peoples and THs. Certain species were independently cited by many of the informants for their medicinal uses to treat human and livestock ailments. The results of the study showed that some MPs were popular than others and highest informant consensus goes to *Ocimum lamiifolium* was cited by 21 informants (16.15%). The finding agrees with other work reported by Getaneh and Girma (2014) that *Ocimum lamiifolium* cited by highest number of respondents. The popularity of this MP was due to the preference of the species for treating febrile illness in the community rather than going to modern medication for the disease and its easy access in the home gardens of many people. *Otostegia integrifolia* cited by 16 informants (12.3%), *Lepidium sativum* cited by 14 informants (10.77%), *Croton macrostachyus* cited by 12 informants (9.23%), *Justicia schimperiana* cited by 12 informants (9.23%), *Allium sativum* cited by 11 informants (8.46%) and others were cited by ten and more than ten respondents as shown in Table 7. Popularity of those MPs was due to access as a result everybody had the chance to see the treatment with minimum secrecy of plants.

Table 9 List of MPs corresponding to informants (citied by ≥ 10 informants)

Botanical name of MPs	**Number of informants**	**Percentage of informants (%)**
Ocimum lamiifolium	21	16.15
Otostegia integrifolia	16	12.3
Lepidium sativum	14	10.77
Croton macrostachyus	12	9.23
Justicia schimperiana	12	9.23
Allium sativum	11	8.46
Solanum incanum	11	8.46
Cucumis dipsaceus	11	8.46
Withania somnifera	11	8.46
Eucalyptus globulus	11	8.46

Sources: Researcher's data

Informant consensus factors (ICF)

Diseases treated by MPs reported in Heban Arsi district were grouped in to different categories based on the site of occurrence of the disease, condition of the disease as well as treatment resemblance of the disease. The informant consensus factors were calculated for each category (Table 8). In this study, the informant consensus of MP usage resulted in ICF ranging from 0.51 to 0.84 per disease category.

Table 10 Informant consensus factors (ICF).

Diseases category	Number of MP species	Use citation	ICF
Headache related diseases	37	99	0.63
Evil	27	61	0.57
Stomach related diseases	39	78	0.51
Wound	13	40	0.69
Diseases affect both human and livestock	18	53	0.67
Skin affecting diseases	40	123	0.68
Cattle diseases	26	69	0.63
Sensor organ diseases	29	90	0.69
Livestock diseases other than cattle diseases	7	32	0.81
Anemia	4	20	0.84
Reproductive organ related diseases	14	46	0.71
Swelling related disease	7	24	0.74

Sources: Researcher's data

As shown on Table 8, the ailments Anemia scored the highest value (0.84) followed by livestock diseases other than cattle diseases where scored the second highest value (0.81). This similar with finding of (Tugume *et al*., 2016) that Anemia disease scored highest ICF in Mabira Central Forest Reserve, Uganda. This indicates that informants use relatively few taxa to manage specific disease conditions as well as consistency in the use of plant species.

MPs used to treat those ailments were more popular and effective to cure the ailments, and the ailments were more common than the others in the area. Low value of ICF indicates that the informants disagree on taxa

to be used in the treatment within a category of illness. In this study the lower ICF value was scored (0.51) for the category of diseases like Stomach related diseases. This category may be indicative for lack of consistency in the use of MP species in the study area.

Preference ranking of human and livestock disease

When there are different species prescribed for the same health problem, people show preference of one over the other. Preference ranking of 7 MPs that were reported for treating febrile illness human disease and 7 MPs that were reported for treating blackleg livestock disease were conducted after selecting 10 key informants separately. Febrile illness was most frequently reported human disease in the study area. The key informants were asked to compare the given MPs based on their efficacy, and to give the highest number (7) for the MP which they believed most effective in treating febrile illness and the lowest number (1) for the least effective MP in treating febrile illness. *Ocimum lamiifolium* which scored 57 and ranking first indicating that it was most effective in treating febrile illness and followed by *Otostegia integrifolia* which scored 52 and ranking second; the least effective was *Allium sativum* (Table 9). Similar finding was reported by Kassa *et al*. (2016) that *Ocimum lamiifolium* ranked first to treat fever human disease in Degega and its surrounding areas of Goljota.

Table 11: Preference ranking of MPs used to treat febrile illness human disease.

MP species	Key informants labeled 1-10										Total	Rank
	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}		
Allium sativum	1	3	2	4	2	2	3	4	5	1	27	7th
Croton macrostachyus	3	5	5	4	3	2	3	2	3	5	35	4th
Justicia schimperiana	2	3	2	3	3	4	3	5	2	2	29	6th
Lepidium sativum	5	3	6	7	3	4	5	4	3	5	45	3rd
Ocimum lamiifolium	5	6	5	5	7	7	6	5	5	6	57	1st
Otostegia integrifolia	5	5	4	6	6	4	5	5	6	6	52	2nd

Sources: Researchers data

Blackleg was the most frequently reported livestock disease in the study area. The key informants were asked to compare the given MPs based on their efficacy, and to give the highest number (7) for the MP which they believed most effective in treating blackleg and the lowest number (1) for the least effective MP in treating blackleg. *Croton macrostachyus* scored 45 and ranking first indicating that it was most effective in treating blackleg and followed by *Embelia schimperi* which scored 34 and ranking second; the least effective was *Solanum incanum* (Table 10). Limenih *et al*., (2015) also reported that *Croton macrostachyus* ranked first to treat malaria disease in Dega Damot Woreda, Amhara region, North Ethiopia.

Table 12: Preference ranking of MPs used to treat blackleg livestock disease.

MP species	Key informants labeled 1-10										Total	Rank
	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}		
Croton macrostachyus	3	5	5	4	3	6	3	5	6	5	45	1st
Cucumis dipsaceus	2	2	1	2	3	1	2	2	2	3	20	6th
Embelia schimperi	3	3	2	5	3	4	3	5	2	4	34	2nd
Lepidium sativum	2	3	3	2	3	2	2	3	3	2	25	4th
Scadoxus multiflorus	2	3	2	2	3	2	3	3	2	2	24	5th
Solanum incanum	2	2	1	2	2	1	2	1	2	2	17	7th

Sources: Researcher data

Pairwise comparison

In this study, ten key informants were selected to indicate the efficacy and popularity of these six MPs species reported to treat Snake bite disease, and pairwise comparison was done for those species (Table 11). *Calpurnia aurea* ranked first followed by *Ekebergia capensis, Allium sativum* and *Stereospermum kunthianum* respectively. *Schefflera abyssinica* and *Verbascum sinaticum* were less preferred and less efficacious compared to the other four species.

Table 13: Simple pairwise comparison of six MPs used to treat snake bite.

Botanical name of MP species	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	total	rank
Allium sativum	3	4	4	5	6	3	4	3	4	4	40	3rd
Calpurnia aurea	5	6	6	6	5	6	6	6	6	5	57	1st
Ekebergia capensis	6	5	3	4	3	4	5	5	3	6	44	2nd
Schefflera abyssinica	2	1	1	2	4	2	2	1	1	1	17	5th
Stereospermum kunthianum	4	3	5	3	2	5	3	4	5	2	36	4th
Verbascum sinaticum	1	2	2	1	1	1	1	2	2	3	14	6th

Sources: Researcher data

Direct matrix ranking

In Heban Arsi district, the majority of the peoples rely on wild plants for various purposes such as construction, fencing, firewood, furniture and medicine. To evaluate the relative importance and to check the major impact on such plants direct matrix ranking was performed. In the area, a number of MPs were found to be multipurpose species being utilized for a variety of uses.

Seven most reported multipurpose species and six use categories were involved in direct matrix ranking with 10 key informants. Respondents evaluate their relative importance to the local peoples and the extent of the existing threats related to their use values. The value for use reports across the selected key informants were summed up and ranked for each species.

The results of the direct matrix ranking revealed that *Cordia africana* ranked first and hence it was the most preferred plant by local peoples for various uses and the most threatened species as the key informants reported, which was evidently shown by its scarce distribution in the area. This scarcity of *Cordia africana* was due to over harvesting for not only medicinal but also for other uses such as furniture and firewood mostly. This finding is in line with Teklay (2015) that *Cordia africana* was most preferred multipurpose plants in Kilte Awulaelo district, Tigray region, Northern Ethiopia.

Ficus vasta, *Croton macrostachyus*, *Eucalyptus globulus*, *Olea europaea cuspidata*, *Juniperus procera* and *Afrocarpus falcatus* ranked 1st, 2nd, 3rd, 4th, 5th and 6th respectively (Table 12).

So, the top ranked species were highly threatened that there was high rate of loss of *Cordia africana* in the study area. Even though the rank was given, all of the species particularly the top ranked ones are under question in their long-term survival, because as the livelihood of some people in the society depends on these species.

Table 14: Average direct matrix ranking of seven commonly used species in study area.

Use diversity / species	*Ficus vasta*	*Olea europaea cuspidata*	*Croton macrostachyus*	*Eucalyptus globulus*	*Afrocarpus falcatus*	*Juniperus procera*	*Cordia africana*
Charcoal	4	2	2	0	4	3	4
Construction	4	4	3	5	3	4	4
Fencing	4	3	5	5	2	3	4
Firewood	5	4	5	5	2	3	5
Furniture	5	5	4	3	5	5	5
Medicine	3	3	5	4	2	2	4
Total	25	21	24	22	18	20	26
Ranks	2nd	5th	3rd	4th	7th	6th	1st

Sources: Researcher's data

CONCLUSION AND RECOMMENDATIONS

Conclusion

In Heban Arsi district several plants are used for medicinal purposes. As compared to other studies much number of MPs and associated IK were reported to be used in study area for human and livestock aliments. The highest numbers of MPs were used in Degega district (midland), but collection was not restricted only to their locality the move other districts to harvest MPs. Most of the MPs were used for human aliments rather than livestock aliments.

Most of MPs were harvested from wild rather than farmland and home garden. Herbs were highly utilized growth forms of MPs than trees, shrubs, climbers and lianas.

Root parts of MPs were highly harvested for remedy preparations, followed by leaves and seeds. Most of the MPs were prepared by crushing their part used and fresh forms were mostly used in the study area. Oral

application was the most commonly used route of administration.

In the study area elders have better knowledge of medicinal plant than younger, while there was negative and significant difference between level of education and number of medicinal plant species cited.

There was significant difference between male and female informants in their knowledge of medicinal plants, and also there was also a significant difference was found between number of medicinal plants reported by key informants and household respondents.

Recommendations

- District's stakeholders should undertake conservation activities for threatened MPs as shown by *Afrocarpus falcatus* regeneration by pruning branches.
- Indigenous knowledge should be encouraged by the districts agriculture and natural resources office to store seed of annual MPs harvested from farmland in their home and conserve threatened MPs in their home gardens.
- Concerned institutes should focus on threatened MP species to encouraging gene bank and botanical garden conservation methods.
- Concerned organization should establish MP nurseries and propagate seedlings of the most-preferred MPs to farmers.
- Recognitions and intellectual property rights should be given by concerned bodies to community for continuity of IK.
- Further investigation is needed to determine multipurpose of MPs in study area.

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