

Ethnomedicinal Study of Plants Used against Human Ailments in Aseko District, South East Ethiopia

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Research

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Abstract

Background

Over exploitation of MPs to treat human ailments in highly populated regions caused by deforestation and agricultural expansion disappearing (MP) species diversity in the areas, MPs Hence, this study was aimed to document and analyze the plant-based ethnomedicinal knowledge of the people in order to preserve the existing indigenous knowledge.

Methods

Ethnobotanical data were collected using semi-structured interview, key informants interview, guided field observations, group discussions & market survey. Quantitative approaches were used to determine Informant Consensus Factor (ICF), pair wise comparison, preference ranking and Fidelity level (FL) values.

Results

A total of 96 medicinal plant species belonging to 89 genera and 66 botanical families were reported to treat human diseases in the Aseko District. Plant Families with the highest number of species were Lamiaceae and Solanaceae, followed by Fabaceae. About 44% of Medicinal Plants (MPs) preparations were reported to be obtained from leaves. Highest ICF values were recorded for gastrointestinal (0.76) & parasitic and febrile illnesses (0.74) indicating best agreement among informants' knowledge on MPs used to treat ailments in these categories. The highest fidelity level values (100% FL) were recorded for *Ocimum gratissimum* L against febrile diseases, *Rubus steudneri* Schw against Asthma and *Podocarpus falcatus* against Intestinal Parasite) for each, showing conformity of knowledge on species of the best healing potential. *Cordia africana* was ranked first in a direct matrix ranking exercise of multipurpose Medicinal Plants. The output of preference ranking exercise indicated that *Urtica simensis* Steudel was the most preferred species to treat gastritis.

Conclusion

The study revealed that Aseko district is rich in MP diversity and associated indigenous knowledge. However, anthropogenic factors (over exploitation) coupled with acculturation threaten the sustainability of MPs in the study area. Promoting a complementary in-situ and ex-situ conservation approach in the District is highly recommendable for MP sustainability.

Background

The great dependency of human upon plants for their livelihoods was primarily started by domestication about 10,000 years ago [1]. According to World Health Organization (WHO), about 70 percent of the world's population relies on plants for their primary health care and some 35,000 to 70,000 species has been used as medicaments, a figure corresponding to 14–28% of the 250,000 plants species estimated to occur around the world [1–3],

Approximately 80% of the worlds' populations from developing countries depend mainly on traditional medicines derived from plant materials [5]. Ethnobotany is the study of "local people's interaction with the natural environment: how they classify, manage and use plants available around them" [1, 2]. Traditional medicine is the sum total of

knowledge, skills, and practices based on the theories, beliefs, and experiences, indigenous to different cultures, which are used to maintain health, as well as to prevent, diagnose, improve or treat physical and mental illnesses [3, 28, 29]. It is practiced throughout the world and depends on locally available of natural resources (e.g., plants) and indigenous knowledge. [4] However, the rich indigenous knowledge on many of the traditional plant remedies is subjected to loss as it has mainly been neither passed orally for generations without being properly nor scientifically documented [7]

Ethiopia is rich in biodiversity resources and TK (Traditional knowledge) [10]. In Ethiopia, MPs have considerable roles in a healthcare system, where 80 percent of human populations depend on medicinal plants for the treatment of different human health problems [6, 7, 8, and 9]. In Ethiopia, both direct and indirect causes of biodiversity loss attracted attention Ethiopia 's commitment to design and implement conservation strategies to save the country 's genetic resources [6]. Such direct causes (drivers) include habitat conversion, unsuitable resource utilization, invasive species, and climate change whereas the indirect drivers include demographic changes (population growth), poverty, and low level of awareness and weak coordination [6].

Ethiopia is rich in biodiversity and known for having many endemic plants. There are 6027 higher plants species, of which 10% are end emic to the Country [11]. This richness in species diversity is associated with the wide ranges of altitude, geographical diversity with high and rugged mountains, flat-topped plateaus and deep gorges, incised river valleys and rolling plains [11]. Although Ethiopian ethnobotanical study of medicinal plant inventories including those of [4, 7–9, 12, 13, 33, 35, 37, 39, 41] have attempted to document medicinal importance of traditional MPs in some cultural groups, though recording of the 85 different ethnolinguistic communities has remained largely unexplored. Therefore, in order to enrich the knowledge of Ethiopia's flora and socio-cultural diversity complete inventory of each ethnic group is highly required.

Accordingly, the present study aimed to fill the knowledge gap by documenting the Traditional Knowledge, utilization, management and conservation of human MPs used in Aseko District, Arsi Zone, Ethiopia. It also aimed to identify the economic potential of MPs in the area.

Materials And Methods

Description of the Study Area

Aseko District is situated between $8^{\circ}15'10''\text{N}$ to $8^{\circ}41'0''\text{N}$ latitude and $39^{\circ}55'40''\text{E}$ to $40^{\circ}16'20''\text{E}$ Longitude (Fig. 1). The total area of the district is 607 km^2 , which accounts for 2.9% of the total area of Arsi Zone [15].

The topography of the district consists of mountain ranges stretched from west Hararge Zone to Gugu Mountains in Arsi. The altitude of the district ranges between 2946 and 1177 meters above the sea level. the topography is part of Arsi-Bale mountains massif and surrounded by undulating low laying plateau [59]. These mountain ranges are dissected by major and small rivers. Moreover, the district has many hills. The majors are Abakoro, Bako, Dao Gulliso, Komicha, Simo, Woranbus etc. having an altitude more than 2100 m above sea level [15]

Due to its altitudinal location, the climatic condition of the district is dominated by moderately cool temperature ('*Woyenadega'* Agro ecology) (48%), ranging from 15°C - 20°C . The remaining type of climate are cool ('*Dega'* Agro ecology) (25%) and moderately warm ('*Kola'* Agro ecology) (27%) having a minimum and maximum temperature of 10°C - 15°C and 20°C - 25°C , respectively. The rainfall pattern is bi-modal, a short rainy season or '*Belg'* [from March to April] and a long rainy season/ '*Kiremt'* [from June to September and sometimes up to October] [15].

The vegetation cover of the study area consists of different species of natural forest, bushes and shrubs. The forest cover of the district was 10,501 hectares in the year 2007. The vegetation of the study area include dry evergreen montain forest with important tree species such as *Junipers procera*, *Cordia africana*, *Olea europaea*, *Croton macrostachyus*, *Bersama abyssinica*, *Olea capersis sus spp. macrocarpa*, *Olinia rochetiana* and *Allophylus abyssinicus*. There are also woodlands, bush lands, sub afro-alpine vegetation and grasslands in the study area [14]. Mountainous parts of the district such as Bofe, Worgona, Weranbus and Miro are covered with natural forests containing diverse plant species including trees [15]. The indigenous people inhabiting the area belong to the Oromo ethnic group. They speak Oromic language, the regional language of Oromia region.

Human population & health status

According to the estimation from ECSA (2007) the total population for the District is **113,187**, of which **57, 077** were men and **56,110** were women; **6,284** or 5.55% of its population were urban dwellers. According to AWHO [60], the highest prevalent disease in the district is pneumonia (21%) followed, by acute fever illness/AFI (13%) and upper respiratory tract (infection) (10.13%).

Table 1 Major human diseases in Aseko District in the year 2017		
Type of disease	No of population	%
Pneumonia	1272	21.09
AFI/Acute fever illness	840	13.93
Upper Respiratory tract inf	611	10.13
Diarrheal/non bloody/	594	9.85
Violence & other injury	555	9.2
Trauma	495	8.21
Malaria	441	7.31
Urinary tract infection	433	7.18
Helmintiasis	397	6.58
Typhoid fever	392	6.5
Total	6030	100
Source: - Aseko District Health office (AWHO, 2017)		

Methods

Cluster multi-stage sampling has been used for the selection of study sites. Based on the preliminary survey that survey was conducted from September 10 to 30, 2017, out of **18** Kebeles in Aseko district, three Kebeles (the smallest admistrative unit of the government in Ethiopia), namely Dere Oda *from ‘Kola’*, Haro Ale *‘Woyenadega’* and Dima Aseko *‘Dega’* have been selected purposively based on agroecological differences, availability of plant resources and medicinal plant knowledge as used by Zewdie Kasa [16]. Key informants (KIs) for Ethnobotanical data collection were purposively selected by snow ball method [1;17;18]. Accordingly, a total of **24** KIs were selected from the three Kebeles.

Selection of informants for household’s survey was done following the method described by Krejcie and Morgan [19], Accordingly only individuals who were 20 years old and above were included as the sample informants. This age group was chosen since they could be legally account for their actions but selecting participants below age 20 may require parental approval, which could make the study impractical. The required number of household sampled in each kebele was calculated by the formula [20].

$$n = \frac{NP(1-P)}{N-1(\frac{d}{Z_{\alpha/2}})^2+P(1-P)}-----eq. (1)$$

Where, n = sample size for each selected area

P = prevalence of traditional medicinal users in Ethiopia (80%)

N = Total household of selected Kebeles

d = margin of error (10% of P) Z_{α/2}= value under normal standard table (1.96)

Accordingly, a total of **95** HHs and further **19%** none response rates were selected from 4885 HHs in the three selected *Kebeles*. As a result, 114 informants were selected for household interviews (HHIs) and **24** KIs making the total sample size equals138 (Table 2).

A systematic random sampling procedure was used to obtain the required sample units of 114 informants. It was based on selection of units situated at a certain predetermined interval called the sampling interval. It was calculated as follow:

$$\text{Sampling interval}=\frac{\text{total number of BSU in the population}}{\text{number of sampling units needed}} -----eq. (2).$$

Table 2
Number of sampled HHs and KIs from each *kebele* proportionally

Total No. of HHs		Sampled HHs		Sampled KIs		Total sampled HHs & KIs		Subtotal		Grand Totalled
Kebeles	Total HHs	M	F	M	F	HHs	KIs	M	F	
Dere Oda	1802	32	10	7	2	42	9	39	12	51
Haro Ale	1731	31	9	6	2	40	8	37	11	48
Dima Aseko	1352	22	10	4	3	32	7	26	13	39
Total	4885	85	29	17	7	114	24	102	36	138

Ethnobotanical Data Collection

Semi-structured interviews, focus group discussions, Field Observations, guided field walk and market survey were used to collect ethnobotanical data [1, 21, 22, and 23]. Prior to data collection discussion was made with the informants to explain their cooperation to the documentation of their knowledge on MPs in their area and to get their verbal informed consent. Before the actual house-to-house survey starts a pilot, the survey was carried out to test the

applicability and clarity of the questionnaire to the respondents. This was done by asking the first five people encountered in each kebele by the principle of first come first served principle.

Informants were interviewed individually using the local Afaan *Oromoo* language [1 2, 21]. Independent Field Observations & Guided Field Walk, which gave an opportunity for more discussion with individual informants, followed all semi-structured interviews and the practical identification and collection of traditionally used MPs in their natural environment [21, 23]. In addition, the focus group (3–4 focus group per kebele with average number of 5 participants per FGD) were chosen to gain further information on MPs knowledge of the community and ascertain the reliability of the data collected through semi-structured interviews [21].

Major markets of Aseko District i.e., Hojadura, Aseko and Irressa were surveyed for availability, price and unit of measurement of marketable MPs (if any). Voucher specimens of MPs were collected on the field with the help of traditional healers and local field assistants. Specimens were pressed, dried, identified, labeled, and deposited at the Ethiopian Biodiversity Institute (EBI). Identification of specimens was performed both in the field and later at and also at Hawassa University Wondogenet College of Forestry and Natural Resources (WGCFNR) using taxonomic keys and floras [53–60] and by comparison with authenticated herbarium specimens in EBI.

Data analysis

Preferences of medicinal plant species used to treat the commonly reported human ailments in the study area were ranked [1, 23]. Informant Consensus Factor (ICF) values [12] were calculated to determine the most important human ailment categories in the District and identify potentially effective medicinal plant species in respective disease categories. ICF values were obtained by computing number of use citations in each disease category (nur) minus the number of times species used (nt), divided by the number of use citations in each category minus one.

$$ICF = \frac{nur-nt}{nur-1}.....Equation (3)$$

Where, ICF = Informants Consensus Factor nur = number of use citation in each category, nt = number of species used

Pair comparison was used for evaluating the degree of preferences or levels of importance of certain selected plants/parts of plants [1, 26]. Moreover, rank was made based on the report of the informants. Numbers of pairs were determined by the following formula [27].

$$N = \frac{n(n-1)}{2}Equation (4)$$

Where, N = Total number of pairs n = number of items

Direct matrix ranking exercise was done following [1] and Cotton [21] in order to compare multipurpose use of a given species and to relate this to the extent of its utilization versus its dominance

Fidelity level index was used to quantify the importance of a given species for a particular purpose in a given cultural group [21]. According to [31, 23 and 32], an index fidelity level was calculated as follows.

$$FLI (\%) = \left(\frac{Ip}{Iu}\right) * 100Equation (5)$$

Where, Ip = is the number of informants who independently indicated the use of a species for treating a particular disease and I_u = is the total number of informants who reported the plant for

Results

Diversity of Medicinal Plant Used Against Human Ailments in Aseko District (District)

A total of 96 MP species belonging to 90 genera and 66 botanical families were reported to be used for treating human ailments in Aseko District (**appendix 2 Additional file to be attached**). The family Lamiaceae and Solanaceae 5 species each were represented by the highest number of species' followed by Fabaceae and Euphorbiaceae 4 species each (Fig. 4). Each of the remaining 50 families had single species representation. Thus, 24% of families were represented by more than one medicinal plant species.

Sources & Indigenous Knowledge (IK) Transfer in the Study Area

The result of the study shows that the most prominent sources of IK in the study area were parents/family members (62.3%) followed by herbalists (11.6%) (Fig. 5).

Habitats And Habits Of Mps In The Study Area

Identified growth forms of MPs indicated that dominance herbs followed shrubs and Epiphytes were the least the growth forms of MPs in the study area (Fig. 3). MPs collected from the study are predominantly wild species. Out of the 96 species, 67 species (70%) had a wild origin while 29 species (30%) were collected from domesticated areas of homegardens.

Plant Parts and Condition of Mps Used for Remedy Preparation

Despite mentioning different plant parts used for remedy preparation, the majority (44%) of preparations were from leave parts alone followed by roots (19%) and barks (10%).

Table 3
Parts of MPs used for remedy preparation in the study area

Parts Used	Frequency	Percentage
Leaves alone	149	43.82
Root alone	66	19.41
Seed	37	10.88
Bark	13	3.82
Fruit	12	3.53
Bulb	10	2.94
Others	9	2.65
Stem	8	2.35
Latex	6	1.76
Rhizome	6	1.76
Roots & Leaves mixed	5	1.47
Entire plant	5	1.47
Sap	5	1.47
Leaves and bark mixed	3	0.88
Flower	2	0.59
Stem oil	2	0.59
Twigs	2	0.59

Regarding condition used freshly harvested plant parts were the dominant ones (57.2%) used in remedy preparation whereas dried parts were used least (24.9%); the remaining 17.9% of remedies were reported to be prepared both from dried or fresh parts of medicinal plant species (Fig. 7).

Disease Types and Treatment Methods

About 55 disease types were reported by Healers and identified with the help of health experts of Aseko District Health Office and Abomsa General Hospital Health experts in Aseko District Constipation, diarrhea, Gastritis and taeniasis were the most commonly reported health problems under the gastro-intestinal disease category, whereas atopic dermatitis (eczema) was most frequently reported under the dermatological disease category (Appendix 1 Additional file to be attached).

Visual inspection and interview were the commonly reported diagnosis methods prior to prescription of any herbal medicine to the patient or victim. Depending on types of the reported ailments, traditional healers diagnose patients with an interview for symptoms followed by visual inspection of eyes, skin color, tongue, throat, sores status, bleeding, infections and sensing body temperature of their patients with their bare hands.

Modes of Remedy Preparation

Traditional healers in the study area reported that they follow various ways of remedy preparation which depends on the type of ailment. The major modes of remedy preparation were Crushed (20%); pounding and homogenizing plant parts (19%); squeezed (13%); Powdering (12%) and others such as concoction, chewing, burning, cooking, roasting and soaking constitute about (36%) (Fig. 8).

Routes of Administration and Application

Medicinal plant preparations were administered through different routes. Oral application was the best represented (54.41% and most commonly used route of administration followed by topical or dermal application (29.42%). The remaining remedies were reported to be administered through nasal (7.65%); auricular (2.94%); teeth surface (2.65%); anal (1.18%) and others (1.73%) routes depending on the type of ailment reported by the respective patients (Fig. 9).

Dosages and Antidotes

Most MPs prescribed and given to patients are applied without any standardized doses with is a traditional way of measuring. However, approximate dosages (although no fixed standards) were reported to be determined based on age, sex, type of diseases, status and physical appearance of patients visiting the healers. Some medicinal plant preparations were mentioned to be measured in small cups locally called SIINII BUNAA referring to traditional cups used for drinking coffee or plastic jugs while others were measured as handful, spoonful or size of a finger. As per to informant's coffee, milk, honey, yoghurt, butter and dissolved powder of roasted barley, locally known as BESSO, were commonly reported antidotes for herbal preparations with adverse side effects.

Marketability of MPs

Out of the 25 (26%) species reported as marketable, only five species i.e., *Echinops kebericho* Mesfin, *Embelia schimperi* Vatke, *Hagenia abyssinica* (Bruce) J.F. Gmel., *Withania somnifera* (L.) Dun. in DC. and *Silene macrosolen* A. Rich. were found on markets being sold and purchased entirely for the purposes of their medicinal applications.

The remaining reportedly marketable MPs were mainly sold for their non-medicinal uses but occasionally applied as medicine when the need arises. The average price of a cup (siinii bunaa) of *Embelia schimperi* fruits at Hojadura, Iressa, and Aseko local markets was 7.50 Eth Birr (0.27 USD), whereas for a bunch ($\approx$ 250-325 gm) of the root material of *Echinops kebericho* and *Silene macrosolen* was 11 Birr (0.4 USD); and the price was 9 Birr (0.3 USD) for a similar bunch of *Withania somnifera* roots. A jug of *Hagenia abyssinica* inflorescence was sold for 8 Birr (0.29 USD).

Efficacy of MPs

About twelve disease categories were identified from the total of 55 various human ailments reported in the District. Amongst these, the categories with the highest ICF values were gastro-intestinal & parasitic diseases (0.76) which was followed by Febrile illness (0.74); and oral, dental and pharyngeal diseases (0.62) (Table 2). Highest plant use citation (25.36%) was found for gastrointestinal and parasitic diseases followed by dermatological diseases (20.29%)

Table 4
ICF values of traditional MPs for treating human ailments in Aseko District

Disease categories	Species	% of all species	Use citation	% of all use citation	ICF
Gastro-intestinal and parasitic	9	9.38	35	25.36	0.76
Febrile illness	8	8.33	28	20.29	0.74
Oral, dental and pharyngeal	6	6.25	14	10.14	0.62
External injuries, bleeding	9	9.38	19	13.77	0.56
Placental retention and urine retention	7	7.29	13	9.42	0.50
Evil spirit and evil eye	11	11.46	20	14.49	0.47
Respiratory	5	5.21	8	5.80	0.43
Dermatological	11	11.46	18	13.04	0.41
Swelling, Blood and lymphatic system	7	7.29	11	7.97	0.40
Organ disease	10	10.42	14	10.14	0.31
Malaria and fever	8	8.33	10	7.25	0.22
Musculoskeletal and nervous system	10	10.42	12	8.70	0.18
Sensorial	6	6.25	7	5.07	0.17
Insect allergy & poison	8	8.33	9	6.52	0.13
Others	15	15.63	19	13.77	0.22

Table 5
Fidelity Level Index of Most Common Uses of MPs in the study area

Species	Used to Treat	FL (%)
<i>Ocimum gratissimum</i> L.	Fibril illness	100
<i>Rubus steudneri</i> Schw	Asthma	100.
<i>Podocarpus falcatus</i>	Intestinal Parasite	100.
<i>Echinops kerebicho</i>	Blotting, Diarrhea, Urinating problem	93.3
<i>Ocimum urticifolium</i>	Eye disease, Fibril illness, Head ache	88.9
<i>Lagenaria siceraria</i>	Skin rash (ringworm), Malaria, Ear disease, Evil eye, Snake bite	87.5
<i>Lepidium sativum</i>	Malaria, Blotting, Diarrhea, Tonsillitis, Cough Fibril illness	86.5
<i>Calpurnia aurea</i>	Snake bite, Arthropod external parasite, Wound	87.5
<i>Allium sativum</i>	Malaria, Stomach ache, Blotting,	77.8
<i>Ricinus communis</i>	Anthrax, Ulecercic lymphagities, Blotting	75.0
<i>Phytolacca dodencandra</i>	Liverache, Gonorrhea, Hemorrhoid, Rabies, Hyena bite	66.7
<i>Cucumis ficifolius</i>	Stomachache, Febrile illness, Skin infection, Black leg, Blotting, Hemorrhoid	62.5
<i>Croton macrostachyus</i>	Evil eye, Gonorrhea, Febrile illness, Headache, Hemorrhoid, Rabies, Lymphatic swelling	52.6

Table 5 shows that *Ocimum gratissimum* L., *Rubus steudneri* Schw, and *Podocarpus falcatus* are the medicinal plant species which had the highest fidelity level whereas *Croton macrostachyus* had relatively the lowest FL.

Preference ranking

The finding showed that the preference of particular MP species against particular ailment is not necessarily the same; it varied from district to district. Among the five selected MPs used to treat Gastritis, *Urtica simensis* Steudel stood first, followed by *Ensete ventricosum* W (Table 6).

Table 6
Preference ranking of MPs reported for treating Gastritis

MPs used	Respondents (R1-R10)										Total	Rank
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10		
<i>Urtica simensis</i> Steudel	4	5	4	5	4	4	5	4	5	4	40	1st
<i>Ensete ventricosum</i> W	5	5	4	3	5	3	4	3	5	5	37	2nd
<i>Linum usitatissimum</i> L	5	4	5	2	3	4	3	5	4	4	35	3rd
<i>Vernonia amygdalina</i>	5	4	3	5	1	3	5	3	4	3	33	4th
<i>Zingiber officinale</i> R.	3	1	2	4	3	2	3	5	3	4	26	5th

N.B Scores in the Table 4 indicate ranks given to MPs based on their efficacy. Highest number (5) given for the medicinal plant which informants thought most effective in treating Malaria and the lowest number (1) for the least effective plant.

Pair Wise Comparison Of Mps Used To Rabies

The results of paired comparison established to calculate the use totaled of MP species used to treat rabies in the study area. Accordingly, *Justicia schimperiana* stood first followed by *Phytolacca dodecandra* and *Clutia abyssinica* (Table 7).

Table 7
Pair wise comparison results of MPs used to Rabies

MPs used	Respondents (R1-R9)									Total	Mean	Rank
	R1	R2	R3	R4	R5	R6	R7	R8	R9			
<i>Justicia schimperiana</i>	5	4	5	3	5	3	4	5	4	38	4.2	1st
<i>Ficus sycomorus</i>	3	5	4	5	4	3	5	4	4	37	4.1	2nd
<i>Phytolacca dodecandra</i> L	4	5	3	4	2	5	3	4	3	33	3.7	3rd
<i>Myrsine africana</i>	5	1	3	4	5	3	3	5	2	31	3.4	4th
<i>Clutia abyssinica</i>	3	4	2	1	4	5	4	3	3	29	3.2	5th
<i>Brucea antidysenterica.</i>	2	3	4	5	3	0	2	4	5	28	3.1	6th
<i>Hypericum revolutem</i>	3	2	1	5	4	1	2	1	3	22	2.4	7th
<i>Croton macrostachyus</i>	1	2	3	2	1	5	0	4	3	21	2.3	8th

Direct matrix ranking (DMR) of multipurpose MPs

In the study area, there are plants species surveyed for multiple uses. Key informants selected eight plant species that had multiple uses (Table 8). The output of the direct matrix ranking (DMR) exercise on eight multipurpose MPs enabled to identify the most threatened the medicinal plants in the area. Accordingly, *Cordia africana* was ranked first (most threatened) followed by *Hagenia abyssinica* (Table 8). The results also indicated that those multipurpose medicinal plant species are currently exploited more for construction, firewood and lumbering purposes than for their medicinal role.

Table 8

Average DMR score of fifteen key informants for eight MPs species with additional uses besides medicinal value

Plant species	Use categories							Total	Rank
	Medicine	Firewood	Charcoal	Construction	Food	Fence	Forage		
<i>Cordia africana</i>	3	4	5	5	3	2	0	22	1st
<i>Hagenia abyssinica</i>	4	5	1	5	0	3	3	21	2nd
<i>Podocarpus falcatus</i>	4	5	3	5	0	2	0	19	3rd
<i>Croton macrostachyus</i>	5	4	3	4	0	2	0	18	4th
<i>Acacia abyssinica</i>	2	4	5	4	0	2	0	17	5th
<i>Justicia schimperiana</i>	5	2	0	1	0	4	3	15	6th
<i>Ruta chalpensis</i>	4	1	1	0	0	3	3	12	7th
<i>Ricinus communis</i>	3	1	0	0	2	3	1	10	8th

Threats to MPs in Study Area

The main threats for MPs in the area were agricultural expansion (24.3%), which was most hazardous to MPs and their habitats. Most informants' perceived that construction and pesticide are the least destructive factor (Table 9).

Table 9

Ranking of factors perceived as threats to MPs based on their level of destructive effects

Factors	Respondents (R1-R7)							Total	%	Rank
	R1	R2	R3	R4	R5	R6	R7			
Agricultural expansion	7	3	6	7	6	7	4	36	24.3	1st
Firewood & Charcoal	5	7	6	5	2	5	2	30	20.3	2nd
Climate change(Drought & Erosion	4	5	3	4	7	4	5	27	18.2	3rd
Grazing	5	1	3	5	4	5	3	23	15.5	4th
Construction & timber	2	3	5	3	4	2	6	19	12.8	5th
Pesticide	3	1	1	5	4	3	2	17	11.5	6th

Conservation and Management Practices of Medicinal Plants

In Aseko *District* or, irregular remnants aged evergreen forests that contain many MPs are found mainly around the Ethiopian *Orthodox Tewahedo Churches, Mosques 'Awliyyaa/ Iddoo Kadhanaa Waaqaa'* (a place where Oromo peoples including elders and knowable community members meet to discuss and decide socioeconomic, cultural, & religious activities at different ceremonies and holidays or as required). Hence, someone sees a patch of indigenous old-aged trees in the study area; This shows that culture, belief, and religion contribute to the conservation of MPs.

In the study area, some community members and traditional practitioners were found to cultivate MPs. About 30%, of the medicinal plants collected were reported as found cultivated at home gardens and these include plants such as *Catha edulis* (Vahl) Forssk. Ex., Endl., *Coffea arabica*, *Hagenia abyssynica*, *Ruta Chalpensis*, and *Echinops kebericho*. They grow the desired MP species in their homegardens, crop fields and fences.

Traditional beliefs in the area also have their own unintentional role in conservation and sustainable utilization of MPs. Giving conservation priority for identified threatened medicinal plants, promoting in-situ and ex-situ conservation of MPs in Aseko area as well as Establishing the district's Traditional Healers Association, by creating awareness, providing funds, land for cultivating MPs and helping their activities with professional guidance helps to conserve the fast wear away MPs of the study area.

Discussions

The results of the current study showed that Aseko District has relatively rich in medicinal plant diversity where 96 plant species belonging to 90 genera and 67 botanical families were identified. Results indicated that traditional medicine is still playing a role in meeting the basic healthcare necessities of the peoples and their livestock. Good vegetation cover, acceptance of traditional medicine, Efficacy, Cost and limited access to modern healthcare facilities could be among the factors that have made people be more reliant on local MPs. The wide uses of these plants indicate that there is a good consensus on the effectiveness of their medicinal belongings.

The finding showed that knowledge of MPs is passed mainly through family relation like everywhere else in Ethiopia [38–40]. Social relations and religions also assist in the diffusion of MPs knowledge among the rural communities. This is particularly true for MPs that are used to treat common ailments such as fibril, headache, and abdominal complaints. However, under difficult cases the community members often contact the specialist healers. Due to the belief held among the community, ordinary people do not use the MPs that are on use by the healers since it is believed that doing so will lead to the loss of MPs healing power. Such restrictions assist in MPs conservation since social restrictions serve to limit MPs harvesting. Melesse Maryo *et al.* [39] reported similar idea.

Results have also proved the role played by traditional MPs and the local community holding considerable traditional health knowledge in assisting the primary healthcare needs of the District community. The number of MPs harvested in the District is found to be lower than that of other area in the country investigated for their ethnomedicinal wealth [12, 41] and higher than that of other areas in the country investigated by [40]. Although cultural, economic, ease of accessibility and efficacy related factors might have played major roles for the people of Aseko to rely on traditional medicine, the cultural factor might have been the most important one resulting in a sentimental devotion to the ancestral medical traditions/practices by continuation it as a highly valued heritage of the society or of the great fathers and mothers.

Dominance of medicinal plant species from families, Solanaceae, Lamiaceae, Fabaceae and Euphorbaceae could be attributed to their wider distribution and abundance in the flora area [50–58]. This is also confirmed by consistent recording of ethnomedicinal uses of species from the above-mentioned families in different Ethiopian ethnobotanical inventories [9, 12]. Most MPs used in the area (39.6%) were found to be herbs. This could relate to the fact that they are easily accessible in the nearby areas than trees and shrubs often harvested from patches of forests distantly located from resident areas. The finding agrees with the general pattern of dominance of herbaceous species seen in most medicinal plant inventories in Ethiopia and other countries [9, 40, and 42]. Wild habitats of Aseko were found to be major pools of traditional MPs providing about 70% of all reported MPs. However, the investigation showed that these habitats are subjected to anthropogenic impacts and consequently lessening in size due to an ever-increasing population pressure resulting in the loss of many medicinal species sheltering in the wild. The current finding is also in

agreement with previous reports of overdependence on wild habitats to harvest MPs [13, 26, and 42] than an effort to cultivate and use them sustainably.

In this study, leaves are the most frequently utilized part of plant organs (44%). Analogous results on different ethnobotanical studies by [43–46] were reported in different area. It was also observed that residents have been using leaves to identify MPs. Gathering leaves could be promoted as a more sustainable method since in most cases at least a number of leaves are left over on the mother plant which then allows them to carry on its life functions. As roots of medicinal plant species were reported to be harvested for most remedy preparations (19%), next to leaves, overexploitation of entire root parts for remedial preparations shows the threat posed on long-term survival of corresponding MPs. Mining of root parts of MPs was also commonly reported by other ethnomedicinal records elsewhere [12, 26, and 30]. Harvesting of roots kills the parent plant and could be a severe threat for survival of the often rare and slowly reproducing MPs of the area. Ermias Lulekal *et al.* [12], Fikru Ayana [42] also reported that utilization of the root part is risky to the survival and ecological aspect of the plant.

Results also showed prominent use (58.5%) of freshly harvested plant parts for traditional remedy preparation used against various ailments. The persistent use of freshly harvested medicinal plant materials in the area is reported to be related to the notion of achieving high efficacy using active ingredients of fresh plant parts which they thought could be lost on drying. This is because of the fact that the content or ingredients may be lost or reduced when the plants became dry. However, fresh collection could threat MPs since local people have no habit of preserving dry form of traditional medicine in most cases. Other ethnomedicinal inventories [35, 40, and 46] have also indicated wide use of fresh plant materials for remedy preparations due to reportedly better efficacy related factors than using dried plant materials.

The dominant use of medicinal plant Crushing (20%) and Pounding (19%) for various ailments might be related to their proven effectiveness over many years of trial and indigenous knowledge accumulated on efficacy of such preparations. The results of the study are similar with other studies done by different authors in different parts Ethiopia [40, 47, 29, and 36]. But they disagree with the results of Ermias Lulekal *et al.* [12] who indicate the dominant preparation in Ankober district is decoctions for various ailments might be related to their proven effectiveness over many years of trial and error indigenous knowledge accumulated on efficacy for the particular community.

The fact that most remedies in the study area were applied orally (54.41%) followed by topical or dermal application (29.42%) could be due to the high occurrence of gastrointestinal and dermatological disorders in the study area (**Appendix 2 additional to be attached**). Predominance of oral and dermal routes of herbal drug application in the study area could be because of high prevalence of gastrointestinal and skin related problems in the area. Dermal of remedial application could also be attributed to the fact that it reduces the chance of intoxication by drugs than when it is administered orally. In addition, both oral and dermal routes permit fast physiological reaction of prepared medicines with the pathogens and upturn its curative power. Patients with skin infections were reported to be treated by rubbing and pasting herbal preparations whereas those with sores were treated by chewing the part of the medicinal plant and spitting the juice on the sore. For internal ailments, herbal preparations were mainly prescribed to be administered orally whereas for a general malaise steam bath and vapour inhalation were commonly reported. In connection to this, reports showed that oral and dermal route of administration of remedies found to enhance the physiological reactions of remedies with the pathogens that in turn increase the healing power of the medicine. In this regard, similar findings were reported away [7, 61; 62].

The number and different types of diseases (55 disease types) (**Appendix 1 additional file to be attached**) for which traditional healers were most visited by patients indicated a liking of local people in the study area to visit traditional healers and the nature dispensary. Economic, cultural, efficacy, limited access to modern medicine and availability

factors were reported as the key factors which lead the community to hit at the door of traditional healthcare practitioners than the few distantly located healthcare centers with unaffordable prices. Similar findings were reported by [9, 46, and 12].

Visual checkup of patients is the more obvious diagnostic method practiced by all local healers in the area. Although changes in body temperature, skin and eye color, appetite and physical appearance help traditional healers to detect which patients face sicknesses it was only through visual experience that identification of diseases and prescriptions look like to be made. Other researchers [11, 46, and 12] have also reported similar diagnostic methods in different cultural groups. Misidentification of diseases commonly leads to misprescription which may result in adverse effects to patients. Even though dosages of remedies for various ailments were reported to be determined based on age, occurrence of pregnancy, physical fitness/appearance and gender of the patient, there were no standardized measurements or guidelines set by traditional healers.

Overdose of remedies was also reported to bring adverse effects like vomiting, diarrhea, burning sensations and sometimes fainting of the patient. Lack of precision and standardization has been mentioned as a global drawback of the traditional healthcare system [22, 12] Traditional healers in our study area reported the use of different antidotes including BESSO, milk, coffee, honey, yoghurt, and butter for reversing adverse effects and stabilizing any disorder. The same pattern of using antidotes was also reported for other cultural groups elsewhere [25, 26, 33, and 12].

The results from market survey of MPs indicated that most MPs (74%) have no marketability report and were not available on major market places of the District during the time of research. This would show that the majority of MPs are collected from the wild for remedy preparations only when the need arises. Although 26% of the MPs were available on the market *Echinops kebericho*, *Embelia schimperi*, *Hagenia abyssinica*, *Withania somnifera* and *Silene macrosolen* were the only ones to be sold or purchased for their traditional medicinal uses. The market value of these species (with a price range from 0.27 USD per bunch of root or jug of inflorescences to 0.4 USD for a cup of fruits) showed the income generation potential of a number of MPs and gives an indication of potential demand of those marketable plants by the community. However, such marketability could also indicate that the plants are under pressure since they are purposefully hunted for income generation. Other reportedly marketable MPs of Aseko were mainly gathered and sold for their uses related to edibility, spice, stimulants, lumbering, firewood, and construction purposes. Although the investigation indicated current market potential of MPs in Aseko, a relatively wider domestic trade of Ethiopian MPs was reported for other cultural groups in the country [13, 48, and 22]. Thus, our finding can also be used as a base line for a future in-depth study of the moneymaking potential of MPs of the area through successive market survey over number of years and value chain analysis study of potential plants.

The highest recorded ICF values (0.76 and 0.74) indicated best agreement among informants on the use of medicinal plant species reported to be used for treating gastrointestinal, and parasitic and febrile illnesses, respectively. The observed highest informants' agreement coupled with high plant use citations for these disease categories could also indicate the relatively high incidence of the latter diseases in the area. According to [23], high ICF values are important to identify plants of particular interest in the search for bioactive compounds. Accordingly, about 9 MPs of Aseko (with high ICF values) for treating gastro-intestinal and parasitic diseases are under investigation for their pharmacological properties by our research theme.

Andrade-Cetto and Heinerich [24] reported that lower fidelity level indicates a given medicinal plant species could have more number of mentions by the informants than medicinal plant species that have high fidelity level. The fact that MPs had the highest FL values could be an indication of their good healing potential at least with the local population. According to Trotter and Logen [30] plants that are used repeatedly are more likely to be biologically active as MPs. Confirmation or consensus could not be taken as a single measure of the potential efficacy of any medicinal

plant. Thus, efficacy is not the only factor that influences the informant choice but the prevalence of a given plant and disease in the area can affect informants' choices.

The reported highest fidelity level values for *Ocimum gratissimum* L against febrile diseases, *Rubus steudneri* Schw against Asthma and *Podocarpus falcatus* against Intestinal Parasite (100%FL) each, could be considered as a clue for the high healing potential of these plants against the corresponding diseases. Plants with highest fidelity level values could also be targeted for further phytochemical investigation to prove the bioactive components that are responsible for their high healing potential [12, 30].

The output of a direct matrix ranking exercise showed highest values/ranks for a number of multipurpose MPs of the study area including *Cordia Africana*, *Hagenia abyssinica* and *Podocarpus falcatus*. The result indicates that these plants are exploited more for their non-medicinal uses than for reported medicinal values. Thus, the result calls for an urgent complementary conservation action to save the fast eroding multipurpose medicinal plant species of the area. Yineger *et al.* [49, 12] has also reported the same pattern of highest exploitation of multipurpose MPs for uses other than their traditional medicinal importance in south eastern Ethiopia.

The preference ranking exercise helped to identify the most-preferred medicinal plant species to treat Gastritis. Accordingly, *Urtica simensis* Steudel stood first, followed by *Ensete ventricosum* W and *Linum usitatissimum* L scored highest values and were found the most-preferred ones to treat the disease. Further investigation of these species for their bioactive components against Gastritis may bring promising results.

It was also found that traditional healers show maximum secrecy in handling MPs knowledge. Moreover, they try not to outflow the knowledge out of the family circle. These facts coupled with the absence of any written document on MPs of the area show the threat on the future use of ethnomedicinal potential of Aseko.

Conclusion

Generally, results of this investigation confirmed a rich human medicinal plants and indigenous knowledge on their utilization in Aseko District. Although Aseko District was found to be rich in medicinal plant diversity, the effort to conserve plants and associated indigenous knowledge was observed to be very feeble. The effort from some traditional practitioners to cultivate MPs at home gardens calls for a sustained governmental support to promote overall in-situ and ex-situ conservation strategies for MPs of the District. It is also recommended to establish a traditional healers' association in the district and strengthen members by providing professional support and land to establish as much medicinal plant nurseries as possible so as to conserve the fast-eroding medicinal plant wealth of the area.

Abbreviations

EBI: Ethiopian Biodiversity Institute; **MPs:** Medicinal Plants; **WGCFNR:** Wondogenet College of Forestry & Natural Resources; **MTU:** Mizan Tepi University

Declarations

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Availability of data and materials

Plants collected were deposited in the Federal University of Hawassa Wondogenet College of Forestry and Natural Resources herbarium (WG-CFNR), and the Federal Ethiopian Biodiversity Institute.

Authors' contributions

JS, ZG and MM were Participated in the study. JS collected the data and analyzed the data. All authors contributed to the writing of the manuscript. All authors read and approved the final manuscript.

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Ethics approval and consent to participate

Consent for publication

Collaborators were informed that results would be presented in a scientific article and gave their approval.

Competing interests

There are no competing interests.

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Figures

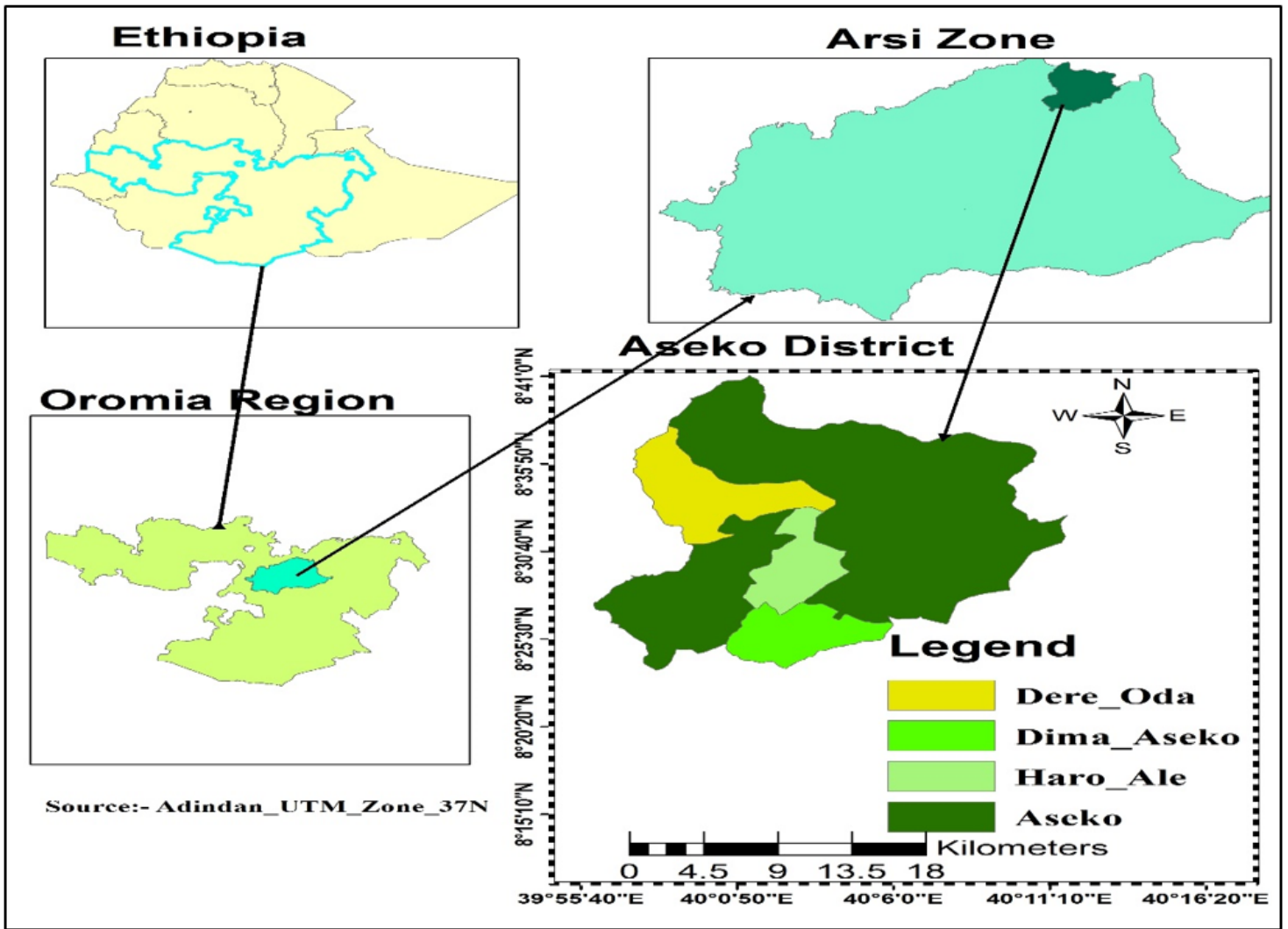


Figure 2

Map of study area



Figure 4

Natural Forests in Haro Ale Kebele



Figure 6

Afforested areas in Naannoo Aseko kebele (Area Closure)

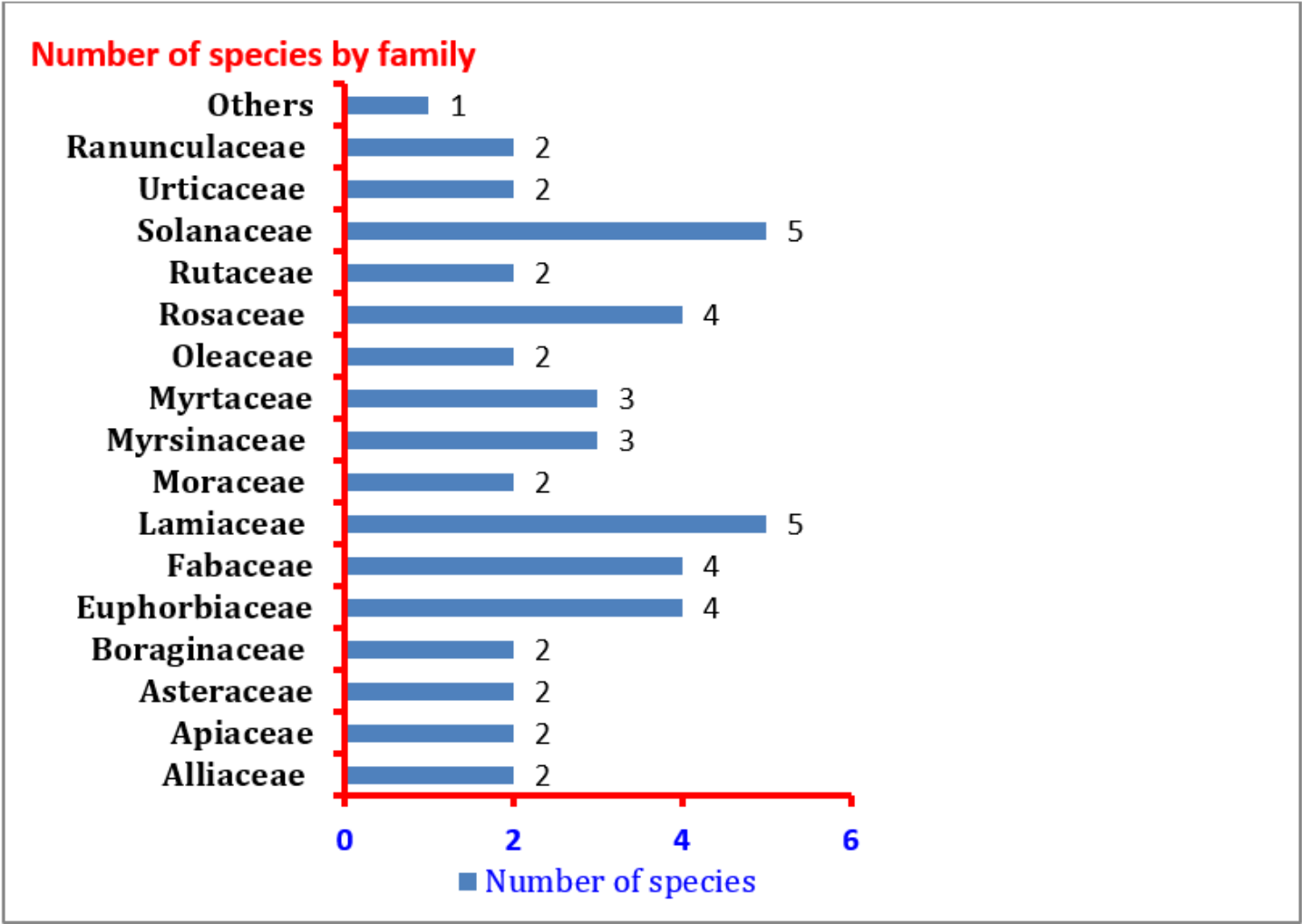


Figure 8

Number of species by each family in the study area

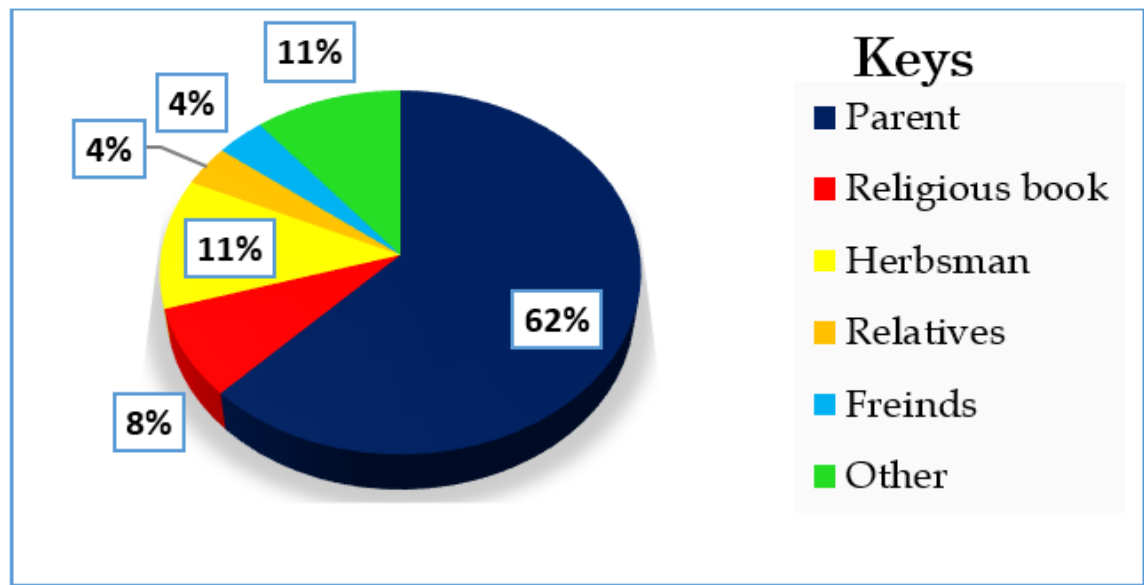


Figure 9

Major Sources of Indigenous Knowledge in the Study Area

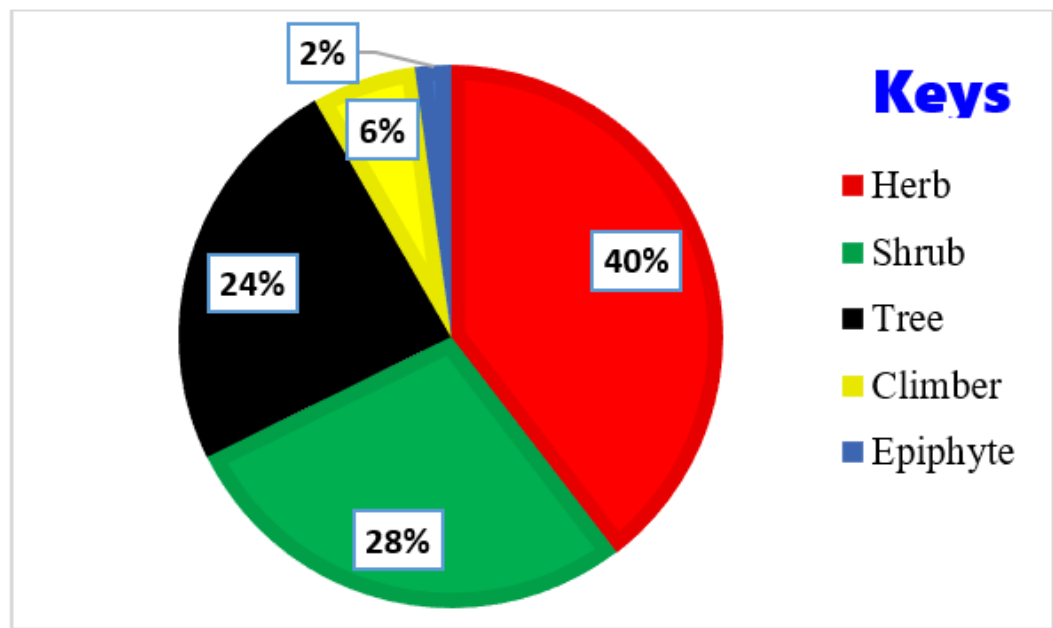


Figure 11

Growth Forms of MPs Species in the Study Area

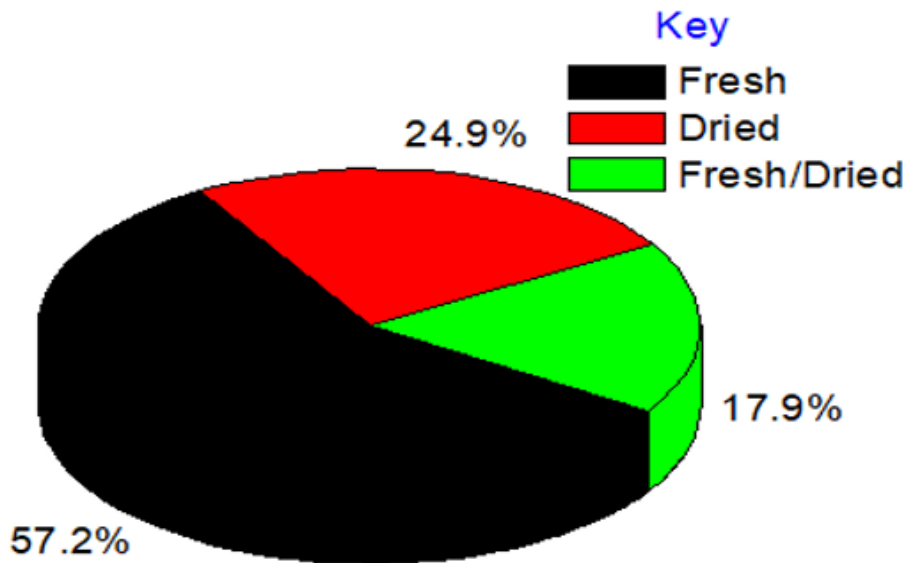


Figure 13

Condition of MPs used for remedy preparation in the study area

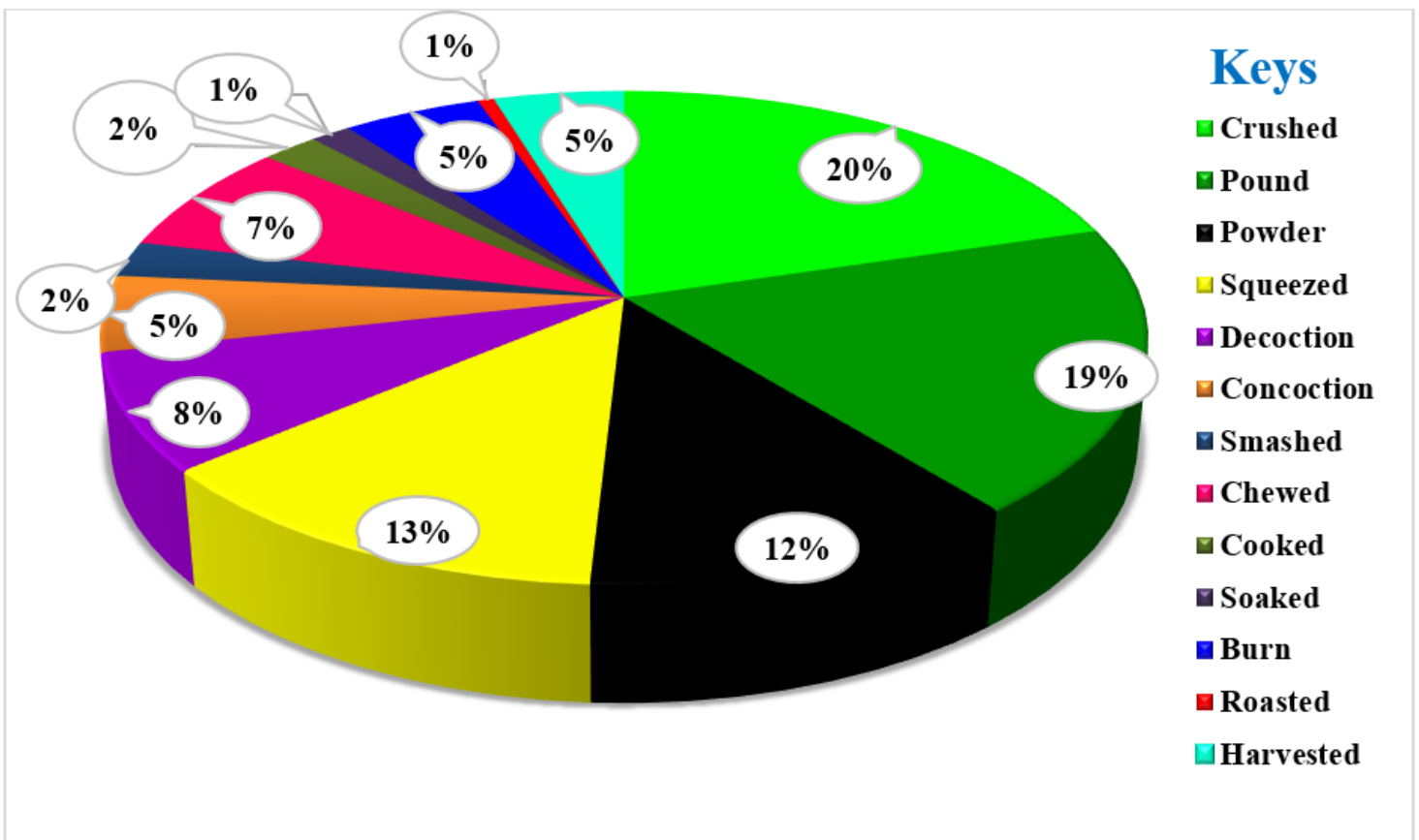


Figure 15

Modes of remedy preparation in the study area

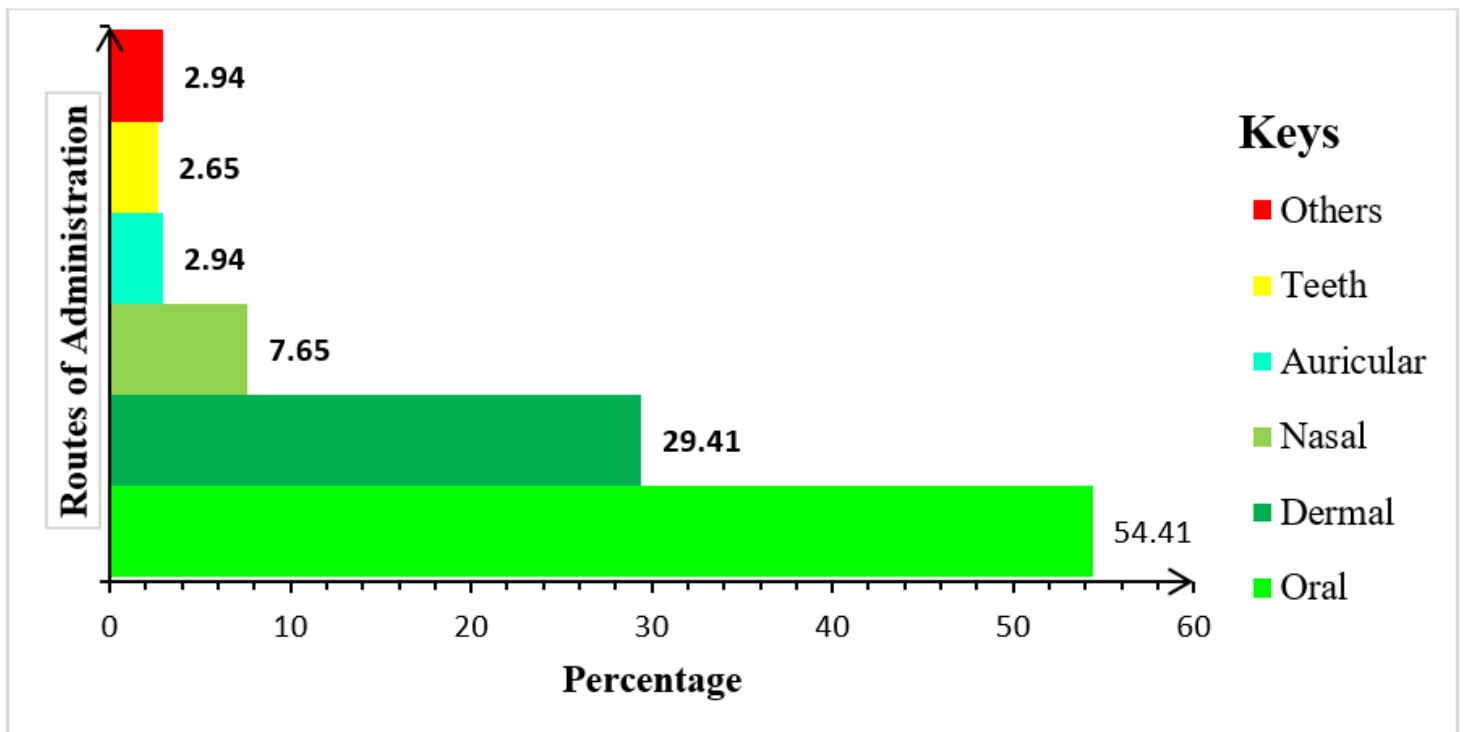


Figure 17

Routes of remedy administration in the study area

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Appendix.docx](#)
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