

An Ethnobotanical Study of Medicinal Plants in Amaya District, South West Shewa Zone of Oromia Regional State, Ethiopia

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Research

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Abstract

The purpose of the study was to identify medicinal plants and document associated indigenous knowledge of the Amaya District's people related to differentiating the parts of medicinal plants, and their modes of preparation and administration to treat human and livestock diseases in South West Ethiopia. A total of 112 medicinal plant species belonging to 96 genera and 56 families were identified and documented. Most of the medicinal plants harvested were herbs followed by trees. Leaves were the most frequently used medicinal plant parts, followed by seeds and roots to prepare traditional remedies. Pounding was the most widely used mode of preparation in the study area, followed by crushing and chewing. The most commonly used route of administration was oral. The majority of medicinal plants were used in fresh condition to treat diseases. A Pearson correlation test indicated a significant difference between age of informants and number of medicinal plant species cited, and between level of education and number of medicinal plant species cited in the District. *Ocimum lamiifolium* specie was cited by the highest proportion of informants, and ranked first in treating febrile illness human disease in the study area. Malaria disease category scored the highest number of informant consensus factor value. *Acmella caulirhiaz* ranked first to treat tonsillitis infections. *Cordia africana* ranked first as a multipurpose medicinal plant. Farm expansion, firewood collection and lack of interest of the young and learned groups towards traditional medicines were the major threats to medicinal plants. Hence, identification and documentation of the medicinal plant species and the knowledge of the local people on how to prepare and use them is so vital for preserving them. Community based cultivation in home gardens and farmlands besides conserving them in wild, where they grow, are recommended to minimize the loss of those medicinal plants.

Introduction

From ancient times, plants have been rich sources of effective and safe medicines (Russell *et al.*, 2006). Hence, the world primary means of treating diseases and fighting infections have been based on the use of medicinal plant species (MPs). The local peoples of different localities have also advanced their own specific knowledge on plant resource uses, management and conservation (Cotton, 1996). Such indigenous knowledge (IK) of MPs and their use by indigenous cultures are beneficial for conservation of cultural traditions and biodiversity, besides healthcare and drug development in the present and upcoming day (Tamiru *et al.*, 2013). Accordingly, globally, about 64% of the total world population is reliant on traditional medicine (TM) for their healthcare needs (Phondani *et al.*, 2016). 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 had been relied on TMs (Bekele, 2007; Birhanu *et al.*, 2015) for past several years. 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). However, in the country, TM is faced with the problem of sustainability and continuity mainly due to the loss of taxa of MPs (Kelbessa *et al.*, 1992; Asfaw Z., 2001), that is, in turn, caused by natural and anthropogenic factors (Lulekal *et al.* 2008). Hence, there exists an accelerated destruction of plant resources with loss of IK. Besides, among 85 diverse ethnolinguistic Ethiopian communities, most of them are uninvestigated (Lulekal *et al.* 2013). Hence, documentation of the traditional knowledge (Teklehaymanot and Giday, 2007).

Over utilization of wild plants in the District, particularly from Tulu Roge and Gefersa forests, and the lack of knowledge about proper conservation practices also lead to the loss of biodiversity. As a result, there is a greater danger for the loss of MPs together with IK. Despite the problems are urgent and critical, there is no any ethnobotanical study conducted to document the MPs and associated IK of the people in the District. Lack of integration of IK with modern science for continuity, and transfer of IK from elder to young generation also needs due attention. The researchers were, thus, motivated to conduct this study in the District: (1) to identify and document medicinal plants and their parts used for medicinal purpose to treat human and livestock ailments, and (2) to examine modes of preparation, application and route of administration for remedies of the local people in the study area.

Materials And Methods

2.1. Description of the Study Area

The study will be conducted in the Ameya District, which is one of the 12 districts of South West Shewa Zone of Oromia Regional State, Ethiopia (Fig. 1). The capital of the District is Gindo, which is 30 km away from the Zonal Capital, Waliso, and 144 km South West of Addis Ababa. The District is divided into 40 kebeles, where 36 of them are rural and four of them are urban Kebeles. The total land area size of the District is about 93,279 ha (unpublished document of Ameya District Agricultural Office, 2017). The District is located between 8° 29'59, 99"N and 37° 44'59, 99" E latitude and longitude, respectively. The altitude of the study area ranges between 1500–3240 m above sea level.

The District is classified into three agro-climatic zones: 1) highlands, ranging from 2,700 m to 3,240 m; 2) midlands, ranging from 2,100 m to 2,600 m, and 3) lowlands, ranging from 1,500 m to 2000m above sea levels. The climate data were obtained from the Metrological station of the study District. Accordingly, the rainfall pattern of the study area is unimodal, where the heavy rainy season ranges from April to September, whereas the dry season extends from October 15 to March 15, but still there is intermittent rainfall in October, March and April. The maximum and minimum mean annual rainfalls of the area were 1127 mm and 8.38 mm, respectively. The highest and lowest mean temperatures were also 28.4°C and 12.3°C, recorded in February and December, respectively. The mean annual temperature and rainfall of the study area is 19.6°C and 1127 mm, respectively.

Regarding the populations and health services of human and livestock in the study area also described briefly here. Accordingly, the total populations of the Amaya districts in 2018 were 122,056 (61,578 males and 60,478 females), out of the total population 5.13% is urban dweller (CSA, 2007). In this district, there was one hospital, 8 clinics and 34 health posts under governmental ownership (ADHO, 2018). Amaya District has also a livestock population of 345,600; out of this, 160,600 were cattle, 35,400 were goats, 32,600 were sheep, 15,200 were donkey, 3,300 were mules, 8,500 were horse and 99,000 were poultry (ADANRO, 2017). The major livestock feeds on the natural grazing, hay, crop residues and local beverage by-products. Concerning to the availability veterinary services, up to the end of 2017, there was eight clinic and 15 health post in the District (ADANRO, 2017). There were various diseases (such as fever, malaria, tonsilin, cancer, anthrax and so on) affecting the health of both humans and/or livestock in the District.

2.2. Study Design

Descriptive survey methods were employed to collect data from the respondents and field surveys carried out in the study area, and to analyze them as well. Hence, both qualitative and quantitative data were collected and analyzed for this study. Longitudinal survey design was applied as the data were collected more than once for assuring the accuracy of the data collected from respondents.

2.3. Study site selection and their sampling techniques

Before starting the actual field study, a one-week reconnaissance survey was conducted to select sample Kebeles, and to obtain preliminary information about agro-climatic zones, availability of both medicinal plants and the local traditional healers in which Kebeles of the District. Thus, the whole kebeles (40) of Amaya District are already stratified to three agro-climatic zones (highland, midland and lowland); of which, five Kebeles, representing the three agro-climatic zones, were selected purposively depending upon their proximity to forest areas, different altitudinal ranges and availability of both MPs and traditional healers. Therefore, one Kebele named by Marii Saqalaa Karrayyuu, from lowland; two Kebeles named by Arba Sadden Kuraa and Gindoo town from midland, and two Kebele named by Guultii Bolaa and Kuraa Bolaa from highland agroclimatic zones were selected using both stratified and purposive sampling techniques.

2.4. Informant Selection and their sampling techniques

For ethnobotanical data collection, totally, 70 participants were selected from the representative sample Kebeles. Out of the total, 60 informants were household respondents, who are ordinary residents, and were selected randomly. Based on the recommendation of each selected Kebele administrative bodies, development agents, local authorities and religious leaders (Martins, 1995), the remaining 10 key informants, who are knowledgeable elders and traditional healers, were selected purposively for interview.

2.5. Ethnobotanical data collection methods

2.5.1. Structured and semi-structured interviews and focus group discussion

Ethnobotanical data were collected from February 15, 2019 to March 30, 2019 during two field trips to the study area. The first field trip was conducted to collect primary data from respondents regarding ethnobotanical data. The second field trip was conducted in order to confirm ethnobotanical information and to request people participated in study in order to show the wild medicinal plants they used to treat human and livestock ailments (Martin, 1995; Cotton, 1996). Accordingly, structured and semi-structured interviews, focus group discussions, and guided field walks with informants were employed to obtain IK of the local people on health, plant parts used, mode of preparation, applications, and route of administration.

Structured and semi-structured interviews were conducted with both household respondents and key informants, respectively, based on the items prepared beforehand in English, and translated to local language, 'Afaan Oromoo', later on. Then, the interviews were held in 'Afaan Oromoo' directly. Information regarding local names of MPs, plants part used, methods and condition of preparation, disease treated, route of administration, medicinal values, threats and conservation practices to MPs was

recorded. Field observation was also made on the morphological features and habitats of MPs species in the guided field walk.

2.5.2. Market survey

Market survey was also made to record the name and availability of MPs, mixture used in preparation of drugs sold in the local markets of the study area. The market survey was conducted two times for each open market found in Gindoo and Qotaa towns via observation and using semi-structured questionnaire interviews with drug producers and sellers.

2.5. 3. Field survey for plant specimens' collection, and identification

At the end of interviews, the reported MPs were collected from the natural vegetation in the wild and home garden. Plant identification was performed both in the field and in Debre Berhan University. The specimens collected were numbered, pressed, and dried for further identification. Further identification of all specimens was done by comparison with authentic specimens, illustration and taxonomic keys from flora of Ethiopia and Eritrea (volume 1–8). Finally, the identified specimen was deposited in the temporary Herbarium of Debre Berhan University.

2.6. Data Analysis

2.6.1. Descriptive statistics

Descriptive statistics such as percentage and frequency were employed to summarize the data on the MPs uses. The information gathered from local people such as medicinal values, application, methods of preparation, routes of administrations, disease treated, parts used and growth form of MPs and other associated IK were summarized using descriptive statistics. To make summary calculation, to draw bar graphs, scatter graph and pie-charts, MS Excel spreadsheet 2010 was used. Statistical package for social science (SPSS) version 20 was also applied to summarize Pearson correlation between age of respondents and level of education in relation with number of species cited.

2.6.2. 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 the follows: number of use citation in each category (nur) minus the total number of species used (ns), divided by the number of use citation in each category minus one (Heinrich et al, 1998).

$ICF = \frac{Nur - Ns}{Nur - 1}$, where, IFC = Informant consensus, Nur = number of use citation and Ns = number of species used. The 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 informant to treat a particular ailment. The low ICF values indicate that informants disagree on the plant species to be used to treat a category of ailments.

2.6.3. Preference Ranking

Preference ranking was conducted to rank some selected MPs based on degree of their effectiveness in treating a particular 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 help to indicate the most effective MPs used by the community to treat disease.

2.6.4. Paired comparison

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

2.3.5. 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 MPs, multipurpose MPs species were selected out of the total MPs, and use diversities of these plants were also 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 was summed up and ranked.

Results And Discussion

3.1. Characteristics of Sample Respondents

In order to represent the whole agro-climatic zones of the Amaya District, sample respondents (70) were selected from five sample Kebeles (14 respondents from each), which are distributed in three agro-climatic zones: highland, midland, and lowland of the District. Regarding the ages of the respondents, most of them had above 40 years old (~ 63%). This shows as the ages of the respondents increase, they become more knowledgeable due to the experience they gain in their life. This was also reported by other authors (Lulekal et al. 2008, 2013).

3.2. Composition and Growth Form of Medicinal Plants in Amaya District

A total of 112 MP species belonging to 96 genera and 54 families were identified in study the area (Appendix 1). With regard to plant family, Fabaceae and Asteraceae were the most popular to the area and, both were represented by nine species (8.03%), followed by Solanaceae with eight species (7.145%); Lamiaceae, seven species (6.25%), and Euphorbiaceae, six species (5.35%) (Supplementary file 1). This result indicated that the two dominant families are frequently used for medicinal purpose. This finding agrees with other studies in

Loading [MathJax]/jax/output/CommonHTML/jax.js ., 2008; Awang et al., 2014; Alebie and Mehamed, 2016).

Regarding their growth forms, among 112 MPs recorded from the study area, the highest representation was for herbs (51 species, 45.5%), followed by trees (25, 28.57%), and shrubs (5, 22%). The least was liana (4 species, 3.57%) (Fig. 2). This could be related to the fact that these species exhibit high level of richness and easy to obtain them, because herbs form of MPs easily available in home garden and forest patches. This finding agrees with previous studies conducted by Awas and Demissew (2009), Lulekal et al. 2013, Enyew et al. (2014), Kebede et al. (2016), and A Moges and Y. Moges (2019).

Out of the total identified MPs, 72 species (64.28%) were reported to be used to treat human ailments only, 14 species (12.5%) to livestock ailments only and 26 species (23.27%) to both human and livestock (Appendix 2). This result indicated that most of MPs used for treating human ailments. Similar results are reported by different authors in MPs studies carried out elsewhere (Lulekal et al., 2008; Mesfin *et al.*, 2010; Enyew et al., 2014; Getaneh and Girma, 2014; Kassa et al., 2016).

3.3. Habitat of MPs

As depicted in Fig. 3, of the total, 65 species (58.03%) were collected from wild alone; 27 species (24%), from both home garden and wild; 11 species (9.82%), from home garden alone and nine species (8.03%), from farmland. This finding shows that local people in study area mostly depended on wild sources than home garden and farmland to obtain the MPs. This finding agrees with the reports of Lulekal et al. (2013), Kassa et al. (2016) and Fenetahun and Eshetu (2017), A. Moges and Y. Moges (2013). However, collection of MPs was not limited to the Kebeles of traditional healers, where they live in, rather the healers also harvested from other Kebeles in the District. The collection of MPs from wild was mainly carried out in the morning because, firstly, those plants were mostly obtained far away from their residents, and secondly, the traditional healers believe that those medicinal plants would be effective only when they are collected in the morning. Yet, the studies and our field observation showed that these wild habitats are subjected to human factors, leading to the loss of habitats, and many medicinal species available in the wild.

3.4. Parts Used, Modes of Preparation and Administration of Medicinal Plants

3.4.1 Medicinal plant parts used

People in Amaya District were used different part(s) of MPs for preparation of traditional medicines to treat human and livestock ailments (Supplementary file 2). Leaf parts (37 species) of MPs were the most frequently reported to be used in study area, followed by seeds (15 species) (Fig. 4). This is a good practice and even be promoted as a more sustainable method because leaves are many per tree so that using leaf parts rather than the other parts (particularly the root, including the bark, stem parts) of the MPs may not have significant impacts on the survival of the mother plants, whereas using the root parts of the MPs through uprooting of the whole plants is causing total death of the mother MPs. In fact, excessive use of leaves also has negative effect on survival and regeneration of MPs, but not as such serious as that of damaging the root, bulb, stem and bark parts used. Many authors (Amenul, 2007; Etana, 2010; Yineger and Yewhalaw, 2007) also confirmed that leaf parts of MPs mostly used for TM preparation.

Figure 4: Plants parts used for preparation of medicine in the study area

3.4.2. Modes of preparation

In Amaya District, different modes of preparation (Appendix 2) were used to treat human and livestock ailments. As depicted in Fig. 5, the major modes of preparation were pounding (30 species), crushing (29 species), pounding and filtering (20 species). This indicated that the people of the study area uses different ways of preparation and application methods 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. This is similar with the work of Amenul (2007), who reported that most of the preparation was done by pounding.

3.4.3. Application of medicinal plants for remedies (routes of administration)

The prepared traditional medicines are applied in a number of methods. Hence, based on the report of the respondents of the study area, the major routes of administration used were oral only (36), dermal only (28), oral and dermal (19), nasal only (7), anal (3), nasal and oral (3) (Fig. 6). This result indicated that both oral and dermal routes permit quick physiological reaction of the prepared medicines with the pathogens; thereby they increase the curative powers of the infected ones. Hence, oral application of remedies was popular as also reported by many other authors (Mesfin et al., 2009; Zerabruk and Yirga, 2012; Alebie and Chala Mehamed, 2016).

Figure 6: Routes of application of remedies in treating ailments in the study area

3.4.4. Conditions of preparation and dosage of medicinal plants

As also illustrated in Fig. 7 and Appendix 2, the preparation of the MPs identified for remedies in the study area were in fresh (76 species), dry (23 species) and fresh or dry (8 species) conditions. This finding showed that most of the species are prepared for remedies in their fresh conditions. The frequent use of freshly processed remedies could also imply the accessibility of MPs in the locality and their high curative power while preparing in fresh conditions. This finding is also similar with other many authors' reports (e.g., Yineger et al., 2007; Chala Mohammed *et al.*, 2016).

In the study area, to determine the dosage, different units of measurements and the duration of administration are used. In fact, there is no uniformity with regard to the dosage of the medicine between the different traditional healers and local people (use by themselves) for same disease, although all the traditional healers and local people 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. Accordingly, as reported by the respondents, the amounts to be administered were estimated by the use of measurements such as length of a finger (for bark, root and stem), coffee and/or 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 people of the study area consider to determine the duration of using the medicine. Lack of precision and standardization is, therefore, the major drawback in practicing MPs for treatments of human and livestock ailments, which are also reported by other ethnobotanical studies carried out in Ethiopia (Lulekal E. et al., 2008; Balemie and Mahamat Seid, 2014).

3.5. Marketed Medicinal plants

As depicted in Table 1, market survey results obtained from Gindoo and Qotaa markets indicated that MPs sold at market were not widely used for medicinal values, rather for other purposes. This shows that the local people prefer either immediately to collect these plants by themselves from the available area in the District so as to prepare traditional medicine or directly go to traditional healer in order to get treatments instead of buying the MPs from the market. This finding is also reported by Giday et al. (2009) and Mesfin et al. (2014), who stated that most of the MPs are not traded at market rather collected from environment when needed.

Table 1
List of MPs reported marketability with their local names and uses

Botanical name	Local name	use
<i>Aframomum corrorima</i>	Korarimaa	spices
<i>Allium sativum</i>	Qullubbi adii	Spice and food
<i>Brassica carinata</i>	Raaffuu	food
<i>Vacia faba</i>	Baaqelaa	Food
<i>Carica papaya</i>	Paapayya	Food
<i>Catha edulis</i>	jimaa	psychoactive
<i>Guizotia abyssinica</i>	Nuugii	food
<i>Hardeum vulgare</i>	Garbuu	food
<i>Allium cepa</i>	Qullubbi dimaa	food
<i>Coffea arabica</i>	Buna	psychoactive
<i>Eragrostis tef</i>	xaafii	Food
<i>Ensete ventricosum</i>	Warqee	Food
<i>Eucalyptus globulus</i>	Bahargamoo adii	Firewood construction
<i>Lepidium sativum</i>	Feexoo	Medicine
<i>Linum usitatissimum</i>	Talbaa	Food and income
<i>Ruta chalepensis</i>	Ciraakoota	Spices and medicine
<i>Echinops kebericho</i>	korabichoo	Spices
<i>Zingiber officinale</i>	Ginjinbila	Spices

3.6. Distribution of Local People's Knowledge Related to MPs

3.6.1. Distribution of knowledge on MPs corresponding to ages of respondents

The relationship of the knowledge of respondents on MPs corresponding to their age was illustrated in Fig. 8. A Pearson correlation test indicated a positive and significant ($r = 0.77$, $p < 0.000$ and $\alpha = 0.01$) correlation between age group and the number of MPs reported by the respondents in the study area. This means as age increases, a large number of MPs are reported. The likely reasons behind that as the ages of the respondents increase, they accumulate different knowledge regarding to MPs. In contrarily, the young generations were not found to use MPs as their parents and grandparents used due to modernization, un-aging, religion, absence of voluntarisms from traditional healer and elders to transfer their IK and lack of knowledge of the young about the importance of traditional medicine. Similar finding was reported by Giday et al. (2003), Zenebe et al. (2012) and Kebede et al. (2016).

3.6.2. Distribution of knowledge on medicinal plants corresponding to level of education

The knowledge of respondents relating to MPs based on their level of education is demonstrated in Fig. 9. A Pearson correlation test indicated a negative and significant ($r = -0.456$, $p < 0.000$ and $\alpha = 0.01$) correlation between a level of education and the number of species reported by the informants in the study area shown. This finding indicated that as the more the person is educated, the less number of MPs were mentioned. The possible reasons behind that educated people do not prefer to use TM due to modernization and religion factors and their preference to use modern medicine. Similar findings were reported by some other authors (Girmay *et al.*, 2012; Kebede et al., 2016).

3.7. Ranking of medicinal plants

3.7.1. Informant consensus

In Amaya District, MPs which were popular due to the wide range of diseases they treat and commonly used are well known by the local peoples and traditional healers. 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. Accordingly, the highest informant consensus goes to *Ocimum lamiifolium*, which was cited by 32 informants (45.71%), followed by *Allium sativum* (38.57%), *Linum usitatissimum* (34.28%), *Croton macrostachyus* (28.57%), *Citrus limon* (27.14), *Aloe kefaensis* (25.35) and others as displayed in Table 2. The popularity of *Ocimum lamiifolium* 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, as well as due to its accessibility, everybody had the chance to see the treatment with minimum secrecy of plants. The finding agrees with other work reported by Getaneh and Girma (2014).

Table 2
List of MPs corresponding to informants (cited by ≥ 15 informants)

Botanical name of MPs	Informants in:	
	Number	Percentage
<i>Ocimum lamiifolium</i>	32	45.71
<i>Allium sativum</i>	27	38.57
<i>Linum usitatissimum</i>	24	34.28
<i>Croton macrostachyus</i>	20	28.57
<i>Citrus limon</i>	19	27.14
<i>Aloe kefaensis</i>	17	25.35
<i>Datura stramonium</i>	16	22.85
<i>Platostoma rotundifolium</i>	15	21.42
<i>Lepidium sativum</i>	15	21.42
<i>Phytolacca dodecandra</i>	15	21.42
<i>Vernonia amygdalina</i>	15	21.42
<i>Ruta chalepensis</i>	15	21.42

Informant consensus factors (ICF)

Diseases treated by MPs reported in the study area were grouped into 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 3). In this study, the informant consensus on MPs usage resulted in ICF values ranging from 0.42 to 0.87 per disease category. As shown in Table 3, the ailments Malaria scored the highest value (0.87) followed by internal and external parasitic diseases (0.83). 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 (0.42) for the category of diseases like sensor organ related diseases. This category may be indicative for lack of consistency in the use of MPs in study area.

Table 3
Informants consensus factors (ICF)

Disease Category	Number of MPs	Use citation	ICF
Gastric and stomach related disease	26	75	0.67
Febrile illness and cough	23	99	0.77
Cattle disease	18	96	0.80
Reproductive organ disease	4	10	0.67
Wound and bleeding	35	98	0.64
Anemia and blood pressure	5	9	0.5
Internal and external parasitic problem	12	54	0.83
Evil	4	14	0.76
Malaria	3	17	0.87
Skin affecting disease	11	30	0.65
Sensor organ related disease	12	20	0.42
Disease affecting both human and livestock	10	36	0.74

3.7.2. Preference ranking of human disease

When there are different species prescribed for the same health problem, people show preference of one over the other. Preference ranking of seven MPs that were reported for treating febrile illness human disease was 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 MPs which they believed most effective in treating febrile illness and the lowest number (1) for the least effective MPs in treating febrile illness. Accordingly, as presented in Table 4, *Ocimum lamiifolium* and *Croton macrostachyus* were stood the 1st and 2nd preferences of the informants, respectively, to treat the febrile illness, whereas *Solanecio gigas* was the least preference of them. This indicated that *Ocimum lamiifolium* were most effective in treating febrile illness. Similar finding was reported by Kassa et al. (2016) as *Ocimum lamiifolium* ranked first to treat fever human disease in Tulu Korma and its surroundings in Ejere District, Western Shewa Zone of Oromia Regional State.

Table 4
Preference ranking of MPs used to treat human febrile illness disease in the study area

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		
<i>Allium sativum</i>	1	3	4	5	2	2	4	5	1	3	27	6th
<i>Croton macrostachyus</i>	5	5	6	4	6	5	6	5	3	4	49	2nd
<i>Eucalyptus globulus</i>	3	5	4	5	4	2	1	2	3	2	31	5th
<i>Ocimum lamiifolium</i>	7	6	6	5	4	6	6	7	5	6	58	1st
<i>Platostoma rotundifolium</i>	5	3	6	7	2	3	4	5	6	5	46	3rd
<i>Solanecio gigas</i>	3	2	2	1	4	2	3	1	4	3	25	7th
<i>Withania somnifera</i>	4	3	2	2	4	3	4	2	4	4	34	4th

3.7.3. Pairwise comparison

In this study, ten key informants were selected to indicate the efficacy and popularity of the six MPs, reported to treat Tonsillitis infections so that pairwise comparison was done for those species. Accordingly, *Acmella caulirhiza* (52) ranked first followed by *Solanum incanum* (46), *Zingiber officinale* (40) and *Allium sativum* (29) as shown in Table 5. This indicated that *Acmella caulirhiza* was the most efficient MPs in treating Tonsillitis infections, whereas *Vernonia amygdalina* and *Citrus limon* were the least preferred and efficient when compared to the others.

Table 5
Simple pairwise comparison of six MPs used to treat tonsillitis infection

Scientific name of MPs	Key informants labeled from I ₁ -I ₁₀										Total	Rank
	I ₁	I ₂	I ₃	I ₄	I ₅	I ₆	I ₇	I ₈	I ₉	I ₁₀		
<i>Acmella caulirhiza</i>	4	5	6	6	5	5	6	4	5	6	52	1st
<i>Allium sativum</i>	2	3	2	4	2	3	4	2	3	4	29	4th
<i>Citrus limon</i>	2	1	3	1	2	2	3	1	2	1	18	6th
<i>Solanum incanum</i>	4	5	5	5	4	4	5	5	4	5	46	2nd
<i>Vernonia amygdalina</i>	2	1	3	4	3	2	3	1	2	3	24	5th
<i>Zingiber officinale</i>	3	4	5	4	5	3	4	3	5	4	40	3rd

3.7.4. Direct matrix ranking

In this study area, the majority of the people rely on wild plants for various purposes such as construction, charcoal, firewood, furniture, and fencing besides medicine. To evaluate the relative importance and check the maior impact on such multipurpose 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, who were requested to give value, from 5 to the most used plants for particular purposes, up to 0 (zero) to the least ones. Respondents evaluated the relative importance of these MPs to the local peoples and the extent of the existing threats related to their use values. The values for use reports across the selected key informants were summed up and ranked for each species.

Based on this, the results of the direct matrix ranking revealed that *Cordia africana* ranked first and followed by *Eucalyptus globulus*, *Hagenia abyssinica*, *Croton macrostachyus*, *Ficus vasta*, *Juniperus procera* and *Podocarpus falcatus*, which ranked 2nd, 3rd, 4th, 5th, 6th and 7th (Table 6), respectively. Hence, *Cordia Africana* was the most preferred multipurpose plant and over harvested for not only medicinal purpose, but also for other uses such as furniture and construction largely. Therefore, the most preferred plant by local people for various uses, the most threatened species; which was evidently shown by its scarce distribution in the area. From this, one could conclude that the top ranked species were highly threatened as 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 since the livelihoods of some people in the study area directly depended on these species. This finding is in line with Teklay (2015) that *Cordia africana* was most preferred multipurpose plants in Kilte Awulaelo District of Tigray Regional State, Northern Ethiopia.

Table 6
Average direct matrix ranking of seven commonly used species in the study area.

Scientific name of MPs	Use category						Total	Rank
	Charcoal	Fire wood	Construction	Fencing	Furniture	Medicine		
<i>Cordia Africana</i>	10	13	20	12	20	12	87	1st
<i>Podocarpus falcatus</i>	12	10	3	4	17	2	48	7th
<i>Eucalyptus globulus</i>	5	22	20	23	5	10	82	2nd
<i>Hagenia abyssinica</i>	0	5	20	10	22	20	77	3rd
<i>Juniperus procera</i>	0	5	18	5	20	2	50	6th
<i>Ficus vasta</i>	15	10	15	5	12	1	58	5th
<i>Croton macrostachyus</i>	15	10	0	8	10	20	63	4th
Total	57	75	96	67	106	87		
Rank	6th	4th	2nd	5th	1st	3rd		

3.8. Factors Threatening Medicinal Plants

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Factors threatening MPs are caused by anthropogenic and natural causes. Based on the respondents' perception, farm expansion (cited by 20 informants) stood first, followed by firewood and charcoal (18), and furniture (10) to be the most threatening factors to MPs in the study area. The least threatening factor was plant collection for medicine (1) (Fig. 10). This study indicated that farm expansion was found to be the highest threatening factor to MPs it might be due to increasing in population. Balemie and Seid (2014), Bekele and Reddy (2015) and Birhanu et al. (2015) also reported similar finding. Generally, MPs were majorly threatened by human induced factors such as farm expansion, firewood collection, furniture, pesticide and herbicide application on farmland, and introduction of exotic plants (such as *Eucalyptus globules*). Natural factors such as droughts are also the other challenges to MPs.

3.9. Conservation of Medicinal Plants

Different conservation practices were reported to be practiced by local peoples in the study area aiding for continuity of MPs and associated IK. *Ex-situ* conservation such as plantation of MPs in home garden by collecting threatened wild MPs, bulbs and seed storage for annual crop and MPs scarce from the wild. Additionally, the annual and perennial MPs were being grown in farmlands of the local people. *In-situ* conservation practices were also implemented by local peoples. For instance, using closure areas the local people allow the MPs to regenerate by themselves (e.g. *Podocarpus falcatus*) through pruning the branches of them and restricting grazing by their livestock. Moreover, forests are currently being conserved by efforts of the community and the local government around the Asasa forest, Roge forest and Karsa Kile forests, thereby, wild MPs are conserved.

Conclusion

In Amaya District, several plants are used for medicinal purposes. As compared to other studies, a number of MPs and associated IK were reported to be used for human and livestock aliments in study area. Most of the MPs were used for human aliments rather than livestock aliments, and harvested from wild rather than farmlands and home gardens. Herbs were highly utilized growth forms of MPs than trees, shrubs, climbers /lianas. Leaf parts of MPs were highly harvested for remedy preparations, followed by seeds and roots. Most of the MPs were prepared by pounding their parts used, and fresh forms were mostly used in the study area. Oral route of administration was the most commonly used ways of application. In the study area, elders have better knowledge of medicinal plant than younger, while peoples are more educated and young, they do not prefer to use MPs as their parents and grandparents did due to their modernization, un-aged, religion and absence of interest from traditional healers and elders to transfer their IK to other persons. Farm expansion, firewood and charcoal collection, furniture, drought, overgrazing, over harvesting for food and spices, construction, introduction of exotic plants, application of pesticide and herbicide, and use for medicine were the major threatening factors to MPs in the study area. Local peoples were practicing *ex-situ* and *in-situ* conservation approaches for decreasing loss of MPs from the study area. Plantation of MPs, seed and bulb storage, and restricting grazing by livestock were the major efforts of the local people along with the support of the government to conserve plants in their natural habitats.

Declarations

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Availability of data and materials

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Acknowledgement

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Declaration of interest

The authors declare that they have no competing interests in this section.

Ethics approval and consent to participate

Before data collection, the authors got an ethical letter from the Ethical Board of Debre Berhan University, and consent from each participant of the data collection.

Authors' contribution

Both Desalegn (DD) and Admasu (AM) proposed the title together. The data collection was made by DD with close supervision of AM. The identification of medicinal plants, however, was made by both DD and AM, besides further identification in National Herbarium of Addis Ababa University. Data were analyzed and interpreted by both. However, DD was a major contributor in writing the manuscript with in depth revisions made by AM. At the end, all authors read and approved the final manuscript.

Consent for publication

We, the authors, did not use any table, video or figure from somebody else. All of the tables and figures presented in this manuscript besides supplementary files are produced from our primary data. However, if you assume a detail, figure or something else requires a 'consent letter/ request', we will submit it using your or our institution format while requesting in the future.

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Figures

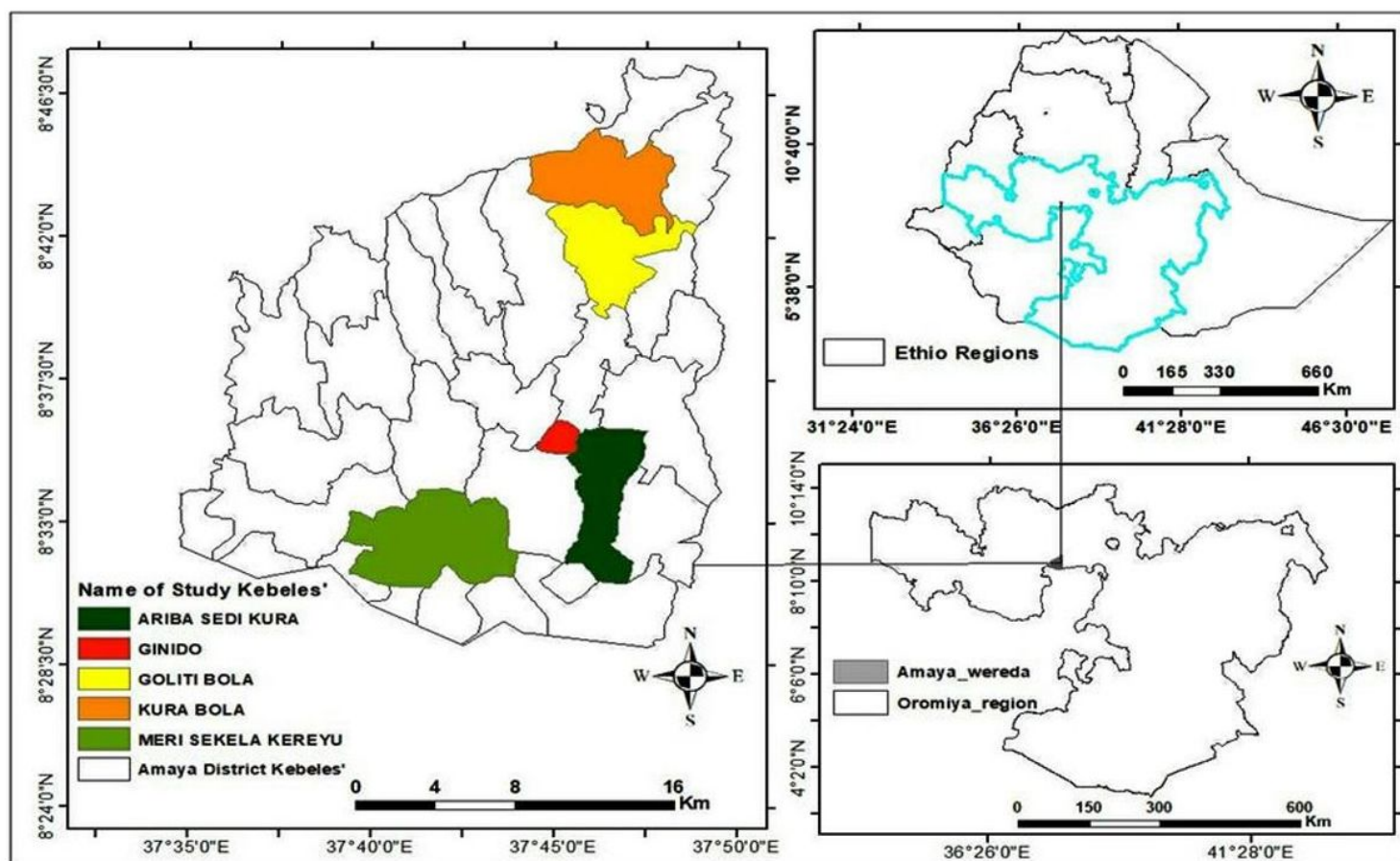


Figure 1

A map illustrating the study District in Oromia Regional State, Ethiopia. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

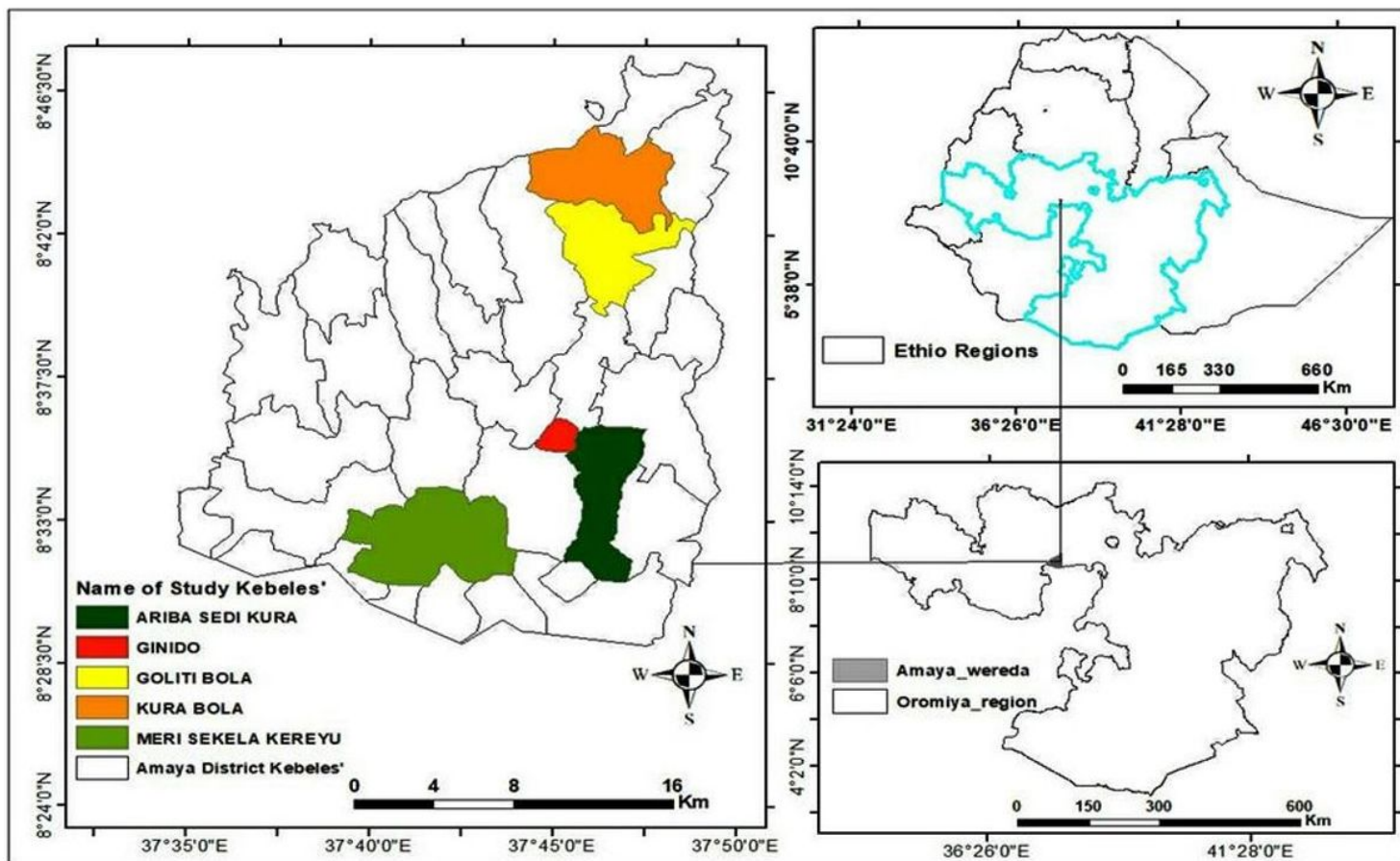


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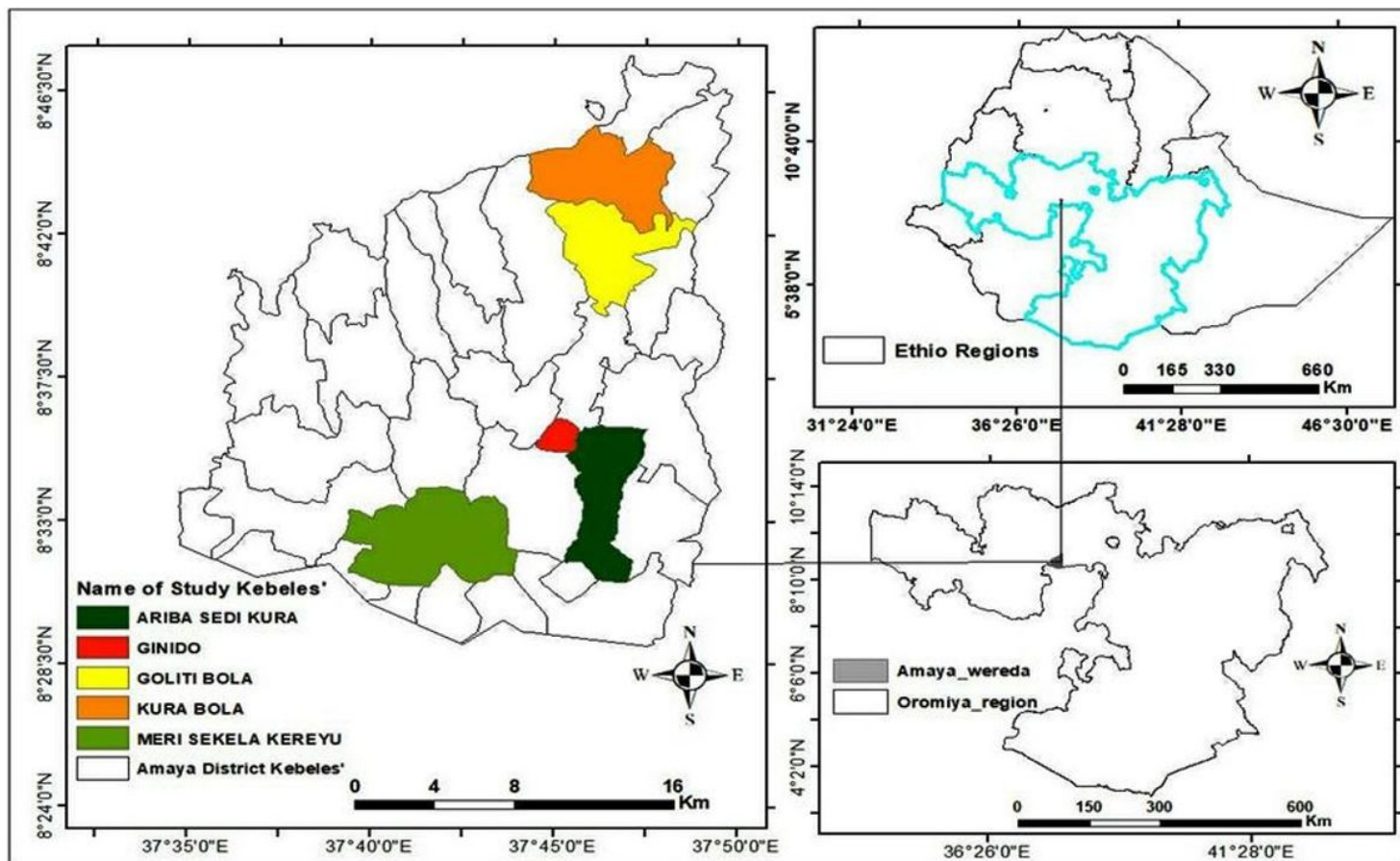


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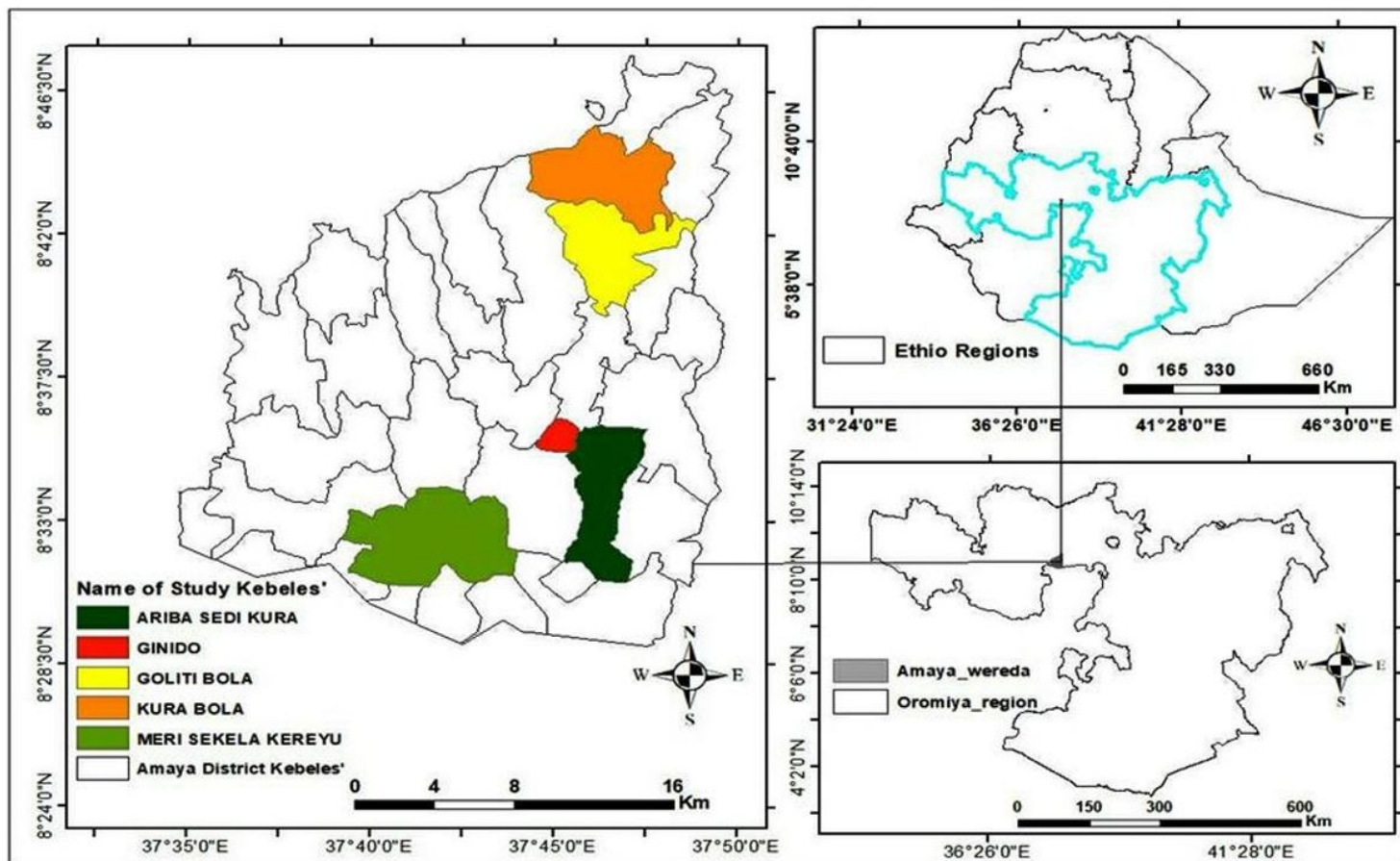


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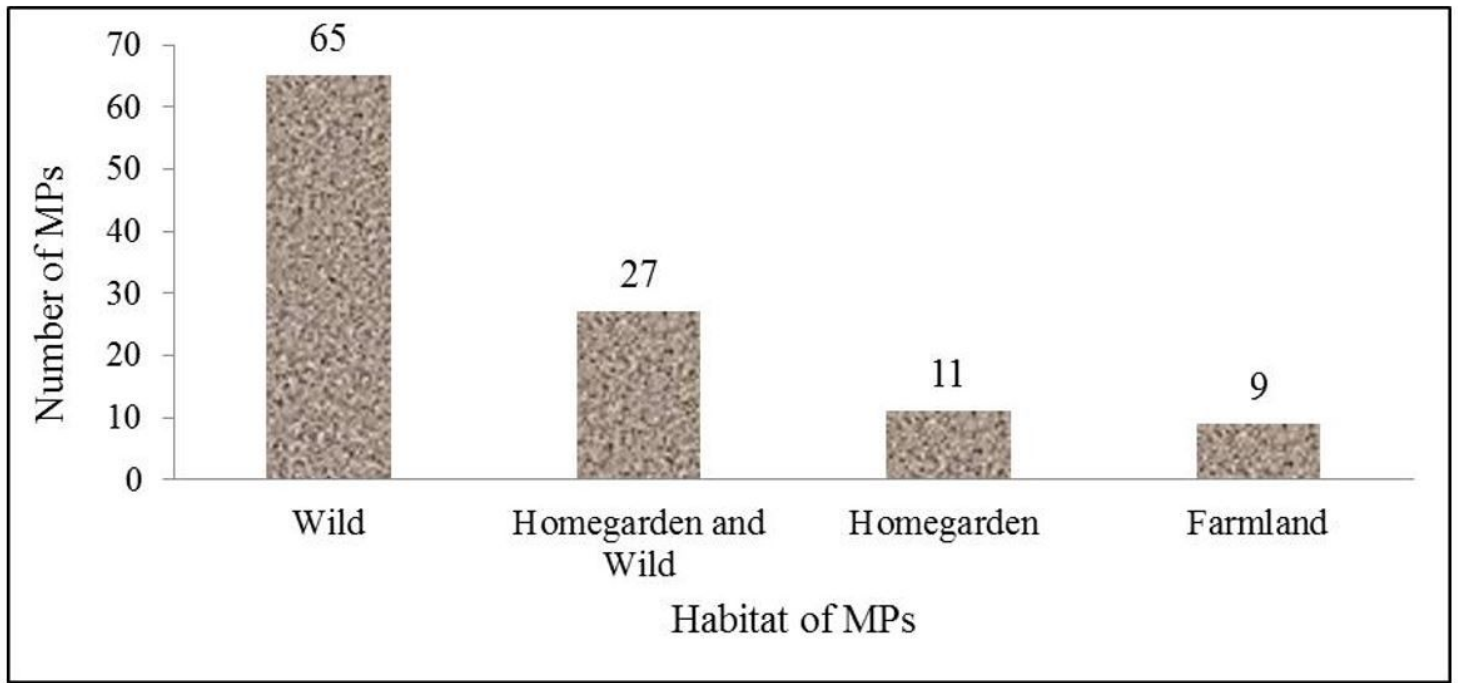


Figure 2

Growth form of MPs in the study area

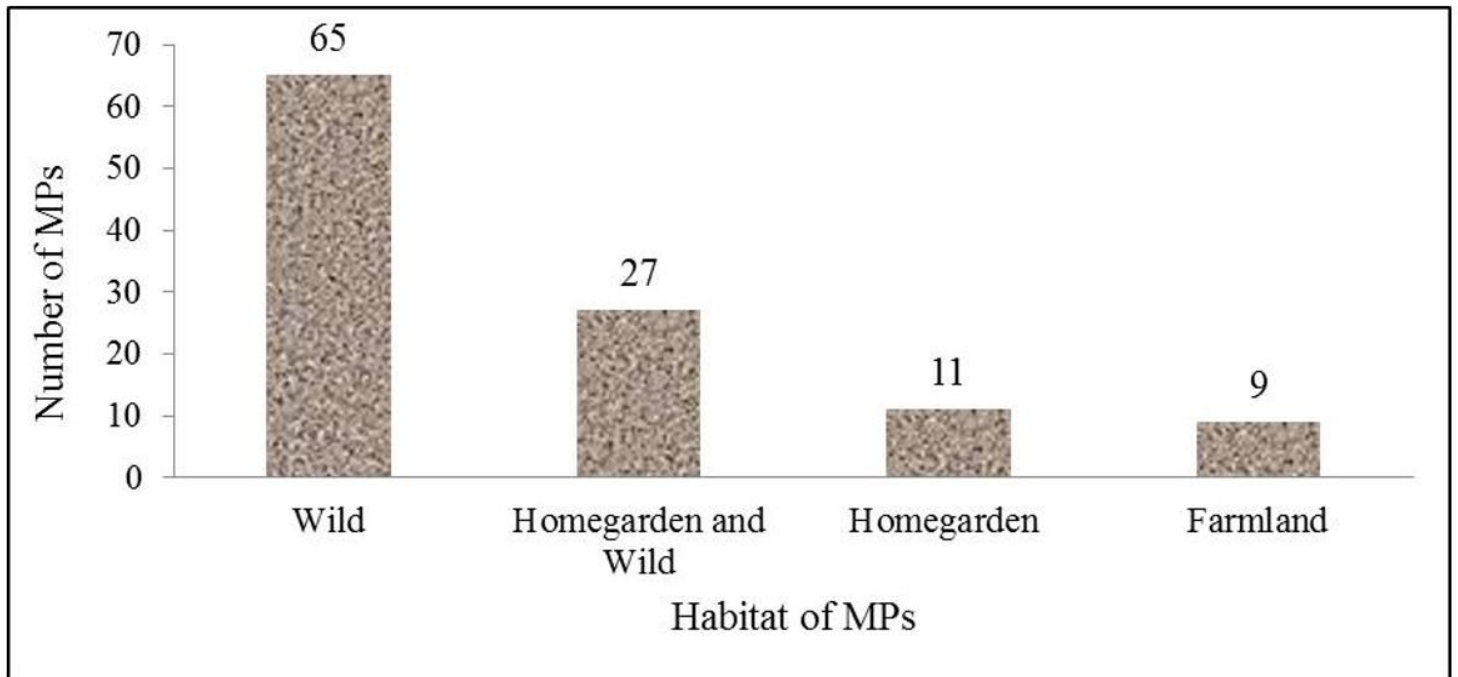


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Growth form of MPs in the study area

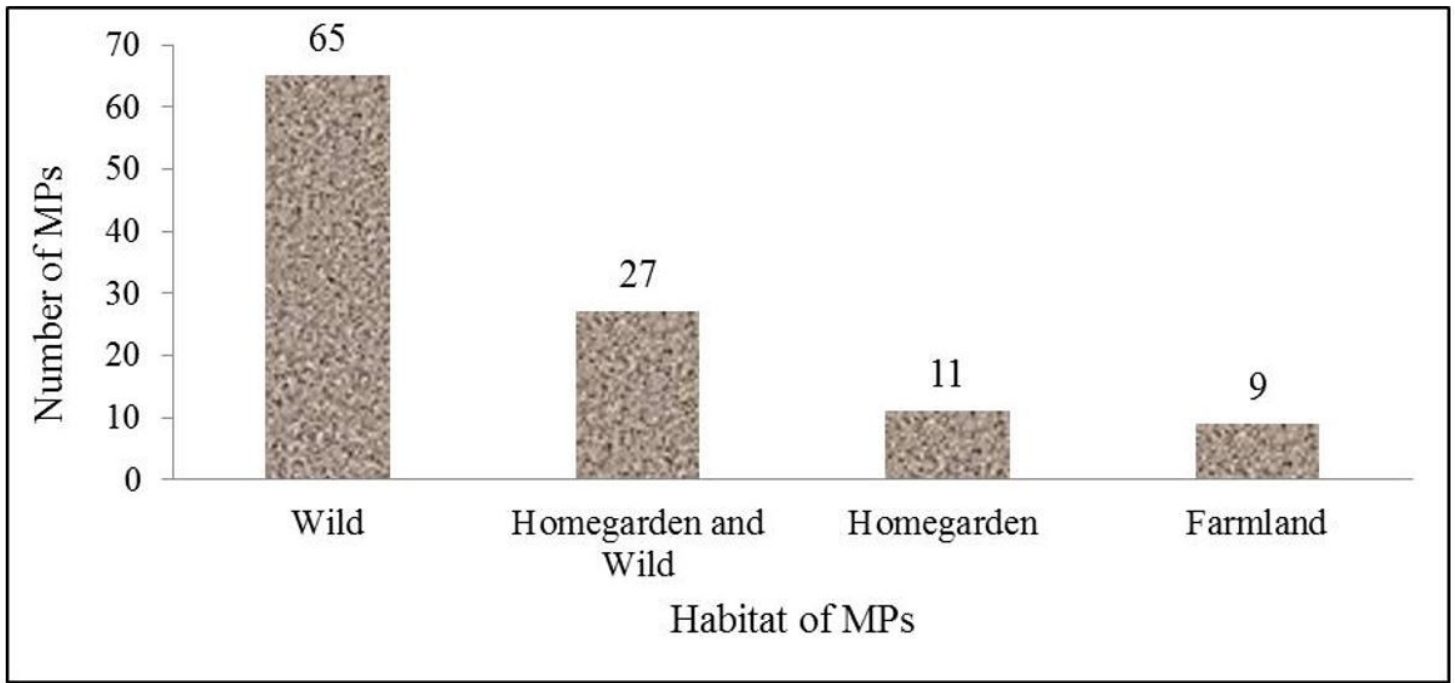


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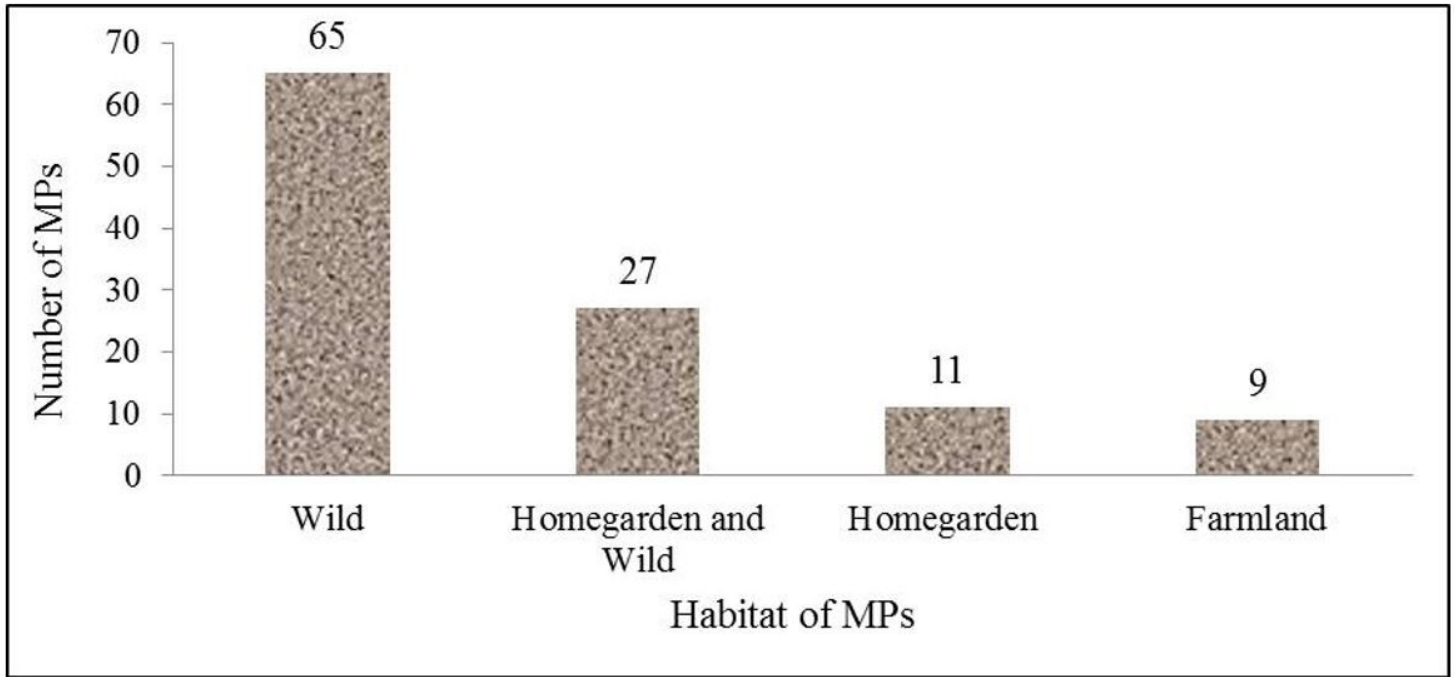


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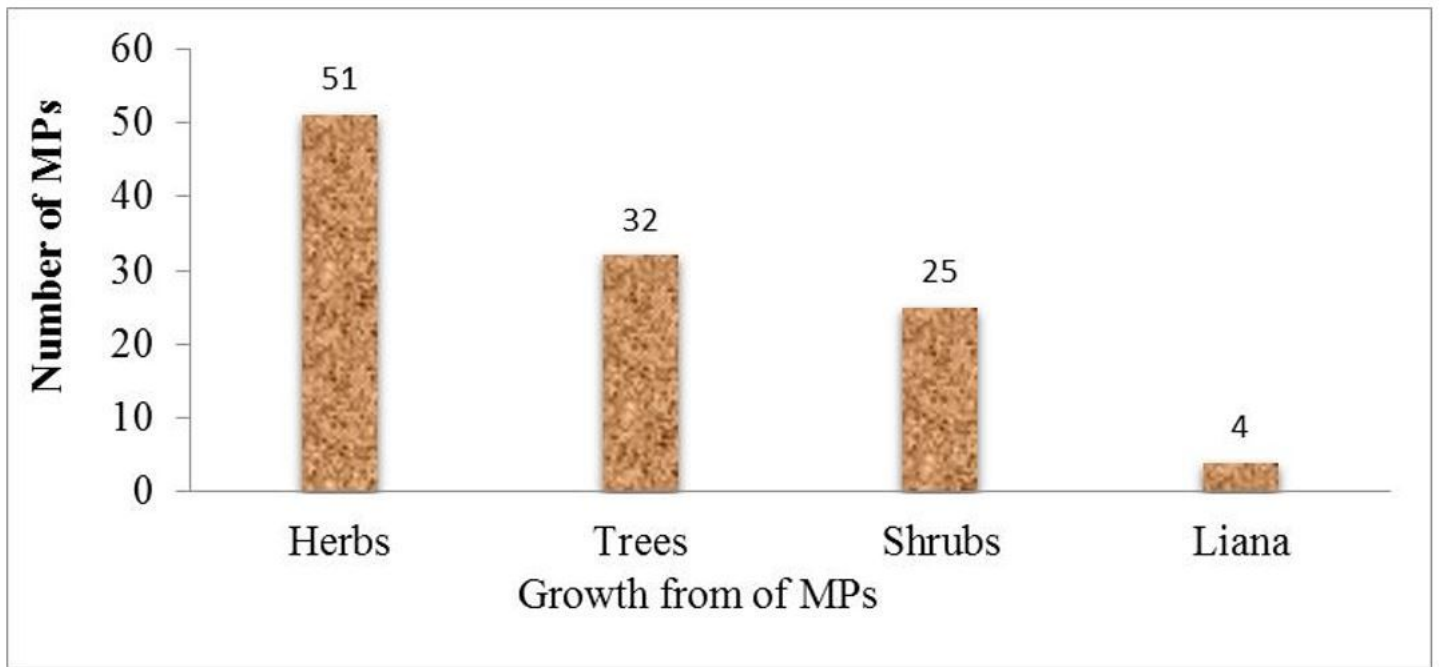


Figure 3

Habitats of MPs in the study area

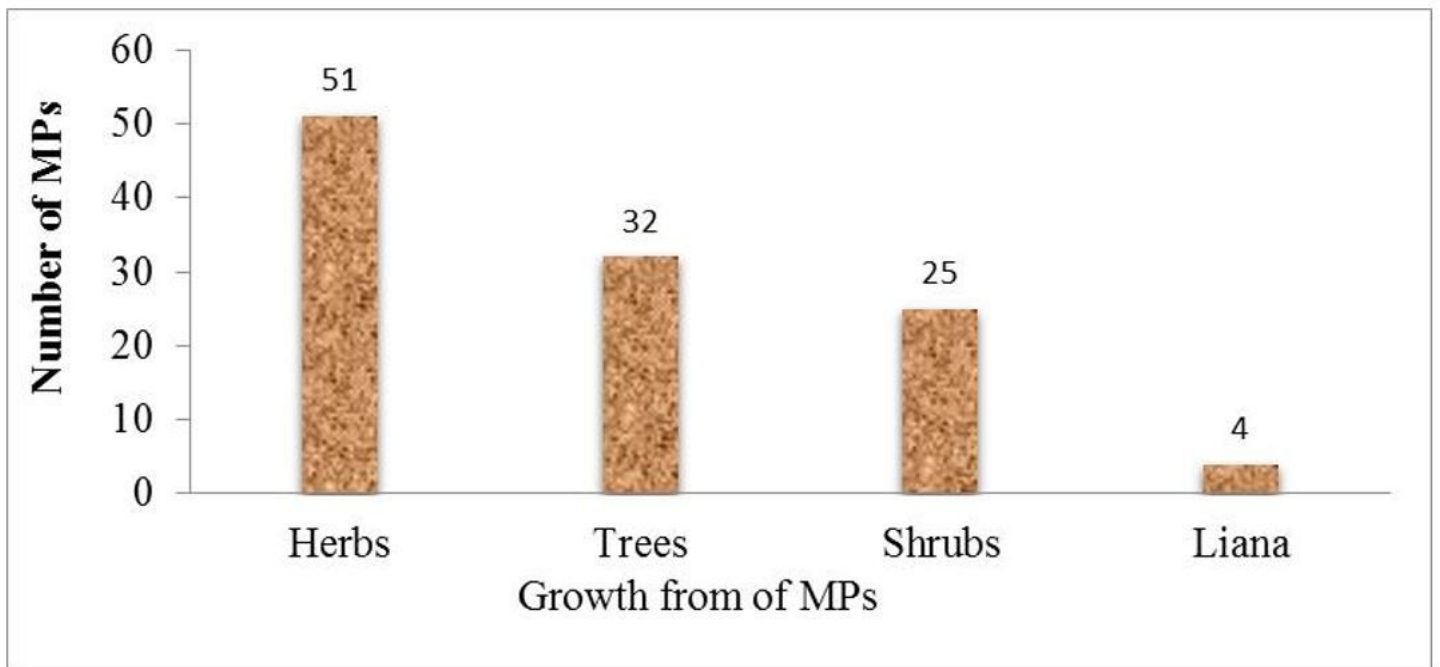


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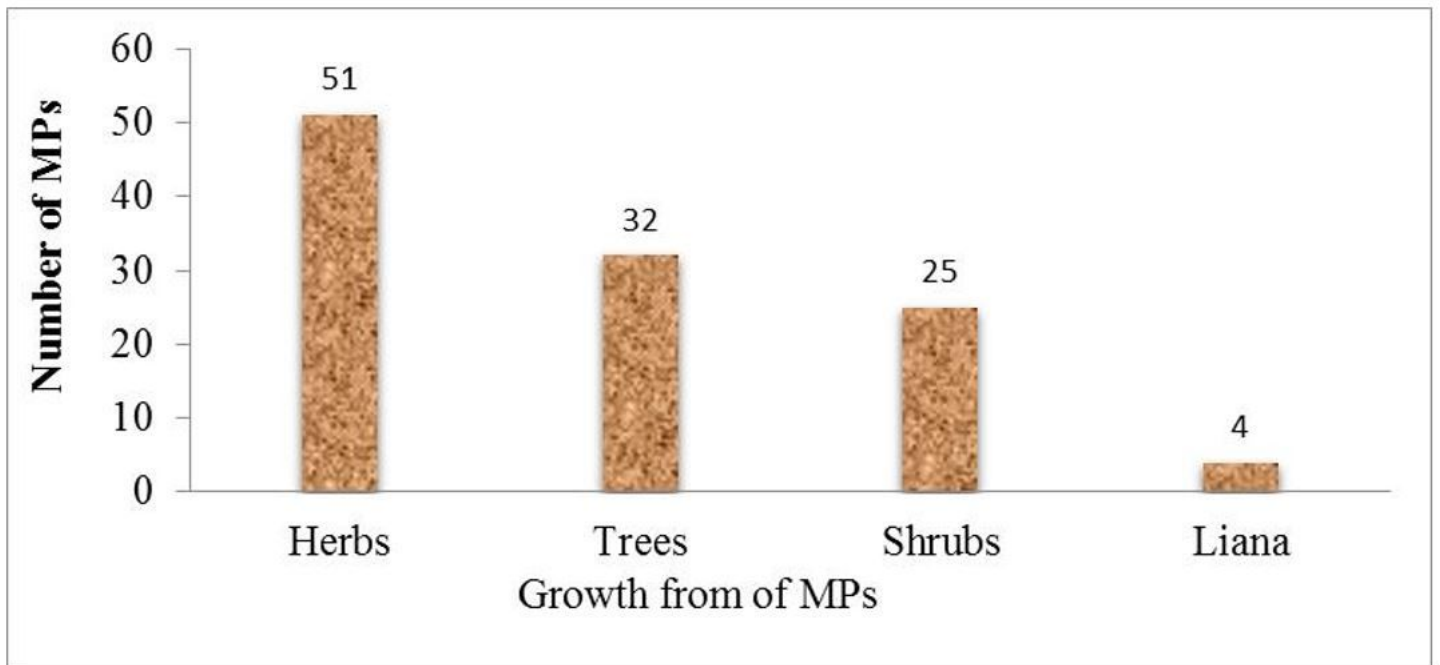


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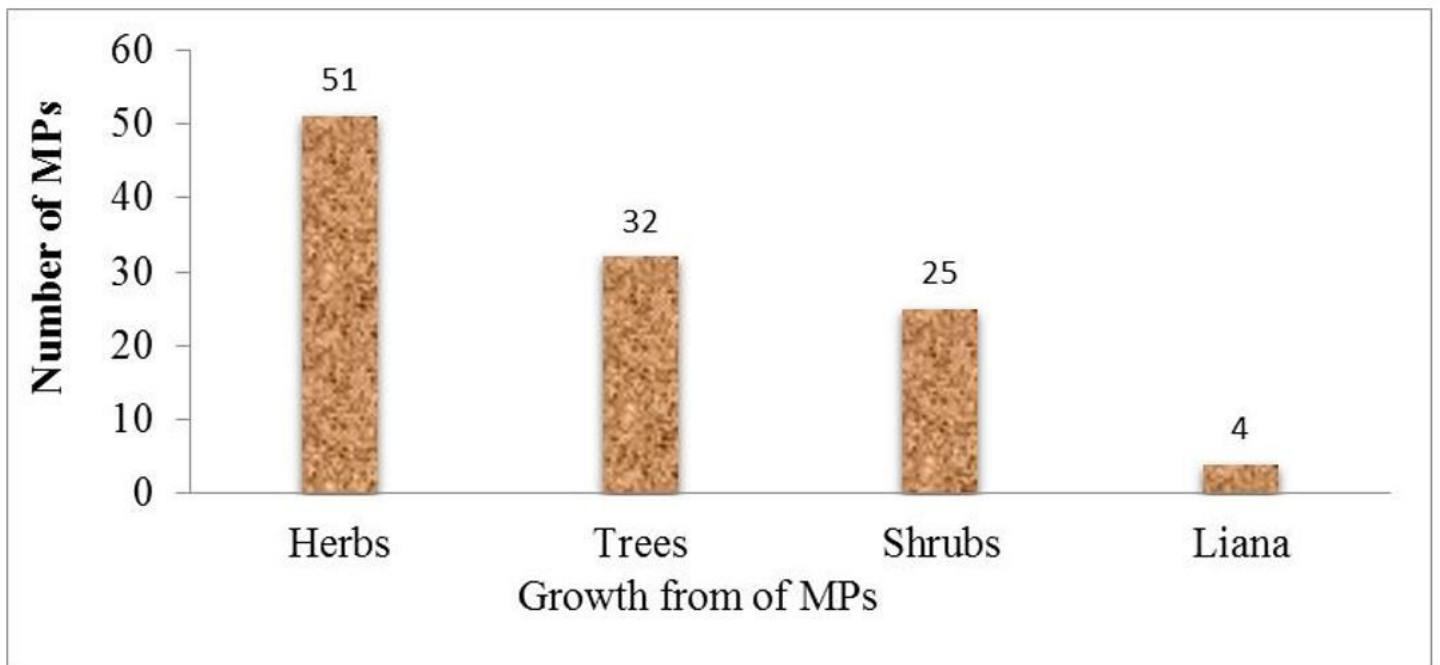


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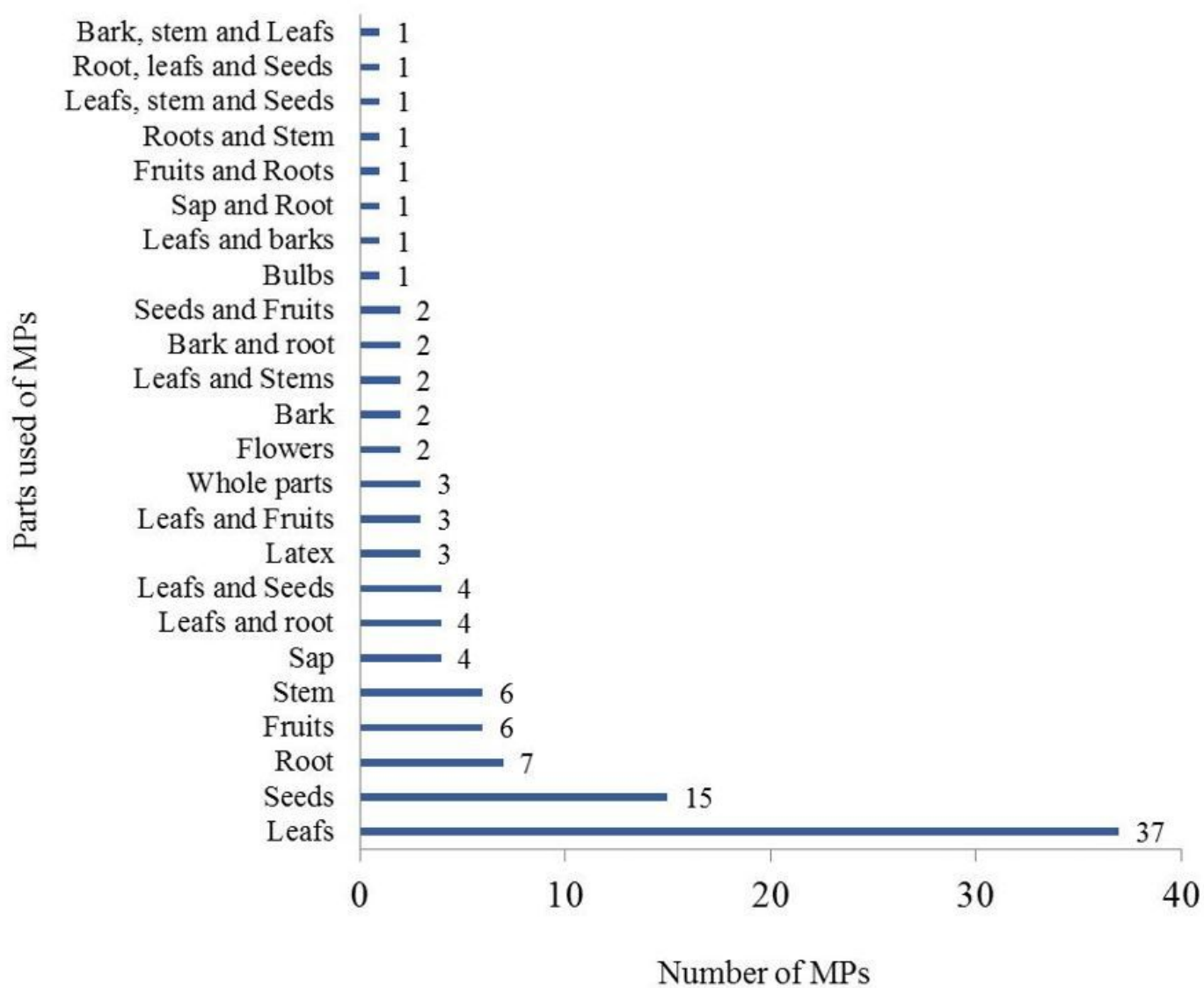


Figure 4

Plants parts used for preparation of medicine in the study area

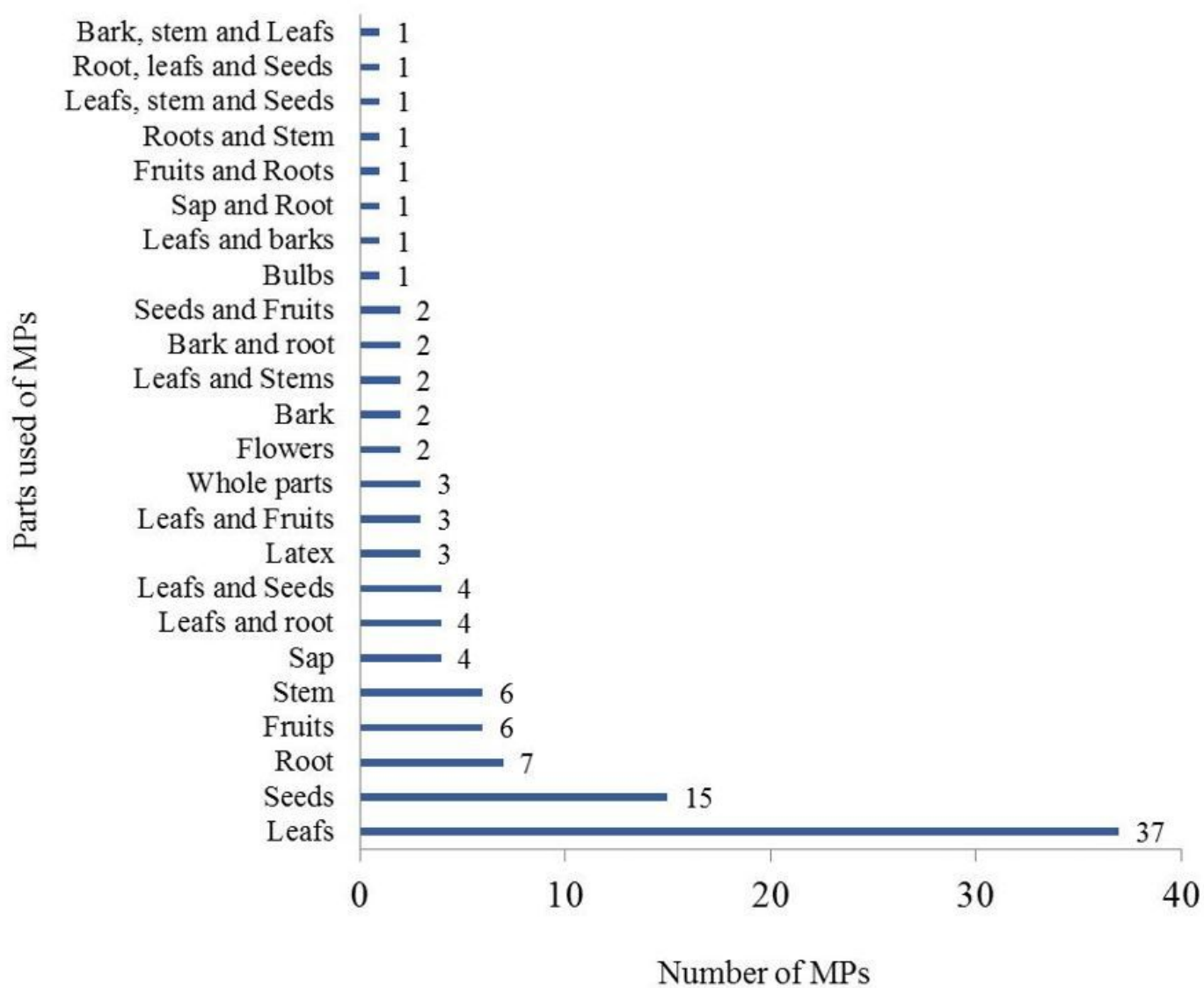


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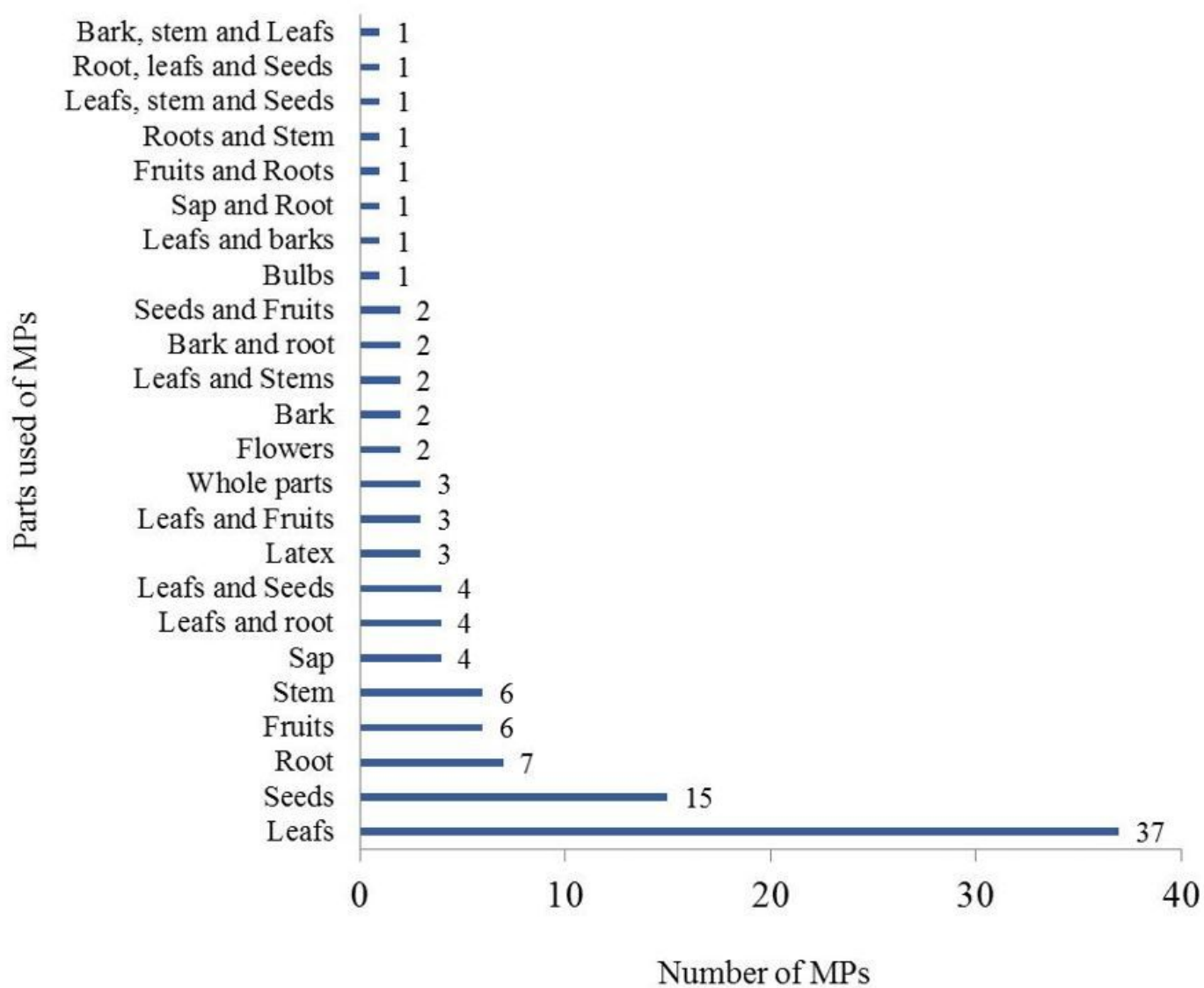


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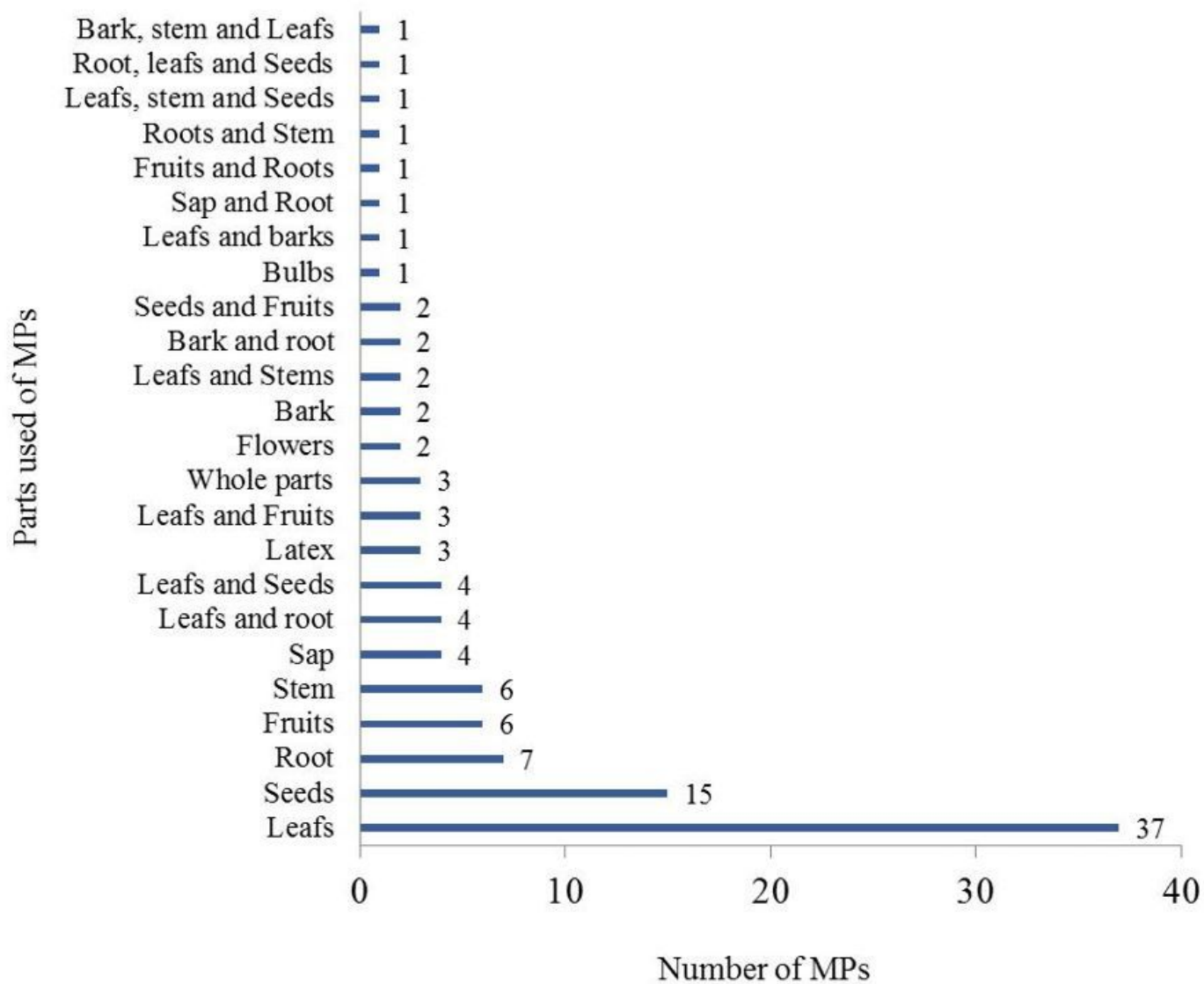


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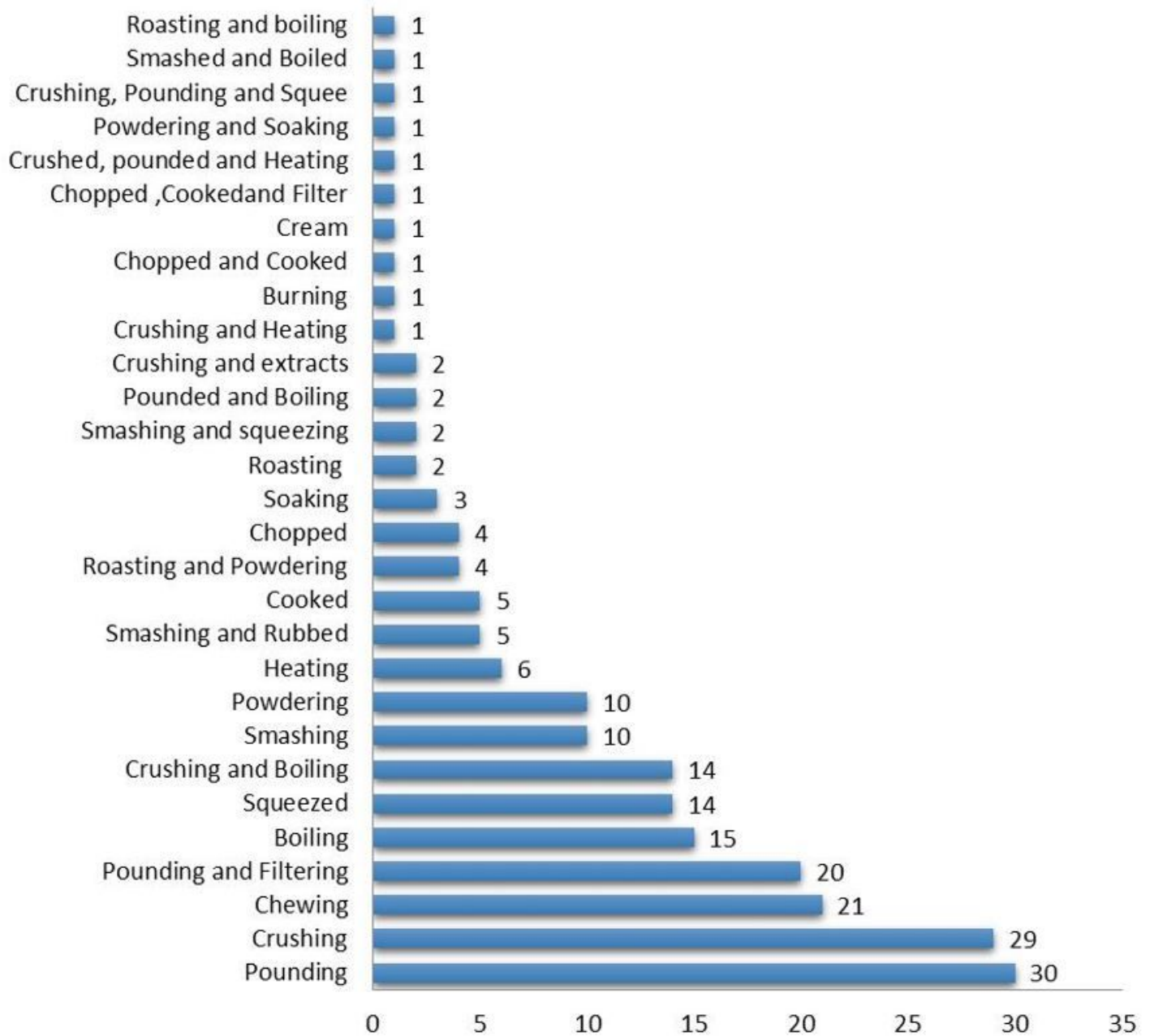


Figure 5

Modes of preparation of medicine from MPs used to treat both human and livestock

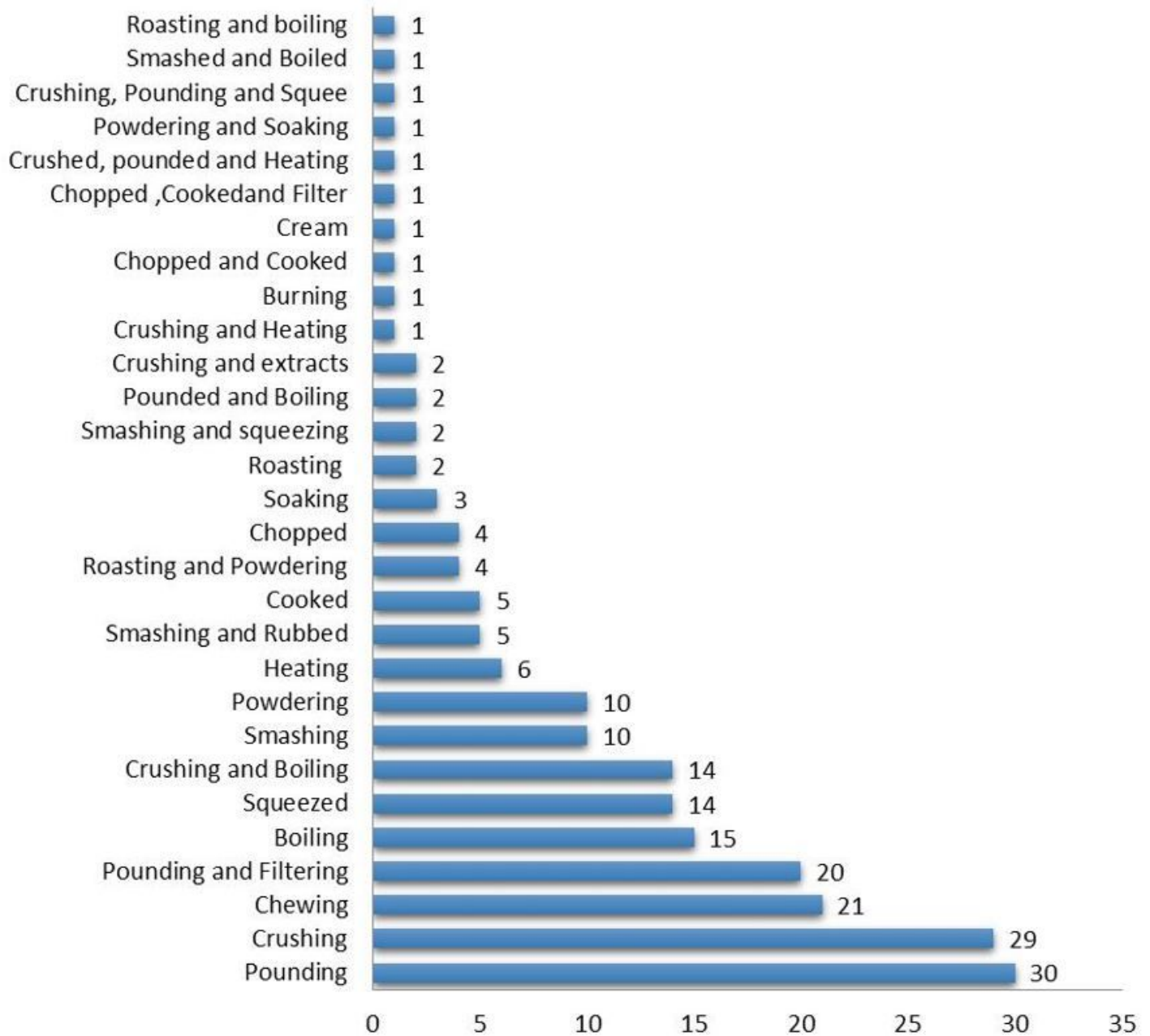


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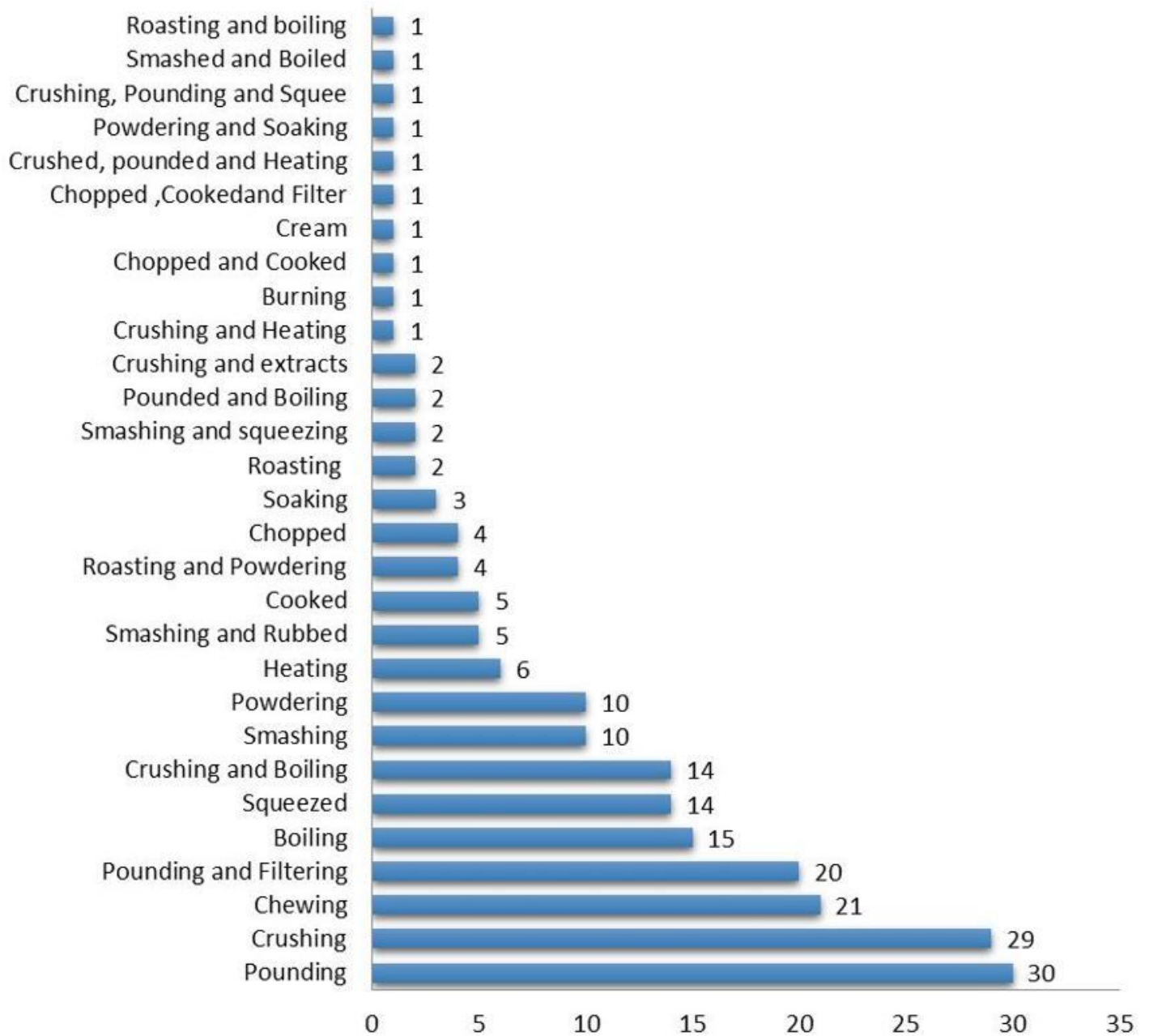


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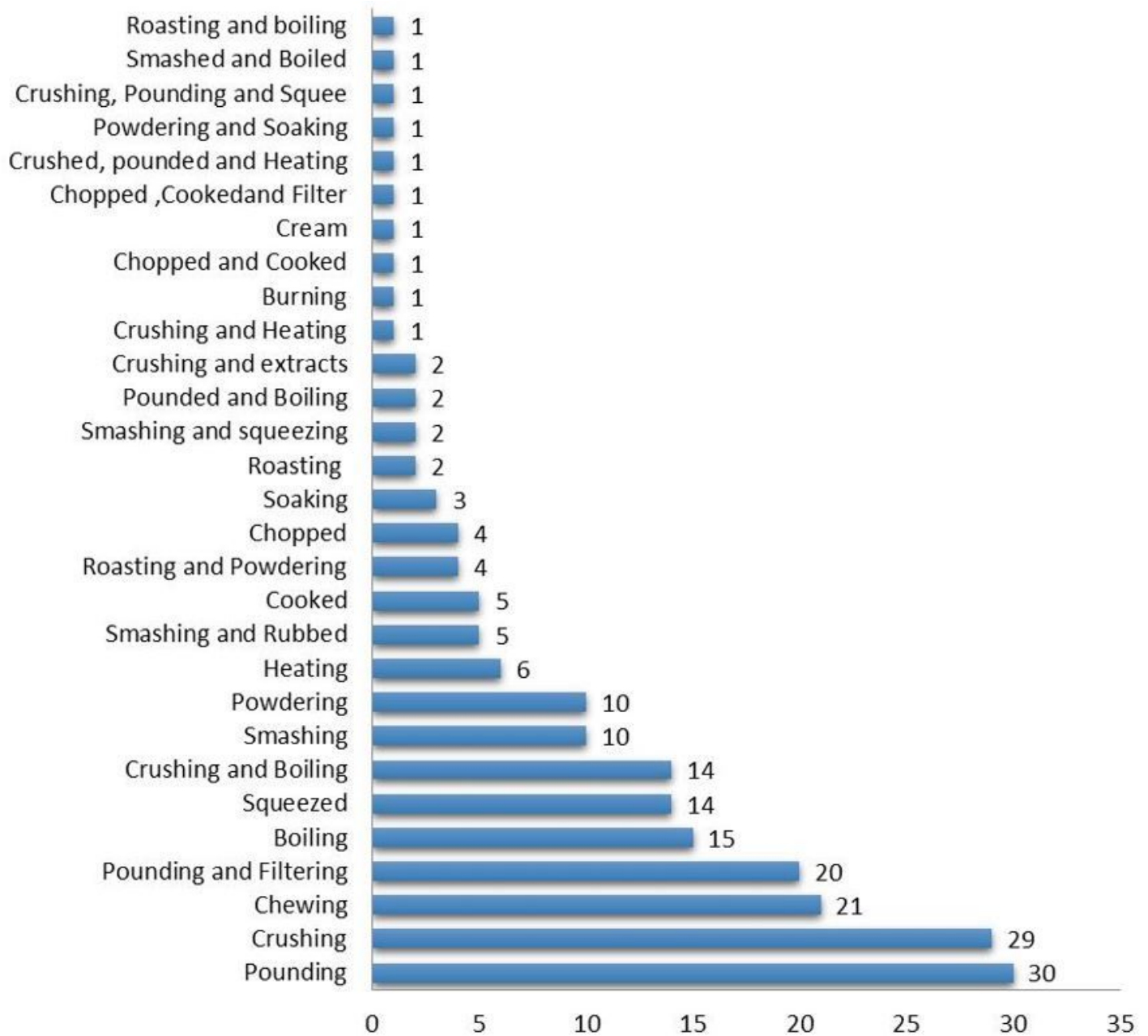


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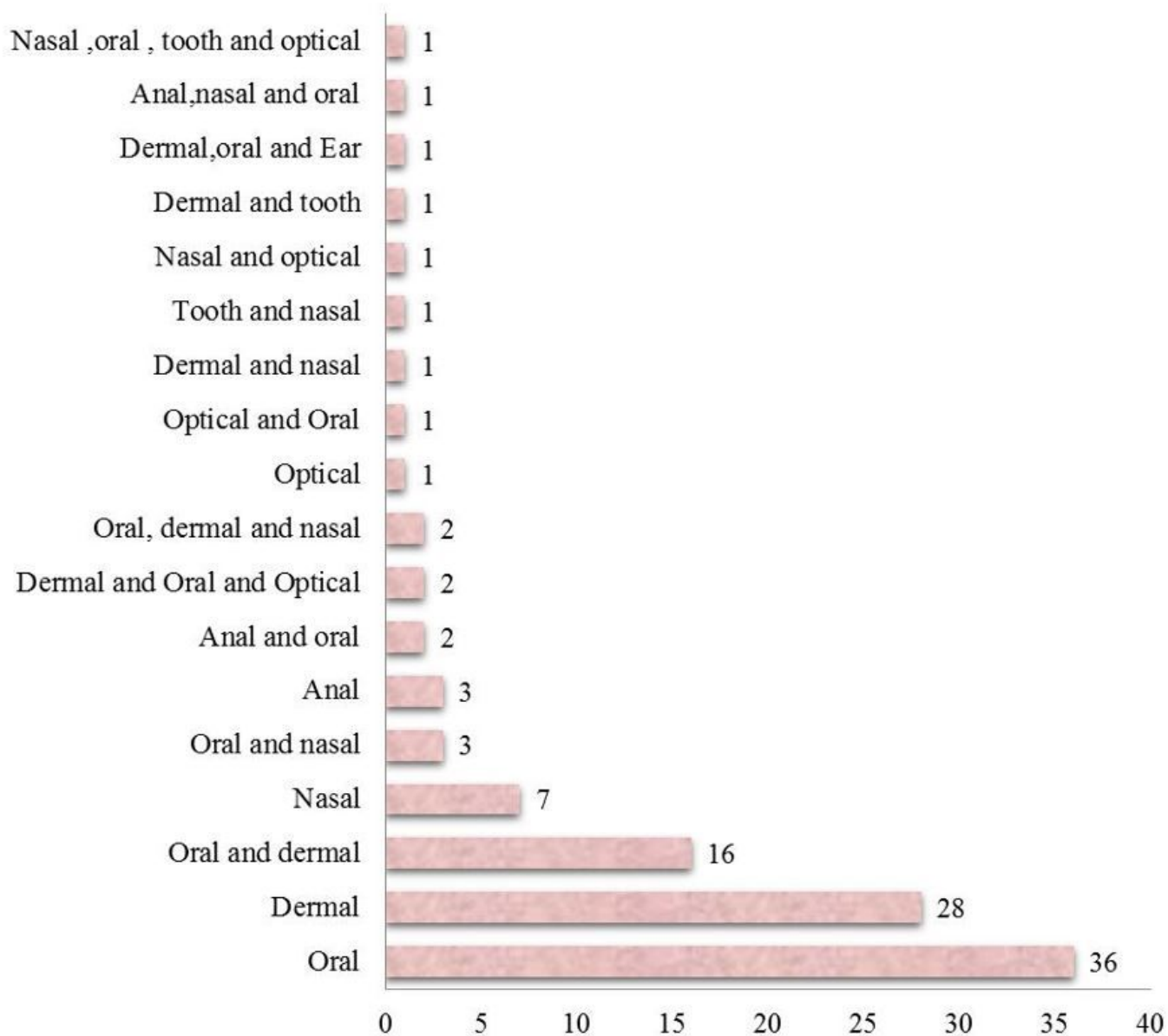


Figure 6

Routes of application of remedies in treating ailments in the study area

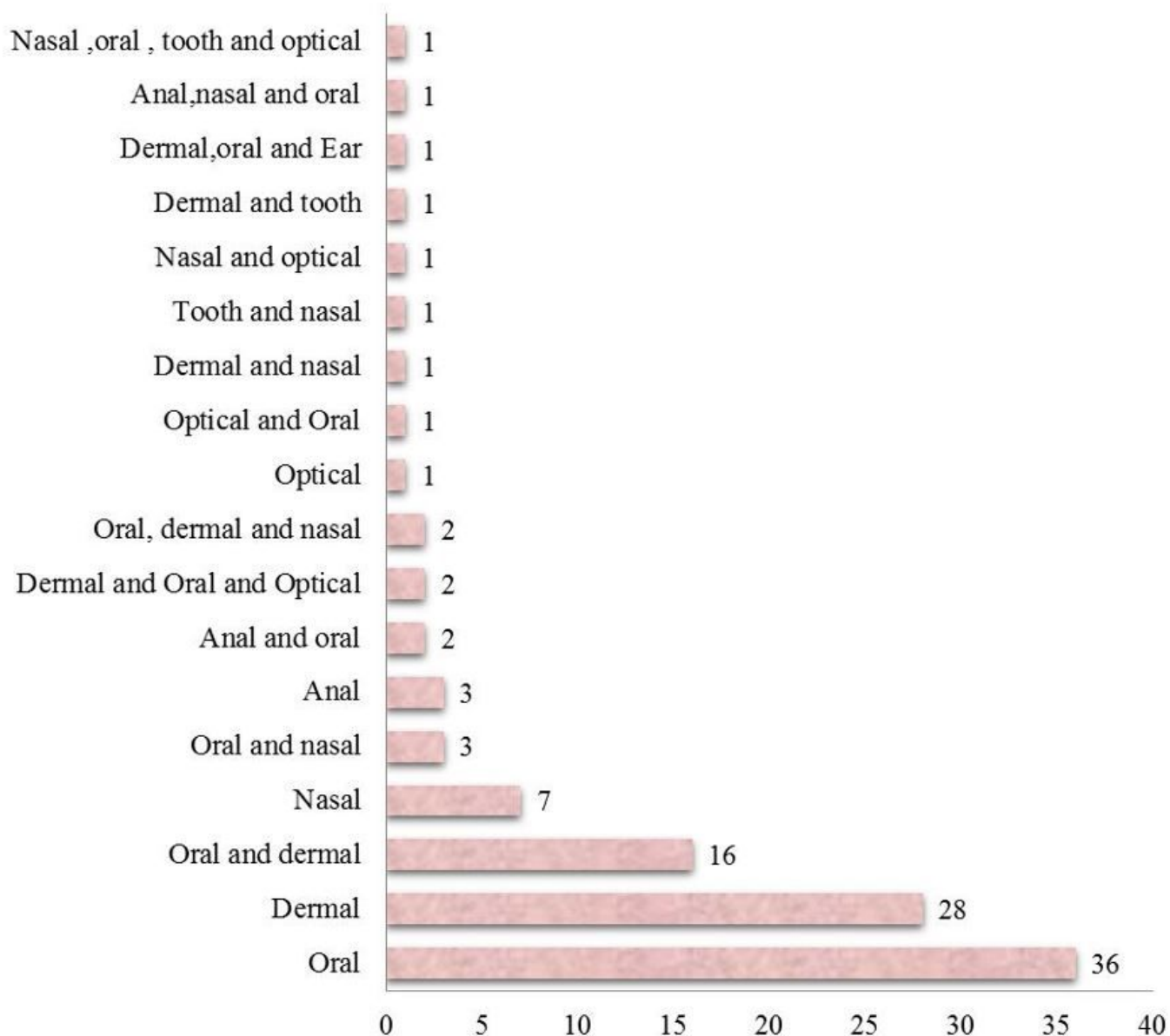


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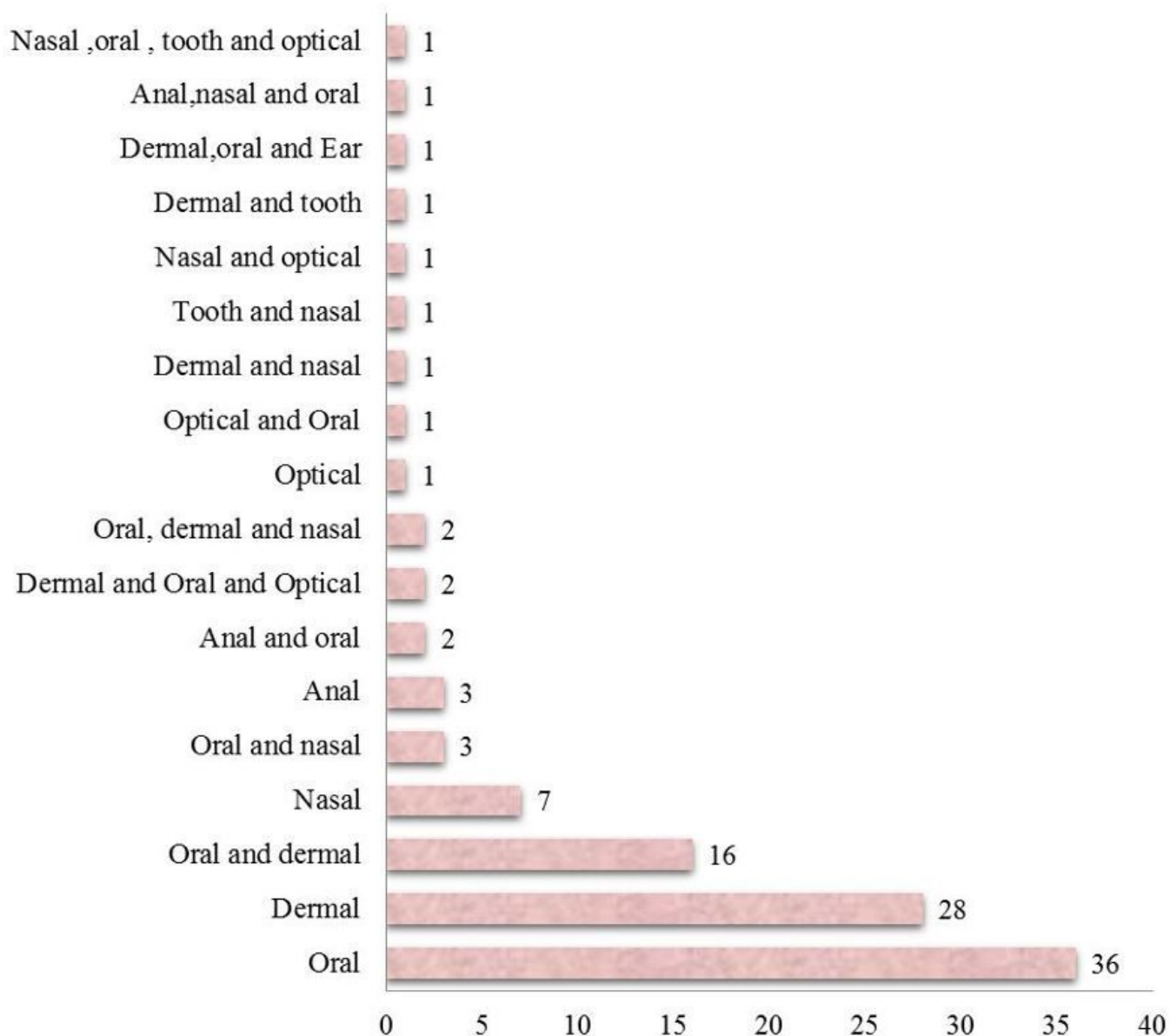


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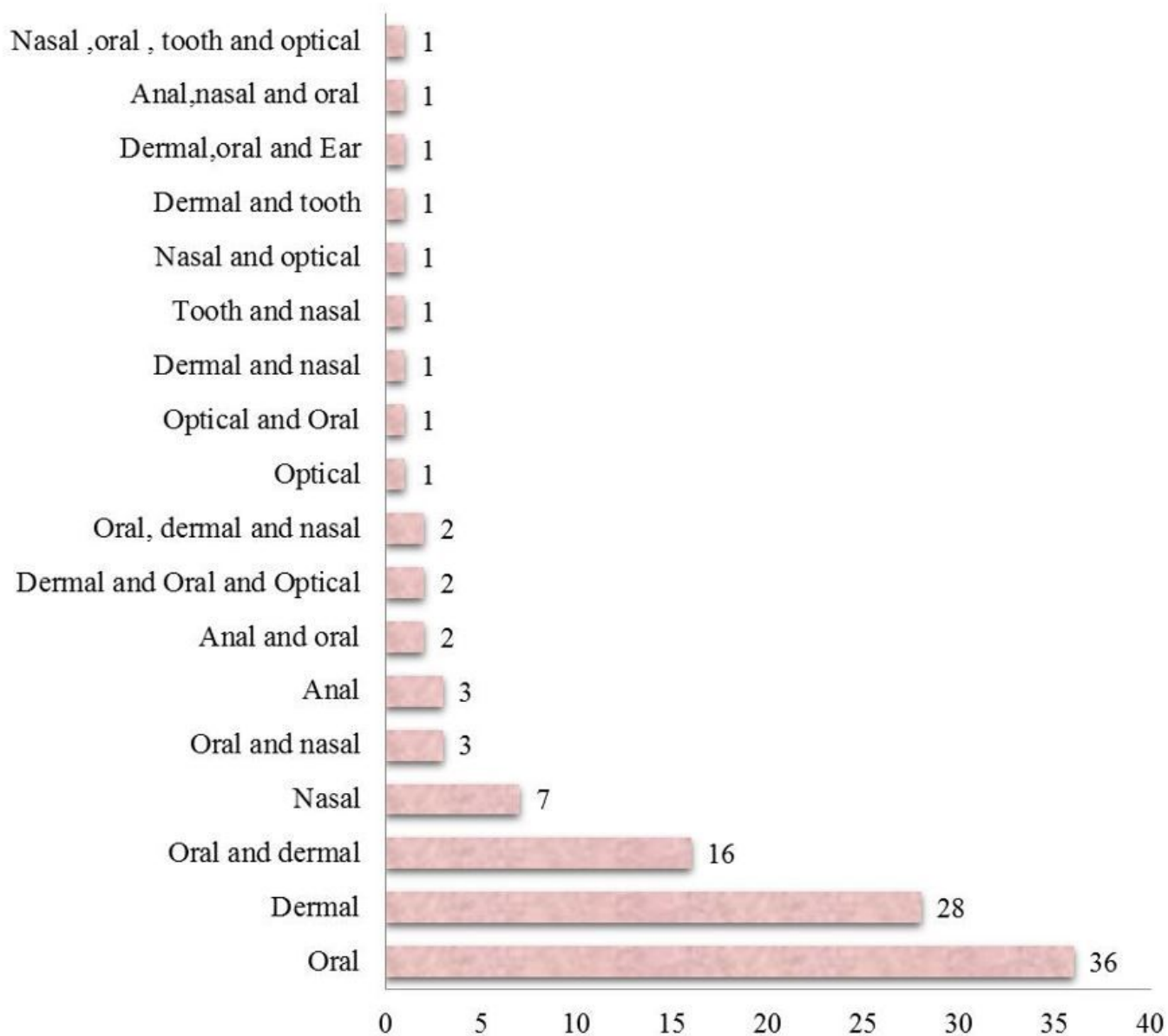


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Routes of application of remedies in treating ailments in the study area

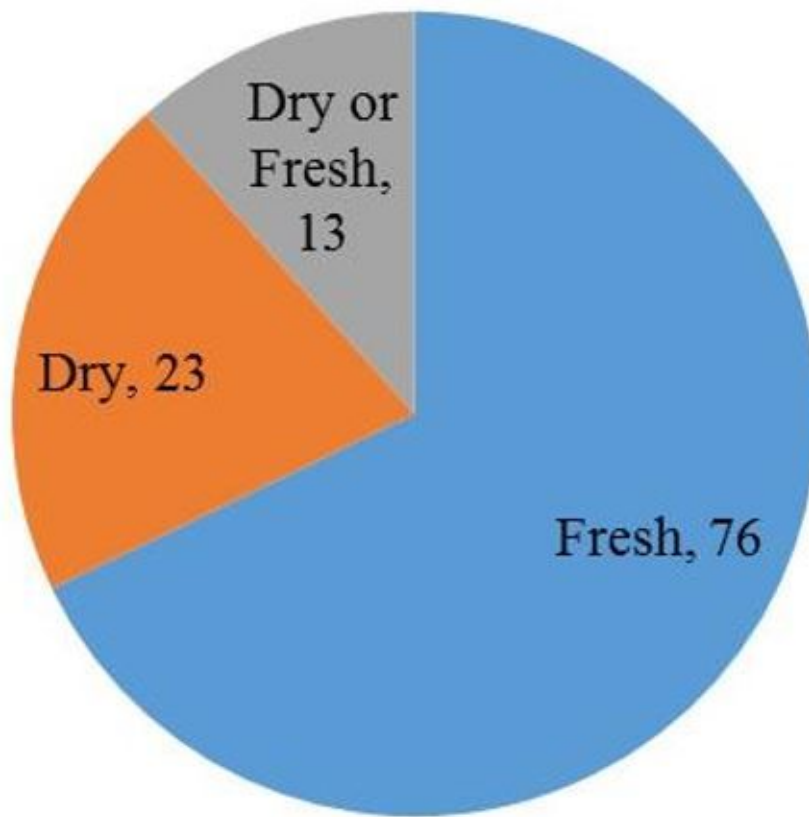


Figure 7

Condition of preparation of medicine to treat human and livestock in the study area

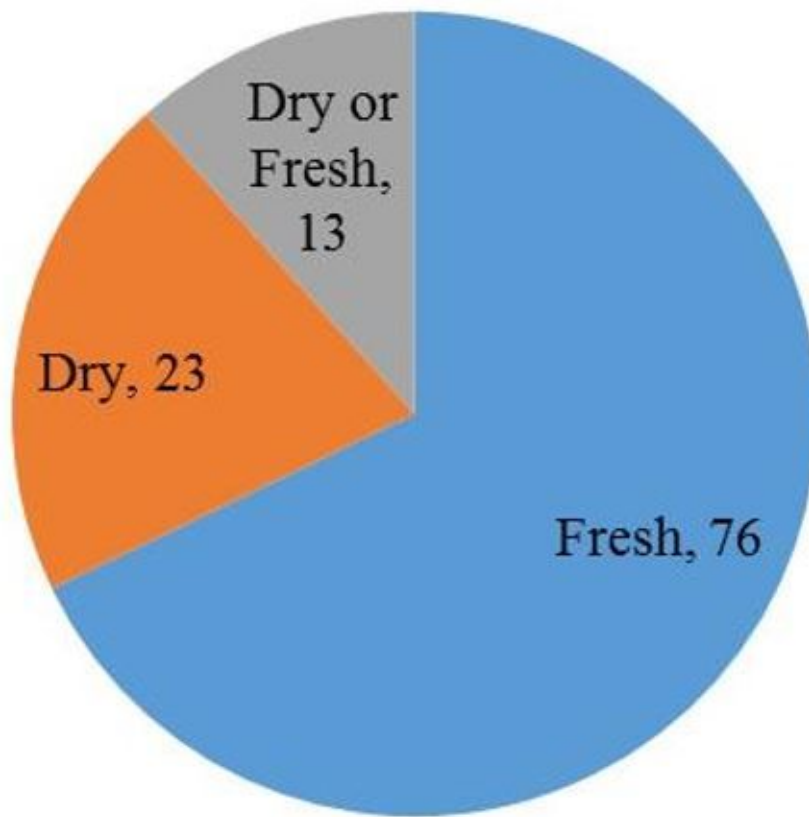


Figure 7

Condition of preparation of medicine to treat human and livestock in the study area

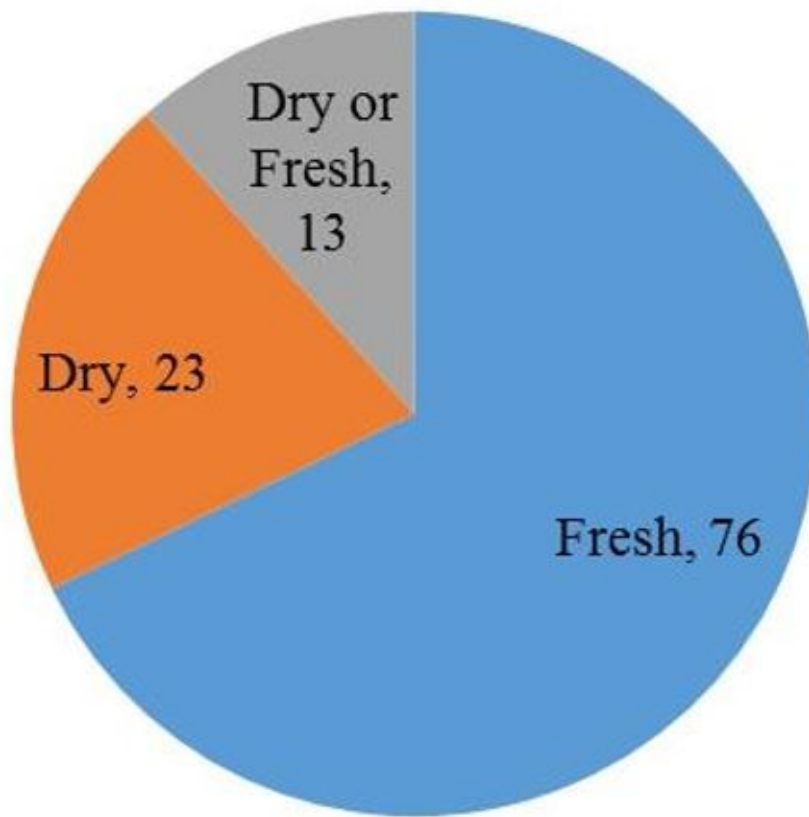


Figure 7

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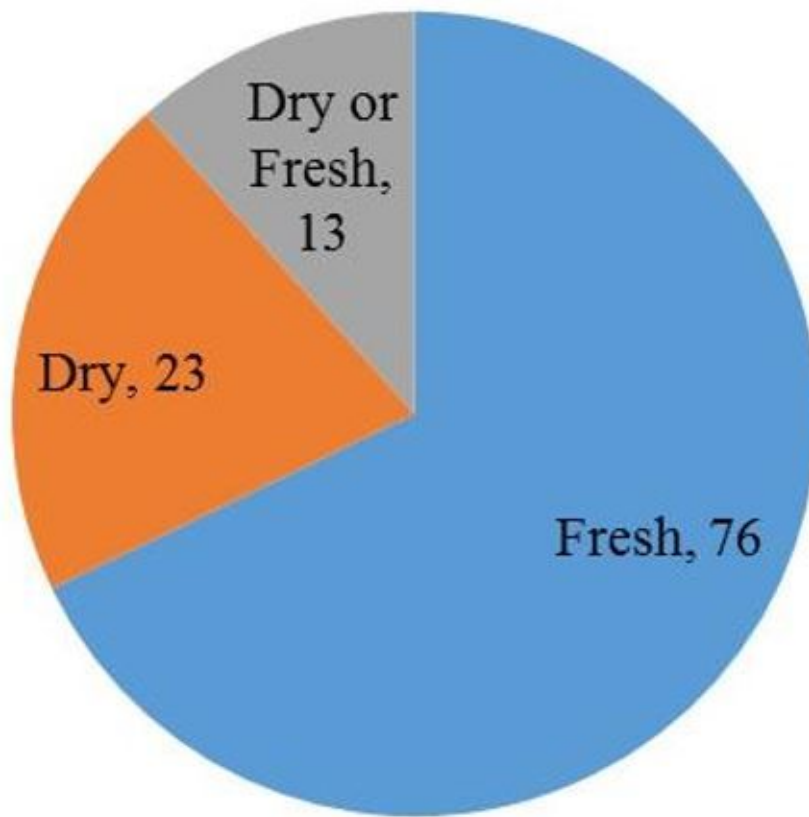


Figure 7

Condition of preparation of medicine to treat human and livestock in the study area

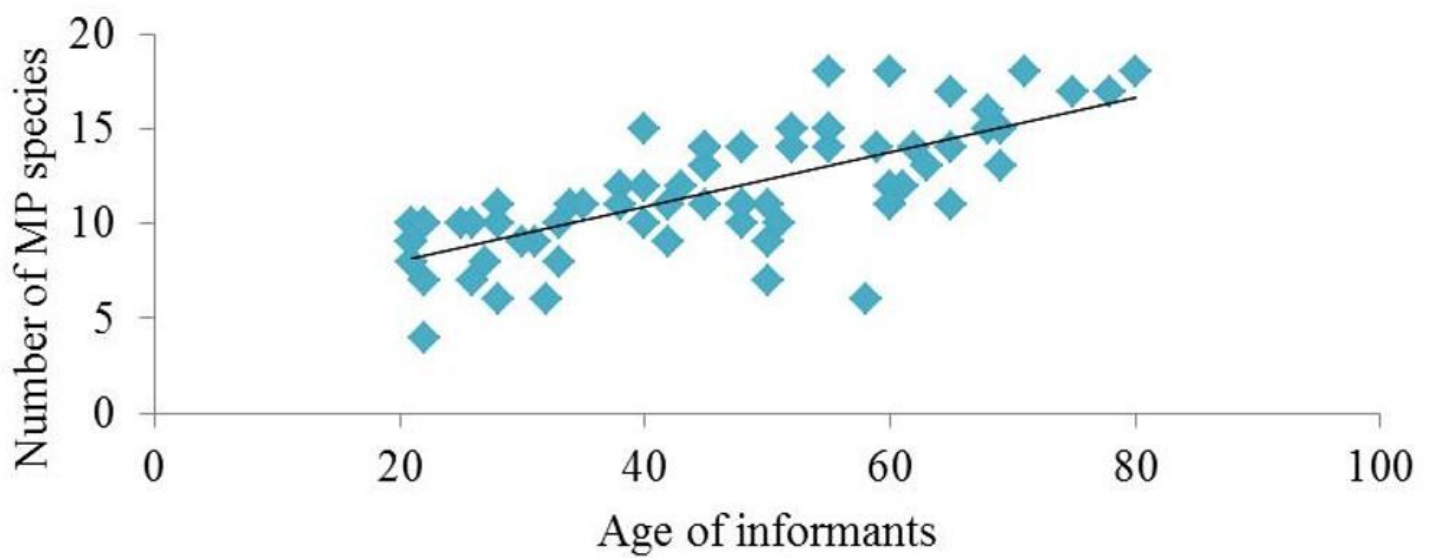


Figure 8

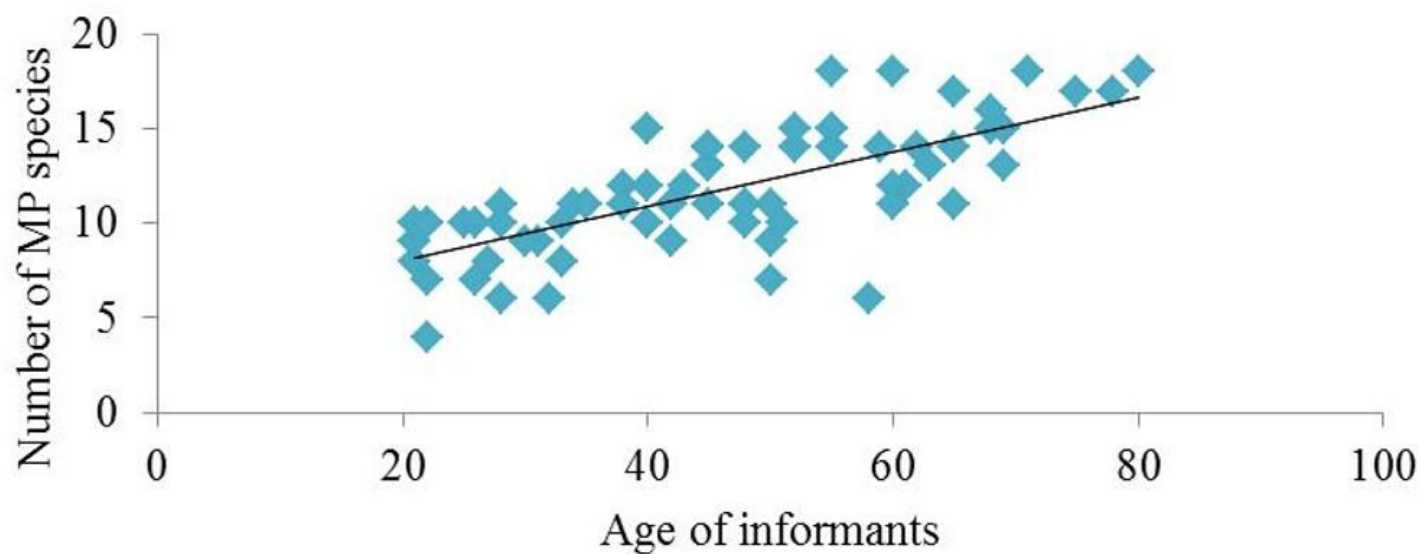


Figure 8

Distribution of MPs corresponding to age of respondents

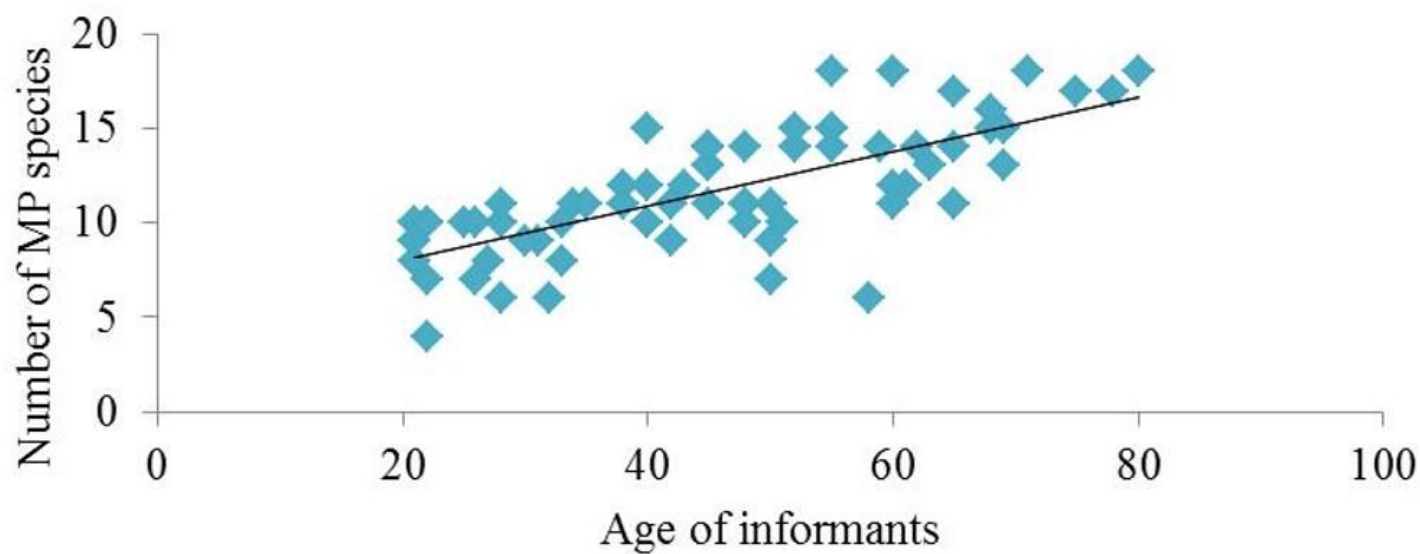


Figure 8

Distribution of MPs corresponding to age of respondents

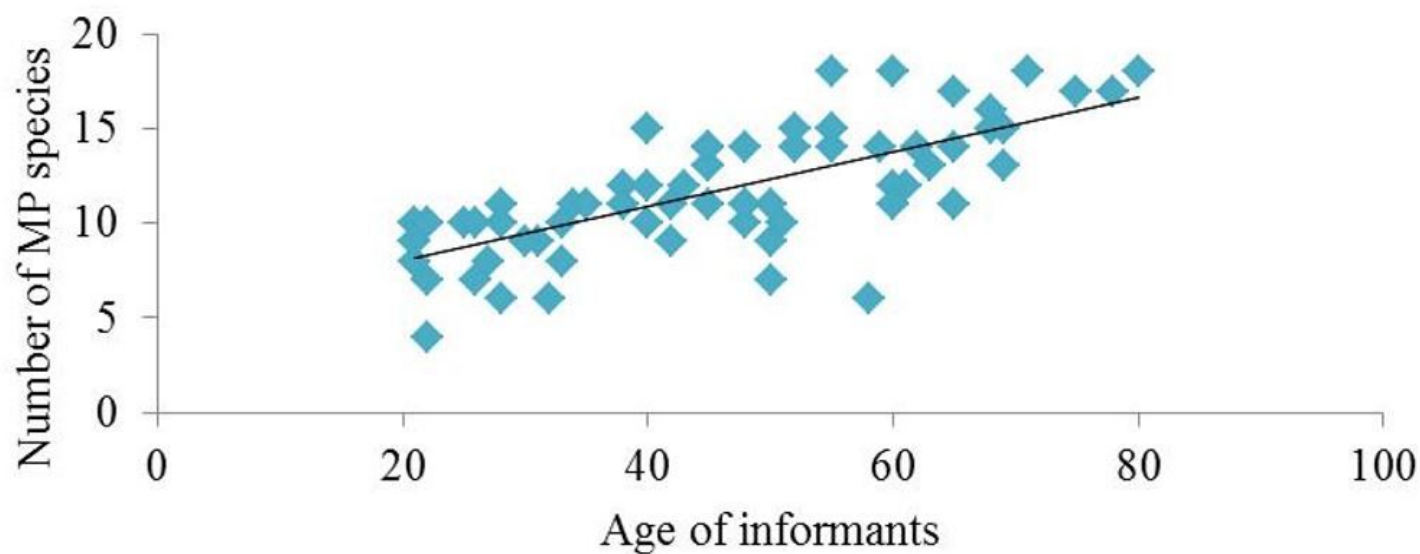


Figure 8

Distribution of MPs corresponding to age of respondents

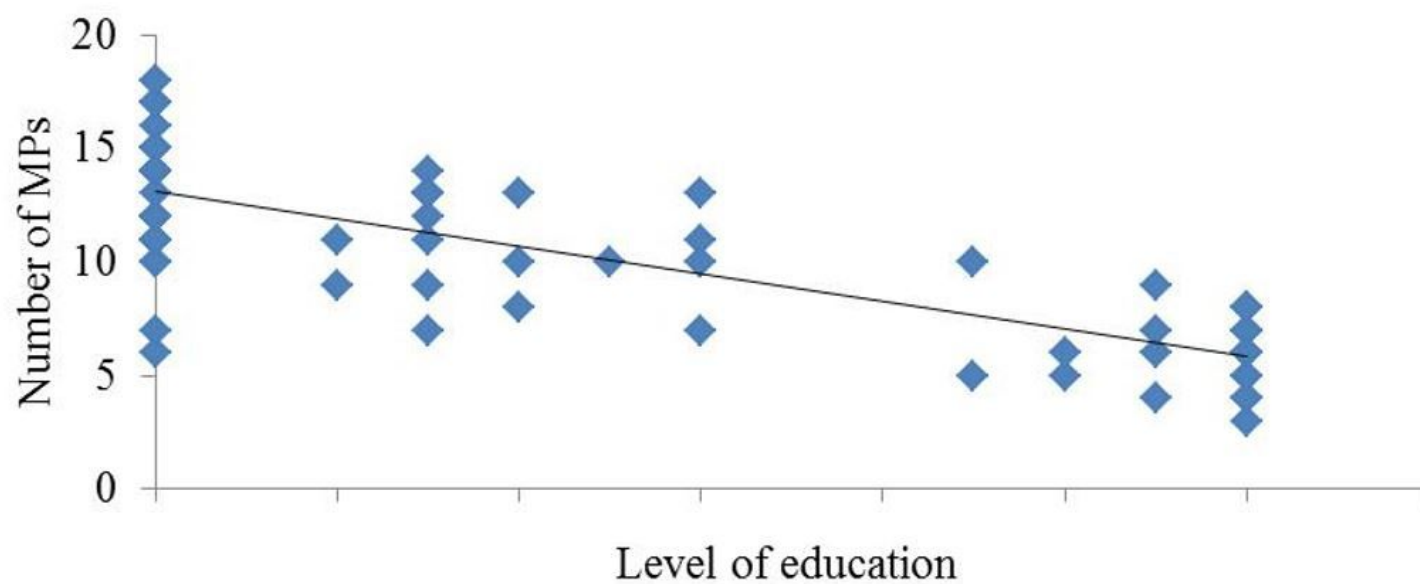


Figure 9

Distribution of medicinal plants corresponding to level of education of informants

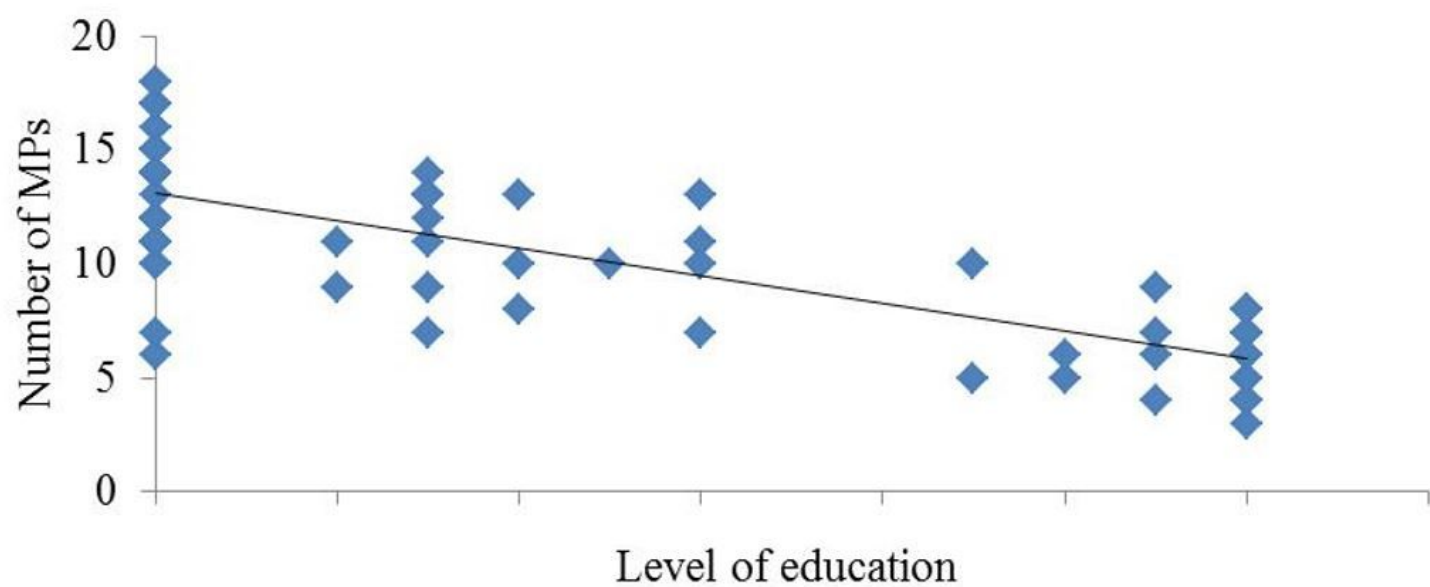


Figure 9

Distribution of medicinal plants corresponding to level of education of informants

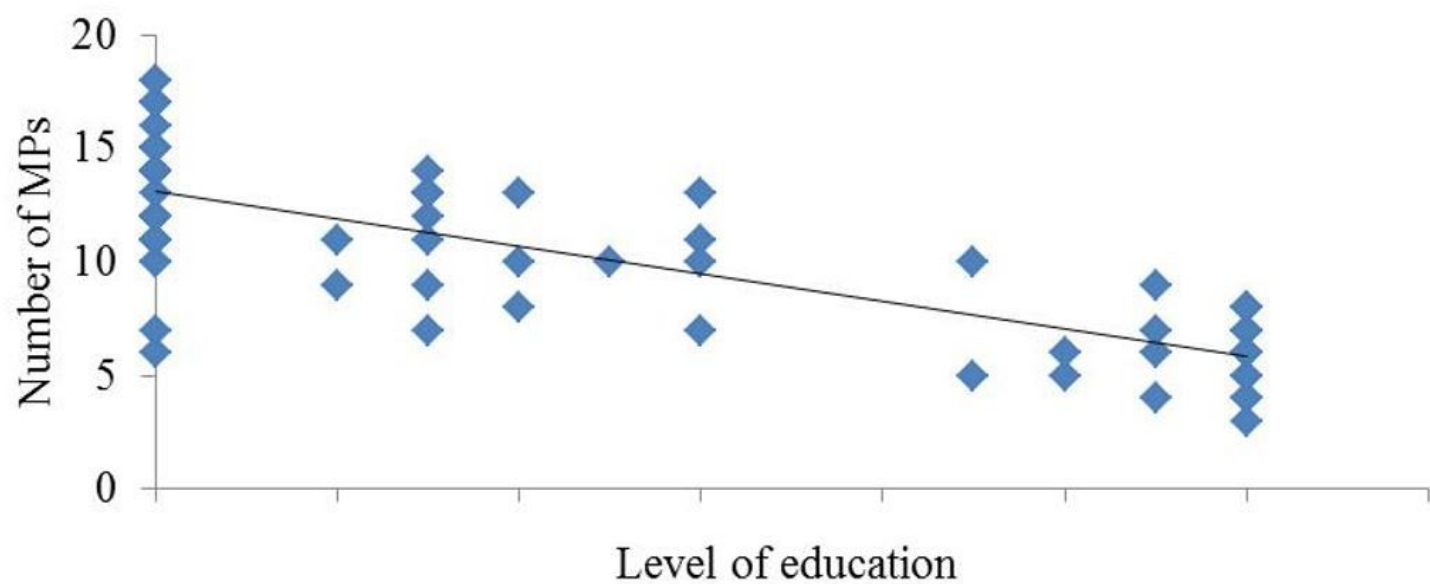


Figure 9

Distribution of medicinal plants corresponding to level of education of informants

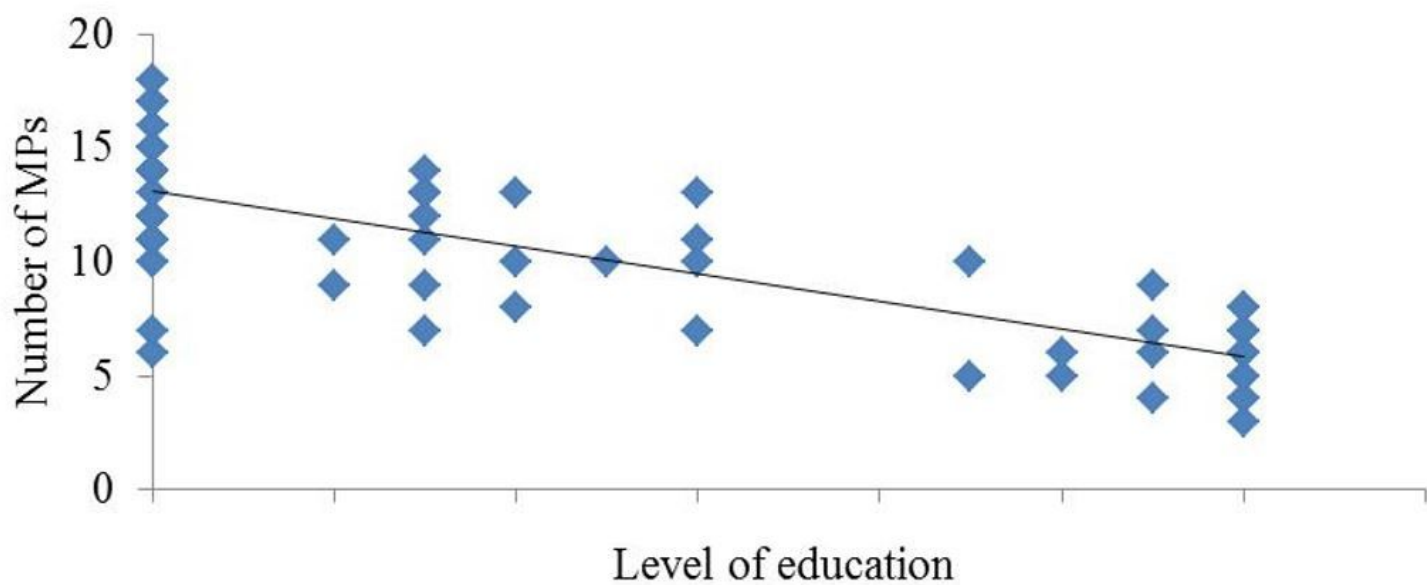


Figure 9
 Distribution of medicinal plants corresponding to level of education of informants

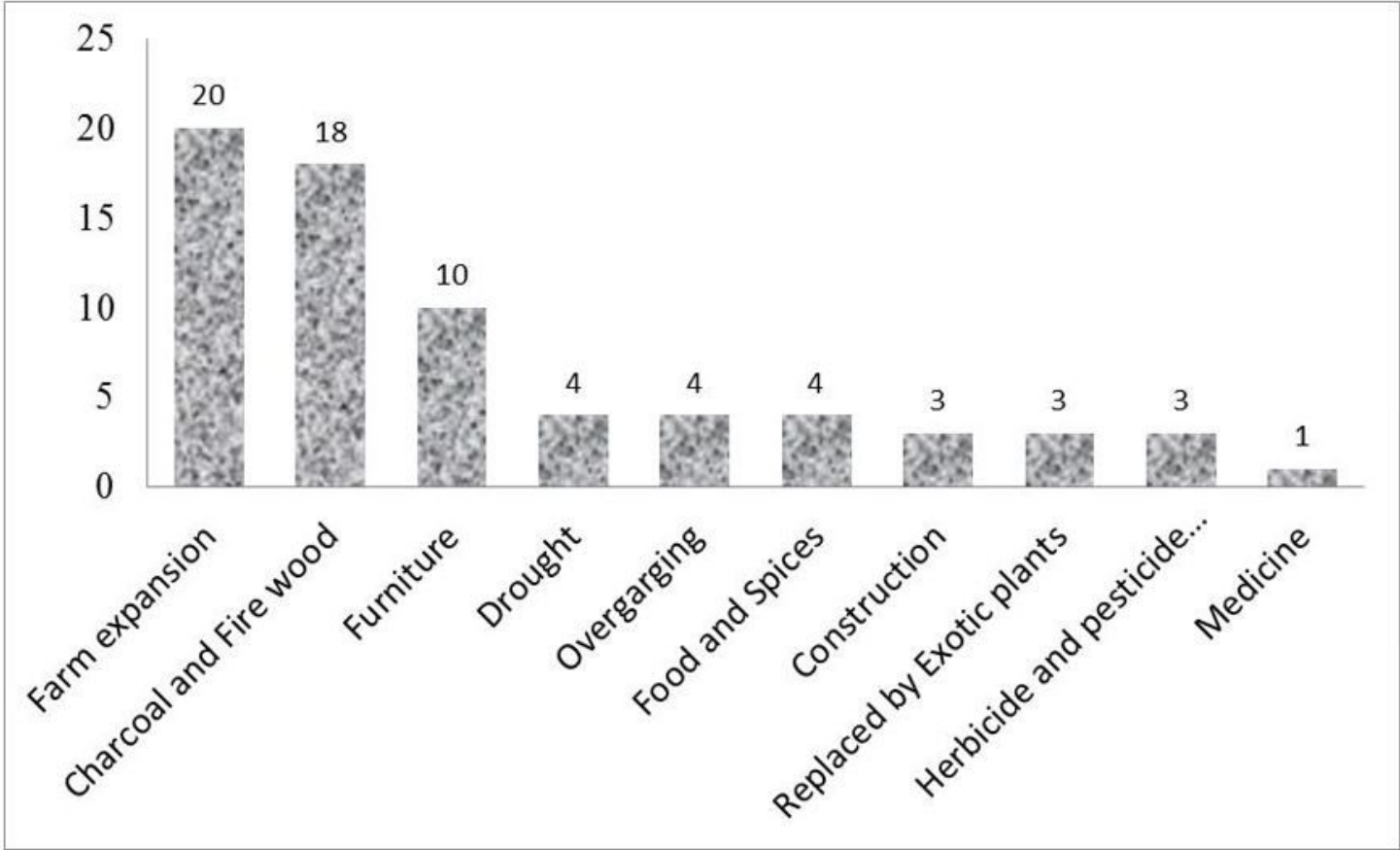


Figure 10
 Factors threatening MPs and number of respondents in the study area

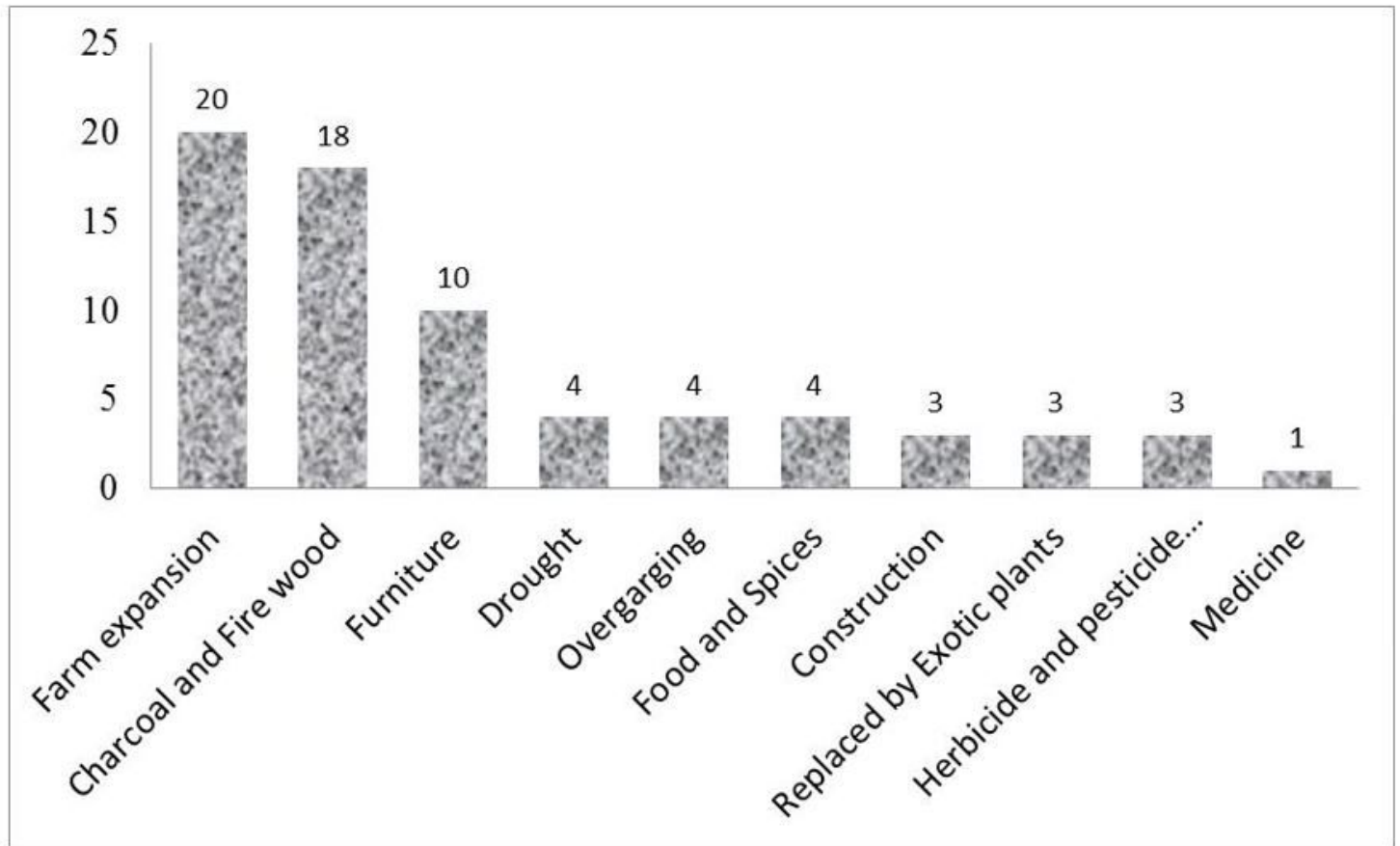


Figure 10

Factors threatening MPs and number of respondents in the study area

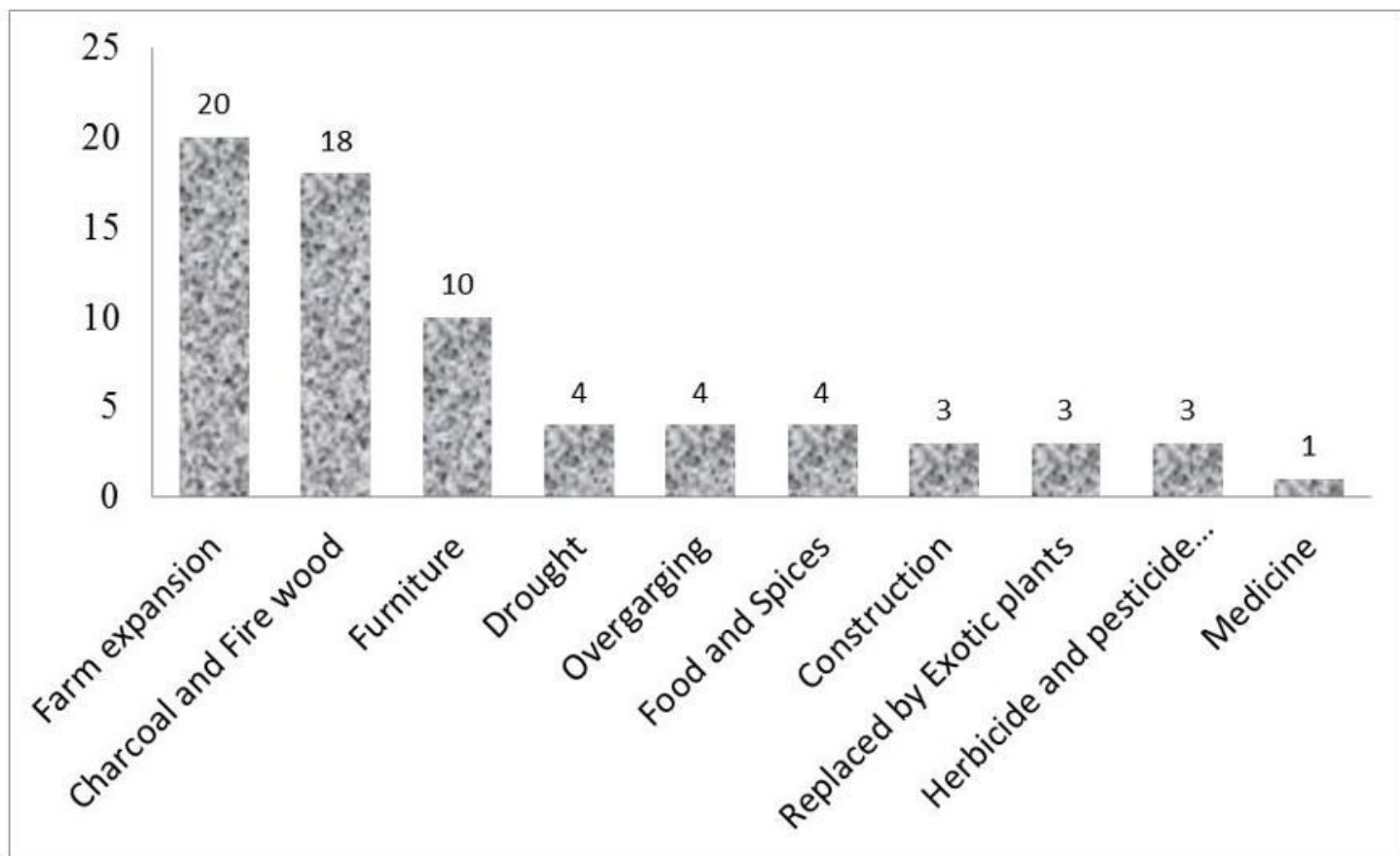


Figure 10

Factors threatening MPs and number of respondents in the study area

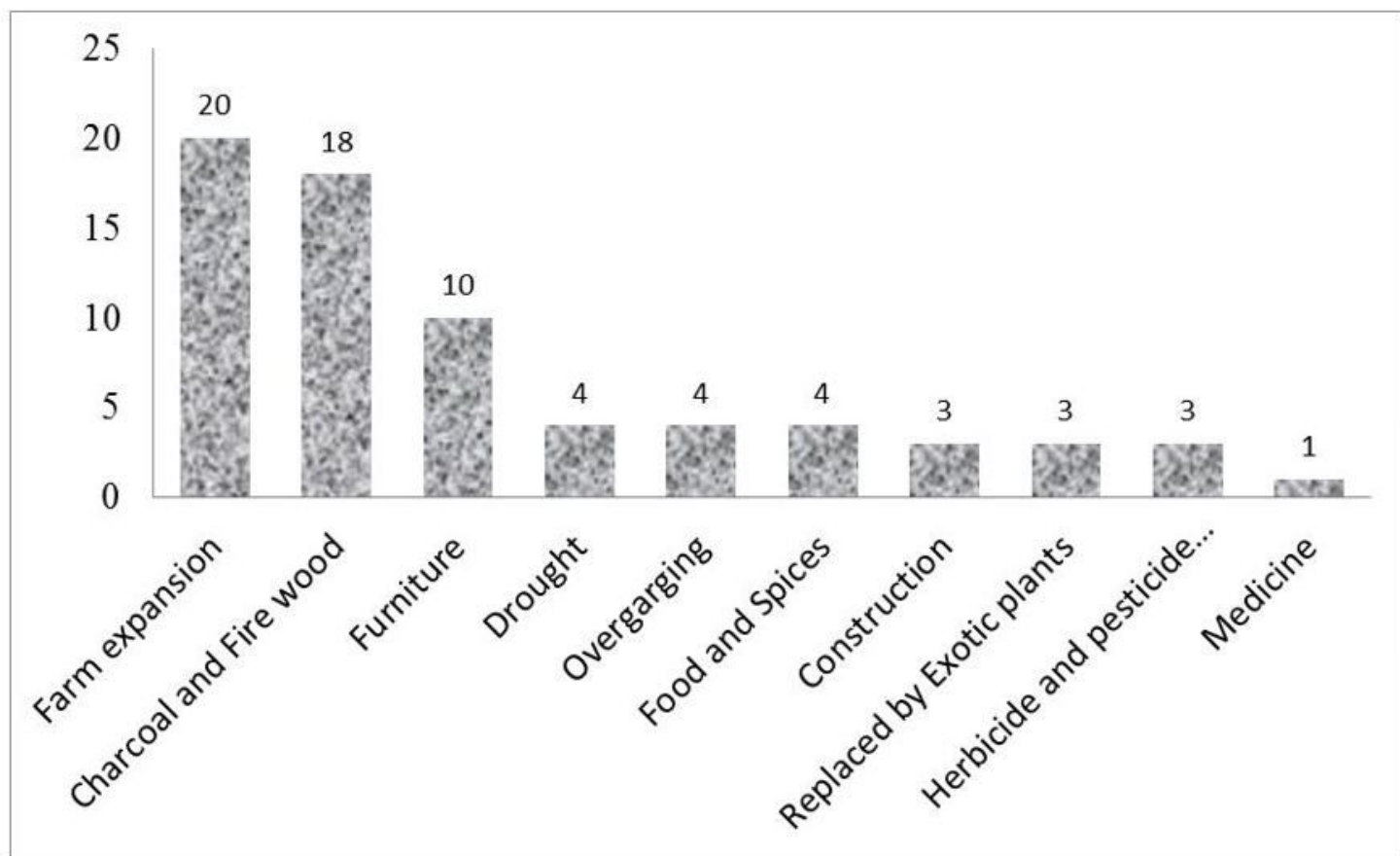


Figure 10

Factors threatening MPs and number of respondents in the study area

Supplementary Files

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