

An Ethnobotanical Study of Traditional Medicinal Plants Used to Treat Human and Livestock Ailments From Diguna Fango District, Wolaita, Southern Ethiopia

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Research Article

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Abstract

Background

Plants have been used as a traditional medicine for many years for the people of Wolaita, Ethiopia. The aim of the study was to record these local knowledge of the peoples who inhabit the Diguna Fango district.

Methods

A semi-structured interview was conducted with a total of 60 informants.

Results

Totally, 50 species belonging to 24 families were identified to treat 28 human and livestock ailments. Solanaceae (14.3%) was the most abundant family whereas; the rosaceae (1.00) had the highest family use value (FUV). Most of the plants (82%) were reportedly used to treat human diseases. Herbs (34%) were the dominant growth habits, followed by trees (33%). The leaves (30%) were identified as the most used plant part. The most common methods of remedy preparations were eating and chewing (18.2% each) followed by grinding (13.61%). Oral (73.3%) was the major route of administration, followed by dermal (21.7%). The cardiovascular system diseases category (1.00) had a higher informant consensus factor value followed by the fever disease category (0.90). *Croton macrostachyus* Hochst. ex Delile, *Commelina benghalensis* L., *Triticum dicoccon* (Schrank) Schübl and Pentas spp. (100%) had a higher fidelity level to treat swelling, chirt (skin diseases), weight gain, and bone fractures, respectively. *Persea americana* Mill. was ranked highest as the most preferable medicinal plant for various purposes by local people, followed by *Acacia abyssinica* Benth. The principal threatening factors reported were charcoal production (26%), agricultural expansion (15%), and firewood (14%). Out of the plants and their uses documented, 16% of the medicinal plants and 28.6% of the uses were novel.

Conclusions

The present study indicated the existence of indigenous knowledge of medicinal plants to treat human and livestock ailments. Therefore, there should be mentoring for the local people in the study area to conserve their indigenous knowledge and resources.

Introduction

Human beings have relied on nature for their basic requirements as the source of medicines, shelters, food, fragrances, clothes, flavors, fertilizers, and means of transportation throughout their lives. Well before the prehistoric era, plants were used for medicinal purposes to treat and cure diseases and to improve the health and well-being of humans and livestock. The majority of the populations in most of the developing countries depend on plants for primary healthcare [1] [2]. The medicinal plants are the source for the discovery of novel drugs and a quarter of the modern drugs contain one or more active principles of plant origin [3] [4]. According to Ohigashi [5], the top 25 best-selling medicines in the world originated from plant materials and still form the basis for modern health systems. The significance of medicinal plants to human livelihoods is essentially immeasurable [6].

In Ethiopia, 80% of the people use medicinal plants and their products for remedies. However, the knowledge and use of plants in many ethnic rural cultures has not been studied [7] [8]. Even though, medicinal plants are remaining the most important and sometimes the only source of therapeutics [9]. The community utilizes roots, barks, and other parts of the plant to make phytotherapies [10] and in the process they have developed their own local knowledge. This knowledge is transferred orally from one generation to the others via herbalists and well-informed elders. The traditional local doctors would be the best source of information about the medicinal values of the plants. Many practicing local doctors are still present in Ethiopia but, with the progress of modern medicine, the influence and the number of those doctors are decreasing rapidly.

Despite their use as a source of medicine since time immemorial, the study and recording of medicinal plants has recently begun [11]. A few studies have been conducted and documented the medicinal properties of locally available plants, parts used, and ways of applications in southern Ethiopia, Assegid and Tesfaye [12] in Benna Tsemay district, Chama [13] in Damot Woyde district, Mirutse *et al.* [14] and Giday *et al.* [15] in Sheko, Agisho *et al.* [16] in Hadiya zone, Hailemariam *et al.* [17] in Konta special woreda, Tolossa *et al.* [18] in South Omo, Melesse *et al.* [19] in Kambata, Regassa [20] in Hawassa city, Tefera and Kim [21] in Hawassa zuria district, Tuasha *et al.* [22] in Dalle district, Sidama zone. However, in the Dinguna Fango district of Wolaita, there is no ethnobotanical literature concerning the medicinal use of plants. People in this region have developed traditional methods to provide remedies for the most

common human illnesses through the use of plants. Therefore, for the conservation of plants, ensuring their sustainable use, and preserving knowledge for the next generation, documentation of traditional knowledge in this area is significant.

Materials And Methods

Study area description

The study was conducted in the towns of Bitena, Dimtu, and Bilate eta (Toto) Diguna Fango district, Wolaita zone, southern Ethiopia (Fig. 1). The district is located between 6° 51' 37.224"-6° 57' 57.1" N latitudes and 38° 02' 15.7"- 38° 7' 32.1456" E longitudes. The altitudinal range of study area is between 1395 m.a.s.l. and 2070 m.a.s.l. The area is located approximately 350 km south of the capital of the country Addis Ababa and 93 km from Sodo town, the capital town of the zone in the northeast direction. Diguna Fango is bordered on the southwest by Damot Weyde district, on the west by Damot Gale district, on the north by Hadiya zone, on the northeast by Oromia region, and on the east by Sidama region. The average annual rainfall and temperature of the area are approximately 700 mm and 21°C, respectively. The western escarpment belongs to the Weyna Dega agro-ecological zone (mean annual temperature and rainfall of 19°C and 1500 mm, respectively), whereas the rift floor belongs to the Kola zone (mean annual temperature and rainfall of 23°C and 700 mm, respectively).

Sampling informants

The study populations are the informants found in selected communities of Diguna Fango district. A stratified random sampling technique (based on the local community settlement in rural or urban settings) was used to take a representative sample from rural and urban villages within the selected communities. Totally two municipal towns and one kebele farmer's association 'the smallest administrative unit contained within a district' were selected based on the presence of informants. The selected towns and one farmer's association were Bitena and Dimtu towns, and Bilate eta. A total of 60 informants (53 men and seven women) 20 from each of three villages were selected. The ages of the informants were between 20 to 57 years. From the total informants, six key informants (10% of the general informants) selection was done based on the purposive sampling technique, by determining the key person 'Hiillaa' of the community based on the recommendation of the community. A key-person is an experienced person within society by giving remedies for any human and livestock ailments and handy fix all bone fractures by using his/her indigenous knowledge.

Ethnobotanical data collection and identification

In the course of the study, both qualitative and quantitative data were gathered through observation, questionnaires, and interviews from June 2020 to October 2020. Semi-structured interviews were conducted with informants who knew or used plants as medicine including about 10% of the total heads of family units (60 informants) to determine and explore the traditional knowledge regarding the utilization of medicinal plant species, their usefulness, the utilized part, mode of preparation, or method of processing the plants. The interview activities were carried out in their entirety using an open and close-ended questionnaire prepared in Wolaita language and translated into English language (Annex: questionnaire). Informant selection was based on the snowball sampling technique, by determining the key person 'Hillaa' of the community. A key-person is an experienced person within society by giving remedies for any human and livestock ailments and handy fix all bone fractures by using indigenous knowledge.

Data analysis

The collected data from observation, questionnaires, and interviews was tabulated and organized. To analyze the collected data Excel window 2019 was utilized in addition to other appropriate statistical methods such as frequency distribution and percentage. According to disease categories in earlier work [21], [23] and with some modification, the ailments were categorized based on the usage reports mentioned by the informants in the study area.

Quantitative analysis

Fidelity Level (FL). FL is used to calculate the percentage of informants claiming the use of a given species for a particular purpose in a given cultural group or to determine the most preferred plants for a treatment of a particular ailment and calculated as: $FL (\%) = N_p/N \times 100$

Where: N_p is the number of informants that claim a use of a plant species to treat a particular ailment. N is the number of informants that claim the plant as a medicine to treat any given ailment. The plant species that are widely used to treat a particular ailment by the local people have higher FL values than those that are less popular [23].

Family Use Value (FUV). FUV signifies the use-value of a given plant family that is used as medicine for a particular disease. It is calculated as: $FUV = \sum UVs/Ns$

Where: $\sum UVs$ is the sum of the use-values for all species belonging to a particular family. Ns is the total number of species in the same family. High values of FUV might be because the plant species were cited by a large number of people in the study area [24].

Informant consensus factor (ICF). ICF was calculated using the formula $ICF = Nur-nt/nur-1$, where ICF denotes the informant consensus factor, nur is a number of use citations, and nt is the number of species used [25]. ICF values range from 0.00 to 1.00. High ICF values are obtained when only one or a few plant species are reported to be used by a high proportion of informants to treat a particular ailment. Low ICF values indicate that informants disagree over which plant to use.

Direct matrix ranking

Key informants evaluated the functionality of multifunctional medicinal plants to the local people and indicated their scores for each medicinal plant (on a scale of 1 to 5). Based on use criteria (5 = best; 4 = very good; 3 = good; 2 = less used; 1 = least used and 0 = no value) Nine medicinal plants were selected to be evaluated in six usage categories.

Preference ranking

A preference ranking of six medicinal plants that were reported as effective for treating a particular ailment was conducted by using those six key informants by following [1]. Hence the most occurring disease treated by more medicinal plants was given least (1) and highest (5) score by key informants. This scoring and ranking system was also applied for the other seven medicinal plant species on their degree of local scarcity.

Results

Composition, ways of remedy preparation, and utilization of medical plants

Totally, 50 medical plants belonging to 24 families were identified in the study area. The most common human ailments in the study area were stomachache, common cold, malaria, tonsillitis, diabetes, toothache, rabies, intestinal parasites, skin disease, headache, and snakebite. Most medicinal plants prescription (70%) was orally administered and followed by dermal and nasal. The investigation of the remedy's preparation indicated that grinding, crushing, chewing, and boiling was the majorities of remedies modes of preparation (Table 1).

Solanaceae (14.3%) was the dominant family followed by Asteraceae (10.2%), Poaceae (10.2%), Euphorbiaceae (8.16%), Lamiaceae (6.12%) and Musaceae (4.1%). The family Rubiaceae, Myrtaceae, Fabaceae, and Brassicaceae were each with 4.08%. Rosaceae, Commelinaceae, Rutaceae, Linaceae, Caricaceae, Verbenaceae, Aloaceae, Moringaceae, Zingiberaceae, Alliaceae, Lauraceae, Rhamnaceae, Ranunculaceae, Scrophulariaceae and Flacourtiaceae were each with 2.04%.

Family use value

The number of species within a family was calculated to get their Family Use Value. The result showed that Rosaceae had a high FUV (1.00), followed by Commelinaceae (0.98), Musaceae (0.97), and Rubiaceae (0.93). In contrast Flacourtiaceae (0.15) has lower FUV followed by Scrophulariaceae (0.27).

Therapeutic indications

In the study area, 28 ailments affecting humans and livestock were identified in 11 categories (Table 2). Each of the majority of species (22.58%) were indicated to treat gastrointestinal ailments, followed by dermatological infections/diseases (12.9%), skeletomuscular system disorders (9.67%), respiratory systems diseases (19.35%), genitourinary ailments (3.2%), poisonous bites (6.5%), cardiovascular system diseases (3.2%), endocrine/metabolic/nutritional (6.5%), sensory neuron disease (3.2%), fever (3.2%) and general and unspecified ailments (9.7%) (Fig. 2).

Used forms, habit, and used parts of the plants

Medicinal plants were mainly used in fresh form (65.62%), 25% of it was used in dried form and the remaining 9.38% was used in fresh and dried forms (Fig. 3). Medicinal plants used to treat both human and livestock ailments consisted of 31 herbs (62%), 11 trees (22%), and eight shrubs (16%) species. Thus, the most common growth form of medicinal plant in the study area was a herb, followed by trees and shrubs (Fig. 4). The dominant plant part used to prepare remedies were leaves (30%), followed by seeds (21%), fruit (12%), root (10%), latex (6%), bulb (6%), rhizome (5%), pod (5%), bark (3%), shoot (1%) and stem (1%) (Fig. 5).

Administration route, methods of remedy preparation, and dosage

Medicinal plants were given via different routes of administration, such as oral, dermal, and nasal. The most commonly used route was oral (73.3%), followed by dermal (21.7%). The remaining (5%) was held by nasal and optical application routes (Fig. 6). The most commonly used methods of remedy preparation were eating and chewing (18.2% each) followed by grinding (13.61%), squeezing (10.6%), drinking (7.6%), smelling (6.06%), powdering (4.55%), painting (4.55%), boiling (4.55%), hold on (3%), fumigating (3%), dressing, sucking, spitting and in liquid form (1.52% each) (Fig. 7).

The dosage prescribed for the treatment of the same health condition varies between the informants. It was indicated that the doses for liquid preparations were prescribed through estimation, in terms of a full, half, or one-fourth of a coffee cup 'Sini', depending on the age of the patient being treated. For certain herbal preparations that are considered harmless, the doses depend on the patient's interest and/or ability to chew a plant or eat it for a certain health condition like sudden stomach pain relief. (e.g., chewing *Solanum Incanum* L. roots used to get stomach pain relief).

Human health problems treatment plants

A total of 50 species belong to 24 families were recorded, 41 (82%) species were used to treat human diseases (Fig. 7). A single plant can treat a number of human ailments, and a single ailment can be treated by many plants. For instance, stomachache is a major disease and can be treated by 16 medicinal plants. From the plants, *Allium sativum* L. and *Vernonia amygdalina*, Sch. Bip were used to treat more than three human ailments (Table 4).

Livestock ailments treating plants

A single medicinal plant was recorded as being used to treat livestock disease only 1 (2%) (Fig. 8). In the study area, livestock diseases were treated with fewer plants compared to those used to treat human diseases.

Human and livestock health ailments treatment plants

A total of eight (16%) species were recorded as being used to treat both human and livestock diseases (Fig. 8). The most common diseases which affect human and livestock in the study area were skin disease, rabies, wound, and bone fractures.

Informant consensus factor

The disease categories with the highest informant consensus factor (ICF) values were cardiovascular system diseases (1.0), followed by fever (0.9), general and unspecified (0.86), skeletomuscular system disorders (0.82), endocrine/metabolic/nutritional (0.79), respiratory systems diseases (0.78), dermatological infections/diseases (0.76), sensory neuron disease (0.75), genito-urinary ailments (0.66), poisonous bites (0.57) and gastrointestinal ailments (0.55) (Table 2). The medicinal plants that had higher ICF values were presumed to be more common and effective when used to treat a certain disease. However, poisonous bites and the gastrointestinal ailments category had a lower ICF value compared to other categories. Lower ICF values indicated that the informants disagreed on the taxa to be used as a treatment within the disease category. A greater number of plant species were used to treat gastrointestinal ailments (25) followed by dermatological infections/diseases (12) and then respiratory systems diseases (10).

Informant consensus

In this study, some medicinal plants were popular than others, and the highest informant consensus value was found for *Triticum dicoccon* (Schrank) Schübl which was cited by 60 respondents for treatment of bone fractures and weight gain. The second highest informant consensus value was found for *Allium sativum* L., which was cited by 59 respondents for treating cough, malaria,

stomachache, evil spirit 'Goromootiya' or 'Buda' (Table 3). Informant consensus values give a good indication about particular species that serve for particular health problems and about specific medicinal plants used for several health problems.

Fidelity level

Croton macrostachyus, *Pentas* spp., *Triticum dicoccon* and *Commelina benghalensis* were the four plant species with the highest fidelity levels (100%). The first two species were in the skeletomuscular system disorders categories and the following two species were in endocrine/metabolic/nutritional and dermatological infections/diseases categories, respectively, and were followed by *Citrus aurantiifolia* (98%) and *Solanium macrocarpon* (97%) correspondingly within the gastrointestinal and respiratory systems diseases categories. A higher fidelity level (FL) can imply that a particular plant purpose is preferred if informants mentioned it often. In contrast, the lowest fidelity level value was assigned to *Verbascum sinaiticum* (25%), followed by *Euphorbia tirucalli* (27%) from poisonous bites and the genito-urinary ailments category, respectively. A lower fidelity level implies that a particular plant purpose is not preferred (Table 4).

Direct matrix ranking

Based on the evaluation of key informants, the functionality of multifunctional medicinal plants to the local people scored from 1 to 5. The output of the direct matrix analysis found *Persea americana* Mill. to be the preferred medicinal plant used for various purposes by the local people, followed by *Acacia abyssinica* Benth. and *Eucalyptus globulus* Labill. (Table 5).

Preference ranking

A preference ranking of six medicinal plants that were reported as effective for treating stomachache was conducted after selecting six key (knowledgeable) participants. Stomachache is the most occurring disease treated by more medicinal plants. The members were requested to associate the specified medicinal plants with their efficacy. The results showed that *Hagenia abyssinica* (Bruce ex Steud.) J.F.Gmel. scored the highest mark and ranked first indicating that it was the most effective in treating stomachache and followed by *Solanium incanum* L. (Table 6). The preferences ranking of seven threatened medicinal plants of the study area as shown in Table 7, *Acacia abyssinica* Benth was scored the highest mark, and ranked first indicating that it was the scarcest followed by *Syzygium guineense* and *Eucalyptus globulus* Labill.

Additional practices of the people on the usage of medicinal plants

In the study area, the majority of respondents reported that the medicinal plants can also be used as cash crops, firewood, spice, food, fodder, charcoal, insect repellent, furniture, and household construction materials. In this case, 29% of the medicinal plant species were reported to be used for cash crops, the highest rate, followed by firewood (19%), and spice (16%).

Threats to medicinal plants

Information related to potential threats to the medicinal plants in the study area was recorded. According to the responses from the informants, numerous factors are considered as threats. The major threat to medicinal plants were charcoal production (26%) followed by agricultural expansion (15%), firewood (14%), household construction and furniture making (14%), deforestation (11%), secrecy (8%), unwillingness of young generation (4%), oral-based knowledge transfer (3%), lack of awareness (3%) and environmental degradation (2%) (Fig. 9).

Discussion

Around 500 higher plant species, with around 12 percent endemism, and thus one of Africa's six rich plants biodiversity countries, are believed to have a home in Ethiopia [26]. The genetic diversity of the different biotic make-up is also high, making the country a vital diversity hotspot for plants. Ethiopia has a large portion of two of the world's 25 biodiversity-rich hotspot regions, namely the Eastern Afromontane Biodiversity Hotspot and the Horn of Africa-Biodiversity Hotspot. These hotspots are home to a lot of useful wild biodiversity, especially medicinal plants. Medicinal plants are the oldest known source of healing for both human and livestock diseases.

It is estimated that nearly 6000 plant species with popular therapeutic usage in Africa [27]. About 80% of the people in the country use raw medicinal plants to meet their primary health care needs. This high percentage is due to a variety of factors, including restricted

exposure to modern pharmaceutical products, and accessibility.

This research has recorded the distribution of 50 medicinal plants in 26 families used for treating common animal and human diseases. Out of the 26 plant families, Solanaceae (14.3%) was the biggest contributor, followed by Asteraceae and Poaceae (10.2%) and Euphorbiaceae (8.16%). Solanaceae are considered to have a wide variety of alkaloids. Therapeutic, these are the most potent known anticholinergic species used for medicinal purposes in the world. The Solanaceae family is characteristically ethnobotanical, which is commonly used by humans. It is an essential source of food, spice, and medicine and is also recorded for insecticidal properties [28].

In the report, Asteraceae and Poaceae were the second dominant families in human health care. However, other ethnobotanical researchers [29] [30] considered Asteraceae to be dominant in their field of study. This can be attributed to the geographical location, the social condition, and other cultural causes of local communities. The degree of ethnobotanical exploration in their areas of study may be a further explanation, or the entire region may not have been explored thoroughly.

In the field of research, most plants have been used for treating human and livestock diseases. Among the 50 medicinal plants, 41 species were used for the treatment of 27 human ailments, whereas one species was used to treat one livestock ailments. The other eight species were used for the treatment of four common human and livestock diseases. Many medicinal plants have been used to treat a greater proportion of human diseases than animals because of human diseases such as stomachache, snake biting, cough, malaria, wound, 'mitch', and toothache. The rural population in the study area due to its socio-economic situation, the distance from its living area, and a lack of road infrastructure are not readily accessible for modern medical facilities. Abebe [8] and Hostettmann and Marston [2] have stated that 80% of people in the country are still using herbal remedies for various problems. Similar results from their study sites have been recorded in Ethiopia by many researchers [14] [12] [33]. Medicinal plants are often gathered from the wild by the healers in the study field. Most ethnomedicinal plants come from wild areas [13] [16].

The medicinal plants in the study area had diverse growth forms; in this case, herbs were the dominant growth form. Similarly, Chama [12], Giday *et al.* [14], Hailemariam *et al.* [16], and Lulekal *et al.* [31] reported that most medicinal plants were herbs in Damot Gale, Sheko, Konta and Ankober districts, respectively. In contrast, the majority of medicinal plants were shrubs in the south Omo and Mana Angetu [17], [32]. Regassa [18], in Hawassa city, indicated that the majority of the collected medicinal plants there were trees.

The results showed here that leaves were the most commonly used component, contributing rather than harvesting a root and/or whole plant to the conservation of plants. In the same way, Hailemariam *et al.* [16], Giday *et al.* [14], and Chama [12] reported leaves as the predominant plant part used in their study site. In contrast, the most frequently used plant parts were roots in the Hadiya zone [15] and in Benna-Tsemaye [11]. Lulekal *et al.* [32] and Tolossa *et al.* [17] also noted roots were the most commonly used plant part in a study focusing on Mana Angetu district and south Omo, respectively.

The local people in the Diguna Fango district use different remedy preparation process based on the type of disease to be treated. Eating, chewing, grinding, squeezing, drinking, smelling, powdering, painting, boiling, hold on, and spitting were some of the preparation methods used to treat human and livestock diseases. In this survey, eating and chewing were the most widely used process. Apart from Diguna Fango, the most widely used remedy preparation methods have also been identified in similar findings [11] [18] [20]. These were grinding, followed by chewing, boiling, eating, and in liquid form.

The remedies prepared have been administered in various ways. Some of the administrative routes have been oral, dermal, and nasal. In the present region, most remedies have been administered orally and the dermal and nasal routes have been followed. In various parts of Ethiopia, similar findings have also been reported. In the district of Damot Woyde the majority of medicinal plants were given orally [12]. Tolossa *et al.* [17] reported that the majority of plants were used in oral applications in the south Omo. Tolossa and Megersa [33] found that prepared remedies were widely administered orally in Berbere district, Bale zone of Oromia Regional State.

In the study area, the diseases affecting both humans and livestock were 28 in number. This indicated that the people of the district suffered from fewer ailments as compared to those in other areas, such as in the Berbere district, Tolossa and Megersa [33], Damot Gale district, [12] and the south Omo [17]. Moreover, a single human ailment found to be treatable by several medicinal plants. This is in agreement with the findings of earlier studies [32], [33], [34] that found a single disease to be treated by several medicinal plants. The present study found that 22.58% of medicinal plants were used to treat gastrointestinal diseases, with slightly lower rates for dermatological infections/diseases (12.9%). Similarly, among the south Omo people, 24.2% of medicinal plants were used to treat gastrointestinal complaints [17].

On average, the number of medicinal plants was substantially higher for informants under the age of 20 years than for informants above 35 years and by illiterate informants than literate ones. This may be due to the influence of modernization and a lack of interest among younger generations in botanical medicines that would contribute to the conventional knowledge of older people. Similar conclusions also show that there are substantial gaps between different age groups in traditional knowledge [34]. Unlike the study now underway, the literary young people Tefera and Kim [20] have a higher level of knowledge in the use of medicinal plants than analphabets and old people.

For gastrointestinal disorders, the highest citation was found, followed by Fever. Similarly, the most frequently treated diseases in Hawassa [18] and South Omo [17] were gastrointestinal disorder and parasite infection. Furthermore, a study conducted in the Ethiopian community Sheko revealed that the widely treated diseases were skin and gastrointestinal problems [13]. In Berta, the ethnic group of Benishangul-Gumuz, diarrhea was a widely treated disease [35]. The disparity may be influenced by the climate, ethnicity, and hygiene variations in the regions.

The highest-fidelity levels (100%) were found for *Croton macrostachyus*, *Pentas spp.*, *Triticum dicoccon*, and *Commelinabenghalensis* in the current study. The first two species were in the skeletomuscular system disorders categories and the following two species were in endocrine/metabolic/nutritional and dermatological infections/diseases categories, respectively. The category with the highest ICF values was cardiovascular system diseases, followed by Fever (Malaria). Similarly, the category with the highest ICF values was fever (malaria), followed by insects and ectoparasites diseases in Hawassa zuria district [20]. Regassa [18] reported stomachache had high degrees of ICF and that malaria showed the highest FL in Hawassa city.

The highest informant consensus value was found for *Triticum dicoccon* (Schrank) which was cited by 60 respondents for treatment of bone fractures and weight gain. Medicinal plants with higher informant consensus need to be seriously considered for further ethnopharmacological studies since they are species widely applied by many people and they have been utilized for a long time [36].

The output of the preference ranking indicated that *Hagenia abyssinica* (Bruce ex Steud.) J.F.Gmel., *Rutachalepensis* L., and *Solanum incanum* L. were the most commonly preferred medicinal plants as treatment for stomachache in humans in the study area. Similar findings for south Omo showed that the highest numbers of plant species were reported to treat abdominal or stomach disorders [17]. *Acacia abyssinica* Benth, *Syzygium guineense* subsp. *Macrocarpum* (Engl.) F. White and *Eucalyptus globulus* Labill, were ranked as the most threatened medicinal plants of the study area.

According to the direct matrix ranking results, *Persea americana* Mill, was ranked first as the most preferred medicinal plant used for various purposes by the local people. The second and third most preferable medicinal plants were *Acacia abyssinica* Benth. and *Eucalyptus globulus* Labill., respectively. However, *Prunus africanus* is the most preferred medicinal plant for various uses in the Hadiya zone [15]. *Croton macrostachyus* is the most multipurpose medicinal plant in the Berbere district of the Bale zone [33]. In the present study, *Persea americana* Mill. was used as a type of food, as fodder, as cash crop, in house construction, and sometimes in charcoal making.

According to the responses from informants, the main causes of the loss of medicinal plants in the study area were charcoal production following agricultural expansion, firewood, household construction and furniture making, deforestation, secrecy, unwillingness of the young generation, oral-based knowledge transfer, lack of awareness and environmental degradation. Similar results were found in other research concerning threats to medicinal plants in Berbere district [33], Damot Gale [12], and south Omo [17]. In order to maintain the indigenous knowledge and prevent the extinction of medicinal plant resources, greater conservation understanding of all members of the society is required.

Comparison with previous ethnobotanical studies

Allium sativum L. and *Vernonia amygdalina*, Sch. Bip., were the most frequently used plant for stomachache, malaria, wound, evil eye, and cough in the present study, and similarly, Chama [12] reported this plant use for malaria in Damot Woyde district. Giday *et al.* [14] reported for headache treatment in Sheko and for evil eye Wubetu [37]. *Coffea arabica* L. was the most frequently used plant for headaches and wound in the present study. These findings also agreed with the study conducted in the Sheko district [14] and Guba Lafto district [38]. The plant in the present study for the treatment of wounds is reported for the first time.

Capsicum annum L. and *Capsicum frutescens* L. were the most commonly used medicinal plants as a treatment for headache in the present study. Similar findings for Sheko people showed that the plants were reported to treat headache [14]. *Aloe vera* was reported in

the present study for the treatment of malaria, diabetes, and wound. The previous studies conducted in other areas mentioned the use of Aloe spp. for cold and malaria treatment in Kembata [18] and Damot Woyde district [12].

Zingiber officinale and *Rhamnus prinoides* was the most frequently used plant and reported to be used against tonsillitis and cough in our study. Similarly, Chama [12] mentioned these plants are used for tonsillitis and cough. *Triticumdicoccon* (Schrank) Schübl, *Linumusatissimum* L. and *Hordeumvulgare* L. were used to treat bone fractures; weight gain, liver disease, and bone strength in the present study, whereas it is used for similar purpose in other study areas [20].

Moringa stenopetala (Bakerf.) Cufod was documented for amoeba, hypertension, malaria, asthma treatment in the current study. Hailemariam *et al.* [16] and Tefera and Kim [20] reported this plant use for similar health problems from Konta special woreda and Hawassa zuria district, respectively.

Citrus aurantiifolia (Christm.) Swingle, *Datura stramonium* L. and *Dovyalis abyssinica* (A. Rich.), were reported for the first time to be used for toothache treatment in the present study. However, *Citrus aurantiifolia* (Christ) was mentioned by Tefera and Kim [20] for their area of study in order to treat gastritis and hypertension. Soni *et al.* [41] indicated the treatment of stomach and intestinal pain that results from worm infestation, toothache, and fever from inflammation by using *Datura stramonium* L. Tuasha *et al.* [21] reported *Dovyalis abyssinica* (A. Rich.) for treat of malignancies in Dalle district.

Nigella sativa L. was used for stomachache in the present study. Similarly, this plant was reported for stomachache and headache in Hawassa city [19]. Others reported it for common cold, asthma, leprosy, and streptothricosis [40] and [41]. *Capsicum annum* L. and *Carica papaya* L. reported in the present study for the treatment of gastritis were supported by Amsalu *et al.* [41] and Maji and Banerji [42]. According to Amsalu *et al.* [41], these plants are used for the treatment of dysentery and vomiting.

Croton macrostachyus Hochst. ex Delile and *Euphorbia abyssinica* were reported for swelling and headache treatment in the current study. Amsalu *et al.* [41] and Abera [43] reported these plants for gastrointestinal disease and rabies. However, in line with the present finding Tefera and kim [20] reported *Euphorbia abyssinica* for treatment of swelling, gastritis, malaria, and headache. *Citrus aurantiifolia* (Christm.) Swingle reported in the present study for the treatment of motion sickness. Similarly, Mohsenzadeh *et al.* [44] mentioned this plant for motion sickness treatment. Another study mentioned *Cordiaafricana* Lam. as a good treatment for motion sickness [41].

Artemisia abyssinica Sch. Bip. ex. Rich and *Ruta chalepensis* L. were the most frequently used plant for evil eye and stomachache in the present study. This finding agrees with the finding of Chama [12] and disagrees with the finding of Giday *et al.* [14] conducted in other areas which stated the plant use for headache and cold.

According to the comparison of our findings with others ethnobotanical studies in Ethiopia, novel plant uses of some medicinal plants were documented. *Commelina benghalensis* L., *Manihotesculenta* Crantz., *Pentas* spp., *Persea americana* Mill., *Solanummacrocarpon* L., *Sorghumbicolor* (L.) Moench and *Spilanthesmauritiania* DC. were completely novel use in our study area and never ever reported in other similar investigations. The pharmacological activities of these plants are novel findings that are only known in this area for such medicinal purposes.

Dosages of herbal remedies

There is no standardization of the dosage of herbal remedies in the study area; the sum depends on the herbalist who prepares the herbs for medicine. The same plant species with a specific part are recommended in different doses for the treatment of related conditions. Various reports consider the lack of standardization and quality control one of the key disadvantages of traditional medicine. There remains no consensus among informants on the doses and inadequate dosage accuracy of certain prescription remedies [14].

Several authors recall that a restriction on traditional medicinal plants is the lack of an appropriate dosage for a specific disease. The dosage also varies between the plants [45] [46]. The toxicity and harm potential of some medicinal plants are a common concern for people who want standardization in conventional medicine. Traditional practitioners are usually believed to either disregard the strengths of the drugs themselves or to not bother to match doses to patients' size or bodyweight [47]. However, some traditional healers are known to prescribe various dosages and frequencies according to age, gender, and other conditions or to vary from one medicine to the other.

Medicinal plants trade and cultivation

Commercialization and marketing of medicinal plants shall take place on the market on a weekly or biweekly. The fresh and dried collections of some plants is sold were *Artemisia afra*, *Ruta chalepensis*, *Linum usitatissimum* L., *Lippia adoensis* Hochst., *Ocimum gratissimum* L., *Triticum dicoccon* (Schrank) Schübl, *Hordeum vulgare* L., *Avena sativa* L. and all *Capsicum* spp. In addition, parts of different medicinal plants are also marketed for their medicinal value (*Allium sativum*, *Lepidium sativum*, *Nigella sativa*, and *Zingiber officinale* Rosc). Drugs using indigenous medicine are the cheapest and mostly the only available form of healthcare in rural areas of Ethiopia. Friends, relatives, and neighbors provide traditional treatment free of charge or paid under more flexible arrangements, such as payment in cash or kind and on a credit basis. This is particularly prevalent in rural communities.

Plants are not grown for medicinal purposes, with the exception of the rare cases where certain food crops of medicinal value are grown. This is because the quantity of medicinal plants traded is very small and there is no coordination of large-scale added value and production. Therefore, in the future, there is a potential for higher demand for certain species and it is therefore important to recognize them and to conduct the necessary investigations into the techniques of propagation and cultivation. Such a program will also be the basis for small enterprises to improve the potential to generate local population income.

Conclusion

The results of the research showed that medicinal plants are highly diverse in the Diguna Fango area. Fifty medicinal plant species have been identified in 28 human and animal diseases. There have been documented 50 medicinal plant species for 28 human and livestock diseases. It is concluded that to prevent different human and livestock ailments, local people rely on indigenous knowledge. Stomachache, malaria, toothache, cough, tonsillitis were common in human diseases, while wounds and cough were common in livestock. Major differences of knowledge between the different age groups were identified in the field. The older illiterate informants over 45 years of age were more knowledgeable than young informants under 25 years of age on average.

Charcoal production, agricultural expansion, firewood, household construction, and furniture making have been the main threats to medicinal plants in the Diguna Fango district. The traditional medicinal knowledge gap between older and younger generations has also affected the loss of indigenous knowledge in younger generations due to lack of willingness. For this reason, mentoring programs, to conserve indigenous knowledge and insights to avoid their medicinal plants' extinction, should be provided for local people in the study area. In addition, alternative energy, such as the expansion of biogas plants, is required to reduce the utilization of medicinal plants for the production of charcoal and firewood. The in vitro and ex vitro propagation conservation of endangered medicinal plants should be developed to protect medicinal plants from extinction. Moreover, current documented information on Wolaita's medicinal plants is available as informative baseline data for future studies of medicinal plants of importance and phytochemical studies.

Recommendation

Numerous plants and households use different plant mixtures to treat a specific disease and preferences vary between households. Growing medicinal plants in the home gardens and other areas outside forests is at least an alternative to minimizing threats and the lack of supply usually associated with seasonal fluctuation. In addition, the following strategies are recommended to improve the role of botanical-based traditional medicine and the practitioners in the study area and in the country as well.

1. Identification and registration of traditional medicine practitioners.
2. Appropriate skills upgrade training programs for selected and registered traditional medicine practitioners
3. Encouraging the formation of a strong national association for traditional medicine practitioners.

Declarations

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Ethics approval and consent to participate

Although these studies present a minimal risk to participants, has been conducted in accordance with the declaration of Helsinki that provides guidance for the researcher to protect research subjects. The study was approved by the Institutional Research Review Board (IRB) of Wolaita Sodo University. Consent to participation is not applicable to this article.

Consent for publication

All authors agreed to the public this original research work

Availability of data and materials

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Abenezer Wendimu, Wondimagegnehu Tekalign, and Biniyam Asfaw. The first draft of the manuscript was written by Abenezer Wendimu and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1: The diversity of medical plants with their ways of preparation and utilization to relieve common human ailments

Scientific and family names	Common names	Local names	Habit	Used to treat	Parts used	Ailments	Preparation and utilization
<i>Acacia abyssinica</i> Benth., Fabaceae	Flat-Top Acacia	Odorwa (W), Girar (A)	Tree	H	Root	Tonsillitis	The fresh root bark of <i>Acacia abyssinica</i> is chewed the juice is swallowed.
					Bark	Headache	The gum sometime appears on the bark is smelled to relieve headache.
<i>Allium sativum</i> L. Alliaceae	Garlic	Tuummuwa (W), Nech shinkurt (A)	Herb	H	Bulb	Cough, Malaria	The fresh peeled bulb of <i>Allium sativum</i> is ground and boiled with vegetable oil or butter and the prepared sauce is eaten with 'Enjera'.
					Bulb	Stomachache	Or, the fresh bulb, honey and <i>Capsicum annum</i> mixed together and a spoonful of the blended mixture is taken every morning before breakfast.
					Bulb	Evil spirit 'Goromootiya' or 'Buda'.	The fresh peeled bulb of <i>Allium sativum</i> is given to evil spirited patients to smell directly or in mixture with other foods. If the patient hesitate to take, then, they conclude that the patient is evil spirited.
<i>Aloe vera</i> , Aloaceae	Aloe	Godarre utta (W), Iret (A)	Herb	HL	Latex	Malaria, Diabetes	The fresh latex of <i>Aloe vera</i> is peeled and the inner white part is eaten directly. Or, the fresh peeled latex is mixed with water and taken orally. (H)
					Latex	Wound	The fresh latex of <i>Aloe vera</i> is pitched and the wound is painted by jelly substance from the latex

							in order to repel insects from landing. (HL)
<i>Artemisia abyssinica</i> Sch. Bip. ex. Rich, Asteraceae	Worm wood	Cuqqunniya (W), Chigugn (A)	Shrub	H	Root	Evil spirit	The fresh roots of <i>Artemisia abyssinica</i> is squeezed with water and given orally to the patient. Or, the root is chopped and smelled.
<i>Artemisia afra</i> , Asteraceae	Worm wood	Naatiraa (W), Ariti (A)	Herb	H	Leave	Stomachache	The fresh leaves of <i>Artemisia afra</i> are chewed and the juice swallowed. Or, the leaves are mixed with butter and drunk, specifically, pregnant women.
<i>Avena sativa</i> L. Poaceae	Oat	Qambbaraa (W), Aja (A)	Herb	HL	Seed	Bone fractures, Weight gain,	The dried seed of <i>Avena sativa</i> is ground and the powder is boiled with hot water. Thereafter, the prepared thick juice is given orally. (HL). Or, the powder is made to be porridge and eaten with milk. (H).
<i>Brassica nigra</i> L. W.D.J. Koch, Brassicaceae	Black mustard	Santta ayfiya (W), Senafich (A)	Herb	H	Seed	Stomachache	The dried seeds of <i>Brassica nigra</i> together with <i>Lepidium sativum</i> seeds are ground. Thereafter, the powdered is mixed with water and the juice is given orally. Or, the dried seed of <i>Brassica nigra</i> is ground and mixed with water to be taken orally.
<i>Capsicum annum</i> L. Solanaceae	Chili	Qaariya (A), Kariya (A)	Herb	H	Pod	Stomachache/amoebiasis	The chili distinguish three kinds of <i>Capsicum</i> spices: (1) 'Karya', the immature green fruits; (2) 'Berbère', the bulk of the red mature

							pungent fruits; which is mixed with fresh garlic, basil, ginger and rue and ground by traditional grinding mill with or without water. (3) 'Mitmita', the small extremely pungent fruits. One of these can be eaten with 'Enjera' to relieve the intestinal pain.
						Gastritis	The fine ground pod powder of <i>Capsicum annum</i> is mixed with water and drunk. (Two teaspoonful of powder would be used to mix in coffee cup).
<i>Capsicum frutescens</i> L. Solanaceae	Chili	Mixaamixuwa (W), Mitmita (A)	Herb	H	Pod	Headache	The fresh pod of <i>Capsicum frutescens</i> is chewed and taken orally.
<i>Carica papaya</i> L. Caricaceae	Papaya	Paappayaa (W), Papaya (A)	Tree	H	Fruit	Gastritis	The fresh fruit of <i>Carica papaya</i> is peeled and the flesh is taken orally with or without sugar.
<i>Citrus aurantiifolia</i> (Christm.) Swingle, Rutaceae	Lemon	Loomiya (W), Lomi (A)	Tree	H	Fruit	Toothache	The fresh fruits of <i>Citrus aurantiifolia</i> are squeezed and the juice is taken orally, rinsed or kept in mouth.
					Fruit	Motion sickness (vomiting)	The fresh fruit of <i>Citrus aurantiifolia</i> is can either be smelled or eaten.
<i>Coffea arabica</i> L. Rubiaceae	Coffee	Tukkiya (W), Buna (A)	Tree	HL	Seed	Headache	The dried seeds of <i>Coffea arabica</i> are roasted and the smoke is smelled. Or, the roasted seeds are ground and boiled with hot water to be taken orally. (H).

					Seed	Wound	The dried seeds of <i>Coffea arabica</i> are roasted and ground. Thereafter, the powder is applied on the wound. (HL).
<i>Commelina benghalensis</i> L. Commelinaceae	Tropical spiderwort	Dal'iisha (W), Wof ankur (A)	Shrub	H	Stem	Skin disease, 'chirt' (Shattuwa)	The fresh and young stem of the <i>Commelina benghalensis</i> is squeezed and the jelly substance released is painted on the skin surface.
<i>Croton macrostachyus</i> Hochst. ex Delile, Euphorbiaceae	Rush foil	Anka (W), Bisana (A)	Tree	H	Leave	Swelling	Slightly roasted fresh leave of <i>Croton macrostachyus</i> is hold and kept on the swells.
<i>Datura stramonium</i> L. Solanaceae	Jimson weed	Macharara (W), Laflafuwaa(W), Itse Fars (A)	Herb	HL	Seed	Toothache	The dried seeds of <i>Datura stramonium</i> are boiled with butter and tooth is fumigated with steam vapor. (H).
					Leave	Skin disease	The dried leave is ground and mixed with water to be applied on the skin. (HL).
<i>Dovyalis abyssinica</i> (A. Rich.) Flacourtiaceae	Dovyalis	Kooshimiya (W), Koshim (A)	Herb	H	Leave	Toothache	The fresh leaves of <i>Dovyalis abyssinica</i> are chewed and hold on the tooth.
<i>Echinops kebericho</i> , Asteraceae	Kebericho	Boorisaa (W), Kebericho (A)	Herb	H	Root	Stomachache	The fresh root of <i>Echinops kebericho</i> is chewed and swallowed.
<i>Eleusine coracana</i> L. Gaertn. Poaceae	Finger millet	Dagusaa (W), Dagusa (A)	Herb	H	Seed	Back pain	The dried seeds of <i>Eleusine coracana</i> are ground mix with food to be taken orally.
<i>Ensete ventricosum</i> (Welw), Musaceae	Enset	Uuttaa (W), Enset (A)	Shrub	H	Root	Bone strengthen	The root of fresh <i>Ensete ventricosum</i> is processed and the end product called 'Kocho' made

							to be porridge is taken orally specially for pregnant women and injured patients.
					Root	Constipation	'Kocho' is made to flat bread called 'Kita' and taken orally.
<i>Eucalyptus globulus</i> Labill., Myrtaceae	Tasmanian blue gum	Paranjaa zaafiya (W), Nech bahezaf (A)	Tree	H	Bud	Cough/cold	The fresh leave buds of <i>Eucalyptus globulus</i> are pinched and sometimes mixed with <i>Solanecio gigas</i> leave and boiled with water. Or, Its leaves are boiled in hot water and patient covers his/her face with some cloth and inhales the steam evaporating.
					Seed	Stomachache/Karshshuwa	The fresh seed coverage is chewed and swallowed.
<i>Euphorbia abyssinica</i> J.F.Gmel., Euphorbiaceae	Candelabra Spurge	Akkirssaa (W), Qulqual (A)	Herb	HL	Latex	Rabies	The fresh latex of <i>Euphorbia abyssinica</i> is ground and applied on the bitten section (H). Or, given orally (L).
<i>Euphorbia tirucalli</i> L. Euphorbiaceae	Pencil cactus	Maaxxuuwa (W), Kinchib (A)	Herb	H	Latex	Hemorrhoids	The fresh latex of <i>Euphorbia tirucalli</i> is pitched and the falling milk like white fluid is dropped on the hemorrhoids.
<i>Hagenia abyssinica</i> (Bruce ex Steud.) J.F.Gmel., Rosaceae	Hagenia	Koosuwa (W), Koso (A)	Tree	H	Fruit, Leave	Stomachache/worm	The fresh fruits of <i>Hagenia abyssinica</i> and sometimes their leaves are squeezed with water and taken orally.
<i>Hordeum vulgare</i> L. Poaceae	Barley	Banggaa (W), Gebis (A)	Herb	H	Seed	'Wugat', Weight gain	The dried seeds of <i>Hordeum vulgare</i> is ground and the powder is mixed with water. Thereafter,

							boiled in hot water and taken orally.
<i>Lepidium sativum</i> L. Brassicaceae	Cress	Sibbikka (W), Fetto (A)	Herb	H	Seed	Stomachache	The dried seeds of <i>Lepidium sativum</i> is ground and mixed with <i>Allium sativum</i> . Thereafter, a little water is added and the prepared sauce is eaten with 'Enjera'. Or, the sauce is with tablespoonful of honey is taken before breakfast.
<i>Linum usitatissimum</i> L. Linaceae	Linseed	Talbbaa (W), Telba (A)	Herb	H	Seed	Bone fractures, Weight gain, Liver disease	The dried seeds of <i>Linum usitatissimum</i> are ground and mixed with water. Thereafter, the prepared thick fluid is taken orally.
					Seed	Bone strengthen	The dried seed of <i>Linum usitatissimum</i> is fine ground and made to be porridge is taken orally specially for pregnant women and injured patients.
<i>Lippia adoensis</i> Hochst. Verbenaceae	Fever tea	Kosrotiya (W), Koseret (A)	Herb	H	Leave	Stomachache	The dried or fresh leaves of <i>Lippia adoensis</i> are chewed or the ground leave powder is added into already prepared coffee to be taken orally.
<i>Manihot esculenta</i> Crantz. Euphorbiaceae	Cassava	Mitta boyyiya (W), Kassba (A)	Shrub	L	Leave	Cough	The fresh leaves of <i>Manihot esculenta</i> is squeezed with water and the juice is given orally specifically for chicken.
<i>Moringa stenopetala</i>	Moringa	Halakkuwa (W), Shiferaw (A)	Tree	H	Leave	Amoeba, Hypertension, Malaria, Asthma	The fresh leaves of <i>Moringa</i>

(Bakerf.) Cufod, Moringaceae							<i>stenopetala</i> is boiled in hot water and taken orally. Or, the dried leaves are ground and made to be tea called 'Moringa tea' which is also to be taken orally.
<i>Musa accuminata</i> Colla, Musaceae	Banana	Muuziya (W), Muz (A)	Herb	H	Fruit	Skin disease/Pimple	The small amount of creamy flesh of fresh peeled banana (<i>Musa accuminata</i>) has been applied on the raised and colored spots on the surface of the skin (pimple).
<i>Nicotiana tabacum</i> L. Solanaceae	Tobacco	Tambuwa (W), Tinbaho (A)	Herb	HL	Leave	Wound	The dried ground powder of <i>Nicotiana tabacum</i> leave is sometime mixed with <i>coffee arabica</i> powder and applied on the wound.
<i>Nigella sativa</i> L. Ranunculaceae	Black cumin	Tikur azmud (A) Karetta sawuwa (W)	Herb	H	Leave	Stomachache	The fresh leaves of <i>Nigella sativa</i> is crushed and pounded with <i>Ruta chalepensis</i> , <i>Lepidium sativum</i> and sometimes <i>Allium sativum</i> . Thereafter, the ground mixture is taken orally with a spoonful of honey before breakfast.
<i>Ocimum gratissimum</i> L. Lamiaceae	Basil	Gulluwa (W), Damakese (A)	Herb	H	Leave	General malaise (Mitch), Malaria	The fresh leaves of <i>Ocimum gratissimum</i> are boiled in hot water and the juice is taken orally.
<i>Ocimum lamiifolium</i> Hochst. ex Benth., Lamiaceae	Basil	Gulluwa (W), Damakessie (A)	Herb	H	Leave	Stomachache	The fresh or dried leave of <i>Ocimum lamiifolium</i> is crushed and added to already prepare coffee. Or, the fresh or dried leaves are

							squeezed with water and take orally before food in morning.
Pentas spp., Rubiaceae		Dambburssaa (W)	Herb	HL	Leave	Bone fractures	The fresh leaves of the plant is boiled with hot water and given orally. The fresh leave of the plant is crushed and squeezed. Then, the thick liquid is filtrated and taken orally twice a day or one, accordingly.
<i>Persea americana</i> Mill., Lauraceae	Avocado	Abokkaduwaa (W), Abokados (A)	Tree	H	Fruit	Diabetes	The fresh fruit of <i>Persea americana</i> is peeled and the flesh taken orally.
					Fruit	Dandruff, skin disease	The fresh fruit of <i>Persea americana</i> is applied on the injured skin surface.
<i>Rhamnus prinoide</i> L'Hér. Rhamnaceae	Hop	Geshuwa (W), Gesho (A)	Shrub	H	Leave	Tonsillitis	The fresh leaves or ripened fruit of <i>Rhamnus prinoide</i> are chewed and the juice is swallowed.
<i>Ruta chalepensis</i> L. Rutaceae	Rue	Xalotiya (W), Tena adam (A)	Herb	H	Leave	Stomachache	The fresh leaves of <i>Ruta chalepensis</i> are boiled with tea or coffee and taken orally. Or, the leaves are squeezed with water and the juice is taken orally.
					Leave	Evil spirit 'Goromootiya' or 'Buda'.	The fresh leave of <i>Ruta chalepensis</i> is given to Evil spirited patients directly or in mixture with already prepared coffee or tea. If the patient is hesitate to take due to it's smell, then, they conclude

							that the patient is evil spirited.
<i>Solanium macrocarpon</i> L. Solanaceae	Brihati	Santta buluwa (W), Embuaye (A)	Shrub	H	Leave	Cough, Stomachache	The fresh leave of <i>Solanium macrocarpsm</i> is ground and mixed with butter. Thereafter, the mixture is boiled and taken orally.
<i>Solanium incanum</i> L. Solanaceae	Thorn apple	Bulluwa (W) Embuaye (A)	Shrub	H	Root	Stomachache	The fresh root of <i>Solanium incanum</i> is chewed and the juice is swallowed.
<i>Sorghum bicolor</i> (L.) Moench, Poaceae	Sorghum	Maldduwa (W), Mashila (A)	Herb	H	Seed	Skin disease	The dried or sometimes fresh seeds of <i>Sorghum bicolor</i> are chewed and the juice is spit on skin.
<i>Spilanthes mauritiana</i> DC., Asteraceae	Spilanthes	Aydamiia (W),	Herb	H	Fruit	Tonsillitis	The fresh fruit of <i>Spilanthes mauritiana</i> is chewed and the juice is swallowed.
<i>Syzygium guineense</i> subsp. <i>Macrocarpum</i> (Engl.) F. White Myrtaceae	Water berry	Ochchaa (W), Doqima (A)	Tree	H	Bark	Diarrhea	The fresh bark of <i>Syzygium guineense</i> is ground and mixed in water to be taken orally.
<i>Thymus schimperi</i> Ronniger, Lamiaceae	Thyme	Zimbanuwaa (W), Tosign (A)	Herb	H	Leave	Diabetes	The dried leaves are chopped and boiled with water to make a tea of <i>Thymus schimperi</i> . Or, the dried stem or leaves of <i>Thymus schimperi</i> is ground and the powder would be added to already prepared coffee or tea is taken orally.
<i>Trigonella foenum-graecum</i> L. Fabaceae	Fenugreek	Shuqquwa (W), Abish (A)	Herb	H	Seed	Wound	The dried seeds of <i>Trigonella foenum graecum</i> are ground and its powder is used for wound dressing.
<i>Triticum</i>	Emmer	Bangгаа (W),	Herb	HL	Seed	Bone fractures, Weight	The dried

<i>dicoccon</i> (Schränk) Schübl, Poaceae		Sinde (A)				gain		seeds of <i>Triticum dicoccon</i> are directly given to eat. (L). The dried seeds of <i>Triticum dicoccon</i> is ground to make porridge. Thereafter, the porridge is given orally. (H).
<i>Verbascum sinaiticum</i> Benth., Scrophulariaceae	Mullein	Yahiya joro (A)	Herb	H	Root	Snake bite		The fresh or dried root of <i>Verbascum sinaiticum</i> is crushed slightly and given for chewing soon after snake bait.
<i>Vernonia amygdalina</i> , Sch.Bip., Asteraceae	Sweet bitterleaf	Garaa (W), Girawa (A)	Tree	H	Leaf	Stomachache, Malaria		Fresh leaves of <i>Vernonia amygdalina</i> are mixed with <i>Rumex nervosus</i> and <i>Justicia schimperiana</i> leave. Thereafter, the mixed leaves are squeezed together with water and the resulting juice is taken orally.
					Leaf	Wound		<i>Vernonia hymenolepis</i> dried or sometimes fresh leaves are crushed and placed on a wound is to stop bleeding.
					Shoot	Evil spirit		The fresh shoot of <i>Vernonia amygdalina</i> is ground and mixed with water, filed in the beaker and stand in front of the room. When an evil spirited person enters to the home, the water in the beaker fall and the patient is identified.
<i>Zingiber officinale</i> Rosc., Zingiberaceae	Ginger	Yenjeeluwa (W), Zinjibil (A)	Shrub	H	Rhizome	Stomachache		The peeled fresh rhizome of <i>Zingiber officinale</i> is chewed and

			the resulting juice is swallowed. Sometimes it can be used with <i>Artemisia afra</i> .
	Rhizome	Cough/cold	The peeled fresh rhizome of <i>Zingiber officinale</i> is ground with mortar and pestle. Thereafter, the crushed is boiled by water by 70 - 120°C to 10 minutes and the prepared juice called 'Kishir shai' is drunk as it cool enough to take via mouth.
	Rhizome	Tonsillitis	The fresh rhizome is crushed and chewed.

Key: Local name: A = Amharic, W = Wolaita; Used to treat: H = human, L = livestock, HL = human and livestock. Enjera is a kind of unleavened flat and thin bread made of 'tef' *Eragrostis tef* (Zucc.).

Table 2: Disease category, abbreviations of reported diseases and informant's consensus factor

No.	Category name and abbreviations	Reported diseases	No. species	Nur	ICF
1.	Gastrointestinal ailments (GIA)	Stomachache, amoeba, gastritis, Motion sickness (vomiting), constipation, liver disease, toothache	25	54	0.55
2.	Dermatological infections/diseases (DID)	Wound, chirt (shattuwa), skin disease, dandruff	12	46	0.76
3.	Skeletomuscular system disorders (SMSD)	Back pain, bone fracture, swelling	6	29	0.82
4.	Respiratory systems diseases (RSD)	Tonsillitis, cough, asthma	10	41	0.78
5.	Genito-urinary ailments (GUA)	Hemorrhoids	1	3	0.66
6.	Poisonous bites (PB)	Rabies, snake bite	7	15	0.57
7.	Cardiovascular system diseases (CSD)	Hypertension	1	40	1.00
8.	Endocrine/metabolic/nutritional (EMN)	Diabetes, weight gain	7	29	0.79
9.	Sensory neuron disease (SND)	Headache	3	9	0.75
10.	Fever (F)	Malaria	5	44	0.90
11.	General and unspecified (GU)	General malaise (Mitch), wugat, evil spirit	6	37	0.86

Table 3: Informant consensus for medicinal plants used against two or more specific ailments

No.	Scientific names	Family names	No. of informants	Percent (%)	Rank
1.	<i>Triticum dicoccon</i> (Schrank) Schübl	Poaceae	60	100%	1 st
2.	<i>Allium sativum</i> L.	Alliaceae	59	98%	2 nd
3.	<i>Citrus aurantiifolia</i> (Christm.) Swingle	Rutaceae	58	97%	3 rd
4.	<i>Capsicum annum</i> L.	Solanaceae	57	95%	4 th
6.	<i>Ruta chalepensis</i> L.	Rutaceae	56	92%	5 th
7.	<i>Vernonia amygdalina</i> , Sch.Bip	Asteraceae	55	91%	6 th
8.	<i>Zingiber officinale</i> Rosc.	Zingiberaceae	54	90%	7 th
9.	<i>Manihot esculenta</i> Crantz.	Euphorbiaceae	53	88%	8 th
10.	<i>Coffea arabica</i> L.	Rubiaceae	52	86%	9 th
11.	<i>Linum usitatissimum</i> L.	Linaceae	48	80%	10 th
12.	<i>Aloe vera</i>	Aloaceae	47	78%	11 th
13.	<i>Ocimum gratissimum</i> L.	Lauraceae	43	72%	12 th
14.	<i>Datura stramonium</i> L.	Solanaceae	40	67%	13 th
15.	<i>Avena sativa</i>	Poaceae	39	65%	14 th
16.	<i>Eucalyptus globulus</i> Labill.	Myrtaceae	38	63%	15 th
17.	<i>Hordeum vulgare</i> L.	Poaceae	37	62%	16 th
18.	<i>Persea americana</i> Mill.	Lauraceae	34	57%	17 th
19.	<i>Solanium macrocarpon</i> L.	Solanaceae	29	48%	18 th
20.	<i>Acacia abyssinica</i> Benth.	Fabaceae	25	42%	19 th

Table 4: Fidelity Level (FL) of medicinal plants in the study area

Disease categories	Plant species	Specified diseases	Np	P	FL (%)
Gastrointestinal ailments (GIA)	<i>Manihot esculenta</i> Crantz.	Amoeba	35	40	88%
	<i>Ensete ventricosum</i> (Welw)	Constipation	43	51	84%
	<i>Citrus aurantiifolia</i> (Christm.) Swingle	Motion sickness (vomiting)	49	50	98%
	<i>Linum usitatissimum</i> L.	Liver disease	53	60	88%
	<i>Carica papaya</i> L.	Gastritis	48	50	96%
	<i>Capsicum annum</i> L.	Gastritis	39	43	90%
	<i>Citrus aurantiifolia</i> (Christm.) Swingle	Toothache	41	50	82%
	<i>Datura stramonium</i> L.	Toothache	43	51	84%
	<i>Dovyalis abyssinica</i> (A. Rich.)	Toothache	24	56	42%
	<i>Allium sativum</i> L.	Stomachache	41	50	45%
	<i>Artemisia afra</i>	Stomachache	36	60	60%
	<i>Brassica nigra</i> L. W.D.J. Koch	Stomachache	20	39	51%
	<i>Capsicum annum</i> L.	Stomachache	20	43	47%
	<i>Eucalyptus globulus</i> Labill.	Stomachache	15	45	33%
	<i>Hagenia abyssinica</i> (Bruce ex Steud.) J.F.Gmel.	Stomachache	50	60	83%
	<i>Echinops kebricho</i>	Stomachache	45	52	87%
	<i>Lepidium sativum</i> L.	Stomachache	54	60	90%
	<i>Lippia adoensis</i> Hochst.	Stomachache	33	40	83%
	<i>Nigella sativa</i> L.	Stomachache	25	58	43%
	<i>Ocimum lamiifolium</i> Hochst. ex Benth.	Stomachache	39	56	70%
<i>Ruta chalepensis</i> L.	Stomachache	54	60	90%	
<i>Solanum macrocarpon</i> L.	Stomachache	36	60	60%	
<i>Solanum incanum</i> L.	Stomachache	57	60	95%	
<i>Vernonia amygdalina</i> , Sch.Bip.	Stomachache	21	45	47%	
<i>Zingiber officinale</i> Rosc.	Stomachache	54	58	93%	
Dermatological infections/diseases (DID)	<i>Commelina benghalensis</i> L.	Chirt (shattuwa)	60	60	100%
	<i>Persea americana</i> Mill.	Dandruff	57	60	95%
	<i>Coffea arabica</i> L.	Wound	32	47	68%
	<i>Vernonia amygdalina</i> Sch.Bip.	Wound	14	45	31%
	<i>Trigonella foenum-graecum</i> L.	Wound	23	45	51%
	<i>Nicotiana tabacum</i> L.	Wound	11	43	26%
	<i>Aloe vera</i>	Wound	29	35	83%
	<i>Datura stramonium</i> L.	Skin disease	45	51	88%
	<i>Musa accuminata</i> Colla	Skin disease	36	48	75%

	<i>Persea americana</i> Mill.	Skin disease	48	50	96%
	<i>Sorghum bicolor</i> (L.) Moench	Skin disease	43	50	86%
Skeletomuscular system disorders (SMSD)	<i>Eleusine coracana</i> L. Gaertn.	Back pain	48	60	80%
	<i>Croton macrostachyus</i> Hochst. ex Delile	Swelling	60	60	100%
	<i>Triticum dicoccon</i> (Schrank) Schübl	Bone fracture	56	60	93%
	Pentas spp.	Bone fracture	60	60	100%
	<i>Linum usitatissimum</i> L.	Bone fracture	57	60	95%
	<i>Avena sativa</i>	Bone fracture	43	57	75%
Respiratory systems diseases (RSD)	<i>Moringa stenopetala</i> (Bakerf.) Cufod	Asthma	40	52	77%
	<i>Acacia abyssinica</i> Benth.	Tonsillitis	19	25	76%
	<i>Rhamnus prinoide</i> L'Hér.	Tonsillitis	41	51	80%
	<i>Spilanthes mauritiana</i> DC.	Tonsillitis	43	53	81%
	<i>Zingiber officinale</i> Rosc.	Tonsillitis	55	60	92%
	<i>Allium sativum</i> L.	Cough	50	57	88%
	<i>Eucalyptus globulus</i> Labill.	Cough	38	45	84%
	<i>Manihot esculenta</i> Crantz.	Cough	32	40	80%
	<i>Zingiber officinale</i> Rosc.	Cough	48	54	89%
	<i>Solanum macrocarpon</i> L.	Cough	58	60	97%
Genito-urinary ailments (GUA)	<i>Euphorbia tirucalli</i> L.	Hemorrhoids	13	53	25%
Poisonous bites (PB)	<i>Euphorbia abyssinica</i> J.F.Gmel.	Rabies	21	47	45%
	<i>Verbascum sinaiticum</i> Benth.	Snake bite	9	43	20%
Cardiovascular system diseases (CSD)	<i>Moringa stenopetala</i> (Bakerf.) Cufod	Hypertension	33	55	60%
Endocrine/metabolic/nutritional (EMN)	<i>Aloe vera</i>	Diabetes	25	51	49%
	<i>Persea americana</i> Mill.	Weight gain	25	34	74%
	<i>Thymus schimperii</i> Ronniger	Weight gain	39	54	72%
	<i>Hordeum vulgare</i> L.	Weight gain	54	59	92%
	<i>Linum usitatissimum</i> L.	Weight gain	37	40	93%
	<i>Triticum dicoccon</i> (Schrank) Schübl	Weight gain	60	60	100%
	<i>Avena sativa</i>	Weight gain	34	45	76%
Sensory neuron disease (SND)	<i>Acacia abyssinica</i> Benth.	Headache	17	25	68%
	<i>Capsicum frutescens</i> L.	Headache	45	50	90%
	<i>Coffea arabica</i> L.	Headache	53	60	88%
Fever (F)	<i>Allium sativum</i> L.	Malaria	45	57	79%
	<i>Aloe vera</i>	Malaria	47	56	84%
	<i>Moringa stenopetala</i> (Bakerf.) Cufod	Malaria	19	54	35%
	<i>Ocimum gratissimum</i> L.	Malaria	32	56	57%
	<i>Vernonia amygdalina</i> , Sch.Bip.	Malaria	22	45	49%

General and unspecified (GU)	<i>Ocimum gratissimum</i> L.	General malaise (Mitch)	43	56	77%
	<i>Hordeum vulgare</i> L.	Wugat	51	56	91%
	<i>Allium sativum</i> L.	Evil spirit	55	60	92%
	<i>Ruta chalepensis</i> L.	Evil spirit	57	60	95%
	<i>Artemisia abyssinica</i> Sch. Bip. ex. Rich	Evil spirit	36	60	60%
	<i>Vernonia amygdalina</i> , Sch.Bip	Evil spirit	40	60	67%

Table 5: Direct matrix ranking of medicinal plants by informants (A-C) based on usage category

Medicinal plants name	Cash crop			Food			Fodder			Firewood			Construction			Charcoal			Total	Rank
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C		
<i>Persea americana</i> Mill.	5	5	5	5	5	5	5	5	5	4	5	5	3	2	3	5	5	5	73	1 st
<i>Acacia abyssinica</i> Benth.	5	5	5	0	0	0	1	3	2	5	4	5	5	5	5	5	5	5	65	2 nd
<i>Eucalyptus globulus</i> Labill.	5	5	5	0	0	0	0	0	0	5	5	5	5	5	5	5	5	5	58	3 rd
<i>Ensete ventricosum</i> (Welw)	5	5	5	5	5	5	5	5	5	1	1	1	3	3	3	0	0	0	57	4 th
<i>Hordeum vulgare</i> L.	5	5	5	5	5	5	5	5	5	1	1	1	1	4	2	0	0	0	55	5 th
<i>Triticum dicoccon</i> (Schrank) Schübl	5	5	5	5	5	5	5	5	5	1	1	2	2	1	2	0	0	0	54	6 th
<i>Sorghum bicolor</i> (L.) Moench	5	4	5	5	5	5	5	3	3	2	2	1	1	2	2	0	0	0	50	7 th
<i>Moringa stenopetala</i> (Bakerf.) Cufod	4	2	4	5	4	5	3	3	2	3	3	4	1	1	2	0	0	0	45	8 th
<i>Croton macrostachyus</i> Hochst. ex Delil	3	2	4	0	0	0	0	0	0	5	4	3	2	3	1	4	5	3	39	9 th
Total	123			89			85			80			74			57				
Rank	1 st			2 nd			3 rd			4 th			6 th			7 th				

Based on use criteria (5 = best; 4 = very good; 3 = good; 2 = less used; 1 = least used and 0 = no value)

Table 6: Preference ranking of medicinal plants used to treat stomachache in humans

Medicinal plants	Informants						Total score	Ranking
	I1	I2	I3	I4	I5	I6		
<i>Hagenia abyssinica</i> (Bruce ex Steud.) J.F.Gmel.	5	5	5	5	4	5	29	1 st
<i>Solanium incanum</i> L.	5	5	4	5	3	4	26	2 nd
<i>Ruta chalepensis</i> L.	5	5	5	4	3	3	25	3 rd
<i>Allium sativum</i> L.	3	4	3	3	5	4	22	4 th
<i>Artemisia afra</i>	1	3	2	1	5	4	16	5 th
<i>Brassica nigra</i> L. W.D.J. Koch	1	2	2	3	5	2	15	6 th

Table 7: Ranking of seven medicinal plants using the procedure of preference ranking based on their degree of local scarcity

Medicinal plants name	Informants (I)						Total score	Ranking
	I1	I2	I3	I4	I5	I6		
<i>Acacia abyssinica</i> Benth.	5	5	5	4	5	5	29	1 st
<i>Syzygium guineense</i>	5	4	5	5	5	2	26	2 nd
<i>Dovyalis abyssinica</i> (A. Rich.)	5	5	3	4	3	3	23	4 th
<i>Ensete ventricosum</i> (Welw)	3	2	5	1	2	3	16	5 th
<i>Eucalyptus globulus</i> Labill.	4	5	4	4	5	3	25	3 rd
<i>Euphorbia tirucalli</i> L.	1	2	2	1	4	2	12	7 th
<i>Croton macrostachyus</i> Hochst. ex Delile	1	2	2	3	4	3	15	6 th

Figures

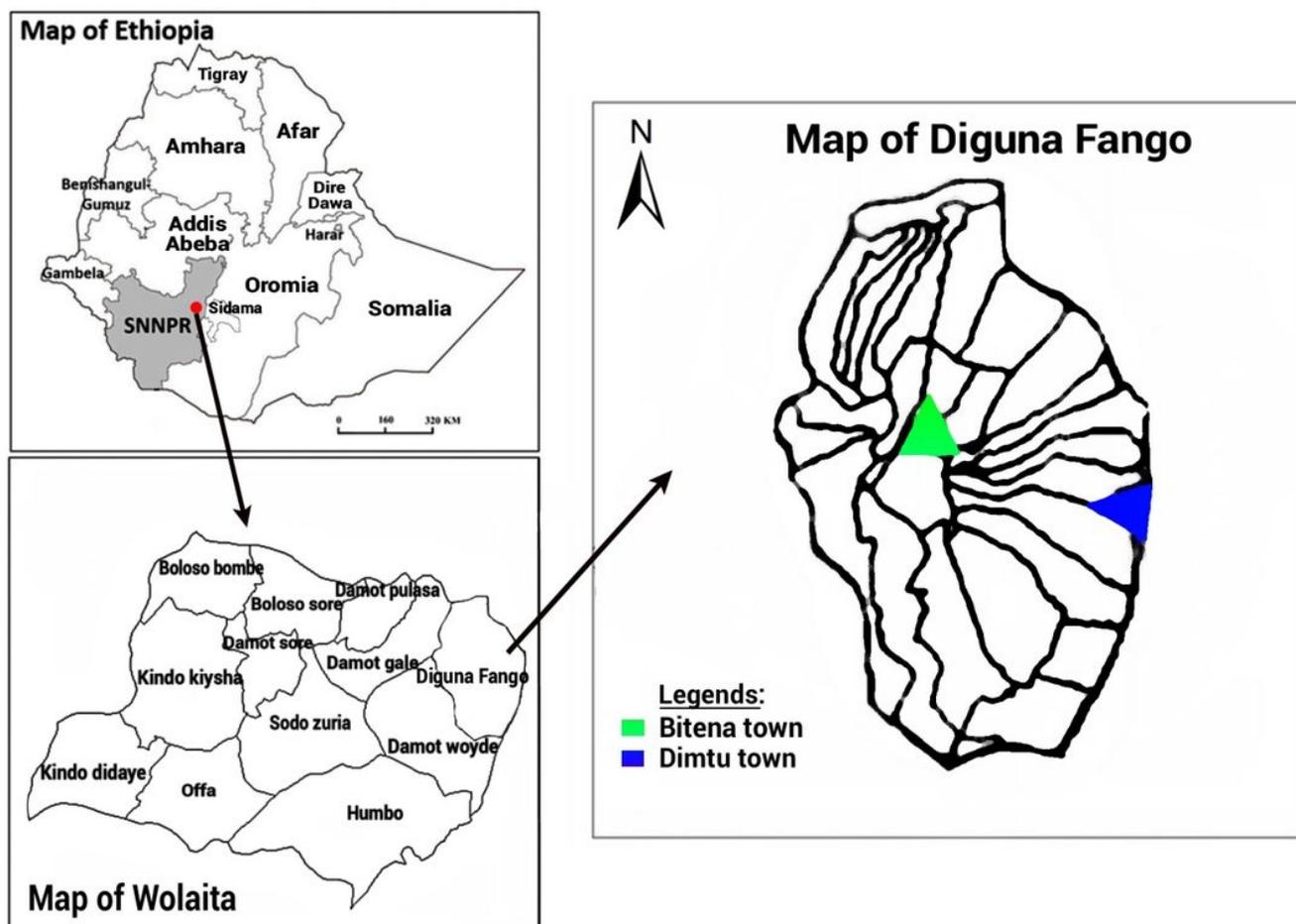


Figure 1

Map of Diguna Fango district, Wolaita zone, Southern Nation Nationalities and Peoples Regional State (SNNPRS), 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.

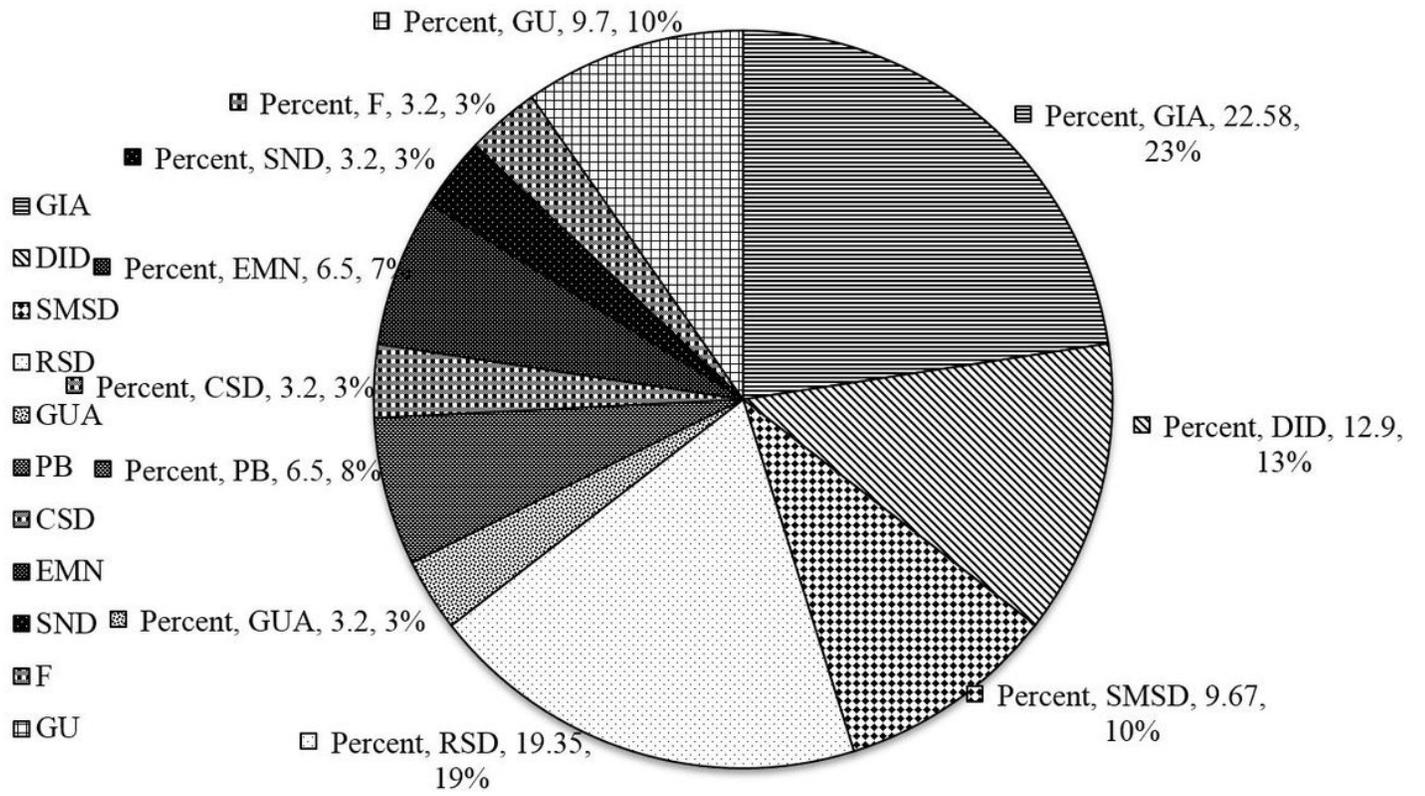


Figure 2

Main therapeutic indications of diseases

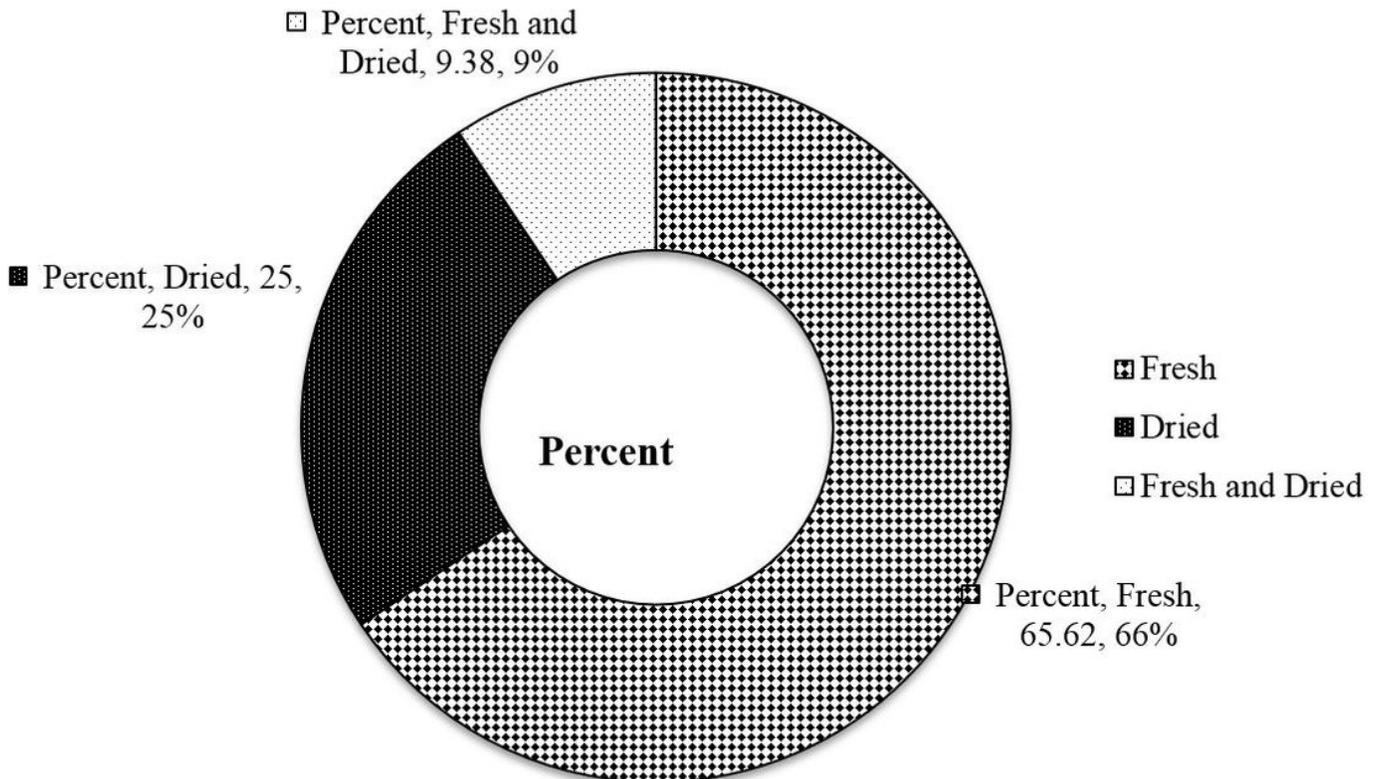


Figure 3

The used forms of medicinal plants

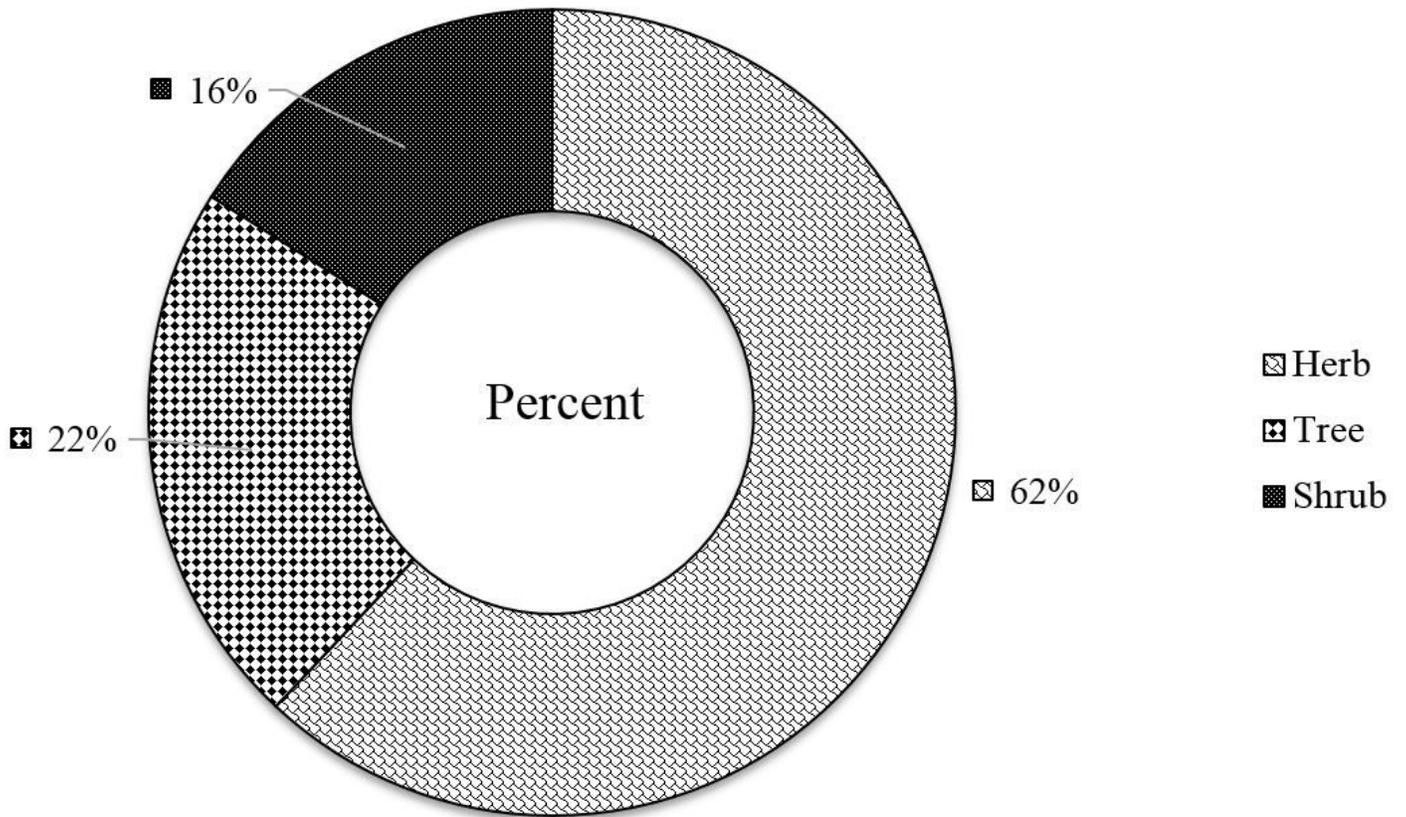


Figure 4

The growth forms of identified medicinal plant species

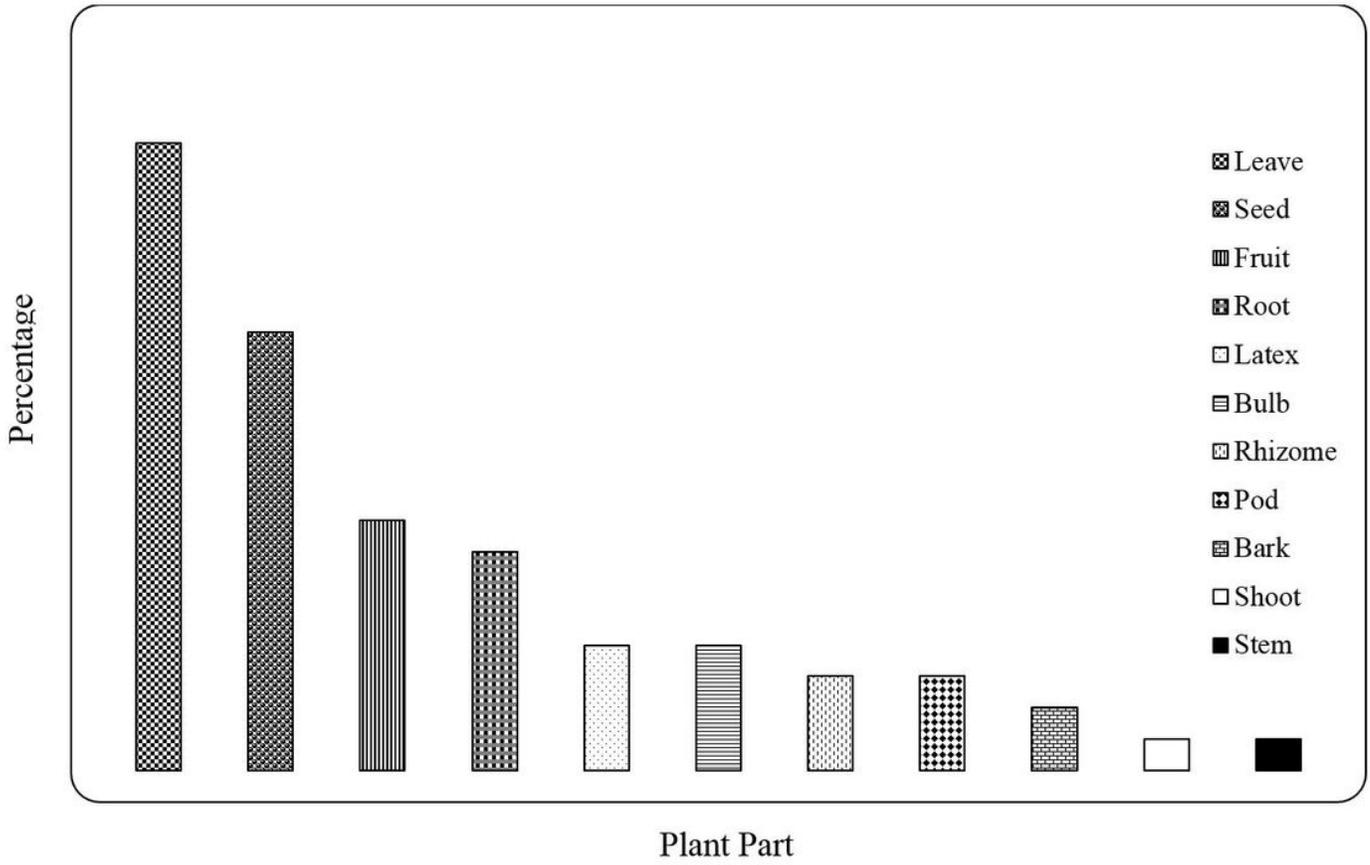


Figure 5

The dominant plant part used to prepare remedies

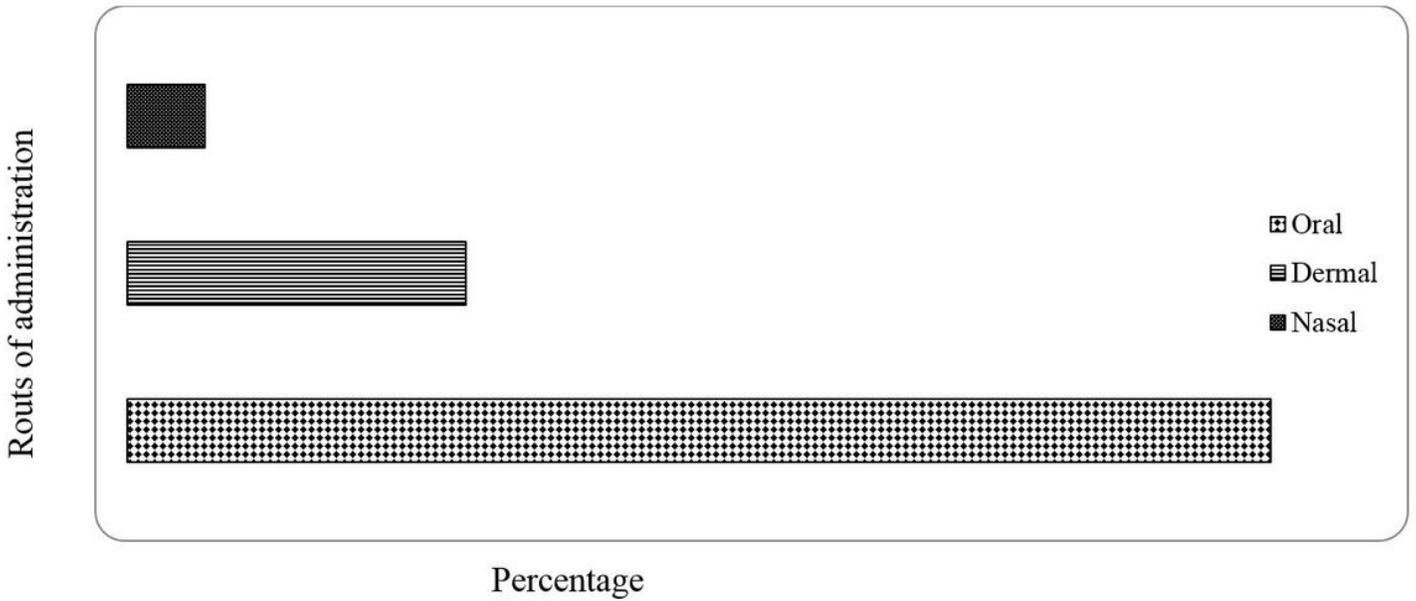


Figure 6

Routes of administration medicinal plants

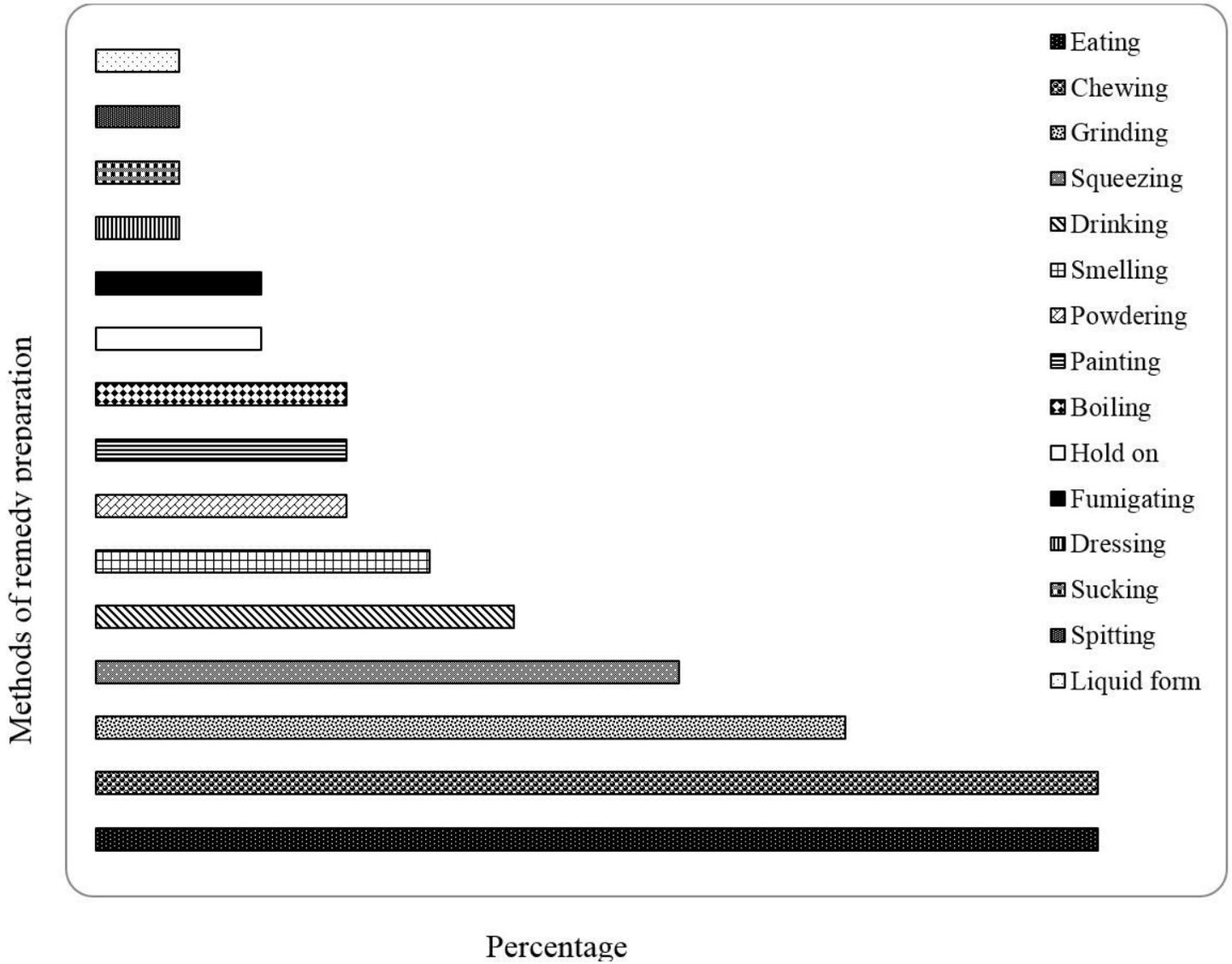


Figure 7

The most commonly used methods of remedy preparation

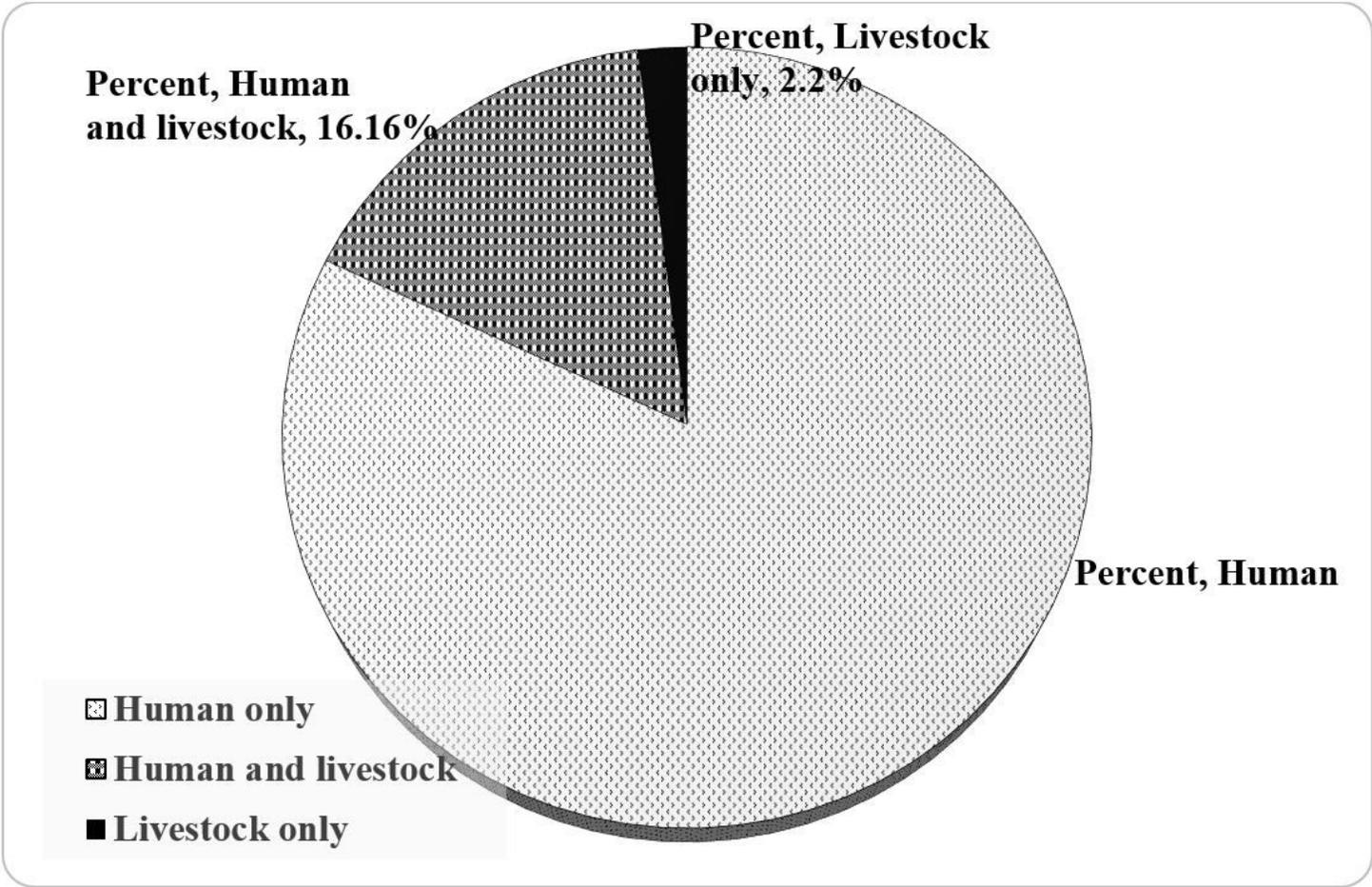


Figure 8

Medicinal plants used for treatment of human health problems

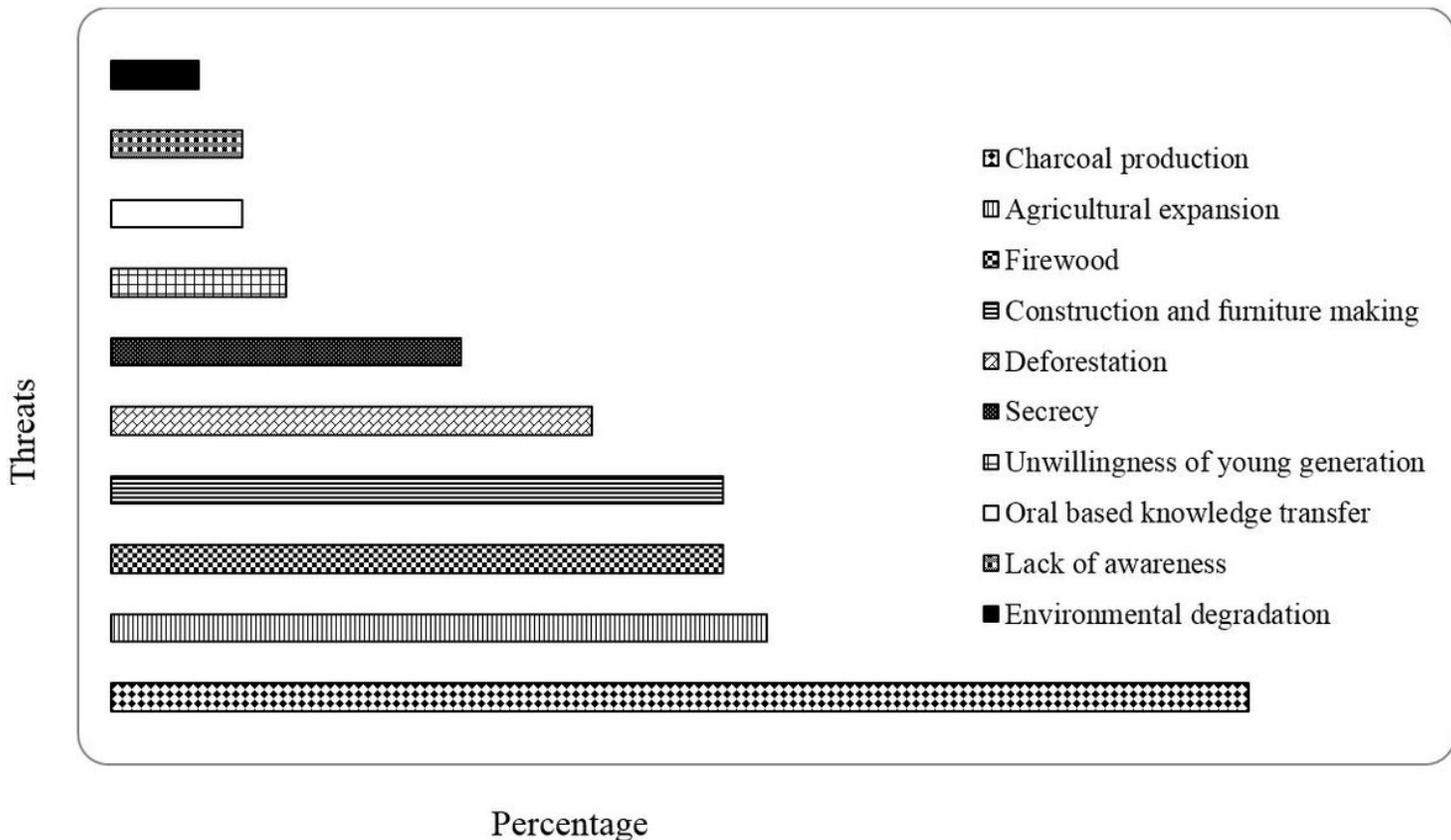


Figure 9

Threats to medicinal plants