Journal of Medicinal Plant Research

Volume 11 Number 31, 17 August, 2017

ISSN 1996-0875

Academic Journals

ABOUT JMPR

The Journal of Medicinal Plant Research is published weekly (one volume per year) by Academic Journals.

The Journal of Medicinal Plants Research (JMPR) is an open access journal that provides rapid publication (weekly) of articles in all areas of Medicinal Plants research, Ethnopharmacology, Fitoterapia, Phytomedicine etc. The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in JMPR are peer reviewed. Electronic submission of manuscripts is strongly encouraged, provided that the text, tables, and figures are included in a single Microsoft Word file (preferably in Arial font).

Contact Us

Editorial Office: jmpr@academicjournals.org

Help Desk: helpdesk@academicjournals.org

Website: http://www.academicjournals.org/journal/JMPR

Submit manuscript online http://ms.academicjournals.me/

Editorial Board

Journal of Medicinal Plants Research

Table of Contents: Volume 11 Number 31 17 August, 2017

ARTICLES

academicJournals

Vol. 11(31), pp. 480-500, 17 August, 2017
DOI: 10.5897/JMPR2016.6274
Article Number: C9E170D65702
ISSN 1996-0875

http://www.academicjournals.org/JMPR

Journal of Medicinal Plants Research

Full Length Research Paper

Diversity, knowledge and use of medicinal plants in Abay Chomen District, Horo Guduru Wollega Zone, Oromia Region of Ethiopia

Mulugeta Kebebew

Department of Biology, Arba Minch University, P. O. Box 21, Arba Minch, Ethiopia.

Received 14 October, 2016; Accepted 3 November, 2016

An ethnobotanical study of medicinal plants was conducted in Abay Chomen District, Western Ethiopia from September 2014 to August 2015. This study documents indigenous medicinal plant utilization, management and the threats affecting them. Ethnobotanical data were collected using semi structured interviews, field observations, preference and direct matrix ranking with traditional medicine practitioners. The data were analyzed using descriptive statistics; informant consensus factor and fidelity level using MS-Excel 2010. The ethno-medicinal use of 93 plant species belonging to 85 genera and 52 families were documented in the study area. The highest family in terms of species number is Fabaceae. Herbs were dominant (31.3%) flora followed by shrubs (30.1%). Most of the medicinal species (52.7%) were collected from the wild. Most of the plants (60.2%) were reportedly used to treat human diseases. The most frequently used plant parts were leaves (34.68%), followed by roots (23.39%). Fresh plant parts were used mostly (53.3%) followed by dried (29.3%) and the remaining (17.4%) either in fresh or dried. Among the preparations, pounding was the dominant (34.1%) form followed by powdering (13.29%). The remedial administration was mostly oral (54.91%) followed by dermal (30.64%). The highest (88.89%) informant consensus factor was associated with *Ocimum urticfoluim* followed by *Allium sativum* (86.67%). The fidelity level of *Allium sativum* was calculated irrespective of malaria treatment. Direct matrix analysis showed that *Carissa spinarum* was the most important species followed by *Syzygium guineense* indicating high utility value of these species for the local community. The principal threatening factors reported were deforestation followed by agricultural expansion.

Key words: Ethno-medicine, ethnobotany, Abay Chomen District, medicinal plants, traditional healers.

INTRODUCTION

Traditional medicine refers to the sum total of all the knowledge, beliefs and practices that are used in diagnosis, prevention and elimination of physical, mental or social imbalance and rely exclusively on practical experiences and observation handed down from generation to generation (WHO, 1998). Medicinal plants

E-mail: mulugetakebebew1@gmail.com.

have important contributions in the healthcare system of local communities as the main source of medicine for the majority of the rural population. Traditional medicine has remained as the most affordable and easily accessible source of treatment in the primary healthcare system of resource poor communities and the local therapy is the only means of medical treatment for such communities (Haile and Delenasaw, 2007). The World Health Organization (WHO) estimates that up to 85% of world population uses herbal medicines for prevention and treatment of diseases, and the demand is increasing in developed and developing countries.

Indigenous knowledge refers to the knowledge, rules, standards, skills and mental sets generated by and kept in custody of local people in a particular area (Quanash, 1998; Getnet et al., 2015). It is the result of many generations and long years of experiences, careful observations and trial and error experiments (Martin, 1995, Getnet et al., 2015). The ethnobotanical literature (Cunningham, 1996) underlines that both saving plant species and documenting and preserving indigenous knowledge associated with them are fundamental urgent concerns.

Ethiopia is endowed with a diverse biological resources including about 6, 500 species of higher plants, out of which more than 14% are said to have been used as traditional plant medicines to treat different human and livestock ailments, while more than 1,000 species have been documented at the Ethiopian National Herbarium database (Tesfaye, 2004; Getnet et al., 2015). Documenting traditional medicinal plants and the related traditional medical knowledge is important in order to facilitate the discovery of new sources of drugs and promote sustainable use of natural resources in Ethiopia.

The local people, as in other parts of Ethiopia depend on traditional medicine, which mostly relies on medicinal plants, to fulfill their healthcare needs as pointed out by Zegeye et al. (2011). Despite this fact, as far as it can be ascertained, there are no studies on ethno-medicinal plants, associated knowledge and the use in the Abay Choman District. However, this study provides sufficiently detailed information on the status of traditional botanical knowledge transfer from generation to generation based on age groups and educational levels as wells as on the ranking of most potential medicinal plants for specific disease treatment in the Abay Chomen District, Western Ethiopia. Hence, this study was framed with the aim of documenting the medicinal plants and the associated ethno-medicinal knowledge of people living in the study area.

MATERIALS AND METHODS

Characteristic features of the study area

Abay Chomen is one of the 180 district in the Oromia Region of Ethiopia. Today, this district is sub-divided into 31 Farmer Associations. Fincha'a is the capital town of the district, about 47 km from the zonal capital Shambu and 280 km from capital town of Oromia called Finfinne. The district has a latitude and longitude of 09°54′N 37°27′E with an altitude ranging from 880 to 2,400 m above sea level. The mean annual temperature and rainfall are 22 to 27°C and 510 to 1530 mm, respectively. The National Census (2007) reported a total population of the district, 48,316, of whom 24,972 were men and 23,344 were women. A survey of the land in this district shows that 11.4% is arable or cultivable, 2.2% pasture, 1.4% forest, and the remaining 83.8% is considered mountainous and part of the Fincha'a Sugar Project. Niger seed, teff, maize, wheat, barley, bean, and root and tuber crops such as potato, ''Anchote'' and others are dominant crops grown in the area.

Reconnaissance survey and study site selection

A reconnaissance survey was conducted from September 2, 2014 to September 4, 2014. Before starting the ethnobotanical study, contacts were made with various offices (District administration, tourism and culture, agriculture and rural development, traditional healers' association and health affairs) to seek permission to carry out the study by informing them about the aims and significance of the study. In this way, full legal procedures were followed and the informed consent of interested participants was obtained. Six rural villages, namely, Fincha Sukuar Project, Sementegna Camp areas, Achane, Kolobo, Gengi Ketela, and Jare were selected for the study. Relative distance, community-forest interactions and altitudinal differences were the basic site selection criteria. Relative distance and community forest interaction were taken as criteria after collecting information from Kebele administrative offices and inhabitants of the area during the reconnaissance survey in order to compare the indigenous knowledge of the communities found nearest to the forest with those found relatively far away (reached after traveling for more than 30 km).

Informant selection

A total of 90 informants (70 males and 20 females) between the age of 18 and 80 were interviewed in this research. Purposive and random sampling techniques were employed to select traditional herbalists and general informants, respectively. The Traditional Association leaders, members of the tourism and culture office, elderly people and religious leaders helped to identify the key informants. In addition, the identified traditional practitioners and members who had earlier been treated by the healers also helped to identify other traditional experts. The general informants were randomly picked (from the list of inhabitants) during field and house visits (15 in each study site) by checking their names from the list of residents obtained from Kebele offices. All interviews were administered after obtaining voluntary consent of each informant and assuring them that the data will be used only for academic purposes.

Data collection

Ethnobotanical data collection was accomplished from September 2014 to August 2015 by living in close contact with the community in the study area, following standard methods (Martin, 1995; Cotton, 1996; Cunningham, 2001). Accordingly, semi-structured interviews, guided field walks, direct observations, market surveys and focus group discussions with key informants and other knowledgeable community members were applied and their knowledge on medicinal plants gathered. Interviews were held based on checklist of questions prepared beforehand in English language and simultaneously translated into Afan Oromo. Interviews focused to informant's demographic features including sex, age, marital status, occupation, religion, educational

background, and duration of time an informant lived in the study area, and indigenous ecological knowledge (traditional ways of classifying vegetation, plants, landscapes and the soils in the area). The major part of the interviews were focused on the local names of medicinal plants used, their habits and habitats, plant part/s used, remedy preparation methods, materials used during preparation, condition of preparation, additives/ingredients used during preparation and administration, dosages administered, and route of administration. Likewise, side effects of the medicine (if any), use of antidotes for adverse effects, the season, month, dates and time of collection and preparation of plant medicines, and market value were also included. Further, the distribution (status) of medicinal plants, the interaction of healers with the district administration, threats and major problems, conservation methods, source of knowledge and ways of transfer and number of years of service as traditional healer were also the major interview points targeted, following the methods used by previous investigators (Martin, 1995; Balick and Cox, 1996; Cotton, 1996).

The semi-structured interviews held with informants usually started at their sitting places and further broadened into field walk with interviewed informants in order to see the plants mentioned in their habitats and voucher collections following Martin (1995). This activity further helped to record growth habits of medicinal plants. Focus group discussions were done with traditional medicinal plant association members, other herbalists, monks and general informants to obtain additional information and to check the reliability. Informants were contacted two to three times and responses of an informant in harmony with each other were taken as relevant and used for data analysis. At times, the preparation methods of the medicinal plants were said to be secret and were not included during discussion. Most field observations were conducted with a single informant in order to keep the knowledge top-secret as this was what the healers in particular preferred. Some of the traditional healers were genuine herbalists, well-known by the local community and owned traditional home pharmacies derived from plant remedies. They were asked to demonstrate their work at their homes and in the field, which was recorded in order to check the consistency in knowledge and practice on the preparation of remedies and their effectiveness. The patients encountered at healers' homes were also asked about the traditional plant medicines they have used and their effectiveness when applied by healers.

Plant collection and identification

Voucher specimens were collected for each plant species during guided field walk with the informants. At times, the field activities included taking notes on plants and the associated indigenous knowledge with preliminary identification of the plants to family and sometimes to species levels. Photographic records were also taken in the field to capture the field sites, plants and other useful memories. The specimens were dried, deep-frozen, and determinations were made at the Ethiopian National Herbarium (ETH), Addis Ababa University, using taxonomic keys and descriptions given in the relevant volumes of the Flora of Ethiopia and Eritrea (Edwards et al., 1995; 1997; 2000; Hedberg and Edwards, 1989; 1995; Hedberg et al., 2003, 2004, 2006, 2009) and by visual comparison with authenticated herbarium specimens. Finally, the accuracy of identifications was confirmed by a senior plant taxonomist and the voucher specimens with labels were deposited at the ETH.

Data analysis

The ethnobotanical data were analyzed using Microsoft Office Excel spreadsheet (2010). The Excel ® was used to calculate sum, percentages, tabulate and draw graphs. Ethnobotanical ranking and scoring methods such as preference and direct matrix rankings as well as pair-wise comparisons and informant consensuses were employed to distinguish priority species and to check consistency. Preference/priority ranking activities were employed on five most preferred and widely used medicinal plant species for the treatment of diarrhea and the most threatened medicinal plants. Direct matrix ranking was employed for the seven most utilized multi-purpose plant species and for the eight factors considered most threatening to medicinal plants. Pair-wise comparison was made on five of the most preferred and commonly used medicinal plants against gonorrhoea. To do this, the number of possible pairs was determined by applying the formula n(n-1)/2, where n is the number of medicinal plant species being compared. For all the aforementioned ethnobotanical ranking and scoring techniques, the same ten key informants who had long time practical experience in traditional plant medicine preparation, administration and collection were engaged. The strength of knowledge of the key informants was evident to the first author who witnessed the clarity of explanations and accuracy of actions. The overall procedures for these activities were conducted following standard ethnobotany texts (Martin, 1995; Balick and Cox, 1996; Cotton, 1996). Informant consensus factor (ICF) for different ailment categories was calculated to test agreements of the informants on medicinal plant knowledge of each category by using the formula ICF = NurNu/Nur-1, where nur is the number of uses reported in each category and Nu is the number of species reported in each category (Heinrich, 2000).

Ethical consideration

All data collections were done with special care on the base of the cultural view of the local communities in the study area. Informants were also informed that the objectives of the research were not for commercial purposes but for academic reasons. Since, ethno-medicinal indigenous knowledge is only obtained from traditional specialists within the community so any value that will obtain as a result of the research will benefit the community. According to ethno-biology code of ethics indigenous knowledge should be protected and a part of the value generated should be transferred back to the authors of the knowledge. Finally, informants accepted the idea and came to reached an agreement.

RESULTS AND DISCUSSION

Indigenous knowledge on health concept

In the study area, the local people call health ("Fayya" in Afan Oromo) which is taken as a special wealth provided by God ("Waaqayyo"). They believe or understand as ailments are the cause for health upset caused either with organisms ("ilbiisa") or can be sent from God as punishment ("Dheekkamsa Waaqayyoo") for wrong doings. They can also classify health problems, as those that can be treated and that cannot. For instance, the informants pointed that AIDs "dhibee baraa" and spiritual diseases "dhibee ayyanaa" are non-curable either traditionally or by modern treatment. From discussion made with elders several poems, proverbs and songs were recorded reflecting the values of health to the local people. To cite few of these: "Fayyan muka nyaata" meaning "healthy man does everything". "Dhibbi abbaan

hin beekne fayyaa dha" meaning “a great wealth and gift is health”. "Fayya xaba seete qayyaan laga ceete” meaning “health needs special care”. These proverbs indicate that, health is considered as a great asset, which is assumed as a life engine for any aspects of life in the area.

Indigenous ecological knowledge of people in the study area

The inhabitants of the study area are owners of rich ethnobotanical and ethno-ecological knowledge as demonstrated by their wide array of knowledge on environmental matters. They classified the land forms, vegetation and soil based on knowledge surviving from ancestral practices, now evident through their elaborate emic categorization systems.

Use based land classification by indigenous people

In the present study, it was found that indigenous people classify their land based on use. (i) Lafa dheeddicha - meaning grazing land saved for cattle, calf, donkey, mule and horse for grazing, (ii) Lafa qonna, meaning agricultural land form that serves for cropping, (iii) Lafa bosonaa, meaning forestland secondary forestlands, where different plant species are found, which is the source of different wood and wood products, (iv) Gooda, refers to an extensive area that is not suitable for agriculture in most cases. It is left aside by the community for common grazing and browsing, (v) Lafa caffe, meaning marshland suitable for irrigation and grazing, (vi) Lafa manaa, meaning residential land where the community has settled, and (vi) Luugoo lagaa, meaning riverine banks where deep gorges or simple gorges are found and better vegetation exists along its course.

Topographic land classification by indigenous people

Indigenous people of the area classify their land also based on topographic landscape: (i) Gaara/Tullu, mountain area characterized with higher altitude and covered with vegetations, (ii) Tabba, land forms with smaller elevation (hills) compared to Tullu, on which agriculture, grazing and other practices can be performed, (iii) Goodaa, refers to an extensive field characterized with lower elevation area, left aside by the community for grazing and browsing. It is a plain around reverine areas, (iv) Dirree/Lafa ciisaa, plain on which settlement and agricultural activities are usually practiced, (v) Qilee/Bowwa, refers to gorges. This land form is mostly covered, shrubs and herbs, and rarely trees and climbers. It is used neither for agriculture nor for grazing, and (vi) Katta, refers to land forms that are dominated by different size of rocks. It is mostly used for grazing.

Soil classification by indigenous people

Indigenous people classify (name) soil based on color, texture and suitability for cropping. (1) Biyyoo diimillee, meaning clay soil, they call it biyyoo diimillee, because of its red color and poor fertility, (2) Biyyoo kootichaa, meaning black soil due to its color and with better fertility than other soil types, (3) Biyyoo cirrachaa, meaning sand soil sandy soils and silt soils resulting from deposition by erosion. This soil type is easily distinguished by its content of fine sand soil with silt, and is suitable to grow specific crop types, (4) Biyyoo walinii, meaning mixed soil type characterized by containing all the aforementioned three soil types, (5) Biyyoo Kosii, soil type containing high amount of organic materials drawn from household left wastes and animal excreta.

Vegetation classification by Indigenous people

According to some informants from the study area, vegetation of the study area is classified based on dominating tree species and density of plants that cover the land. (a) Bosona, this type of vegetation is with densely populated plant species and composed of a range of larger trees, where many wild animals dwell, (b) Luugoo lagaa, refers to riverine forest. The range of plant species composition here varies based on the accessibility of plants existing there to both humans and livestock. In areas where the riverine is shallow deep, it is more densely populated with different species, while in areas where human and livestock interference exists the composition is less, and (c) Ciccita (Hurufa), open woody and shrub land with patches of trees, bushes, shrubs and herbaceous species, and (d) Caffee, marshy vegetation in marshy fields suitable for grazing.

Ethno-medicinal plant species used by people of the study area

In this study, a total of 93 species of medicinal plants were gathered and documented from the study area. The species represented 85 genera and 52 families. Family Fabaceae was represented by 10 species followed by 7 species of Asteraceae and 6 species of Lamiaceae. Rutaceae and Solanaceae were represented by 4 species each; Cucurbitaceae, Euphorbiaceae and Moraceae were represented by three species each. Nine families were represented by 2 species each (Acanthaceae, Araceae, Boraginaceae, Myrsinaceae, Myrtaceae, Polygonaceae, Ranunculaceae, Rosaceae,

and Verbenaceae), while the remaining families were represented by one species (Appendix 1). This result showed that Abay Chomen District is rich in medicinal plants as shown by the presence of 93 species exhibiting wide taxonomic diversity. This number of diverse taxonomic groups of medicinal plants and associated ethno-medicinal knowledge has been observed in different regional state of Ethiopia (Getnet et al., 2015; Meaza et al., 2015; Getaneh, 2016). The existence and utilization of such a large number of medicinal plants by people in the study area indicates that the majority of the people used indigenous medicinal practices to take care of medication problems. The study shows that the traditional healers of the study area were found to play great roles in the primary healthcare systems of the local people as they were treating resource poor people who had little access and could not afford the cost for modern medications.

Sources of medicinal plants

Regarding the distribution of medicinal plants about 49 (52.7%) species were obtained from wild followed by 25 (26.9%) species and 19 (20.4%) species from home garden (cultivated and both cultivated and wild). This indicates that the practitioners depend on the wild source or the natural environment rather than home gardens to obtain the medicinal plants, and the activity of cultivating medicinal plants is very poor in the study area. It also indicates that the natural forest of the study area is being over exploited by traditional practitioners for its medicinal plants composition. This finding is similar to the general pattern seen in most medicinal inventories (Getnet et al., 2015; Meaza et al., 2015; Getaneh, 2016) where wild medicinal plants dominate. The local people cultivate some popular medicinal plants in their home garden for the purpose of medicine such as *Allium sativum*, *Schinus molle*, *Asparagus africanus, Lepidium sativum*, *Carica papaya, Ocimum lamifolium, Otostegia tomentosa, Rhamnus prinoides* and *Nicotiana tabacum*. This and field observation during data collection clearly confirmed that some traditional healers do not have interest to grow in their home garden some plant species that are used to treat specific ailments in order to keep the secret of their medicinal value. This means that most of the medicinal plants found in the home gardens are those also known to have other uses particularly as food.

Growth form of plants used for medicine

The result of growth forms diversity analysis of medicinal plants reveals that herbs constitute the largest category (29 species, 31.3%) followed by shrubs (28 species, 30.1%). Trees amounted to (26 species, 27.9%). The others included climbers (7 species, 7.5%), epiphytes (2 species, 2.1%) and lianas (1 species, 1.1%). Herbs and shrubs make up the highest proportion (57 species, 61.3%) of the medicinal plant species. This could be related to the fact that these species exhibit high level of abundance and easy to obtain them. Relatively high number of herbs and shrubs for medicinal purpose were also previously reported in Ethiopia (Balcha, 2014; Getnet et al., 2015; Getaneh, 2016).

Medicinal plants and their main uses by the local people

Among the reported medicinal plants of the area, some plants were found to treat different health problems affecting the health of both humans and livestock. Out of 93 medicinal plant species in this study, 56 species (60.2%) were noted to treat only human ailments while 20 species (21.5%) are used to treat livestock ailments. Seventeen species (18.3%) wer used to treat both livestock and human ailments. Informant consensus on these medicinal plants confirms their efficacy against some human and/or livestock ailments.

Parts of plants used for medicine

From the total plant parts used for remedy preparation, the leaves and the roots were the most commonly used plant parts in the preparation of remedies accounting for 34.68% (43 species) and 23.39% (29 species) of the total medicinal plants, respectively and lower values for other parts used to treat various health problems (Figure 1). The fear of destruction of medicinal plants due to plant parts collected for the purpose of medicine is minimal as leaves were the leading plant parts sought in the area. Sets of works that were carried out previously elsewhere in Ethiopia also revealed that leaves followed by roots were the common plant parts used to treat various health problems (Mirutse and Gobana, 2003; Abiyu et al., 2014; Balcha, 2014). Herbal preparation that involves roots, rhizomes, bulbs, barks, stems or whole parts have effects on the survival of the mother plants but leaves generally have low impact on individual plants as compared to roots, rhizomes, bulbs, barks, stems or whole parts.

Composition, condition and preparation methods of medicinal plants

In the collection of data concerning the preparation of medicine, informants have reported various skills associated with herbal preparation. These include plant composition (whether single or combined), condition of plant material used (fresh or dry) and methods of preparation. The result showed that most remedies were prepared from single plant species (61.5%) and

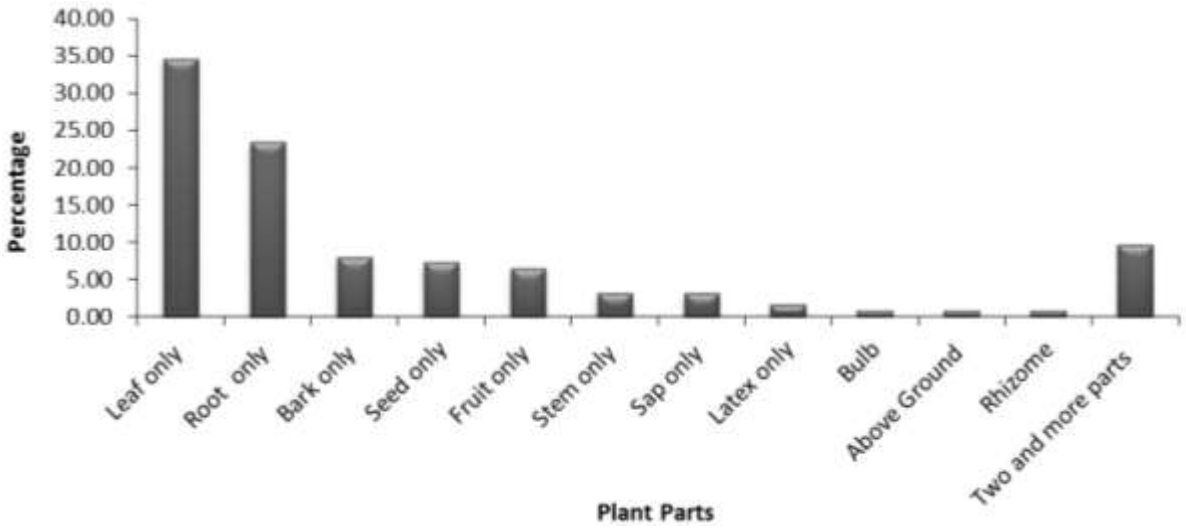

Figure 1. Parts of plants used for medicine preparations.

preparation from combined plant species was about 38.5%. Local people depend on both dry and fresh remedies. In this case, 98 preparations (53.3%) are in fresh form, 54 (29.3%) are dried and 32 (17.4%) are dried and fresh. The dependency of local people on fresh materials put the plants under serious threat than the dried form, as fresh materials are harvested directly and used soon with its extra deterioration with no chance of preservation, that is, not stored for later use. However, local people argue that fresh materials are effective in treatment as the contents are not lost before use compared to the dried forms. The livelihood of most traditional healers relies on fresh materials that have aggravated the decline of rare medicinal plants from the study area according to the informants. Traditional practitioners are collecting medicinal plants with less attention than would be preferred from viewpoint of conservation of plant resource. This finding is significantly similar from all the other findings from other regions of Ethiopia (Debela, 2001; Kebu et al., 2004; Abiyu et al., 2014). The local healers employed several methods of preparation of traditional medicines from plants. The result showed that most remedies were prepared from single plant (61.5%) and preparation from combined plant species was about 38.5%. The result is in agreement with the findings of Dawit (1986) and Debela (2001) in which the single plant preparation were reported to be high and disagrees with works of Mirutse (1999) and Bayafers (2000) in which the combined plant materials were reported to have high proportion in herbal preparation. The local people employ several methods of preparation of traditional medicines. The frequently used methods were pounding, powdering and smashing, respectively. Pounding 59 (34.1%), powdering 23 (13.3%) and smashing 22 (12.7%) are the three main methods of preparation of medicine (Figure 2). The preparation and application methods vary based on the type of disease treated and the actual site of the ailment. The majority of the preparations are made from mixture of different plant species with water and different additive substances like honey, sugar, butter, and salt and milk. These additive substances have different functions, that is, to reduce poisons, improve flavor and as antidotes during adverse effects such as vomiting and diarrhea. Dawit (1986) has also identified the additive substances in herbal remedy preparations with their possible benefits. It was also reported that some medicinal plants are mixed with food and drinks in such manner that, they change their flavor and simple to take. For instance, *Lepidium sativum* is added with a honey to improve its taste.

Route of remedy administration and dosage determination

There are various routes of administration of traditional medicinal plants prepared products by the local community. The major routes of administration in the study area are oral, dermal, nasal, anal and optical. Oral administration is the dominant route (54.91%), followed by dermal route (30.64%) (Figure 3). Both oral and dermal routes permit rapid physiological reaction of the prepared medicines with the pathogens and increase its curative power. This fact has been documented by different authors in the other part of Ethiopia (Abiyu et al., 2014; Balcha, 2014; Getnet et al., 2015). In addition, informants reported that there are related restrictions to enhance rapid physiological reaction and to increase its curative power of remedies. For example, a patient who takes remedy against tapeworm should not take any food six hours before and after administration of the medicine. People of the study area used various units of

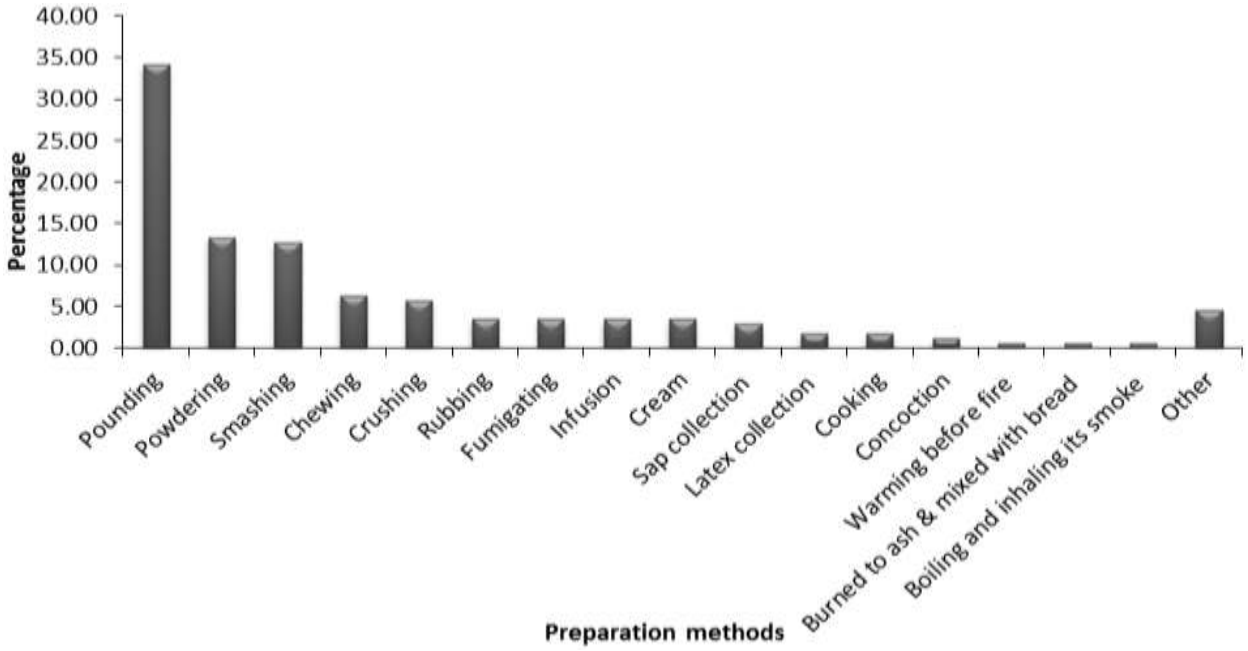

Figure 2. Preparation methods of medicinal plants.

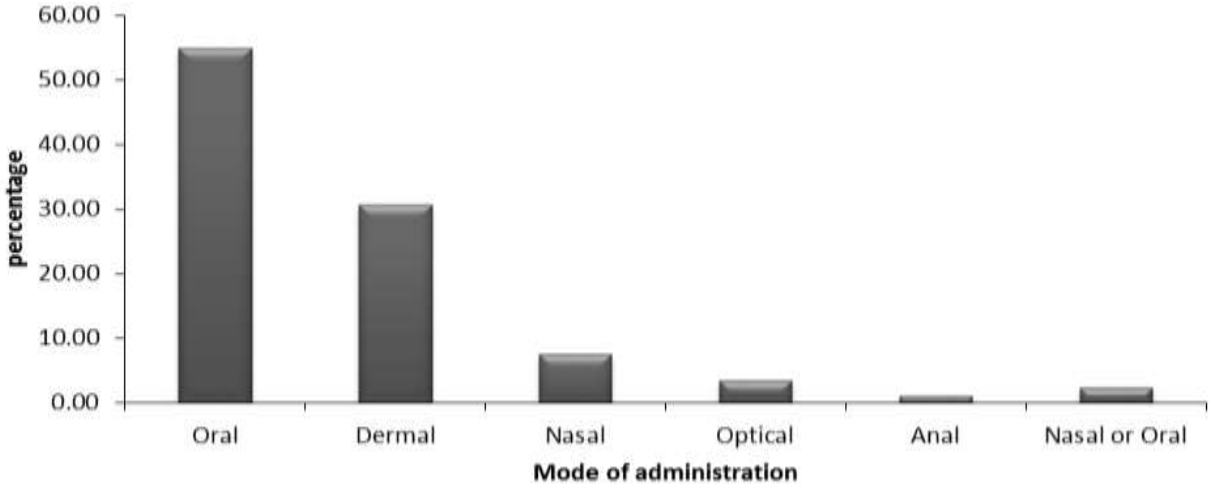

Figure 3. Mode of administration of the plant remedies

measurement and the duration of administration to determine the dosage. Local units such as finger length (e.g., for bark, root, stem), pinch (e.g., for powdered plant medicine) and numbers (e.g., for leaves, seeds, fruits, bulbs, rhizomes, flowers and latex) were used to estimate and fix the amount of medicine. Recovery from the disease, disappearance of the symptoms of the diseases, fading out of the disease sign and judgment of the healer to stop the treatment were some of the criteria used in determining duration in the administration of the dosage. However, from the interview made during the study, it was found that there was disagreement among the healers concerning the dosage system used. For drops of example, some informants suggested that four or five the latex from *Euphorbia candelabrum* is used to treat Ascariasis or gonorrhea, while some suggested that only one drop is enough for the same problem. Still some others suggested that they apply the latex randomly without such measuring system. Although the full dose determination is varying from healer to healer, the dose given depends on age, physical strength and heath conditions. This finding significantly agrees with other findings from other regions of Ethiopia (Dawit and Ahadu, 1993; Abiyu et al., 2014). The healers never administer

Table 1. Some medicinal plants which are found in market.

S/N	Medicinal plants	Use	S/N	Medicinal plants	Use
1	*Allium sativum*	Spice	10	*Linumusitatissimum*	Food
2	*Artemisia abyssinica*	Aromatic	11	*Lipia javanica*	Aromatic
3	*Asparagus africanus*	Aromatic	12	*Nicotiana tabacum*	Stimulant
4	*Carica papaya*	Food	13	*Olea europaea*	Fumigation
5	*Citrus limon*	Food	14	*Otostegia tomentosa*	Aromatic
6	*Colocasia esculenta*	Food	15	*Plectranthus edulis*	Food
7	*Echinops kerebicho*	Fumigation	16	*Rhamnus prinoides*	Beverage
8	*Ficus sur*	Food	17	*Ricinus communis*	Smoothing
9	*Lepidium sativum*	Food	18	*Zingiber officinale*	Food

treatments that are taken internally to pregnant women.

Marketed medicinal plants in the study area

The medicinal plant material found being marketed in the open markets for medicinal purpose was *Nicotiana tabacum* in the treatment of livestock disease. In addition to this, some medicinal plants are sold in the market for other purposes and most of them are sold as food (Table 1). Selling medicinal plants in the market are not a common cultural activity in local markets of the study area. But medicinal plant like *Hagenia abyssinica* (dry flower) is sold in the market for its medicinal purpose. Some fresh collection of *Echinops kerebicho, Artemisia Abyssinica* and *Allium sativum* are also marketed in a local community for their fumigation, aromatic and spice value, respectively. These results are consistent with the findings of various ethnobotanical researches elsewhere in Ethiopia (Getnet et al., 2015).

Informant consensus

The results of the study showed that some medicinal plants are popular than the others, in view of that, *Ocimum urticfoluim* (Hancabbii adii) took the lead where it was cited by 80 informants for its medicinal value for treating fibril illness. *Allium sativum, Citrus limon* and *Echinops kerebicho* are cited by 78, 72 and 68 informants ranking 2nd, 3rd and 4th, respectively (Table 2). The latter three species are used for treating a series of different health problems. The action of plant extracts on different health problems may explain the broad-spectrum nature of plants, while their action on a particular problem explains their narrow spectrum nature. Popularity of these medicinal plants according to key informants is due to their wide range of diseases they treat or due to the abundance of the plant in the area for easy access. The case of *Ocimum urticfoluim* and *Allium sativum* can be cited for their abundant distribution in the area. With this, other medicinal plants mentioned by four or more, scoring percentage greater than 50 and those frequently used ones for treatment of more than two ailments are given in Table 2.

Preference ranking

When there are different species prescribed for the same health problem, people show preference of one over the other. Preference ranking of 5 medicinal plants that were reported as effective for treating diarrhea was conducted after selecting 10 key informants. The informants were asked to compare the given medicinal plants based on their efficacy, and to give the highest number (5) for the medicinal plant which they thought most effective in treating diarrhea and the lowest number (1) for the least effective plant in treating diarrhea. Preference ranking for seven medicinal plants used to treat gonorrhoea (Table 3) shown that *Lepidium sativum* ranked first and hence is the most effective medicinal plant to cure diarrhea. The second and third most preferred medicinal plants against this disease are *Thalictrum rhynchocarpum* and *Amaranthus caudatus*, while the least preferred species compared to the other five species are *Phragmanlhera macrosolen* and *Amorphophallus abyssinicus* according to informants.

Paired comparison

For medicinal plants that were identified by the informants to be used in treating gonorrhea, a paired comparison was made among five of them using ten informants to know their rank (Table 4). *Carissa spinarum, Phytolacca dodecandra, Justica schimperiana* and *Flacourtia indica* were ranked 1st, 2nd, 3rd and 4th, respectively. *Euphorbia condelabrum* are less preferred and less efficacious compared to the other four species.

Direct matrix ranking

In this study, a number of medicinal plants were found to

Table 2. The top 15 medicinal plants and the corresponding informants.

Scientific name	No. of informants	Total (%)
Ocimum urticifolium	80	88.89
Allium sativum	78	86.67
Citrus limon	72	80.00
Echinops kerebicho	68	75.56
Nicotiana tabacum	61	67.78
Ruta chalepensis	50	55.56
Ricinus communis	43	47.78
Lepidium sativum	41	45.56
Croton macrostachyus	39	43.33
Rhamnu sprinoides	38	42.22
Otostegia tomentosa	36	40.00
Carica papaya	35	38.89
Asparagus africanus	34	37.78
Eucalyptus globulus	34	37.78
Ocimum lamifolium	34	37.78

Table 3. Preference ranking of medicinal plants used to treat Diarrhea.

Medicinal plants	Informants labeled R1 to R10											
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Total score	Rank
Amaranthus caudatus	3	4	5	3	4	2	2	1	1	3	28	3
Amorphophallus abyssinicus	2	1	1	2	1	4	5	3	4	1	24	5
Lepidium sativum	5	5	3	4	2	5	4	4	3	5	40	1
Phragmanlhera macrosolen	1	2	4	1	5	3	1	5	2	2	26	4
Thalictrum rhynchocarpum	4	3	2	5	3	1	3	2	5	4	32	2

Table 4. Paired comparisons of six medicinal plants used to treat gonorrhea.

Medicinal plants	Informants labeled R1 to R10											
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Total score	Rank
Justica schimperiana	3	2	5	2	4	3	2	2	5	3	31	3
Carissa spinarum	4	5	4	5	5	5	3	4	4	5	44	1
Euphorbia condelabrum	1	3	1	1	2	4	1	1	2	1	17	5
Flacourtia indica	2	1	2	3	1	1	4	3	1	2	20	4

be multipurpose species being utilized for a variety of uses. The common uses include medicinal, fodder, food, firewood, construction, charcoal, fencing and furniture making. Seven commonly reported multipurpose species and eight use-categories were involved in direct matrix ranking exercise in order to evaluate their relative importance to the local people and the extent of the existing threats related to their use values (Table 5). The results show that the local people harvest seven multipurpose species mainly for firewood, fencing, medicine, charcoal, construction and furniture with the rank of 1st, 2nd, 3rd, 4th, 5th, 6th and 7th, respectively. Thus, the long-term survival of the top-ranked species are under question, as the daily demand of the local society is usual and continuous with lesser rate of re-plantation, except for *Eucalyptus globulus*. This is evidenced by the high rate of loss of *Carissa spinarum, Syzygium guineense* and *Croton macrostachyus* in the area.

Fidelity level index

Confirmation or consensus could not be taken as a single

Table 5. Direct matrix ranking for multiple uses of medicinal plants.

Medicinal plants species	Multiple use of medicinal plants									
	Fire wood	Forage	Construction	Furniture	Food	Charcoal	Fencing	Medicine	Total score	Rank
Acacia abyssinica	3	6	2	2	0	7	5	3	28	6
Cordia africana	2	5	1	7	5	3	2	4	29	5
Carissa spinarum	7	7	4	1	6	2	7	6	40	1
Croton macrostachyus	6	2	3	3	0	6	6	7	33	3
Eucalyptus globulus	4	1	7	6	0	4	4	5	31	4
Syzygium guineense	5	4	5	5	7	5	3	1	35	2
Olea europaea	1	3	6	4	0	1	1	2	18	7

measure of the potential efficacy of any medicinal plant in fidelity level index. Thus, efficacy is not the only factor that influences the informant choice but abundance of a given plant and prevalence of disease in the area can affect informants choices. As malaria is one of the frequently reported diseases in low land areas (Fincha Sukuar project and Sementegna camp area) and less frequent in high land areas (Achane, Kolobo, Gengi Ketela and Jare). Different number of informants from the two areas for malaria case reported the use of *Allium sativum* as a remedy.

The fidelity level index was calculated for *Allium sativum* for the two ecological areas. A total of 13, 17 specific and general use for *Allium sativum* were reported by informants from Achane, Kolobo, Gengi Ketela and Jare. While 17, 18 specific and general uses for *Allium sativum* were reported by informants from Fincha Sukuar project and Sementegna camp area. Use reports of informants from Achane, Kolobo, Gengi Ketela and Jare were compared with informants from Fincha Sukuar project and Sementegna camp area to assess the fidelity level of *Allium sativum (*FL=IP/IU*).* From the comparison, it was found that the fidelity level of *Allium sativum* for malaria treatment by Achane, Kolobo, Gengi Ketela and Jare informants was 76.4%, while for Fincha Sukuar project and Sementegna camp area was 94.4%. Thus, the medicinal value of *Allium sativum* is high in Kola areas compared to Woinadega zones.

Indigenous medicinal plant knowledge development and sharing

Traditional knowledge of medicinal plants in most cases is passed along the family line from parents and other intimates, especially gifted family members (which they described as "Harki isa kan hojeetu", meaning one whose hands are skillful and effectual). Some of the traditional knowledge is generated through the community by listening and practicing while some copied secretly and systematically by following and observing the knowledgeable individuals at times of medicinal plant collection and preparation. Others develop and transfer their medicinal plant knowledge to generations by following up healers after seeking treatment of their family members. In very few cases, individuals developed their medicinal plant knowledge upon careful observation of domestic carnivores, especially the cat, which immediately consumes medicinal plant parts upon preying on poisonous snakes, scorpions and spiders. One healer reported his discovery in this way of *Vernonia adoensis* for the treatment of snake poison. Medicinal plant experts have developed some traditional medicinal plant knowledge from observations of animal feeding to know the plants that are never consumed, which hints at plants not for internal use to ensure safety of the vital organs but rather used for the treatment of dermal ailments such as wounds because of their possible toxic nature. Furthermore, experienced medicinal plant experts create new medicinal knowledge by relating the plant odour with previously known medicinal plants. Some healers were seen recording ethno-medicinal knowledge in small notebooks during fieldwork, which may testify their curiosity and keenness to develop and transfer indigenous knowledge to the next generation.

Threats to medicinal plants and conservation practices

In Abay Chomen District, various factors that were considered as main threats for medicinal plants

Table 6. Threats to medicinal plants.

Factors	Respondents											
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Total score	Rank
Deforestation	8	7	8	8	7	6	8	8	7	8	75	1
Agricultural expansion	6	8	7	6	8	8	6	7	8	7	71	2
Overgrazing and browsing	7	5	5	7	6	7	7	6	6	6	62	3
Charcoal and firewood	4	6	6	5	4	5	5	5	5	5	50	4
Construction material	5	4	3	4	5	3	4	4	4	4	40	5
Extended dry time	2	3	4	2	3	4	3	3	2	3	29	6
Fire	3	2	2	3	2	2	2	2	3	2	23	7
Medicinal plant trade	1	1	1	1	1	1	1	1	1	1	10	8

were recorded by interviewing the informants. The major factors claimed were deforestation (1), agricultural expansion (2), overgrazing and browsing (3), trading charcoal and firewood (4), construction material (5), drought (6), fire (7) and medicinal plant trade (8) (Table 6). These results are consistent with the findings of various ethnobotanical researches elsewhere in Ethiopia, such as that of Balemie et al. (2004), Ermias et al. (2008) and Getnet et al. (2015) indicates some similar investigation. The effort to conserve medicinal plants in the district was observed to be very poor. Some traditional practitioners have started to conserve medicinal plants by cultivating at home gardens, though the effort was minimal. Traditional beliefs in the area also have their own unintentional role in conservation and sustainable utilization of medicinal plants. However, giving conservation priority for identified threatened medicinal plants, promoting *in-situ* and *ex-situ* conservation of medicinal plants in Abay Chomen area as well as supporting the district's Traditional Healers Association, by providing funds, land for cultivating medicinal plants and assisting their activities with professional guidance helps to conserve the fast eroding medicinal plants of the study area.

Conclusions

The present study showed that Abay Chomen District, a high diversity of medicinal useful plants and the people living in the area have a long history of plant use, and that of medicinal plants is exceptionally notable and culturally rooted in the area. Despite the gradual socio-cultural transformation, the inhabitants have retained remarkable knowledge of the plants and their uses. Difficulties in knowledge transfer and the resulting generation gap in knowledge are threatening the continuity of the medicinal plants and the indigenous knowledge on them. On the other hand, the study provided evidence that medicinal plants will continue to play an important role in the healthcare system in the study area, given support through conservation and education. Knowledge and herbal medical practices for the treatment of various ailments among both rural and urban people are major parts of their livelihoods and culture. The traditional knowledge of the use and conservation of these plants is still being transferred from generation to generation, but appeared to be aging. The problem of transfer of knowledge from the elders to the young generation probably arose following the introduction of modern education, religious, spiritual and culture-related factors. Therefore, it is not only essential to conserve such a wealth of information hidden among the local people but also to apply modern science and technology to meet the ever increasing requirements of humankind. Furthermore, conservation of these biological resources is very important because their sustainable use can generate higher levels of employment and income.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES

Abiyu E, Zemede A, Ensermu K, Raja N (2014). Ethnobotanical Study of Traditional Medicinal Plants in and Around Fiche District, Central Ethiopia. Curr. Res. J. Biol. Sci. 6(4):154-167.

Balcha A (2014). Medicinal plants used in traditional medicine by Oromo people, Ghimbi District, Southwest Ethiopia. J. Ethnobiol. Ethnomed. 10(40):1-15.

Balemie K, Kelbessa E, Asfaw Z (2004). Indigenous medicinal plant utilization, management and threats in Fentalle area, Eastern Shewa, Ethiopia. Ethiop. J. Bio. Sci. 3:37-58.

Balick MJ, Cox PA (1996). Plants, People and Culture: Science of Ethnobotany. Scientific American Library, New York, USA.

Bayafers T (2000). A floristic analysis and ethnobotanical study of the semi-wetland of Cheffa area, South Welo, Ethiopia. M.Sc. Thesis. Addis Ababa University.

Cotton CM (1996). Ethnobotany: Principles and Applications. Chichester: John Wiley and Sons Ltd, New York.

Cunningham AB (1996). People, Park and Plants use Recommendations for Multiple use Zones and Development Alternatives Around Bwindi: Impenetrable National Park Uganda. In People and Plants: Paris: UNESCO Working Paper. pp. 18-25.

Cunningham AB (2001). Applied Ethnobotany: People, Wild Plant use and Conservation. People and Plant Conservation Manual.

Earthscans Publication Ltd, London.
Dawit A (1986). Traditional medicine in Ethiopia.The attempt being made to promote it for effective and better utilization. SINET: Ethiop. J. Sci. 9:61-69.
Dawit A (2001). The role of medicinal plants in Health care Coverage of Ethiopia, the possible benefits of integration. In: Medhin Z, Abebe D (eds.), *Coservation and Sustainable Use of Medicinal plants in Ethiopia*. Proceeding of the National workshop on Biodiversity Conservation and Sustainable use of medicinal plants in Ethiopia, 28 April to 1 May 1998, IBCR, Addis Ababa. pp. 107-118.
Dawit A, Ahadu A (1993). Medicinal plants and enigmatic health practice of north Ethiopia. Berhanina Selam Printing Enterprise, Addis Ababa, Ethiopia.
Debela H (2001). Use and Management of Traditional Medicinal Plants by Indigenous People of Bosat Woreda, Wolenchiti area: An ethnobotanical approach. M.Sc. Thesis, Addis Ababa, Ethiopia.
Edwards S, Demissew S, Hedberg I (Eds) (1997). Flora of Ethiopia and Eritrea. Hydrocharitaceae to Arecaceae Volume 6. Ethiopia: Department of Systematic Botany, Uppsala University, Sweden and The National Herbarium, Addis Ababa University.
Edwards S, Tadesse M, Demissew S, Hedberg I (Eds) (2000). Flora of Ethiopia and Eritrea. Magnoliaceae to Flacourtiaceae Volume 2 Part 1. Ethiopia: Department of Systematic Botany, Uppsala University, Sweden and The National Herbarium, Addis Ababa University.
Edwards S, Tadesse M, Hedberg I (Eds) (1995). Flora of Ethiopia and Eritrea. Canellaceae to Euphorbiaceae Part 2 Volume 2. Ethiopia: Department of Systematic Botany, Uppsala University, Sweden and The National Herbarium, Addis Ababa University.
Ermias L, Ensermu K, Tamrat B, Haile Y (2008). An ethnobotanical study of medicinal plants in Mana Angetu District, southeastern Ethiopia. J. Ethnobiol. Ethnomed. 4(10):1-10.
Getaneh GM (2016). Ethnobotanical survey of medicinal plants used in treating human and livestock health problems in Mandura Woreda of Benishangul Gumuz, Ethiopia. Adv. Med. Plant Res. 4(1):11-26.
Getnet C, Zemede A, Ensermu K (2015). Ethnobotanical study of medicinal plants in the environs of Tara-gedam and Amba remnant forests of Libo Kemkem District, northwest Ethiopia. J. Ethnobiol. Ethnomed. 11(4):1-38.
Haile Y, Delensaw Y (2007). Traditional medicinal plant knowledge and use by local healers in Sekoru District, Jimma Zone, South western Ethiopia. J. Ethnobiol. Ethnomed. 3:3-24.
Hedberg I, Edwards S (Eds) (1989). Flora of Ethiopia and Eritrea. Pittosporaceae to Araliaceae Volume 3. Ethiopia: Department of Systematic Botany, Uppsala University, Sweden and the National Herbarium, Addis Ababa University.
Hedberg I, Edwards S (Eds) (1995). Flora of Ethiopia and Eritrea. Poaceae (Graminae) Volume 7. Ethiopia: Department of Systematic Botany, Uppsala University, Sweden and the National Herbarium, Addis Ababa University.
Hedberg I, Edwards S, Nemomissa S (Eds) (2003). Flora of Ethiopia and Eritrea. Apiaceae to Dipsacaceae Volume 4 part 1. Ethiopia: Department of Systematic Botany, Uppsala University, Sweden and the National Herbarium, Addis Ababa University.
Hedberg I, Friis I, Edwards S (Eds) (2004). Flora of Ethiopia and Eritrea. Asteraceae Part 2 Volume 4. Ethiopia: Department of Systematic Botany, Uppsala University, Sweden and the National Herbarium, Addis Ababa University.
Hedberg I, Friis I, Person E (Eds) (2009). Flora of Ethiopia and Eritrea. Lycopodiaceae to Pinaceae. Volume 1. Ethiopia: Department of Systematic Botany, Uppsala University, Sweden and the National Herbarium, Addis Ababa University.
Hedberg I, Kelbessa E, Edwards S, Demissew S, Persson E (Eds) (2006). Flora of Ethiopia and Eritrea. Plantaginaceae Volume 5. Ethiopia: Department of Systematic Botany, Uppsala University, Sweden and the National Herbarium, Addis Ababa University.
Heinrich M (2000). Ethnobotany and its role in drug development. Phytother. Res. 14:479-488.
Kebu B, Ensermu K, Zemede A (2004). Indigenous medicinal utilization, management and threats in Fentale area, Eastern Shewa, Ethiopia. Ethiop. J. Biol. Sci. 3:1-7.
Martin GJ (1995). Ethnobotany: A Method Manual. London: Chapman and Hall, London. pp. 1-151.
Meaza G, Tadesse B, Maria AS, Piero B, Gidey Y (2015). Traditional medicinal plants used by Kunama ethnic group in Northern Ethiopia. J. Med. Plants Res. 9(15):494-509.
Mirutse G, Gobana A (2003). An Ethnobotanical Survey on Plants of Veterinary Importance in Two Woredas of Southern Tigray, Northern Ethiopia. SINET. Ethiop. J. Sci. 26(2):123-136.
Mirutse G (1999). An ethnobotanical study of medicinal plants used by the Zay People in Ethiopia. M.Sc. Thesis. Uppsala, Sweden.
Quanash N (1998). Bicultural diversity and integrated healthcare in Madagascar. Nat. Res. 30:18-22.
Tesfaye A (2004). Conservation of Medicinal Plants in Ethiopia. In The Proceedings of the First Medicinal Plant National Workshop Held in Addis Ababa, Ethiopia: June 30-July 2, 2003. Edited by Kelbessa U, Ayale A, Merga G. Addis Ababa: Ethiopian Health and Nutrition Research Institute. pp. 97-107.
World Health Organization (WHO) (1998). Regulatory situation of herbal medicines. A worldwide Review, Geneva. pp. 1-13.
Zegeye H, Teketay D, Kelbessa E (2011). Diversity and regeneration status of woody species in Tara-gedam and Abebaye forests, Northwestern Ethiopia. J. For. Res. 22:315-328.

Appendix 1. List of medicinal plants used for both human and livestock, scientific name, family, local name, habit, parts used, disease treated, methods of preparation with dosage used and route of application.

S/N	Family	Scientific Name	Local name	Ha	Pu	Use	Disease tr.	Mode of preparation	Route
1	Acanthaceae	*Justica schimperiana* (Hochst.ex.Nees) T. Andres	Dhumuugaa	Sh	RL	Hu	Rabies	Root and leaf of *Justica schimperiana* is pounded together and mixed with water and 2-3 cup of tella is used as a drink.	Oral
					RL	Ls	Blackleg	Leaf and root of *Justica schimperiana* is pounded with dried fruit of *Ricinus communis*. One bottle of the solution is given to cattle.	Oral
					L	Ls	Internal parasites	Pounded leaf of *Justica Schimperiana* is added to barely malt powdered. Three – four glass of tella given to cattle, horse and donkey	Oral
					R	Hu	Gonorrhea	Root of *Justica schimperiana* and leaf of *Erythrina brucei* are pounded and concocted together. One cup of coffee is used as a drink.	Oral
		Acanthus pubescens (Oliv.) Engl.	Kosorru	Sh	Sa	Hu	Tinea corporis	The affected area is massaged by mixture of the sap from shoot tip with latex of *Croton macrostachyus* daily until the sign of the problem disappears.	Dermal
2	Alliaceae	*Allium sativum* L.	Qulubi adi	H	Bu	Hu	Body itching	2-3 bulbs grind up along with equal amount of *Zingiber officinale* and chewed once a day or Rubbing the affected area by the mixture.	Dermal
					Bu	Hu	Malaria	Bulb of *Allium sativum* and rhizome of *Ginger officinale*are pounded and eaten with honey	Oral
					Bu	Hu	Stomach problem	Bulb of *Allium sativum* and seed of seed of *Lepidium sativum* are pounded together and eaten with injera	Oral
3	Aloaceae	*Aloe macrocarpa* Tod.	Arkis	H	Latex	Hu	Fire burn	Covering the burned area by the latex of the young leaf, and repeating every 2 days until it dries.	Dermal
4	Amaranthaceae	*Amaranthus caudatus* L.	Iyaasuu	H	L	Ls	Diarrhea	Leaf of *Amaranthus caudatus* is pounded and boiled with pounded *Allium sativum* and given to cattle.	Oral
5	Anacardiaceae	*Schinus molle* L.	Qudabarbare	T	LF	Ls	Eye disease	Leaf and fruit of *Schinus molle* are chewed and spitted on cattle, equines, goat and sheep eye	Optical
					Se	Hu	Tonsillitis	The seed along with piece of *Z. officinale* chewed slowly for a while. Eventually the whole thing is swallowed	Oral
					Se	Hu	Ascaris	The seed (20-30 in number) cooked and eaten early in the morning to the empty stomach; only once.	Oral
6	Apocynaceae	*Carissa spinarum* L.	Hagamsa	Sh	R	Hu	Evil eye	Root of *Carissa spinarum* is pounded and dried. Dry smoke is used as treatment for evil eye.	Nasal
					R	Hu	Gonorrhea	Fresh root of *Carissa spinarum* pounded mixed with cold water. One cup of tella is used as a drink for three days	Oral
7	Araceae	*Amorphophallus abyssinicus* (A. Rich.) N.E. Br.	icu	H	R	Ls	Diarrhea	Crushed root mixed in the boiled water and given daily in a big water cup for few days	Oral
		Colocasia esculenta (L.) Schott	Godarre	H	L/R	Ls	Leech infestation	The leaf or root infusion is added in to the affected cavity (oral, nasal) until the leech expelled	Nasal/Oral
8	Arecaceae	*Phoenix reclinata* Jacq.	Meexxi	T	LSt	Ls	Eye disease	Leaf and stem of *Phoenix reclinata* and leaf of *Premna resinosa* are chewed together and spitted on cattle eye	Optical
9	Asparagaceae	*Asparagus africanus* Lam.	Sariti	H	R	Hu	Impotency	The root together with roots of *Premna schimperi* and *Olea europaea* pounded and given to the victim with one cup of tella 2-3 h before sexual works	Oral

Appendix cont'd

10	Aspleniaceae	*Asplenium monathes* L.	Digaluu bakkannisaa	Ep	L	Hu	Sudden sickness	Leaf of *Asplenium monathes* is pounded with leaf of *Cussoniaostinii* and 3-4 cup of tea is taken by human.	Oral
		Artemisia abyssinica Sch., Bip. exA. Rich.	Qoddo	H	L	Hu	Tracoma	The leaf is pounded and sieved to rinse the inner eye by the filtrate trice a day.	Optical
					L	Hu	Rabies	Leaf is ground in small water and given to the victim every morning for 3 days in small 'areqe' glass.	Oral
		Bidens pilosa L.	Maxxanne	H	L	Hu	Taneiapedis	Leaf of *Bidens pilosa* is immersed in hot water and rubbed to the affected skin of human.	Dermal
					L	Hu	Nasal bleeding	Freshly squeezed leaves are inhaled through nasal opening.	Nasal
		Carduus leptacanthus Fresen.	Arabadubarti	H	R	Ls	Black leg	The root is ground along with tip shoots of *Cordia africana* and *Thalictrum rhynchocarpum* in water, and given to the cattle in problem, for 5-7 days.	Dermal
					R	Hu	Snake repellent	Root of *Echinops kerebicho* is dried and smoked in house.	Nasal/Oral
11	Asteraceae	*Echinops kerebicho* Mesfin	Qarabicho	H	R	Hu	Internal parasite	Root of *Echinops kerebicho* is dried powdered and mixed with water. Half of tea cup is given to human.	Oral
					R	Hu	Febrile Illness	Dried Root of *Echinops kerebicho* is fumigated.	Nasal
		Echinops macrochaetus Fresen	Kossorru	Sh	St	Ls	Footand mouth disease (FMDs)	Fresh stem of *Echinops macrochaetus* is chopped and fumigated to sheep.	Nasal
		Vernonia amygdalina Del.	Eebicha	T	L	Hu	Malaria	Crushed leaves of *Vernonia amygdalina* concocted with leaves of *Ruta chalepensis*. One cup is served as a drink for 3-5 days with cold water in the morning.	Oral
					L	Hu	Tooth infectiohn	To treat tooth infection leaves *Vernonia amygdalina* are chewed with bulb of *Allium sativum*	Oral
					L	Hu	Stomachache	Intestinal prasites can be killed by using pounded twings*Vernonia amygdalina*, bullb of *Allium sativum* with rhizome of *Ginger officinale* and eaten with honey.	Oral
		Vernonia auriculifera Hiern.	Reeji	Sh	St	Hu	Infected wound	The tip shoots ground along with tip shoot of *Entada abyssinica* and directly sprayed on the wound.	Dermal
12	Bignoniaceae	*Stereospermum kunthianum* Cham.	Botoroo	T	R	Ls	Snake bite	Root of *Stereospermum kunthianum* and dried leaf of *Calpurina aurea* powdered and mixed with water and given to cattle.	Oral
					B	Ls	Retained placenta	Bark of *Stereospermum kunthianum* and *Grewia ferrugineae* are crushed together and mixed with salt, eaten by cattle on dish	Oral
		Cordia africana Lam.	Waddeesa	T	L	Hu	Spider poison	Leaf of *Cordia africana* is burned and the remaining ash is mixed with butter and creamed on affected part.	Dermal
13	Boraginaceae	*Ehretia cymosa* Thonn.	Ulaaga	T	RSt	Hu	Stomachache	The root pounded with young stem tip of *Bersama abyssinica* and taken with tea or both cooked with bean and eaten.	Oral
					L	Hu	Pain	*Ehretia cymosa* leaf is smashed and the sap is taken by human.	Oral
14	Brassicaceae	*Lepidium sativum* L.	Feecoo	H	Se	Hu	Malaria	Seed of *Lepidium sativum* and bulb of *Allium sativum* are pounded together and given to human with honey.	Oral

Appendix cont'd

					Se	Hu	Tonsillitis	Seed of *Lepidium sativum* and bulb of *Allium sativum* are pounded together and given to human with honey for three to four days.	Oral
					Se	Hu	Cough	Seed of *Lepidium sativum* and bulb of *Allium sativum* are pounded together and given to human with honey for five days.	Oral
					Se	Ls	Blotting	Seed of *Lepidium sativum* and bulb of *Allium sativum* are pounded together and given to cattle.	Oral
					Se	Ls	Diarrhea	Seed of *Lepidium sativum* is powdered and mixed with bulb *Allium sativum* and given to cattle.	Oral
15	Capparidaceae	*Capparis tomentosa* Lam.	Harangamaa	Sh	L	Hu	Evil eye	Leaf of *Capparis tomentosa* and *Rutachalepensis* are pounded and mixed in water together and one domestic alcohol cup is used as a drink.	-
					Se	Hu	Malaria	The leaf is crushed, rolled in paper and smoked by patient.	Nasal/Oral
					Se	Hu	Amoebae	Eating over dose of seeds only once.	Oral
16	Caricaceae	*Carica papaya* L.	Papaya	T	L	Hu	Contraceptive	Eating over dose of seeds only once.	Oral
					R	Hu	Hepatitis	The seed crushed and taken with tea trice a week.	Oral
					Fu	Hu	Anaemia	Fruit of *Carica papaya* squeezed and mixed with sugar, and left over night. Two glasses are used as drink early in the morning.	Oral
17	Combretaceae	*Combretum paniculatum* Vent.	Baggi	Li	L	Hu	Ring worm	Latex of *Combretum paniculatum* is pounded and mixed with soda and creamed on affected skin.	Dermal
					Sa	Hu	Eye infection	Adding 2-3 drops of stem sap in to the affected eye once a day.	Optical
					R	Hu	Febrile illness	Root of *Cucumis ficifolius* leaf of *Ocimum gratissimum* and leaf of *Calpurnia aurea* are pounded together and mixed with cold water and a cup of coffee is given to human.	Oral
					Fu	Hu	Ear pain	Sap of fruit of *Cucumis ficifolius* is added to ear canal.	Ear
		Cucumis ficifolius A. Rich.	Hiddi hooloo	Cl	Fu	Hu	Stomachache	A piece of root of *Cucumis ficifolius* chewed with salt and swallowed by human.	Oral
18	Cucurbitaceae				Fu	Ls	Cattle Infection	Root of *Cucumis ficifolius*with leaf of *Teclea nobilis* are pounded together and mixed with cold water. Two cups of tella are given to cattle.	Oral
					L	Hu	Tetanus	Leaf of *Cucumis ficifolius* is smashed and 2-4 drop of the sap is added to the swelling.	Dermal
					Fu	Hu	Tinea versicolor	Inner part of fresh fruit of *Lagenaria siceraria* is creamed on affected head skin.	Dermal
		Lagenaria siceraria (Molina) Standl.	Buqqe hadhaa	Cl	Fu	Hu	Malaria	Ripe fruit of *Lagenaria siceraria* is bored rinsed with cold water, one glass is used as a drink early in the morning.	Oral
					Fu	Hu	Scabies	Inner part of fresh fruit of *Lagenaria siceraria* is creamed on affected head skin.	Dermal

Appendix cont'd

					LB	Ls	Swelling	Leaf and bark of *Zehneria scabra* and leaf *Rumex nervosues* are pounded and rolled in clean cloth, and tied on swelling.	Dermal
		Zehneria scabra (l.f.) Sond	Qorii sinbiraa	Cl	R	Ls	Rabies	Pounded root of *Zehneria scabra* is concocted with pounded root of *Ricinus communis*. One feast of the pond is given to cattle and pack animals.	Oral
					L	Hu	Hook worm	The tips shoot with tip shoot of *Justicia schimperiana* powdered and baked with bread and eaten as a breakfast for a week.	Oral
		Croton macrostachyus Del.	Bakkanisa	T	L	Hu	Tinea corporis	The latex from young tip is collected and applied in thick to the affected area every Wednesday and Friday	Dermal
					B	Hu	Wound	Bark of *Croton macrostauchyus* is dried and powdered, added to wound	Dermal
		Euphorbia condelabrum Kostshy	Adami	T	Latex	Hu/Hu	Gonorrhea and Ascariasis	Five-seven drops collected, baked with one cup of wheat powder and eaten to the empty stomach for 5 days	Oral
					LSt	Hu	Swelling, pain in ear	The leaf and stem infusion is made and drunk or dropped in to the ear The leaf is also warmed before fire and put on the swelled gland for a while	Dermal/Ear
19	Euphorbiaceae				Fu	Ls	Anthrax	Dried fruit of *Ricinus communis* is powdered and mixed with water. One cup of tea is given to cattle.	Oral
					R	Ls	Sudden sickness	Root of *Ricinus communis* and root of *Justica schimperiana* are pounded mixed with cold water. 1-2 cup of tea is given to cattle.	Oral
		Ricinus communis L	Qobo	Sh	Fu	Ls	Blotting	Root of *Ricinus communis* pounded with table salt, mixed with cold water. Half a cup is given to cattle.	Oral
					Fu	Ls	Actinomycosis	Root of *Ricinus communis* is pounded with table salt and soil. One glass of the concoction is given to cattle; half a glass is given to goat and sheep.	Oral
					Fu	Ls	Ulceritic lymphagities	Dried fruit of *Ricinus communis* is powdered and mixed with bark powder of*Prunus africana* and creamed to the ulcerated skin of donkey.	Dermal
					Fu	Ls	Epizoitic lymphagities	Dried fruit of *Ricinus communis* is powdered and mixed with bark powder of *Prunus africana* and creamed to the ulcerated skin of horse and mule.	Dermal
		Acacia abyssinica Hochstex. Benth.	Laaftoo	T	L	Hu	Goiter	Leaf of *Acacia abyssinica* is smashed and the sap is applied to the goiter for three days with needle.	Dermal
		Albizia schimperiana Oliv.	Imalaa	T	R	Hu	Evil eye	Root of *Albizia schimperiana* and *Pterolobium stellatum* are dried and powdered. 3-4 spoon of the powder is fumigated on broken pot.	Nasal
					R	Ls	Swelling	Root of *Albizia schimperiana* is powdered and the powder is rolled in clean cloth and tied to the neck of equines.	Dermal
20	Fabaceae				L	Ls	Scabies	Leaf of *Calpurnia aurea, Croton macrostachyus* and *Justicia schimperiana* are pounded and used to wash scabies of cattle.	Dermal
		Calpurnia aurea (Ait.) Benth	Ceekaa	Sh	L	Ls	Snake bite	Leaf of *Calpurnia aurea* is smashed and 3-4 drop of the sap is given orally to cattle, and 2-3 drop to human.	Oral
					L	Ls	Lumpy skin	Leaf *Calpurnia aurea* is smashed and directly rubbed on skin of cattle.	Dermal

Appendix cont'd

					L	Hu	Ecto-parasite	The leaf is ground along with barks *of Millettia ferruginea* and sprayed on the area of problem (body, cloth. room, bed).	Dermal
		Crotalaria incana L.	Atarii kuruphee	Sh	L	Hu	Tetanus	Leaf of *Crotalaria incana*is crushed and put on swelled area	Dermal
					Sa	Hu	Hepatitis	Sap from the whole part of the plant is directly creamed on affected area.	Dermal
					B	Ls	Swelling	Bark of *Erythrina brucei* pounded with leaf of *Teclea nobilis* mixed with water and half a glass is given to mule and donkey.	Oral
		Erythrina brucei Schweinf.	Waleensuu	T	R	Ls	Eye disease	Root of *Erythrina brucei* and leaf of *Premna resinosa* are pounded together and 4-6 drop of the liquid extract is added to cattle eye.	Optical
		Entada abyssinica (Steud. ex A. Rich.) Gilb. and Bout.	Ambalta	T	B	Hu	Malaria	The bark ground along with rhizome of *Z. officinale* and bulb of *Allium sativum* and chewed once a day for few months.	Oral
		Senna didymobotrya (Fresen.) Irwin & Barneby	Kishkishi	Sh	L	Hu	Snake bite	The root (1-inch) is crushed, homogenized in water and drunk immediately after infection.	Oral
					R	Hu	Elephantiasis	The leaf is soaked in to hot water and used to wash the swell, or simply massaging the swell every night.	Dermal
		Millettia ferruginea (Hochst.) Bak.	Sotallo	T	B	Hu	Ants problem	Taking off the bark & putting the bare stick in the camp of the ants.	
		Vigna membrancea (L.) A. Ric	Hidda hantuutaa	Cl	RL	Ls	Epilepsy	Root and leaf of *Vigna membrancea* pounded together, dried and powdered. Two –three spoons are mixed with water and given to cattle, goat and sheep.	Oral
		Vigna unguiculata L.	Epho	Cl	Se	Hu	Rheumatism	Dried seed is cooked & eaten, and its water is drunk	Oral
21	Flacourtiaceae	*Flacourtia indica* (Burm.f.) Merr.	Akuku	Sh	B	Hu	Gonorrhea, Amoeba and Hook worm	The bark ground along with bulb of *Allium sativum*; and tip shoot of *Croton macrostachyus*. Then 3 spoons are taken once a day for 7-10 days.	Oral
		Ocimum lamifolium Hochst. Ex. Benth.	Hancabbii diimaa	H	L	Hu	Headache	Leaf of *Ocimum lamifolium* is smashed and sniffed.	Nasal
		Ocimum gratissimum L	Daamakasee	H	L	Hu	Febrile illness	Leaf of *Ocimumgratissimum* is smashed and sniffed nasally.	Nasal
		Ocimum urticifolium Roth.	Hanccabbi adii	H	L	Hu	Febrile illness	Leaf of *Ocimum urticifolium, Croton macrostachyus* and *Clausena anista* are smashed together and the sap is sniffed nasally	Nasal
22	Lamiaceae				L	Hu	Headache	Leaf of *Ocimum urticifolium, Carissa spinarum* and *Thalictrum rhynochcarpum* are smashed together and sniffed	Nasal
		Otostegia tomentosa A. Rich.	Tunjuti	Sh	L/R	Hu	Febrile illness	The leaf /root infusion is smelled or the leaf is crushed along with root and rubbed over the affected body part once a day.	Dermal
		Plectranthus edulis Vatke	Dinicha Oromo	H	L/R	Hu	Antidotes and epilepsy	The leaf and root ground together, and given to the victim, 2-3 teaspoon twice a day for 2 days.	Oral

Appendix cont'd

		Premna schimperi Engl.	Urgessa	Sh	L	Hu	Ecto parasite	The stem and leaf burned to fumigate the room or animal cage, so as to disinfect mosquito & flies.	Dermal
23	Lineaceae	*Linum usitatissimum* L	Talbaa	H	Se	Ls	Retained placenta	Seed of *Linum usitatissimum* is powdered and half a glass of the powder is dissolved in water and given to cattle.	Oral
24	Loganiaceae	*Buddleja polystachya* Fresen.	Hanfaaree	T	L	Ls	Eye disease	Leaf of *Buddleja polystachya* is chewed and spitted on cattle eye.	Optical
25	Loranthaceae	*Phragmanlheramacrosolen* (A.Rich) ined.	Digaluu ceekaa	Ep	L	Hu	Diarrhea	Leaf of *Phragmanlheramacrosolen* is pounded and mixed with water. One cup of tella is used as a drink by human.	Oral
26	Malvaceae	*Sida rhombifolia* L.	Karaaba	H	R/L	Ls	Erythroblasto-sis	Root and leaf of *Sida rhombifolia* concoction is given to cattle, horse, donkey and mule for four days; one glass of tella on each day.	Oral
					L	Ls	Skin rash	The leaf infusion is used to wash the body.	Dermal
					B	Hu	Wound	Bark of *Ekebergia capensis* is powdered and half a spoon is added to wound.	Dermal
27	Meliaceae	*Ekebergia capensis* Sparm.	Somboo	T	Sa	Hu	Hemorrhoid	Sap exudate of *Ekebergia capensis* is directly applied to hemorrhoid	Anal
					B	Ls	Trypsis	The bark is crushed along with roots of *Phytolacca dedocandra* and latex of *Euphorbia candelabrum* and homogenized in water. The preparation is given in water cup once a day for 3 weeks.	Oral
					R	Ls	Pest control (parasitic)	Root of *Bersama abyssinica* is powdered and sprayed on cattle skin and fodder	Dermal
28	Melianthaceae	*Bersama abyssinica* Fresen.	Lolchiisaa	T	S	Hu	Ascariasis	Stem tips chopped in to 4-5 pieces (each 1 inch), cooked with bean seed and eaten in empty stomach every morning for 2 consecutive days.	Oral
					L	Hu	Rheumatic	Warming the leaf before fire and holding on affected area.	Dermal
29	Menispermaceae	*Stephania abyssinica* (Dillon.& A.Rich.)Walp.	Hidda kalaala	Cl	L	Hu	Wound	Leaf of *Stephania abyssinica* is pounded and a small amount is added to wound.	Dermal
		Ficus sur Forssk.	Harbuu	T	Sa	Hu	Ring worm	Sap from *Ficus sur* is creamed on affected skin.	Dermal
		Ficus ingens (Miq.)Miq.	Qilinxoo	T	St	Ls	Wound	Sap of *Ficus ingens* is directly creamed on cattle skin.	Dermal
30	Moraceae				St	Hu	Hepatitis	Sap of *Ficus sycomorus* is creamed directly on skin.	Dermal
		Ficus sycomorus L.	Odaa	T	B	Hu	Rabies	Bark of *Ficus sycomorus* and root of *Prunus africana* are powdered together and backed with teff flour and eaten.	Oral
					B	Hu	Hemorrhoid	Bark of *Ficus sycomoru* is dried powdered and mixed with butter and creamed directly.	Anal
					Se	Hu	Tape worm	Seed of *Embelia schimperi* is dried and powdered, mixed with water, two glasses is taken once.	Oral
31	Myrsinaceae	*Embelia schimperi* Vatke	Haanquu	Sh	L	Hu	Internal parasite	Leaf and seed of *Embelia schimperi* and leaf of *Croton macrostchys* are pounded together and one glass is taken by human.	Oral
		Maesa lanceolata Forssk.	Abaayi	Sh	R/B	Hu	Worms	The root and bark ground together and taken with boiled coffee/tea twice a day for 5 days.	Oral

Appendix cont'd

32	Myrtaceae	*Eucalyptus globulus* Labill	Bargamoo adii	T	L	Ls	Avian cholera	Leaf of *Eucalyptus globulus* pounded, boiled and the solution is added to soup of wheat powder and given to hen.	Oral
					L	Hu	Influenza	Leaf of *Eucalyptus globules* is chopped and boiled steam bath is taken by human.	Nasal
		Syzygium guineense (Willd.) Dc.	Baddessa	T	B	Hu	Internal parasite	Bark of *Syzygium guineense* and exudates of *Aloe pubescens* concoction is made. 2-3 cup of coffee is taken by human.	Oral
33	Oleaceae	*Olea europaea* L. subsp. *cuspidata* Wall. ex G. Don	Ejersa	T	R	Hu	Male-impotency	The root together with roots of *Aloe macrocarpa* and *Premna schimperi* pounded in water and given to the victim with tella before bed for few d	Oral
34	Oliniaceae	*Olinia rochetiana* A. Juss.	Noolee	T	L	Hu	Tooth infection	Leaf of *Olinia rochetiana* is chewed with affected tooth and the sap is swallowed.	Oral
35	Phytolaccaceae	*Phytolacca dodecandra* L'Herit	Handoode	Sh	R	Hu	Liver problem	*Phytolacca dodecandra* root is crushed and pounded, mixed with water. One third of a cup is given to human	Oral
					RL	Ls	Hyena bite	*Phytolacca dodecandra* root is smashed with its leaf, and tied on neck of cattle by clean cloth.	Dermal
					R	Hu	Gonorrhea	*Phytolacca dodecandra* and *Croton macrostchys* root are powdered and 1-2 cup of coffee is given to human with coffee.	Oral
					R	Hu/Ls	Rabies	Dried root of *Phytolacca dodecandra* is powdered and one –two cup of domestic alcohol (malakie) is taken by human, 3-4 is used for livestock.	Oral
36	Plantaginaceae	*Plantago lanceolata* L.	Qorxxobbi	H	L	Hu	Skin cut	Fresh leaf of *Plantago lanceolata* is smashed three to four drops of the exudate is added toskin cut.	Dermal
37	Poaceae	*Cynodon dactylon* (L.) Prers	Coqorsa	H	Ag	Hu	Snake poison	Above ground parts of *Cynodon dactylon* is rubbed to the affected skin for seven days with butter.	Dermal
38	Polygonaceae	*Rumex nepalensis* Spreng.	Tultii	H	L	Hu	Spider poison	Leaf of *Rumex nepalensis* is directly rubbed on affected skin.	Dermal
					R	Hu	Amoeba	Root of *Rumex nepalensis* is pounded and two cup of tea is taken with coffee.	Oral
		Rumex nervosus Vahl	Dhangaggo	Sh	R	Hu	Skin rash	Root of *Rumexnervosus* is dried and powdered. 3-4 spoon of the powder is mixed with butter and creamed on affected skin	Dermal
					R	Hu	Blood pressure	The root of *Rumex nervosus* (1-inch) is chewed daily.	Oral
39	Ranunuclaceae	*Clematis simensis* Fresen.	Hidda feetii	Cl	L	Hu	Tonsilites	Leaf of *Clematis simensis* is crushed and pressed, rolled in clean cloth and tied on neck.	Dermal
					L	Hu	Lymphatic swelling	Leaf of *Clematis simensis* and *Lageraaleta* are crushed, smashed and tied on swelling.	Dermal
		Thalictrum rhynchocarpum Dill. & A. Rich.	Fac'a	H	R	Ls	Trypsis	The root ground along with roots of *C. macrostachyus* and given to the cattle in problem every morning.	Oral
					R	Hu	Tetanus	Root of *Thalictrum rhynchocarpum* and *Teclea nobilis* is pounded together. 2-3 tea spoons are taken by human.	Oral
					R	Ls	Diarrhea	Root of *Thalictrum rhynchocarpum* is preserved and powdered. One glass is given to cattle.	Oral

Appendix cont'd

40	Resedaceae	Caylusea abyssinica (Fresen.) Fisch. & Mey.	Reenci	H	R/L	Hu	Scabies	The leaf/root infusion is used to wash the affected area and all the clothes that have been used by the patient.	Dermal
					R	Hu	Impotency	Drinking the powdered root with water and /or using it for toothbrush daily.	Oral
41	Rhamnaceae	*Rhamnus prinoides* L'Herit.	Gesho	Sh	L	Ls	Bloody urine	The leaf ground along with leaf of *Solanum anguivi* and given to the cattle in problem.	Oral
					Se	Hu	Tinea versicolor	The seed pounded and applied to the affected area.	Dermal
42	Rosaceae	*Prunus africana* (Hook.f.) Kalkm.	Hoomii	T	B	Ls	Wound	Bark of *Prunus africana* is powdered and added directly on wound of donkey, mule and horse.	Dermal
					B	Hu	Giardiasis	The bark (half-length of small finger) is chewed and swallowed; alcoholic drink is banned.	Oral
		Rubus apetalus Poir.	Gorra	Sh	Se	Hu	Pain	The seed (dried) is swallowed once a day for 3 -5 days.	Oral
		Citrus limon (L.) Burm.f.	Loomii	Sh	Fu	Hu	Stomach ache	Fruit of *Citrus limon* and bulb of *Allium sativum* are pounded together and mixed with honey and eaten with wheat bread.	Oral
					Fu	Hu	Nasal bleeding	Liquid sap of *Citrus limon* is added to nose or the sap is taken orally.	Nasal/Oral
		Clausena anisata (Willd.) Benth.	Ulumaayii	Sh	L	Hu	Skin rash	Leaf of *Clausena anisata, Solaneciogigas* and *Justicia schimperiana* are pounded together, and creamed on skin.	Dermal
43	Rutaceae	*Ruta chalepensis* L.	Cillaattama	H	L	Hu	Stomach ache	Leaf of *Ruta chalepensis* and leaf of *Vernonia amygdalina*are smashed together and one cup of domestic alcohol is taken by human.	Oral
					BL	Ls	Cocsidiosis	Bark and leaf of *Ruta chalepensis* and root of *Justica schimperiana* are pounded together and given to hen with injera	Oral
					L	Hu	Cough	Leaf of *Ruta chalepensisis* pounded with *Cussonia ostiniichiov* of and eaten with injera.	Oral
					L	Hu	Infulenza	Leaf of *Rutachalepensisis* pounded withbulb of *Allium sativum* mixed with soup and used as a drink.	Oral
		Teclea nobilis Del.	Hadheesa	T	R	Ls	Wound	Root of *Teclea nobilis* is pounded mixed with cold water and 3 glasses given to donkey.	Dermal
44	Salicaceae	*Salix subserrata* Willd.	Alaltu	T	SL	Ls	Joint dislocation, physical worsening	The leaf ground along with immature stem, mixed with bread and given to the cattle in problem.	Oral
45	Sapindaceae	*Dodonaea angustifolia* L.f	Ittacha	Sh	L	Ls	Wound	Dried leaves of *Dodonaea angustifolia* are powdered and sprayed on the wound of pack animals.	Dermal
46	Simaroubaceae	*Brucea antidysenterica* Fresen.	Qomonyo	Sh	L	Ls	External parasites	Leaf of *Brucea antidysenterica* is pounded and mixed with water in dish. The mixture is used to wash skin of cattle, donkey, mule and horse for 3-5 days.	Dermal
47	Solanaceae	*Datura stramonium* L.	Manjii	H	Fu	Hu	Scabies	Powdered fruit of *Datura stramonium* 2-3 spoon of the powder is mixed with butter and creamed.	Dermal
					Fu	Hu	Dandruff	Fruit of *Datura stramonium* is dried and powdered, mixed with water and used to wash head skin.	Dermal
					Fu	Hu	Malaria	Powdered fruit of *Datura stramonium* is mixed with honey and three to four spoons are eaten with pounded *Allium sativum*.	Oral
					L	Hu	Head ache	Roots of *Datura stramonium* is pounded with leaf of *Ocimum gratissimum* sniffed nasally.	Nasal
		Nicandra physaloides (L.) Gaertn.	Hawwixii	H	LR	Hu	Liver problem	Leaf and root *Nicandra physaloide* are pounded together and mixed with cold water. 2-4 cup of tella is used as a drink.	Oral

Appendix cont'd

					LR	Ls	Blotting	Leaf and root of *Nicotiana tabacum* is dried, powdered, mixed with salt and made as bread. Slice is given to cattle for three days.	Oral
		Nicotiana tabacum L.	Tamboo	Sh	L	Ls	Expel leeches	Crushed and backed leaf of *Nicotiana tabacum* is dried, powdered and mixed with water. One third of a litter is given to cattle.	Oral
					L	Ls	Internal parasites	Leaf of *Nicotiana tabacum* is pounded with root of *Carissa spinarum* and mixed with water. A cup of tella given to calf.	Oral
					L	Ls	Trypanos-omiasis	Crushed and backed leaf of *Nicotiana tabacum* is given to cattle.	Oral
		Solanum incanum L.	Hiddi	Sh	Fu	Ls	Snake poison	Snake poisoned goat eats fruit of *Solanum incunum* against the poison.	Oral
					Fu	Hu	Tonsilites	Fruit liquid content of *Solanum incunum* is rinsed with balled cloth stick tip and rolled on tonsillitis.	Oral
48	Thymelaceae	*Gnidia glauca* (Fresen) Gilg.	Qaqaroo	Sh	R	Hu	Kidney problem	Root of *Gnidia glauca* is pounded and mixed with teff powder, then backed and eaten by human.	Oral
49	Tiliaceae	*Grewia ferruginea* Hochst.ex. A. Rich	Dhoqonuu	Sh	L	Ls	Retained placenta	Latex of *Grewia ferruginea* is pounded, mixed with water and one glass of tella is given to cattle	Oral
50	Verbenaceae	*Lipia javanica* Burm.f.	Kusaye	Sh	L	Hu	Ring Worm	Leaf of *Lippia adoensis* is directly rubbed on affected skin.	Dermal
		Premna resinosa (Hochst.) Schauer	Urggeesaa	T	R	Hu	Tooth infection	Root of *Premna resinosa* is chewed and the solution is allowed to be in contact with infected teeth.	Oral
51	Vitaceae	*Cyphostemma cyphopetalum* Fresen.	Hida-reffa	Cl	R	Hu	Tinea versicol	The root is ground along with root of *Rumex abyssinicus* and rubbed over the affected area in strong sunlight.	Dermal
						Hu	Asthema, Gastrite	The rhizome infusion is made and drunk as illness starts.	Oral
52	Zingiberaceae	*Zingiber officinale* Roscoe	Jibibila	H	Rh	Ls	Black leg	The rhizome is pounded along with roots of *D. steudneri* and *M. azedarach*, and given to the cattle.	Oral
						Hu	Stomach ache	The small rhizome taken and is chewed as illness starts.	Oral

Habit (Ha.); Herb (H); Shrub (Sh); Tree (T); Liana (Li); Climber (Cl.); Epiphyte (Ep.). Parts used (Bark, B; Latex, La; Root, R; Leaf, L; Fruit, Fu; Flower, Fw; Seed, Se; Stem, St; Sap, Sa; Bulb, Bu; Root and leaf, RL; Above ground, Ag; Leaf and seed, LSe; Bark and leaf, BL; Whole plant, Wp; Sap, Sa; Leaf and fruit, LFu.

academicJournals

Vol. 11(31), pp. 501-506, 17 August, 2017
DOI: 10.5897/JMPR2017.6381
Article Number: E2A746165704
ISSN 1996-0875

http://www.academicjournals.org/JMPR

Journal of Medicinal Plants Research

Full Length Research Paper

Antibacterial activity of *Datura stramonium* against standard and clinical isolate pathogenic microorganisms

Solomon Baynesagne[1]*, Nega Berhane[2], Wagaw Sendeku[2] and Lianzhong Ai[1]

[1]School of Medical Instrument and Food Engineering, University of Shanghai for Science and Technology, Shanghai 200093, PR. China.
[2]Department of Biotechnology, College of Natural and Computational Sciences, University of Gondar, Gondar, Ethiopia.

Received 30 March, 2017; Accepted 31 May, 2017

Datura stramonium **more commonly known as Jimson weed or thorn apple is a wide growing flowering plant which has been employed by the local community to treat several ailments in Ethiopia. The purpose of the present work was to assess the antibacterial activity of ethanol, methanol, acetone, chloroform and water extracts of *Datura stramonium* leaf extracts using broth dilution and agar well diffusion methods against human pathogenic bacteria. Chloroform extracts showed the highest zone of inhibition against most of the tested bacterial strains at the concentration of 50 mg/ml. Water extracts are not able to show any zone of inhibition against all tested bacterial strains as compared to other four solvents used for extraction. Minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were determined by standard methods. The MIC and MBC results range from 6.25 to 12.5 mg/ml. The present work shows that *D. stramonium* has maximum antibacterial activity against *Staphylococcus aureus* (ATCC 25923; 18.2±2.1 mm) in the chloroform extract, while the minimum antibacterial activity was recorded against *Escherichia coli* clinical isolate (8.2±1.8 mm) (acetone extract). Chloroform extracts showed the highest zone of inhibition against most of the pathogenic bacterial strains tested as compared to the other solvents used for the extraction. In this study, *D. stramonium* leaf extracts showed considerable antibacterial activity that sustains the local residential area which uses this plant to treat bacterial and fungal infections, hence leading to the conclusion that, this plant would serve as sources of antimicrobial agents to obtain the best treatment alternatives for the infective disease. Further investigation of this potential antibacterial agent is required, especially using chloroform as an extraction solvent to precisely demonstrate the antimicrobial effects of the plant.**

Key words: Antibacterial activity, *Datura stramonium*, minimum bactericidal concentration (MBC), minimum inhibitory concentration (MIC), zone of inhibition.

INTRODUCTION

Plants are rich in a broad diversity of secondary metabolites such as tannins, alkaloids, terpenoids and flavonoids that have been set up to exhibit antimicrobial, antioxidant, anti-infectious and antitumor activities (Kirtikar and Basu, 1994; Gupta et al., 2010). The demand for the medicinal plant is increasing in both

developed and producing rural areas due to the affordability, reliability, accessibility and low side effects in therapeutic use have made their recognition worldwide.

During the past ten years, infectious diseases have been listed as the cause of destruction of millions of lives throughout the globe, particularly in the developing countries (Sharma et al., 2013). To treat these diseases, the modern treatment mechanisms have continuously been facing a problem due to associated side effects. Several pathogens have evolved immunity to multiple antibiotics as a result of the mutagenic characteristics of the bacterial genome, rapid multiplication, and transformation of bacterial cells. Consequently, numerous surveys have been carried on in search of medicinal plants having better antibacterial effects against pathogens (Kumar et al., 2007).

In Ethiopia, there are nearly 1000 medicinal plants that constitute about 10% of the entire flora available in the state (Abreham et al., 2015). For several years, the bulk of these plant materials has been employed by the local community as an alternative medicine to treat many diseases, even though most of them are not well characterized scientifically (Geleta et al., 2015).

Datura stramonium is mostly available in tropical and temperate regions and belongs to the family, Solanaceae (Tariq et al., 1989). *D. stramonium* contains tropane alkaloids such as scopolamine, atropine and hyoscyamine. As a result of the presence of these significant biomedical components, *D. stramonium* is considered to be important in treating heart disease, dental and skin infections, ulcer, asthma (Boumba et al., 2005), bronchitis, Leucoderma, fever and piles, sinus infections; it has antimicrobial, anticholinergic (Taha and Mahdi, 1984; Diker et al., 2007; Sharma and Sharma, 2010), anti-inflammatory, anti-fungal (Akinyemi et al., 2005; Giadado et al., 2007; Bouzidi et al., 2011), antioxidant, hypolipidemic, anti-inflammatory, anti-rheumatoid and hypoglycemic properties (Tariq et al., 1989; Gharaibeh et al., 1988; Rasekh et al., 2001; Couladis et al., 2003).

The present work aimed to test the antibacterial activity of *D. stramonium* leaf extracts against the standard and clinical isolate pathogenic microorganisms.

MATERIALS AND METHODS

Collection

D. stramonium leaves used in this study were gathered from different regions of Gondar town. The plant was authenticated by the Department of Biotechnology, University of Gondar, Gondar, Ethiopia. It was rinsed with tap water and dried at room temperature.

Preparation of plant extracts

D. stramonium leaves were ground to a fine powder using an electronic grinder. The solvents used for extraction were ethanol, methanol, acetone, chloroform and distilled water. Approximately, 100 g powder was blended with 300 ml of each solvent. Orbital shaker was used for the extraction purpose in which the sample was subjected to continuous shaking for 3 successive days. The sample was then filtered out using Whatman No. 1 filter paper, then the filtrate was evaporated using a rotary evaporator under reduced pressure at 4°C. The extract was pooled and dried *in vacuo* and stored at 4°C in a refrigerator until screened for antibacterial activity. The stock solution was prepared by taking 100 mg/ml in 50% dimethyl sulfoxide (DMSO), mixed with vortex and stored at 4°C until use in the refrigerator.

Preparation of test microorganisms

The bacterial strains, *Escherichia coli* (ATCC 25922), *Staphylococcus aureus* (ATCC 25923), *Streptococcus pneumoniae* (ATCC 63), *E. coli* (clinical isolate), *Klebsiella pneumoniae* (clinical isolate) and *S. pneumoniae* (clinical isolate) were used. Permission and approval to use clinical isolates was obtained from the ethical clearance board of the University of Gondar Hospital. Microorganisms were grown on nutrient agar at 37°C for 24 h. Standards 0.5 McFarland was prepared by acquiring up to 4 colonies in the normal saline solution according to standard operations.

Antibacterial activity assay

Agar well diffusion method was employed to assess the antibacterial activity of *D. stramonium* ethanol, methanol, acetone, chloroform and water extracts against the human pathogenic bacteria (Taye et al., 2011). The overnight bacterial culture was taken to prepare the inoculums and adjust to 0.5 McFarland standard in 0.9% autoclaved normal saline. The Muller Hinton agar medium was prepared and autoclaved at the 121°C for 15 min. The media were poured into each Petri dish and set aside to solidify under the laminar hood. After solidifying the media, the sterile cotton swab was used to spread the inoculums throughout the medium uniformly. Wells were made using a 6 mm diameter cork borer. Then, 100 µl of each extract adjusted to the same concentration (50 mg/ml) was totaled to a respective well. Vancomycin (30 µg/disc) and chloramphenicol (30 µ g/disc) were practiced as a positive control, while DMSO 50% was applied as a negative control. The agar plate was allowed to rest for 1 h under the laminar hood and incubated later at 37°C for one daytime. The sensitivity of the test microorganisms was found by assessing the diameter of the zone of inhibition in which significant susceptibility was taken as ≥ 7 mm in diameter. All experiments were executed in duplicate and repeated three times.

Determination of minimum inhibitory concentration (MIC)

The minimum inhibitory concentration (MIC) was determined for the extracts that inhibited the growth of testing bacteria in the concentration of 50 mg/ml and for the extracts which showed a zone of inhibition ≥ 7 mm in diameter. Agar well diffusion and microtube dilution methods were used to perform MIC test. In agar

*Corresponding author. E-mail: solbiotech68@yahoo.com.

Table 1. Mean inhibition zone of five solvent extracts of *D. stramonium* at concentrations of 50 mg/ml on different test bacteria.

Test organism	Inhibition zone(mm) Mean±S.D					Control	
	Water extract	Ethanol extract	Methanol extract	Acetone extract	Chloroform extract	V30	C30
S. aureus (ATCC 25923)	0.0	16.5±2.4	14.6±2.3	16.5±2.6	18.2±2.1	17	20
E. coli (ATCC 25922)	0.0	-	-	12.7±1.7	13.7±2.1	27	24
S. pneumoniae (ATCC 63)	0.0	16.7±1.4	15.7±1.7	14.9±1	14.6±1.5	21	23
E. coli (clinical isolate)	0.0	9.1±1.2	9.2±1.6	8.2±1.8	16.2±1.1	20	19
K. pneumoniae (clinical isolate)	0.0	12.3±1.8	-	-	17.5±1.6	19	16
S. pneumoniae (clinical isolate)	0.0	-	8.5±1.6	11.9±2	11.3±1.8	18	22

well diffusion method, double serial dilution was applied from 50 mg/ml to get 1:2, 1:4, 1:8, 1:16, 1:32 and 1:64 in order to get 25, 12.5, 6.25, 3.125,1.56 and 0.78 mg/ml concentration of extracts, respectively, using 50% DMSO. Next, 100 µl of the extract was added to the wells on Muller Hinton agar and then MIC concentration was identified. In microtube dilution method, a similar principle was applied except dilution performed in 1 ml of nutrient broth. To each labeled concentration, a 30 µl of a standard suspension of test microorganisms was added. The controls were developed without any test microorganisms inoculated. The microtube was incubated at 37°C for 24 h. The existence of growth was examined by checking the turbidity of bacteria on each tube before and after inoculation and the results were compared with the control tube.

Minimum bactericidal concentration (MBC)

Dilutions having no visually detectable growth were taken and subcultured on Muller Hinton agar to perform MBC and then incubated for 24 h at 37°C. Ultimately, the outcomes with no visible growth were taken as MBC values.

Data analysis

All data were analyzed using SPSS version 20 and the results are presented as means±standard deviations. Analysis of variation (ANOVA) was employed to define the significant differences between test microorganisms. The statistical significance was determined when P values are ≤ 0.05.

RESULTS

Antibacterial activity of *D. stramonium* using 50 mg/ml concentration of five extracts was measured. The results are presented in Table 1. There was no antibacterial activity observed against all tested microorganisms using water as the extraction solvent. Ethanol extract did not inhibit the growth of *E. coli* (ATCC 25922) and *S. pneumoniae* clinical isolate. However, ethanol extract inhibited the rest tested bacteria with inhibition zone ranging from 9.1 to 16.7 mm. Methanol extract inhibited all tested bacteria strains with the exception of *E. coli* (ATCC 25922) and *K. pneumoniae* clinical isolate. On the other hand, acetone extract inhibited tested pathogenic microorganisms with the exception of *K. pneumoniae* clinical isolate. The chloroform extract inhibited all pathogenic microorganisms investigated with the highest inhibition zone for most tested microorganisms. As compared to methanol and acetone extracts, ethanol extract showed higher ($P < 0.05$) inhibition zone against bacterial strains investigated in this study.

The highest inhibition zone of ethanol extract (16.7 mm) was recorded for *S. pneumoniae* (ATCC 63) and *S. aureus* (ATCC 25923) (16.5 mm). While the maximum zone of inhibition of methanol extract was received from S. *pneumoniae* (ATCC 63) (15.7 mm), *S. pneumoniae* clinical isolate showed the lowest zone of inhibition (8.5 mm). On the other hand, the highest zone of inhibition using acetone extract was recorded for *S. aureus* (16.5 mm), while *E. coli* clinical isolate showed the lowest zone of inhibition which was 8.2 mm. Using chloroform extract, the maximum zone of inhibition was recorded for *S. aureus* (ATCC 25923) (18.2 mm), while the minimum zone of inhibition was obtained for *S. pneumoniae* clinical isolate (11.3 mm).

Vancomycin (30 µg/disc) and chloramphenicol (30 µg/disc) standard antibiotics were applied as positive control while 50% DMSO was applied as a negative control. Chloroform extract showed highest inhibition zone (18.2 mm) for *S. aureus* (ATCC 25923) as compared to Vancomycin (17 mm). In the same extract, *K. pneumoniae* clinical isolate showed better zone of inhibition (17.5 mm) than chloramphenicol (16 mm).

The MIC of *D. stramonium* extracts was determined by agar dilution method. The ethanol extract showed MIC of 6.25% with the exception of *E. coli* clinical isolate and *S. pneumoniae* clinical isolate that showed 12.5%. Methanol extract gave 12.5% MIC for *E. coli* and *K. pneumoniae* clinical isolates, while the rest tested microorganisms showed 6.25%. In the case of acetone extract, *S. aureus* (ATCC 25923), *S. pneumoniae* (ATCC 63) and *S. pneumoniae* clinical isolates showed 6.25% MIC, while the rest showed 12.5% MIC. Chloroform extracts gave 6.25% MIC for all microorganisms tested with the exception of *E. coli* clinical isolate that showed 12.5% MIC (Table 2).

The MBC of ethanol extract against all tested microorganisms was 6.25% except *E. coli* and

Table 2. MIC of ethanol, methanol, acetone, and chloroform extracts of *D. stramonium* against tested bacteria.

Test bacterial organism	Ethanol / Methanol / Acetone / Chloroform			
	25%	12.5%	6.25%	3.12%
S. aureus (ATCC 25923)	-/ - /- /-	-/ - /- /-	-/ - /- /-	+/ +/ + /+
E. coli (ATCC25922)	-/ - /- /-	-/ - /- /-	-/ - / +/-	+/ +/ + /+
S. pneumonia (ATCC 63)	-/ - /- /-	-/ - /- /-	-/ - /- /-	+/ +/ + /+
E. coli (Clinical Isolate)	-/ - /- /-	-/ - /- /-	-/ + /+ /+	+/ +/ + /+
K. pneumonia (clinical Isolate)	-/ - /- /-	-/ - /- /-	-/ + /+ /-	+/ +/ + /+
S. pneumonia (clinical isolate)	-/ - /- /-	-/ - /- /-	+/ - /- /-	+/ +/ + /+

+ and - indicates the availability and absence of growth.

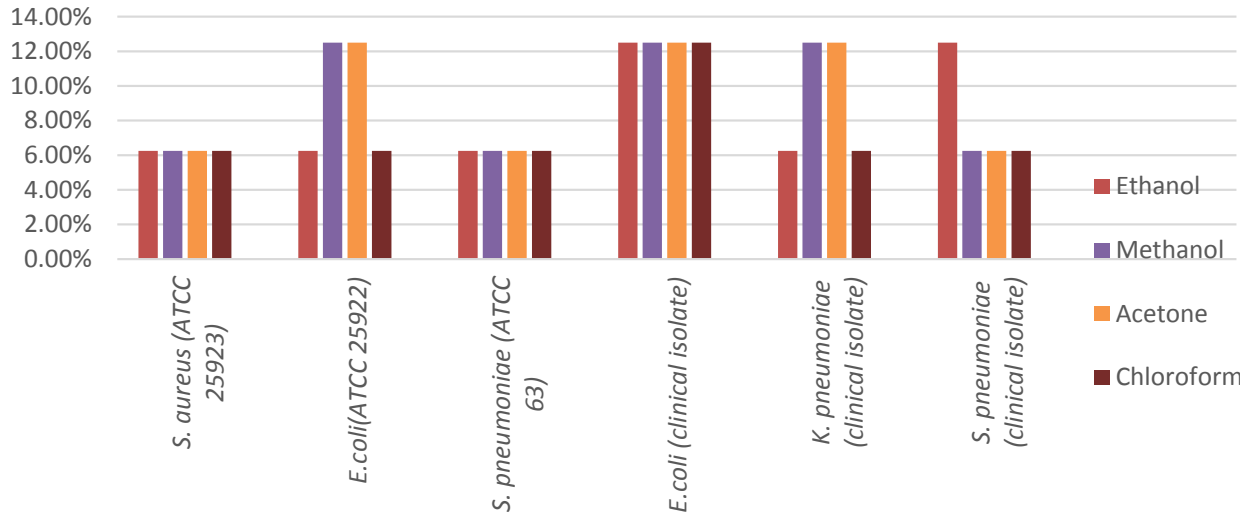

Figure 1. *D. stramonium* MBC of ethanol, methanol, acetone and chloroform extracts against selected pathogenic bacteria.

S. pneumoniae clinical isolates that showed 12.5% MBC. On the other hand, methanol extract showed MBC of 6.25% against *E. coli* (ATCC 25922), *K. pneumoniae* clinical isolate and *E. coli* clinical isolate, 12.5% MBC was observed for *S. aureus* (ATCC 25923), *S. pneumoniae* (ATCC 63) and *S. pneumoniae* clinical isolate microorganisms. However, acetone extracts showed 6.25% against *S. aureus* (ATCC 25923), *S. pneumoniae* (ATCC 63) and *S. pneumoniae* (clinical isolate). The rest tested microorganisms showed 12.5% MBC. Moreover, chloroform extracts exhibited 6.25% minimum bactericidal concentration against in all the tested microorganisms with the exception of *E. coli* clinical isolate that showed 12.5% MBC (Figure 1).

DISCUSSION

The purpose of traditional medicine by local communities is attributed to its accessibility and price effectiveness and thus, the use of herbal medicine is nowadays becoming increasingly more popular in the globe. Medicinal plants constitute an efficient beginning for both traditional and advanced medical specialty. Approximately, 80% of people from developing countries use traditional medicine as primary health care (Eloff, 1998). Consequently, such plants should be investigated in a broad range to better see their properties, safety and efficacy. Over the years, the World Health Organization (WHO) recommended that countries should cooperate with traditional medicine with a survey to identify and exploit aspects that provide secure and efficient remedies for ills of both microbial and non-microbial origins (WHO, 1978).

The significance of plant extracts and phytochemicals, both with known antimicrobial properties can be of great significance in therapeutic treatments. A routine of surveys has been previously conveyed in different states

to prove such efficiency (Ikram and Inamul, 1984; Almagboul et al., 1985; Artizzu et al., 1995). Various plants have been employed as a result of their antimicrobial traits, which are due to compounds synthesized in the secondary metabolism of the flora.

In the present study, antibacterial activities of *D. stramonium* leaf extracts using 5 extracts as extraction solvents have been conducted against the standard and clinical isolate human pathogenic microorganisms.

As per the research, there was no previous work conducted to validate *D. stramonium* leaf extracts using the patterns used in this research in Ethiopia. In the data, water extracts did not show any antibacterial activity against tested pathogenic microorganisms which are supported by previous findings that used water as an extraction solvent for finding active antibacterial components (El safey and Salah, 2011).

The current study shows that leaf extracts of *D. stramonium* inhibited the growth of human pathogenic bacteria *S. aureus* (ATCC 25923) *E. coli* (ATCC 25922), *S. pneumoniae* (ATCC 63), *E. coli* (clinical isolate), *S. pneumoniae* (clinical isolate) and *K. pneumoniae* (clinical isolate) which is in line with the outcomes obtained by Obi et al. (2002).

The leaf extracts of *D. stramonium* showed antibacterial activity against *E. coli* and *K. pneumoniae* which is compatible to Adebayo et al. (1989) who found high antimicrobial activity against those microorganisms. In addition, higher antibacterial activity was obtained against *S. pneumoniae* (ATCC 63) and *S. aureus* (ATCC 25923) and lower antibacterial activity against *E. coli* clinical isolate which is partially in line with the results obtained by Benito et al. (2011) who found higher antibacterial activity against *S. aureus* (ATCC 25923) and *E. coli* (ATCC 25922) and *E. coli* clinical isolate. Moreover, *D. stramonium* extracts showed lower antibacterial activity against *E. coli* clinical isolates which is supported by the results of Eftekhar et al. (2005).

Antibacterial activity of *D. stramonium* leaf extracts is due to the presence of phytochemicals that includes, flavonoids, phenols, tannins, saponins, sterols and alkaloids. Because of the presence of these fundamental biomedicals, *D. stramonium* is considered as treasured medicine and useful in the treatment of many diseases. Phytochemical constituents in the plant sample are known to be biologically active compounds and they are responsible for different activities such as, antimicrobial, antioxidant, antifungal and anticancer (Hossain and Nagooru, 2011; Powar and Powar, 2016).

The classes of alkaloids are among the major poisons known. Aside from being vicious, some alkaloids have also been shown to be useful in correcting renal disorders (Fluck, 1973; Konkwara, 1976). The present work shows that *D. stramonium* has maximum antibacterial activity against S. *aureus* (ATCC 25923), 18.2 mm (chloroform extract) while the minimum antibacterial activity was recorded against *E. coli* clinical isolate (8.2 mm) (acetone extract).

Conclusion

In the present work, the antibacterial activity of *D. stramonium* leaf with 5 different solvents was investigated. Results of this study indicate that *D. stramonium* possesses considerable antibacterial activity that supports the use of the flora in the traditional scheme of medicine for the handling of several diseases. However, advance studies are required to identify and characterize the bioactive compounds responsible for the activity so that, the plant can be used as a natural antimicrobial agent. The presence of secondary metabolites in single or in combination with others could be responsible for the antibacterial activity of the plant.

Extracts obtained from *D. stramonium* in this study were tested only against bacteria and further investigation is necessary to validate against fungal species since the local community uses the leaf of this plant to treat bacterial and fungal infections. Further investigation of this potential antibacterial agent by other researchers is recommended with similar and different forms of pathogenic microorganisms to precisely demonstrate the antimicrobial effects of the plant.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

ACKNOWLEDGEMENTS

The authors are gratefulness to the University of Gondar for providing the research facilities; Department of Biotechnology Laboratory assistants for their follow-up during the entire study. They gratefully acknowledge all the staff members of the Department of Biotechnology, University of Gondar, for their generous and kind assistance.

REFERENCES

Abreham B, Awokech G, Birtukan G, Rahel A, Taye M, Workabeba D (2015). Antimicrobial activity of *Thymus schimperi Ronninger* (*Lamiaceae*) against standard and clinical isolates of human pathogenic bacteria. J. Med. Plants Res. 9(11):379-384.

Adebayo AG, Oloke JK, Aladesanmi AJ (1989). Antimicrobial activities of the leaf extract of *Eugeniauniflora*. Phytother. Res. 3:258-259.

Akinyemi KO, Oladapo O, Okwara CE, Ibe CC, Fasure KA (2005). Screening of crude extracts of six medicinal plants used in Southwest Nigerian orthodox medicine for anti-methicillin resistant *Staphylococcus aureus* activity. BMC Complement. Altern. Med. 5:6.

Almagboul AZ, Bashir AK, Farouk A, Salih AKM (1985). Antimicrobial activity of certain Sudanese plants used in folkloric medicine. Screening for antibacterial activity. Fitoterapia 56:331-337.

Artizzu N, Bonsignore L, Cottiglia F, Loy G (1995). Studies of the diuretic and antimicrobial activity of Cynodon dactylon essential oil. Fitoterapia 66:174-175.

Benito J, Shringib BN, Dinesh KP, Nehru SC, Ashok KJ (2011). Screening of antimicrobial activity of alcoholic and aqueous extract of some indigenous plants. Indo Glob. J. Pharm. Sci. 1(2):186-193.
Boumba A, Mitselou A, Vougiouklakis T (2005). Fatal poisoning from ingestion of *Datura stramonium* seeds. Vet. Hum. Toxicol. 46:81-82.
Bouzidi A, Mahdeb N, Kara N (2011). Toxicity studies of alkaloids of seeds of *Datura stramonium* and synthesis alkaloids in male rats. J. Med. Plants Res. 5(15):3421-3431.
Couladis M, Tzakou O, Verykokidou E, Harvala C (2003). Screening of some Greek aromatic plants for antioxidant activity. Phytother. Res. 17:194-195.
Diker D, Markovitz D, Rothman M, Sendovski U (2007). Coma as a presenting sign of *Datura stramonium* seed tea poisoning. Eur. J. Intern. Med. 18(4):336-338.
Eloff JN. (1998). Which extract should be used for the screening and isolation of antimicrobial components from plants? J. Ethnopharmacol. 60:1-8.
El safey M, Salah GA (2011). *In vitro* antibacterial activities of Rifampicin and Thyme on Methicillin Resistant *Staphylococcus aureus* (MRSA). Asian Trans. Basic Appl. Sci. 1:68-75.
Eftekhar F, Yousefzadi M, Tafakori V (2005). Antimicrobial activity of *Datura innoxia* and *Datura stramonium*. Fitoterapia 76:118-120.
Fluck H (1973). Medicinal plants and their uses. W. Feulshom and Company Limited, New York. pp. 7-15.
Geleta B, Eyasu M, Kebamo A, Mekonnen E, Abebe A (2015). *In vitro* vasodilatory effect of aqueous leaf extract of *Thymus serrulatus* on thoracic aorta of Guinea pigs. Asian Pac. J. Trop. Biomed. 5(1):15-18.
Gharaibeh MN, Elayan HH, Salhab AS (1988). Hypoglycemic effects of *Teucrium polium*. J. Ethnopharmacol. 24:93-99.
Giadado A, Zainab A, Hadiza MU, Serah DP, Anas HY, Milala MA (2007). Toxicity studies of ethanol extract of the leaves of *Datura stramonium* in rats. Afr. J. Biotechnol. 6(8):1012-1015.
Gupta S, Raghuvanshi M, Jain D (2010). Comparative Studies on Anti-Inflammatory Activity of *Coriandrum Sativum*, *Datura Stramonium* and *Azadirachta Indica*. Asian J. Exp. Biol. Sci. 1(1):151-154.
Hossain MA, Nagooru MR (2011). Biochemical profiling and total flavonoids contents of leaves crude extract of endemic medicinal plant *Corydyline terminalis* L. Kunth. Pharmacogn. J. 3(24):25-29.
Ikram M, Inamul H (1984). Screening of medicinal plants for antimicrobial activities. Fitoterapia 55:62-65.
Kirtikar JD, Basu BD (1994). Indian Medicinal Plants. Lalit Mohan Basu; Allahabad, India. pp 1229-1231.
Konkwara JO (1976). Medicinal Plants of East Africa. Literature Burea, Nairobi. pp. 3-8.
Kumar B, Vijaykumar M, Govindarajan R, Pushpangadan P (2007). Ethnopharmacological approaches to wound healing: Exploring medicinal plants of India. J. Ethnopharmacol. 114(2):103-113.
Obi CL, Potgieter N, Randima LP (2002). Antibacterial activities of five plants against some medically significant human bacteria. S. Afr. J. Sci. 98(1-2):25-28.
Powar PV, Powar TA (2016). In-vitro antibacterial activity of sequential crude extracts from *Datura stramonium* seeds. J. Invent. Biomed. Pharm. Sci. 1(1):01-04.
Rasekh HR, Khoshnood MJ, Kamalinejad M (2001). Hypolipidemic effects of *Teucrium polium* in rats. Fitoterapia 72:937-939.
Sharma MC, Sharma S (2010). Phytochemical, Preliminary Pharmacognostical and Antimicrobial Evaluation of Combined Crude Aqueous Extract. Int. J. Microbiol. Res. 1(3):166-170.
Sharma RA, Sharma P, Yadav A (2013). Antimicrobial screening of sequential extracts of *Datura stramonium* L. Int. J. Pharm. Pharm. Sci. 5(2):401-404.
Taha SA, Mahdi AW (1984). *Datura stramonium* intoxication in Riyadh. Trans. R. Soc. Trop. Med. Hyg. 78:134-135.
Tariq M, Ageel AM, Al-Yahya MA, Mossa JS, Al-Said MS. (1989) Anti-inflammatory activity of *Teucrium polium*. Int. J. Tissue React. 11:185-188.
Taye B, Giday M, Animut A, Seid J (2011). Antibacterial activities of selected medicinal plants in traditional treatment of human wounds in Ethiopia. Asian Pac. J. Trop. Biomed. 1(15):370-375.
World Health Organization (WHO) (1978). The promotion and development of traditional medicine. Technical report series. World Health Organ. Tech. Rep. Ser. 622:1-41.

Journal of
Medicinal Plant Research

Related Journals Published by Academic Journals

- *African Journal of Pharmacy and Pharmacology*
- *Journal of Dentistry and Oral Hygiene*
- *International Journal of Nursing and Midwifery*
- *Journal of Parasitology and Vector Biology*
- *Journal of Pharmacognosy and Phytotherapy*
- *Journal of Toxicology and Environmental Health Sciences*

academicJournals