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Journal of Medicinal Plants Research

Full Length Research Paper

Ethnobotanical study of medicinal plants used by local people in Menz Gera Midir District, North Shewa Zone, Amhara Regional State, Ethiopia

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This study was conducted in *Menz Gera Midir* (Ethiopia) to document medicinal plants and related indigenous knowledge of local people. Data were collected from 72 (12 of them key) informants using semi-structured interview, group discussion and guided field walk. Priority ranking, paired comparison and direct matrix ranking were used in data analysis. A total of 155 medicinal plant species, 104 (67.1%) from natural vegetation and 51 (32.9%) from home gardens were collected. From the total species, 115 were reported to cure only human diseases, 10 species for livestock ailments and 30 for both. Asteraceae contributed 16 species and ranked first followed by Lamiaceae with 12 species. Frequently used plant parts were leaves (43.9%) and roots (31%). The recurrent mode of preparation was pounding (27.9%) followed by powdering (16%) and mostly administrated through oral drinking (33%) and dermal cream (15.7%). Paired comparison revealed that *Cucurbita pepo* was the most preferred species to treat headache. However, *Olea europaea subsp. cuspidata* was reported as the most multipurpose plant species. Priority ranking indicated that *Lupinus albus* was the rarest medicinal plant in the study area. The medicinal plant resources of the area were threatened by agricultural expansion, charcoal making, firewood collection and overgrazing.

Key words: Ethnobotany, indigenous knowledge, medicinal plants, Menz Gera Midir.

INTRODUCTION

Historically, relationship between plants and human are not only limited to the use of plants for food, clothing and shelter but also includes their use for religious ceremonies, ornamentation and healthcare (Schultes, 1992). Traditional people around the world acquire unique knowledge of plant resources on which they depend for food, medicine, cultural and religious practice (Martin, 1995). Ethnobotany is then the way of scientific investigation on the use of these plants in traditional culture for food, medicine, magic, rituals, building,

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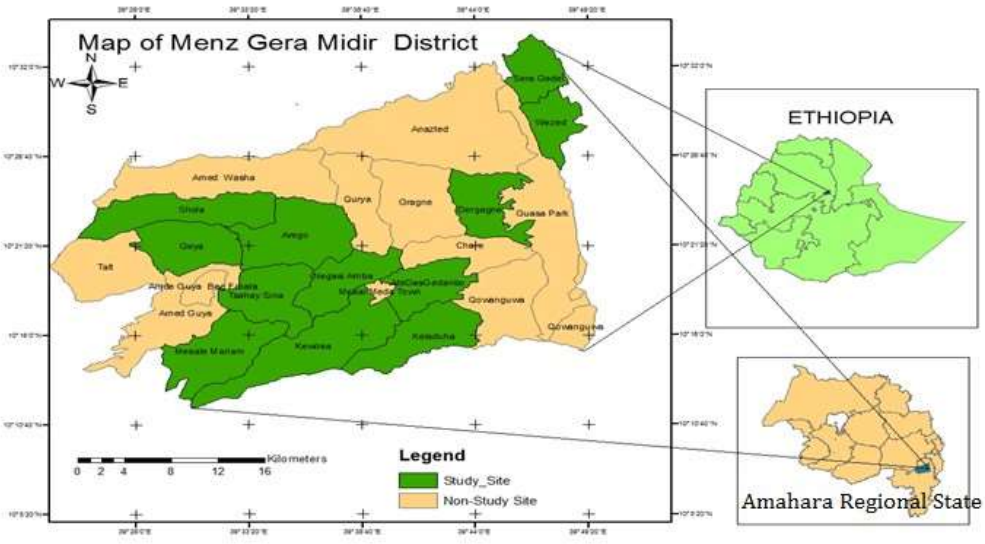

Figure 1. Map of the study area.

Household utensils and implements, musical instruments, firewood, pesticides, clothing, shelter and other purposes (Urga et al., 2004).

Medicinal plants preferably have significant contributions in the healthcare scheme of local communities as the main resource of medicine for the mainstream of the rural population (Hailemariam et al., 2009). About 80% of the world's population relies chiefly on traditional medicine for their healthcare practices (Brown, 1992). This is because the traditional systems are culturally more acceptable and convene the psychological needs of people than modern medicine (Brown, 1992). Thus, medicinal plants are widely used for the treatment of numerous human and livestock aliments in different parts of the world.

Ethiopia has a long history of traditional medication and developed practices to treat diseases using diverse cultural systems found in the country (Shimeils et al., 2012). Healing in Ethiopian traditional medicine is not only concerned with curing of diseases but also with the protection and promotion of human physical, spiritual, social, mental and material wellbeing (Bishaw, 1991). It was widely believed in Ethiopia that the skill of traditional health practitioners is 'given by God' and knowledge on traditional medicines is passed orally from father to a favorite child, usually a son or is acquired by some spiritual procedures. Traditional healing knowledge is maintained by certain families or social groups (Gidaya et al., 2009), although needed to meet the goals of a wider coverage of primary healthcare delivery in all countries.

In Ethiopia, 80% of the population use traditional medicine due to the cultural acceptability of healers and local pharmacopeias, the relative low cost of herbal medicine and the limited access to modern health facilities (Deribe et al., 2006). In addition, there is cultural diversity and the use pattern of the various flora differ accordingly (Balemie et al., 2004). Although the medicinal plants were playing a key role for the development and advancement of modern drugs (Heinrich, 2000), both human and natural factors are heavily contributing to the loss of these plants and cause gradual displacement of associated indigenous knowledge.

Ethiopian people used to transfer indigenous knowledge about traditional medicinal plants mostly in a secret way from generation to generation orally. So then, there is a gap in the documentation and records about traditional knowledge on medicinal plants, even if they are serving as remedies for both human and livestock diseases. Whereas, the knowledge and use of plants is an integral part of many ethnic rural cultures in Ethiopia, the extent of which has not yet been studied in depth (Abbink, 1995). For instance, the ethnobotanical study in the people of Menz Gera Midir has remained unexplored and no documentation has been done on the medicinal plants and the associated knowledge available before this study.

Therefore, this study was conducted to document medicinal plants used by local people and the associated indigenous knowledge acquired regarding the methods to preparation, prioritize for use and the routes of administration in Menz Gera Midir District, Ethiopia.

MATERIALS AND METHODS

Description of the study area

Menz Gera Midir is one of Districts found in North Shewa (Figure 1) in the Amhara Regional State. It is located 282 km Northeast of Addis Ababa, capital city of Ethiopia. The total area coverage is 116, 816 hectare comprising 20 kebeles (small administrative

category next to District). The estimated population was 93,738 (47,994 female and 45, 744 male) and 99.56% of them are Orthodox Christianity followers belonging to the Amhara ethnic group and speaking Amharic as their native language. The elevation of study area ranges from 1680 to 3600 m. a. s. l. and lies between 10°5' to 100°32' N and 38° 28' to 38° 49' E. The soil types of the study area was 61.8% Brown, 18.2% Clay, 13% Red and 7% Gray, and has major agro-climatic zones described as WURCH (Afroalpine), DEGA (highland area) and WEINA-DEGA (middle altitude). Data obtained from the unpublished National Meteorological Service (NMSA) Agency showed that the annual rainfall was 888 mm and the distribution is bimodal and minimum and maximum temperatures was 8.7°C and 20°C, respectively (NMSA, 2013). The vegetation of the area is dry evergreen Afromontane type characterized by the presence of major tree species that include *Juniperus procera, Acacia abyssinica, Podocarpus falcatus, Olea europaea subsp. cuspidata, Hagenia abyssinica, Eucalyptus globulus* and Afro- alpine type with most conspicuous giant lobelia (*Lobelia rhynchopetalum*) and sub-afro-alpine ecosystem. The current land use in the study area was predominantly (85%) smallholder agriculture with an average landholding size of one hectare per household. The seed farming complex was a common practice where barely (*Hordeum vulgare*), wheat (*Triticum* spp.), faba bean (*Vicia faba*) and lentil (*Lens culinaris*) are the dominant crops. In addition, livestock rearing was also an integral part of the agricultural system in the study area.

Study sites and informant selection

In the Menz Gera Midir District, about 20 kebeles were found. Out of these, 12 kebeles were selected purposely through guidance of District's Tourism Office employees based on availability of traditional healers and plant species for the study. These kebeles are: AREGO, ATEDAS-GEDANBO, DERGAGN, GEYA, KELADUHA, KEWOSA, MESALE MARIAM, NEGASI AMBA, SHOLA, SRA GEDEL, TSEHAY SINA and WEZED. A total of 72 informants (47 male and 25 female) aged between 20-90 years (12 of them were key informant taking 1 from each kebele) were selected by the recommendation of elders and local authorities. Out of total informants, 38 completed grade 3-12 and the remaining 34 were illiterate. All informants (62 married, 5 divorced and 5 single) are Orthodox Christian Religion followers and native Amharic speakers.

Ethnobotanical data collection

The data were collected from November 2012 to January 2013 using ethnobotanical data collection techniques such as semi-structured interview, group discussion and guided field walk. Informants were interviewed at least twice for same question to evaluate reliability of the information.

Data analysis

In this study, both qualitative and quantitative analytical tools were used for data analysis following approaches of Martin (1995) and Cotton (1996). The Informant Consensus Factor (ICF) was calculated for each disease category to identify the agreements of the informants on the reported cures for eight human disease categories. The ICF was calculated as follows: number of use citations in each category (Nur) minus the number of species used (Nt), divided by the numbers of use citations in each category minus one (Heinerich et al., 1998). Priority ranking were conducted by asking people to list plants that are becoming increasingly rare in their communal forests. Therefore, a set of eight medicinal plants were selected from the lists reported by most informants as scarce in the study area. Then, selected plants were presented to eight randomly selected key informants to rank them according to their degree of scarcity using numerical value (1, 2, 3, and so on). The most scarce medicinal plant species were given the highest value while abundant one was assigned a value of 1. Then, the numbers were summed and ranked. For the degree of informants herbal remedies preference to treat headache in the study area, paired comparison was done (Martin, 1995). For this purpose, eight key informants were randomly selected and allowed to show their responses independently for pairs of five medicinal plants that are noted for treating headache. All possible combinations were made and sequence of pairs and order within each pair was randomized before every pair was presented to selected informants. Their responses were recorded carefully and then the total values were summarized and ranked based on the informants report. Specificity for a certain disease was then also checked by fidelity level calculation (Friedman et al., 1986). The medicinal plants which have multipurpose nature for local people were checked using direct matrix ranking method. According to informants' indication, eight multipurpose plant species were selected for seven use diversities. Then eight key informants were asked to assign use values: 5= excellent, 4= very good, 3 = good, 2 = less used, 1 = least used, 0 = not used, for each species based on the multiple purpose. Finally, ethnobotanical data were entered in to excel spreadsheet and interpreted using tables, and descriptive statistics.

RESULTS

Taxonomic diversity of medicinal plants

A total of 155 medicinal plant species distributed in 133 genera and 65 families were collected, identified and documented (Appendix 1). From the total families, 61 (93.84%) were angiosperms, 2 (3.08%) gymnosperms and 2 (3.08%) were cryptograms. Among the angiosperms, the most dominant (92%) group were the dicotyledons, whereas 8% were monocotyledons. Asteraceae was found to be the most dominant family that contained 16 medicinal plant species under 13 genera followed by Lamiaceae, which had 12 species distributed in 10 genera. Out of the total collected medicinal plants, 13 species are endemic to Ethiopia and 5 species are placed under the near endemic category since they were found both in Ethiopia and Eritrea. Herbs constituted the largest category of medicinal plants (68; 43.9%) species followed by shrubs (47; 30.3%) in the study area.The natural vegetation of the study area was categorized visually into six major groups based on the dominance of the plant species:

(1) The *J. procera*- dominated plant community type was predominantly found in three Kebeles (KEWOSA, MESALE MARIAM and SRA GEDEL) and around few churches at an altitudinal range of 2700-2930 m a.s.l. Under this, 4 species of medicinal plants were obtained;
(2) The *Lobelia rhynchopetalum*-dominated community type was mainly dominated by a single species and found in DERGAGN Kebele, located at the mountain tops (3458 m a. s. l.);

(3) The *E. globulus*-dominated community type was the plantation found in almost all parts of the study area. This species has been widely planted in the area as it is one of the good money generating species for the farmers in the locality. *A. africanus* and *P. sphacelatum* were common herbaceous medicinal plants found in this community;
(4) The *O. rochetiana* and *R. vulgaris*- dominated plant community type is more diversified and found in SRA GEDEL Kebele, particularly at GAJELO forest. It is located at an altitude ranging between 2500-2830 m.a.s.l. It encompasses 14 medicinal plant species and the most dominant one are *Carissa spinarum, Clutia abyssinica, Maesa lanceolata, Maytenus arbutifolia, Podocarpus falcatus, Pteridium aquilinium,* and *Vernonia amygdalina*;
(5) The other plant community type in the study area was the *Dodonaea angustifolia* and *Rumex nervosus*-dominated type. This plant community encompasses 38 species of medicinal plants distributed in three Kebeles (MESALE MARIAM, SRA GEDEL and KEWOSA) at altitude ranging between 2197-2860 m.a.s.l. The medicinal plants found inthis community type were *Croton macrostachyus, Cyphostemma adenocaule, Euclea divinorum, Euphorbia abyssinica, Myrsine africana, Otostegia integrifolia, Premna schimperi*;
(6) The *Helichrysum* sp.-dominated community contains mainly a single species and dominantly found in WEZED Kebele at an altitude ranging from 2850-3010 m a.s.l. This plant community type harbours the medicinal plants *Dovyalis abyssinica, Hagenia abyssinica, Inula confertiflora, Laggera tomentosa and Vernonia bipontini*.

Furthermore, home gardens were also another source of medicinal plant in the study area. Some of medicinal plant species obtained in the home garden includes *Foeniculum vulgare, Achyranthes aspera, Allium sativum, Artemisia rehan, Ruta chalepensis, Brassica oleracea, Capsicum annuum, Catha edulis, Cucurbita pepo, Daucus carota, Euphorbia ampliphylla, Kalanchoe petitiana, Leonotis ocymifolia, Lippia adoensis, Malus sylvestris, Ocimium lamiifolium, Opuntia ficusindica, Phytolacca dodecandra, Ricinus communis, Sansevieria ehrenbergii, Urtica simensis, Zehneria scabra Allium cepa, Citrus aurantifolia, Citrus limon, Citrus medica, Lagenaria siceraria, lycopersicon esculentum, Myrtus communis and Saccharum officinarum.*

Distribution of medicinal plants and indigenous knowledge

This study revealed that medicinal plants were unevenly distributed in the different plant community types. Of the 155 medicinal plants, 104 (67.1%) species belonged to 86 genera and 52 families found in the wild vegetation whereas 51 (32.9%) species which belong to 47 genera and 28 families were obtained from home garden (Appendix 1). Most of the traditional knowledge of medicinal plants is passed orally and through secret along the family line from parents. Of the total informants, 73.6% gained their medicinal plant knowledge from families and some others by observation (19.4%) and learning (7%) from the other people. Out of the total identified medicinal plants, 115 (74.2%) species belonging to 101 genera and 51 families were those cited as traditional medicine for human ailments, whereas 10 (6.45%) species belonging to 10 genera and 9 families are used to treat merely livestock ailments. Only 30 (19.35%) species under 30 genera and 21 families were used for both livestock and human ailments. The local people were frequently using leaves (43.9%) followed by roots (31%) to prepare plant remedy. As informants mentioned, plant remedies were used in fresh form (67; 43.2%), while (49; 31.6%) were used in the dried form and (39; 25.2%) in either of the two.

In the study area, traditional healers used different ways of medicinal plant remedy preparation. Among these principal methods, pounding ranked first (27.9%), followed by powdering (16%), and squeezing (15.3%) and cooking was the least (0.34%). The prepared remedies were mostly taken oral drinking (33%) followed by dermal application in the form of cream (15.7%) and eating (11.9%). Dosage was estimated using spoon, cup, cans, and glass for liquids, and for powders spoonful counting or in some cases handful (EFEIGN) was used. The dosage is mostly age and patient status dependent.

Human and livestock ailments treated by medicinal plants

In the present study, 83 ailments (68 in human, 6 in livestock and 9 in both humans and livestock) were reported to be treated by medicinal plants (Table2; Appendix 1). The informants also cite top commonly known medicinal plants in the study area using ranks and *C. ficifolius* were cited by 50 (69.44%) informants and ranked 1st, *Artemisia abyssinica* was cited by 49 (68.05%), and *L. ocymifolia* by 48 (66.66 %) (Table 1).

The abundance and scarcity of medicinal plants in the study area was checked by preference ranking exercise conducted on eight species by eight key informants. The results showed that *L. albus* was the scarcest medicinal plant, cultivated only by limited number of individuals in their home garden who asserted that they get the seeds from around Bahir Dar (Table 3).

Moreover, paired comparison was also made to determine the most preferred medicinal plants among the five species that were used to treat headache in the study area. Traditional healers are well experienced to treat headache using different herbal medicine in the study area. Then, the paired comparison techniques were done to select the most promising medicinal plant form the others to treat it.

Thus, eight key informants participated in this activity

Table 1. Top commonly known medicinal plant species in the study area.

Medicinal plant	Number of informants	% of informants
Cucumis ficifolius	50	69.44
Artemisia abyssinica	49	68.05
Leonotis ocymifolia	48	66.66
Allium sativum	46	63.9
Clematis simensis	45	62.5
Ruta chalepensis	45	62.5
Gomphocarpus purpurascens	40	55.55
Verbascum sinaiticum	33	45.83
Vernonia bipontini	33	45.83
Withania somnifera	32	44.44

Table 2. Informant consensus factor for eight disease categories

Category of diseases	Number of species	Number of use citation	ICF
Skin diseases	64	382	0.83
Ailments associated with organs and throat	20	80	0.76
Gastrointestinal tract diseases	46	328	0.86
Organ diseases	34	123	0.73
Genitourinary problems	17	57	0.71
Acute sickness	45	250	0.82
Birth problems	5	8	0.43
Others: rabies, anemia and fibril illness	10	33	0.72

Table 3. Ranking of scarce medicinal plants in the study area.

Medicinal plant	Key Informants (I_1-I_8)								Total score	Rank
	I1	I2	I3	I4	I5	I6	I7	I8		
Millettia ferruginea	5	2	3	4	2	2	3	3	27	6th
Capparris tomentosa	5	5	4	5	3	4	3	3	32	3rd
Tragia cinerea	4	5	4	4	3	3	3	4	30	4th
Lupinus albus	5	5	5	5	4	4	5	4	37	1st
Sansevieria ehrenbergii	5	3	3	4	3	4	3	3	28	5th
Cyphostemma adenocaule	4	3	2	3	2	4	3	4	25	7th
Cucumis ficifolius	4	5	3	1	2	3	4	2	24	8th
Withania somnifera	5	5	5	4	3	4	5	4	35	2nd

I, Informants.

and indicated that *C. pepo* was used more to treat headache followed by *M. salicifolia* (Table 4). Medicinal plants in the study area had also multiple uses for the community. Direct matrix ranking showed that *O. europae*a subsp. cuspidata ranked first due to the multipurpose role it has for the community and this was followed by *E. globulus and J. procera* (Table 5). The fidelity level of the data was calculated based on the diseases frequently reported by informants and traditional use of medicinal plant for treatments. The diseases include evil eye, “EYNEWOG”, wound, eczema, stomach ache; eye disease, fibril illness and common cold which were confirmed to frequently occur in the area. Consequently, traditional healers employed their indigenous knowledge to manage these frequent diseases using selected medicinal plant species (Table 6).

In Menz Gera Midir District, there are natural and human made factors that cause the threat on medicinal

Table 4. Paired comparison of five medicinal plants used to treat headache.

Medicinal plant	Key Informants (I_1-I_8)								Total score
	I1	I2	I3	I4	I5	I6	I7	I8	
Mentha spicata	1	1	1	**2**	**2**	**1**	**2**	**1**	11
Myrica salicifolia	4	3	2	4	2	3	2	3	23
Leonotis ocymifoli	3	1	1	1	2	1	2	2	13
Silene macrosolen	2	3	2	2	3	1	3	3	19
Cucurbita pepo	4	4	4	3	3	4	3	4	29

Table 5. Direct Matrix Ranking for Multipurpose of Medicinal Plant Species in Study Area.

Main uses	*Ficus sur*	*Ficus vasta*	*Croton macrostachyus*	*Podocarpu falcatus*	*Oleaeuropaea subsp. cuspidata*	*Cordia africana*	*Eucalyptus*	*Juniperus procera*
Charcoal	3	5	30	34	39	28	27	29
Construction	17	38	18	32	12	38	39	38
Edible fruit	37	0	0	0	0	0	0	0
Fence	3	4	4	16	24	3	39	30
Firewood	10	18	12	30	37	25	37	30
Medicine	24	28	20	10	38	13	18	16
Tool	30	32	33	35	36	38	19	33
Total	124	125	117	157	186	145	179	176
Rank	7th	6th	8th	4th	1st	5th	2nd	3rd

plants. This study confirms that the most threatening factor for medicinal plants and the associated indigenous knowledge disappearance are anthropogenic factors such as deforestation and overexploitation of landscape for charcoal, fire wood, for construction overgrazing, and agricultural expansion. Informants ranked agricultural expansion as the most serious threat for medicinal plants followed by charcoal making (Table 7).

Local people in the area have strong and actual belief on healing power of plants and they know their habitats, distribution, harvesting techniques, time of harvest and the status of a plant. The healers also know the site in which medicinal plants were found and the parts to be harvested. Plant apex, main root and regenerating parts are not harvested. This is to keep and increase the regeneration capacity of the plant. Therefore, the appropriate way of harvesting technique has direct or indirect contribution for the conservation of medicinal plants, since they limit excessive loss of these plants in one way or another.

Furthermore, sites dominated by *O. rochetiana and R. vulgaris* plant community types and church forests were protected in SRA GEDEL Kebele. In these areas, medicinal plants are sheltered and conserved. On the other hand, it was also observed that the local farmers make use of their indigenous knowledge in protecting important plant species on their farm lands, home gardens, and as live fence. In some cases, few traditional healers cultivate very rare species in their home gardens like *L. albus.*

DISCUSSION

Menz Gera Midir District has relatively high taxonomic diversity in medicinal plants with 155 species reported under 133 genera and 65 families. Asteraceae was the family with the highest number of medicinal plants, which is largely a result of the abundance and wide distribution of members of the family in the flora of Ethiopia and Eritrea (Tadesse, 2004). It is also reported to be the family that encompasses large number of medicinal plant species along with the Lamiaceae and Fabaceae in the nearby Minjar-Shenkora District (Alemayehu et al., 2015).

In the study area, wild medicinal plant species were more dominant (104, 67.1%) and harvested from the natural vegetation. Similarly, ethnobotanical studies undertaken elsewhere in Ethiopia (Birhane et al., 2011; Yirga et al., 2011; Alemayehu et al., 2015; Meragiaw et al., 2016) have repeatedly shown that wild areas are primary sources of medicinal plants. In addition to this, farmlands and home gardens maintain a considerable number (51, 32.9 %) of species used in traditional herbal medicine. Informants during interview and group discussion categorized the medicinal plants of the area into common, medium and rare species. From the total medicinal plant species, 27.74% were recorded as rare, 29% as common and 42.26% as medium in the study

Table 6. Fidelity value of medicinal plants and their uses for frequently reported diseases.

Disease treated	Medicinal plants	Ni	N	$\frac{Ni}{N}$	$\frac{Ni}{N}$ x 100 (%)
Wound	*Aloe pulcherrima*	4	5	0.8	80
	Datura stramonium	14	18	0.78	78
	Laggera tomentosa	10	15	0.67	67
Evil eye	*Capparis tomentosa*	15	15	1	100
	Withania somnifera	16	16	1	100
Eczema	*Clematis simensis*	20	25	0.8	80
	Gomphocarpus purpurascens	10	30	0.3	30
	Urtica simensis	5	7	0.71	71
"EYNEWOG"	*Otostegia integrifolia*	8	15	0.53	53
	Verbascum sinaiticum	13	20	0.65	65
Common cold	*Thymus schimperi*	4	5	0.8	80
	Artemisia abyssinica	24	25	0.96	96
Stomach ache	*Cucumis ficifolius*	25	25	1	100
	Ruta chalepensis	20	25	0.8	80
	Allium sativum	21	25	0.84	84
	Lepidium sativum	12	18	0.67	67
Fibril illness	*Leonotis ocymifolia*	23	25	0.92	92
	Eucalyptus globules	3	6	0.5	50
Eye disease	*Inula confertiflora*	3	4	0.75	75
	Vernonia bipontini	10	23	0.43	43

Table 7. Ranking of threats to medicinal plants.

Major threats	Key Informants (I_1-I_8)								Total score	Rank
	I1	I2	I3	I4	I5	I6	I7	I8		
Agricultural expansion	**5**	**5**	**3**	**3**	**4**	**5**	**4**	**5**	34	1st
Drought	3	3	2	1	3	2	1	2	17	5th
Construction material	1	3	1	2	3	1	3	2	16	6th
Charcoal making	4	2	4	4	3	4	5	3	29	2nd
Overgrazing	4	3	1	2	2	3	1	2	18	4th
Fire wood collection	3	3	4	3	5	4	3	2	27	3rd

5, very highly destructive; 4, highly destructive; 3, medium; 2-destrucive; 1, less destructiveness.

area. As compiled from informant's interview, indigenous knowledge on medicinal plants was differing among age and gender. Although elders are generally considered to be more knowledgeable than the younger (Hailemariam et al., 2009), the traditional medicine practitioners in the study area were more dominated by male individuals with religious education as found in other areas (Giday et al., 2009). Investigations in different parts of Ethiopia showed that transfer of indigenous knowledge between generations was affected by modernization like access to modern education and ignoring the traditional knowledge in addition to health services expansion (Balemie et al.,

2004; Meragiaw et al., 2016; Kewessa et al., 2015).

Mostly traditional knowledge was transferred between family members from parents (73.6%) secretly and orally to more favoured individuals. The findings of Gebeyehu et al. (2014), in Mecha District, West Gojjam confirmed this reality. The second (19.4%) source of knowledge acquisition was observation and learning from the other people. In this case, knowledge was gained from other knowledgeable individuals by payment or carful repeated observation from friends. Currently, 75% of the traditional healers involved in this study planned to transfer their medicinal plant knowledge to their sons (16.7%) to daughters, 8.3% are positive to transfer to any member of the community without compensation. The types of medicinal plants used by local people in Menz Gera Midir were herbs 68 (43.87%) followed by shrubs 47 (30.32%). This result agrees with the findings of other researchers (Friedman et al., 1986; Addisie et al., 2012). This is due to the fact that herbs can grow everywhere and dominate during the wet seasons as compared to others such as trees, shrubs and woody climbers/lianas.

The current study confirmed that considerable number of medicinal plant species were collected and documented for treatment of human and livestock ailments. Out of the collected medicinal plants, more species were reported as being used to treat human diseases compared to medicinal plant species used for livestock ailments. Fewer numbers (6 of livestock diseases) and 10 medicinal plants were reported as compared to humans (68 diseases and 115 species). This showed that people of the study area are more conscious and give more attention for their ailments than the livestock diseases (Megersa et al., 2013).Traditional healers are dominantly using the leaves (43.9%) because of presence of high bioactive compounds which increase efficacy of remedies followed by roots (31%). This is consistent with other findings (Hailemariam et al., 2009; Chekole et al., 2015; Adefa and Abraha, 2011) elsewhere in Ethiopia.

On the contrary, the numbers found in some other parts of the country reported that roots are the most widely used plant parts for medicinal value (Birhane et al., 2011; Mesfin et al., 2009; Flatie et al., 2009). Most of the plant remedies are prepared by pounding (27.9%) followed by powdering (16%) which is positively supported by the finding of Getaneh and Girma (2014) in Deber Libanos District. However, squeezing came in the first place as a way of preparation in Mecha District (Chekole et al., 2015). The prepared remedies were efficiently used in fresh (43.22%) form followed by dried (31.61%) and either of the two (25.17%) to treat aliments. Different findings were also reported in consonance with this study (Meragiaw et al., 2016; Megersa et al., 2013; Yineger et al., 2008).

The routes of administration mostly depend on the nature of ailments to be treated. The most popular way of administration of traditional herbal/plant medicines are oral (47.96%) followed by dermal (28.57%). Various ethnobotanical reports elsewhere in Ethiopia have indicated that oral administration is the predominant route (Hailemariam et al., 2009; Birhane et al., 2011; Yirga et al., 2011; Mesfin et al., 2009). The dosages of remedies are not yet standardized. Because healers are using equipment which are available near their homes for measuring the doses of traditional herbal medicines. However, the dosage is age, physical and health condition dependent of the patient.

Thus, this is expected to cause risk due to under dose and over dose during treatment of patients. Then, lack of precision and standardization has been mentioned as drawbacks of traditional medication (Sofowora, 1982; Abebe, 1986; Araya et al., 2015). Sometimes traditional healers impose the restrictions when certain types of remedies are taken by patients. For instance, patients who take a remedy against impotency prepared from the root of *M. ferruginea* were instructed that their body parts should not touch water for 24 hours to increase efficacy of the remedy. Healers also advise patients to take additives like milk, coffee, tea, tela, butter and honey to improve medication efficacy and reduce the adverse effects of remedies during traditional medication.

The use of medicinal plants was calculated on frequently reported diseases with respect to medicinal plant species. The fidelity level of *Capparis tomentosa* and *W. somnifera* for evil eye and *C. ficifolius* for stomach ache was scored 100. Since these plant species are highly known by the healers and also have high efficacy to treat these diseases. Furthermore, there is no any modern drug that used to heal evil eye. Priority ranking confirmed the existence of some medicinal plants which are referred by local people at scarce situations. The scarcity is resulted because of anthropogenic and natural factors like deforestation for agricultural expansion, fire wood collection, fire, overgrazing and urbanization as major threats of medicinal plants in Ethiopia (Gebeyehu et al., 2014; Getaneh and Girma, 2014; Alemayehu et al., 2015; Kewessa et al., 2015; Chekole et al., 2015).

In the area, informants reported that several medicinal plants have already disappeared from their common habitats and some of them are at risk of extinction. The first factors for the declining of medicinal plants were agricultural expansion followed by charcoal making in the study area. Other reports (Mesfin et al., 2009; Meragiaw et al., 2016) indicated that agricultural expansion was the major threat on medicinal plants both in Wonago and Northwestern Wello districts. In most situations, the home gardens maintain threatened medicinal plants by protecting from grazing and unwise harvesting. This is a good opportunity for wise use and better transfer of the indigenous knowledge to the younger generation. However, in-situ conservation in the natural environment is the best recommended method to save important medicinal plant species for keeping them in their natural condition.

Conclusion

The results of this study indicated that the potential and abundance of medicinal plant species (155) in the Menz Gera Midir District is an important resource for the present and future generations.

The higher proportion (74%) of these plants was used to treat human ailments further indicates the important role that the medicinal flora has for the healthcare of the immediate society and others. The number of human and livestock ailments (83 diseases) treated with medicinal plants also indicates how important these plants are to the society in Menz Gera Midir District.

From this, we can conclude that the community in this area was achieving alternative relief of diseases if the modern therapy is lacking. The natural vegetation in Menz Gera Midir is rich in medicinal plants (104 species) although a good number of species (51species) were available in the home gardens. The results also showed that herbs are the leading remedies in the area while shrubs and trees also had their contributions.

The traditional healers revealed that the leaves are the most frequently used plant parts with roots having their shares to prepare mostly in fresh condition and predominantly administered through oral route. Traditional healers' indigenous knowledge has variation among age and gender in which elders and men are solely shelve their knowledge on herbal medicine and transfer through strict secret. However, modern education is partially contributing to the undermining of traditional knowledge acquisition in younger generation.

The results further showed that many wild medicinal plant species are under threat by the various natural and human factors sending signals for the attention needed to conserve these medicinal plants.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Appendix 1. Medicinal plants distribution and use by local people in the study area

S/N	Scientific Name	Family	Local Name	Habit	Habitat	Ab	PU	CP	Disease/symptoms claimed to be treated	Route	Altit (m)	Geographical Location	Collection Number
1	*Acacia abyssinica* Hochst. ex Benth.	Fabaceae	GIRAR	T	HG	M	Fr	F/D	Orchiticl	Oral	2433	10° 13'15.4"N 039° 32' 47.3E	SW101
2	*Achyranthes aspera* L.	Amaranthaceae	TELENGZ	H	HG	C	R and L	F	Stabbing pain, Uvulitia	Dermal, Nasal	2933	10° 17'52.7"N 039° 34' 54.8E	SW017
3	*Acokanthera schimperi* Schweinf.	Apocynaceae	MIRIENZ	T	W	M	R	D	Intestinal parasite, Evil eye	Oral, Nasal	2371	10° 12'44"N 039° 32' 23.2E	SW108
4	*Allium cepa** L.	Alliaceae	KEY SHINKURT	H	HG	C	Bu	F	Tinea versicolor	Dermal	2310	10° 13'22.2N 039° 31' 47.8E	SW055
5	*Allium sativum*+ L.	Alliaceae	NECH SHINKURT	H	HG	C	Bu	F	Jaundice, Malaria,Ascaries, "Eeynewog", Coccoides	Oral	2956	10° 21'05.1N 039° 34' 42.6E	SW030
6	*Aloe pulcherrima*+ Gilbert and sebsebe	Aloaceae	SETIE - IRET	H	HG	Ra	Lt	F	Wound, Diarrhoea	Dermal Oral	2960	10° 17'59.5N 039° 34' 52.4E	SW075
7	*Aloe debrana*** Christian	Aloaceae	WONDIE – IRET	H	W	C	Lt	F	Stomach ache Vomiting and Diabetes	Oral	2972	10° 18'05.6N 039° 39' 53.9E	SW078
8	*Artemisia abyssinica*+ Sch.Bip.	Asteraceae	CHIKUGN	H	W	C		F	Common cold Evil eye, Typhus	Nasal Neck	2894	10° 17'40.9N 039° 35' 04.8E	SW018
9	*Artemisia rehan** Chiov.	Asteraceae	ARTI	H	HG	C	R	F	Abdominal pain and Stomach ache	Oral	2921	10° 17'50.2N 039° 34'55.6E	SW132
11	*Asplenium aethopicum* (Burm.f.)	Aspleniaceae	-	H	W	C	L	D	Uvulitia	Dermal	2917	10° 17'53.4N 039° 34'53.3E	SW064
12	*Berberis holstii* Engl.	Berberidaceae	ZINKELA	S	W	M	R	D	Heart disease	Oral	2961	10° 18'04.4N 039° 34'53.5E	SW131
13	*Bersama abyssinica* Fresen.	Melianthaceae	AZAMIR	S	W	M	L and R	D	Hypertension, Cough and Ascaris	Oral	2490	10° 13'34.6N 039° 33'29.9E	SW125
14	*Brassica carinata**** A. Br.	Brassicaceae	GOMENZER	H	HG	C	L	F	Jaundice	Oral	3074	10° 18'31.2N 039° 39'22.7E	SW153
15	*Brassica oleracea** L.	Brassicaceae	TQL GOMEN	H	HG	C	L	F	Gastritis	Oral	2884	10° 18'31.2N 039° 39'22.7E	SW135
16	*Buddleja polystachya*'* Fresen.	Loganiaceae	ANFAR	T	HG	M	L	F	Leech	Oral	2927	10° 17'53.4N 039° 34'54.1E	SW071
17	*Capparris tomentosa*+ Lam.	Capparidaceae	GUMERO	S	W	Ra	R	D	Evil eye, kin disease, "EYENEWOG"	Oral Neck	2197	10° 12'31.2N 039° 391'44.7E	SW096
18	*Capsicum annuum**L.	Solanaceae	KARIA	H	HG	M	Fr	F	Malaria	Oral	2801	10° 23'27.3N 039°29'45.3E	SW152

Appendix 1. Contd.

19	*Carissa spinarum* L.	Apocynaceae	AGAM	S	W	M	R	D	Evil eye, Wound, "EYENEWOG"	Oral and Nasal	2798	10° 14'02.4N 039° 30'42.7E	SW050
20	*Carthamus tinctorius* L.	Asteraceae	SUF	H	W	Ra	Se	D	Cough	Oral	2207	10° 12'31.4N 039° 31'48.8E	SW090
21	*Cassipourea malosana'* Aubl.	Rhizophoraceae	WERER	T	W	Ra	L,St,Br	F	Leech	Nasal	2320	10° 13'22.3N 039° 31'48E	SW087
22	*Catha edulis** (Vahl) Forssk. ex Endl.	Celastraceae	CHAT	T	HG	C	L	F	Asthma	Oral	2936	10° 17'52.4N 039° 34'55.6E	SW083
23	*Chenopodium ambrosioides* L.	Chenopodiacea e	AMEDMADO	H	HG	M	Fr	F/D	Wound	Dermal	3077	10° 18'31.4N 039° 39'22.6E	SW141
24	*Citrus limon** (L.) Burm.f.	Rutaceae	BETRE LOMI	T	HG	Ra	Fr	F	Liver disease	Oral	2277	10°12'31.2N 039° 31'49.8E	SW150
25	*Citrus aurantifolia** (Christm.) Swingle	Rutaceae	LOMI	T	HG	Ra	Fr	F	Tinea versicolor, Cancer	Dermal	2320	10° 13'22.3N 039° 31'48E	SW053
26	*Citrus medica** L.	Rutaceae	TRINGO	T	HG	Ra	Br	F	Loss of appetite	Oral	2278	10° 12'32.2N 039° 31'49.7E	SW147
27	*Clematis simensis* Fresen.	Ranunculaceae	YEAZO AREG	Cl	W	M	R and L	F and D	Wart, Eczema, Retained placenta, KUNCHIR	Dermal Oral	2856	10° 17'45.3N 039° 35'13.3E	SW020
28	*Clerodendrum myricoides* (Hochst.) Vatke	Lamiaceae	MISRICH	S	W	M	R and L	F and D	Evil eye, Jaundice	Oral and Nasal	2432	10° 13'17.1N 039° 32'49.6E	SW094
29	*Clutia abyssinica* + Jaub. and Spach.	Euphorbiaceae	FYELEFEG	S	W	M	R	D	Evil eye, Jaundice, "EYENEWOG"	Oral and Nasal	2830	10° 14'12.3N 039° 30'38.3E	SW044
30	*Coffea arabica** L.	Rubiaceae	BUNNA	T	HG	M	L	F	Common cold	Oral	2275	10° 13'18.5N 039° 31'48.9E	SW063
31	*Cordia africana* Lam.	Boraginaceae	WANZA	T	W	M	Br	D	Tumour and Wart	Dermal	2435	10° 13'0.86N 039° 32'52.2E	SW137
32	*Croton macrostachyus* Del.	Euphorbiaceae	BISANA	T	W	M	R and L	F and D	Evil eye, Jaundice, Eye disease	Oral, Nasal,Ocular	2363	10° 13'26.6N 039° 31'48.9E	SW060
33	*Cucumis ficifolius*+ Rich.	Cucurbitaceae	YEMDIR EMBWAY	H	W	Ra	R	F/D	Stomach ache, Gonorrhoea, Rabies	Oral	2299	10° 13'22.2N 039° 31'47.8E	SW057
34	*Cucurbita pepo** L.	Cucurbitaceae	DUBA	Cl	HG	M	Fr	F	Headache	Dermal	2800	10° 30'07.2N 039° 46'48.4E	SW161
35	*Cyathula polycephala* Bak.	Amaranthaceae	CHEGOGOTE	H	W	Ra	L	F	Fibril illness	Oral	2289	10° 12'39.6N 039° 31'58.3E	SW099

Appendix 1. Contd.

36	*Cyathula uncinulata* (Schrad.) Schinz	Amaranthaceae	YEKIL FIKIR	H	W	C	R	F	Stabbing pain	Dermal	2830	10° 14'12.5N 039° 30'38.7E	SW046
37	*Cymbopogon citrates** (DC.) Stapf.	Poaceae	TEJESAR	H	HG	Ra	R	D	Evil eye	Oral and Nasal	3069	10° 18'25.5N 039° 39'20.4E	SW129
38	*Cyphostemma adenocaule* (Steud. exA. Rich.)	Vitaceae	ASERKUSH TEBETEBKUSH	Cl	W	Ra	R and L	F and D	Rabies, Congenital abnormality	Oral, Dermal	2273	10° 13'18.1N 039° 31'49.1E	SW085
39	*Cyphostemma cyphopetalum* (Fresen.)	Vitaceae	GINDOSH	Cl	W	Ra	R	D	Cancer	Dermal	2437	10° 13'20.5N 039° 33'05.8E	SW151
40	*Datura stramonium* L.	Solanaceae	ASTENAGER	H	HG	M	Se and L	F and D	Toothache, Deafness, Tumour	Oral	2909	10° 17'40.6N 039° 34'59.3E	SW022
41	*Daucus carota** L.	Apiaceae	KARROT	H	HG	M	R	F	Kidney problem and Night blindness	Oral	3071	10° 18'25.9N 039° 39'21.6E	SW128
42	*Dodonaea angustifolia* L.f.	Sapindaceae	KITKTA	S	W	M	L	D	Eczema	Dermal	2832	10° 14'12.2N 039° 30'38.6E	SW045
43	*Dovyalis abyssinica (*A. Rich.) Warb.	Flacourtiaceae	KOSHIM	S	W	M	L and Fr	F and D	Fibril illness, Boules	Dermal	2813	10° 31'10.5N 039° 46'57.7E	SW126
44	*Echinops kebericho*** Mesfin	Asteraceae	KEBERICHO	H	W	Ra	R	D	Evil eye	Oral and Nasal	2890	10° 17'42.1N 039° 35'07.9E	SW019
45	*Echinops longisetus*** A. Rich.	Asteraceae	KOSHELIE	S	W	C	L	D	Wound	Dermal	2928	10° 17'54.5N 039° 34'51.6E	SW142
46	*Eucalyptus globulus** Labill.	Myrtaceae	NECH BAHIRZAF	T	W	C	L	F	Fibril illness, "GOLEBA"	Oral and Nasal	2718	10° 31'11.3N 039° 47'09.6E	SW005
47	*Euclea divinorum* Hiern.	Ebenaceae	DEDHO	S	W	M	Br L	F and D	Intestinal parasite, Skin disease	Oral	2411	10° 12'56.9N 039° 32'32.3E	SW107
48	*Euphorbia abyssinica* Gmel.	Euphobiaceae	YEBEREHA KULKUAL	T	W	M	Lt	F	"KUNCHIR"	Dermal	2270	10° 12'32N 039° 31'48.7E	SW114
49	*Euphorbia ampliphylla** Pax	Euphorbiaceae	KULKUAL	T	HG	C	Lt	F	Ascaries , Syphilis	Oral	2927	10° 17'53.3N 039° 34'52.8E	SW065
50	*Euphorbia tirucalli* L.	Euphorbiaceae	KINCHIB	S	W	Ra	Lt	F	Cancer , *Kunchir*	Dermal	2299	10° 13'22.2N 039° 31'47.8E	SW086
51	*Ferula communis* L.	Apiaceae	DOG	H	W	Ra	R	D	Impotency	Oral	2800	10° 14'05.8N 039° 30'42''E	SW049
52	*Ficus sur* Forssk.	Moraceae	SHOLA	T	W	Ra	Fr	F	Constipation	Oral	2407	10° 12'56.9N 039° 32'38.8E	SW106
53	*Ficus vasta'* Forssk.	Moraceae	WARKA	T	W	Ra	L and Br	F and D	AZURIT, Eye disease	Oral Ocular	2300	10° 12'39.7N 039° 32'07''E	SW117
54	*Foeniculum vulgare* Mill.	Apiaceae	ENSILLAL	H	HG	M	L, St,Wh	F and D	Urinary retention , Tonsillitis, Gonorrhoea, Wart	Oral Dermal	2930	10° 18'01.9N 039° 34'36.6E	SW039

Appendix 1. Contd.

55	*Gomphocarpus purpurascens*** A. Rich.	Asclepiadaceae	TIFRNDO	S	W	C	L and Lt	F	Ring worms, Ring worms, Rh factor	Dermal	3081	10° 18'52.7N 039° 40'18"E	SW011
56	*Guizotia schimperi* Sch. Bip. ex Walp.	Asteraceae	MECH	H	W	C	L	F	Tape worm	Oral	2989	10° 20'58.9N 039° 34'42.7E	SW031
57	*Hagenia abyssinica* (Bruce) J.F. Gmel.	Rosaceae	KOSSO	T	W	M	L and Fl	D	Allergic dermolitia, Wound, Tape worm	Dermal Oral	2912	10° 30'26.3N 039° 46'49.2E	SW016
58	*Haplocarpha schimperi* (Sch. Bip. Beauv.)	Asteraceae	GETIN	H	W	C	L	F	Skin cut	Dermal	3095	10° 18'55N 039° 40'00.4E	SW163
59	*Helichrysum* sp.	Asteraceae	NECHILO	S	W	C	L	F	Impotency	Dermal	2906	10° 30'18.7N 039° 46'49.6E	SW134
60	*Heteromorpha arboresescens* (Spreng.)	Apiaceae	YEGIB-MIRKUZ	S	W	Ra	L	F	Inborn Physical abnormality	Dermal	2445	10° 13'11.7N 039° 32'43.8E	SW104
61	*Hordeum vulgare** L.	Poaceae	GEBS	H	W	C	Se	D	Diarrhoea	Oral	2809	10° 31'07.6N 039° 46'54.8E	SW159
62	*Impatiens rothii*** Hook.f.	Balsaminaceae	GISHILT	H	W	M	R	F	Fire burn	Dermal	2773	10°15'09.1N 039° 30'35.9E	SW061
63	*Indigofera vohemarensis*+ Baill.	Fabaceae	KUAKUCHA	H	W	M	R	F	Blood Complication	Neck	2434	10° 13'13.9N 039° 32'55.9E	SW121
64	*Inula confertiflora*** Rich.	Asteraceae	WOYNAGIFT (EGA)	S	W	C	L	D	Eye disease	Ocular	2987	10° 20'59.4N 039° 34'48.9E	SW028
65	*Jasminum abyssinicum* Hochst. ex DC.	Oleaceae	TEMBELEL	Cl	W	M	L	F	Tape worm, Blotting	Oral	2817	10° 14'16.1N 039° 30'42.1E	SW047
66	*Juniperus procera*' Hochst. ex. Endl.	Cupressaceae	YABESHA TID	T	W	C	L	F	"Goleba"	Oral	2775	10° 31'02.9N 039° 47'06E	SW067
67	*Justicia schimperiana* (Hochst.ex Nees)	Acanthaceae	SENSEL	S	W	M	L	F	Jaundice	Oral	2456	10°13'34.9N 039° 33'31.8E	SW081
68	*Kalanchoe petitiana****+ A. Rich.	Crassulaceae	ENDAHAHULA	H	HG	C	L and R	F	Tape worm, Bone fracture, Rabies	Oral	2925	10° 17'51.6N 039° 34'54.4E	SW066
69	*Lagenaria siceraria** (Molina) Standl.	Cucurbitaceae	QIL	Cl	HG	M	L	F	Ear lesion	Ear	2446	10° 13'34.7N 039° 33'32.6E	SW133
70	*Laggera tomentosa*** (Sch. Bip. ex A. Rich.) Oliv. and Hiern	Asteraceae	KESKESO	H	W	C	L	F and D	Typhus , Wound, Common cold	Oral Dermal Nasal	2978	10° 20'59.4N 039° 34'49.2E	SW027
71	*Launaea petitiana* (A. Rich.) N. Kilian	Asteraceae	YEBEG WOTET	H	HG	M	R	F	Stomach ache	Oral	2902	10° 21'47.1N 039°34'53.4E	SW024
72	*Lens culinaris** Medik	Fabaceae	MSR	H	W	C	Se	D	Herpes zoster	Dermal	3083	10° 18'44.4N 039° 40'28.8E	SW010

Appendix 1. Contd.

73	*Leonotis ocymifolia* (Burm. F.) Iwarsson	Lamiaceae	RAS KMR	S	HG	C	L	F	Acute mountain sickness, Fibril illness, “Goleba”	Oral	3084	10° 18'44.3N 039° 40'32.2E	SW014
74	*Lepidium sativum*+ L.	Brassicaceae	FETO	H	HG	C	Se	D	Abdominal pain, Coccoides	Oral	3075	10° 18'25.5N 039°39'20.5E	SW012
75	*Linum usitatissimum** L.	Linaceae	TELBA	H	W	C	Se	D	Gastric	Oral	3080	10°18'53.6N 039° 40'16.3E	SW015
76	*Lippia adoensis**** Hochst. ex Walp.	Verbenaceae	KESSIE	H	HG	C	R	D	Smallpox	Oral and Nasal	2957	10°17'54.4N 039° 34'50.9E	SW098
77	*Lobelia rhynchopetalum*+ Hemsl.	Lobeliaceae	JIBRA	H	W	M	R	D	Evil eye , “Eyenewog”	Oral and Nasal	3458	10°25'31N 039° 47'49.5E	SW146
78	*Lupinus albus* * L.	Fabaceae	GBTO	H	HG	Ra	Se	F/D	Hypertension	Oral	3073	10° 18'26.7N 039° 39'20E	SW158
79	*Lycopersicon esculentum** Mill.	Solanaceae	TIMATIM	H	HG	M	L and St	F	Gonorrhoea	Oral	2317	10° 13'23.1N 039°31'48.7E	SW056
80	*Maesa lanceolata* Forssk.	Myrsinaceae	KELAWA	S	W	M	L	F	Tape worm	Oral	2773	10° 31'02.4N 039° 47'07E	SW084
81	*Malus sylvestris** Miller	Rosaceae	APPLE	T	HG	M	Fr	F	Diabetes	Oral	2891	10° 17'51.5N 039° 34'47.9E	SW156
82	*Malva parviflora* Hojer	Malvaceae	ALENKUATA	H	HG	C	L	F	Wound	Dermal	2926	10° 1753.4N 039° 34'53.3E	SW072
83	*Maytenus arbutifolia* (A. Rich.) Wilczek	Celastraceae	ATAT	S	W	M	R	D	Kidney problem	Oral	2776	10° 30'03.4N 039° 47'06E	SW139
84	*Mentha spicata** L.	Lamiaceae	NANA	H	HG	Ra	L	D	Headache	Oral	3062	10° 18'26N 039° 39'21.7E	SW136
85	*Millettia ferruginea*** (Hochst.) Bak.	Fabaceae	BIRBIRA	T	W	Ra	R	D	Impotency	Oral	2228	10° 12'32.2N 039° 31'45.6E	SW032
86	*Momordica foetida* Schumach.	Cucurbitaceae	KURA HARG	Cl	W	Ra	L and R	D	Intestinal parasite, Syphilis	Oral, Dermal	2439	10° 13'31N 039° 33'21.7E	SW123
87	*Musa* x *paradisiaca** L.	Musaceae	MUSE	H	HG	M	Fr	F	Eczema	Dermal	2240	10° 12'32.2N 039° 31'45.9E	SW145
88	*Myrica salicifolia* A. Rich.	Myricaceae	SHINET	T	W	M	Br	F and D	Headache , Intestinal parasite	Oral, Dermal	2822	10° 14'20.3N 039° 30'46.5E	SW051
89	*Myrtus communis** L.	Myrtaceae	ADES	S	HG	Ra	L	D	Dandruff	Dermal	2283	10° 13'22N 039° 31'48.8E	SW089
90	*Myrsine africana* L.	Myrsinaceae	QECHEMO	S	W	M	Fr	F	Tape worm	Oral	2456	10° 13'12.2N 039° 32'44.5E	SW103
91	*Nicotiana tabacum** L.	Solanaceae	TINBAHO	H	HG	M	L	F	Leech	Nasal	2923	10° 17'52.7N 039° 34'34.2E	SW009

Appendix 1. Contd.

92	*Nuxia congesta* RBr. ex Fresen.	Loganiceae	ATQUAR	T	W	M	R	D	Evil eye	Oral and Nasal	2924	10° 17'54.5N 039° 34'53.9E	SW155
93	*Ocimium lamiifolium** Hochst. ex Benth.	Lamiaceae	DAMA KESSIE	S	HG	M	L	F	Fibril illness	Oral	3068	10° 18'26N 039° 39'23.7E	SW154
94	*Olea europaea* subsp. *cuspidata (*Wall. ex G.	Oleaceae	WEYRA	T	W	M	L	D	Eye disease	Ocular	2921	10° 17'52N 039° 34'53.9E	SW040
95	*Olinia rochetiana* A. Juss.	Oliniaceae	TIFIE	S	W	M	L	D	Wart, Eczema	Dermal	2830	10° 14'13.7N 039° 30'38.9E	SW042
96	*Opuntia ficus-indica** (L.) Miller	Cactaceae	BELES	S	HG	Ra	Fr	F	Heart failure	Oral	2933	10° 17'53N 039° 34'55.1E	SW130
97	*Osyris quadripartita* Decn.	Santalaceae	KERET	S	W	M	L	F	Circumcision wound, Toothache	Dermal	2963	10° 17'47.6N 039° 35'05.5E	SW021
98	*Otostegia fruticosa* (frossk.) ex Penzig	Lamiaceae	BARIANATRA	S	W	M	R	D	Evil eye	Oral and Nasal	2437	10° 13'15.2N 039° 32'47.3E	SW102
99	*Otostegia integrifolia** + Benth.	Lamiaceae	TNJUT	S	W	M	L	F	Acute mountain sickness "EYENEWOG"	Oral	2358	10° 13'25.9N 039° 31'47.7E	SW059
100	*Pennisetum sphacelatum'* (Nees) Th. Dur. and Schinz	Poaceae	SINDEDO	H	W	C	R	D	Blood Complication	Neck	2974	10° 18'03.6N 039° 34'52.4E	SW077
101	*Periploca linearifolia* Quant. Dill. and A. Rich.	Asclepiadaceae	MOIDER	Cl	W	Ra	R	D	Evil eye	Oral and Nasal	2446	10° 13'33.6N 039° 33'24.4E	SW124
102	*Peucedanum winkleri* Wolff	Apiaceae	QERSHASHIBA	H	HG	M	R	D	Evil eye	Oral and Nasal	2928	10° 17'51.8N 039° 34'54.3E	SW140
103	*Phagnalon abyssinicum*** Sch. Bip.	Asteraceae	NIBASEL	H	W	M	L	F	Blotting and Urinary retention	Oral	2987	10°19'17.8N 039° 35'05E	SW079
104	*Phoenix reclinata** Jacq.	Arecaceae	SENIEL	T	W	Ra	R	F	Impotency	Oral	2455	10° 13'01.9N 039° 32'41.7E	SW144
105	*Phytolacca dodecandra** L'Hérit	Phytolaccacae	MEHAN ENDOD	S	HG	C	L	F	Jaundice	Oral	2927	10°17'53.7N 039° 34'53.7E	SW004
106	*Pistacia falcata* Mart.	Anacardiaceae	TANA GEBEZ	T	W	Ra	R	D	Evil eye	Oral and Nasal	2303	10° 12'42.1N 039° 33'44.4E	SW112
107	*Plantago lanceolata* L.	Plantaginaceae	GORTEB	H	W	C	L	F	Wound	Dermal	2855	10° 17'35N 039° 35'03E	SW041
108	*Plectranthus punctatus* + (L. f.) L ' Herit.	Lamiaceae	TIBTIBO	H	W	M	L	F	Diarrhoea "Eyenewog"	Oral	2940	10° 21'19.1N 039° 32'06.6E	SW026

Appendix 1. Contd.

109	*Podocarpus falcatus* (Thunb.) Mirb.	Podocarpaceae	ZGBA	T	W	M	L,Fr, Br	F and D	Inborn physical abnormality, Eye disease, Melasma	Dermal Ocular	2718	10° 31'11.3N 039°47'09.6E	SW082
110	*Polygala rupicola* +A. Rich.	Polygalaceae	ETSE LBONA	H	W	M	R,St	F/D	Snake bit	Oral	2331	10° 13'23.4N 039° 31'47.2E	SW058
111	*Polygonum aviculare* L.	Polygonaceae	KECHKECH	H	W	C	L	D	Eczema	Dermal	2798	10°23'27.6N 039° 29'43.9E	SW069
112	*Premna schimperi* Engl.	Lamiaceae	CHOCHO	S	W	M	L	F	Tinea pedis	Dermal	2333	10° 12'42.1N 039° 32'15E	SW118
113	*Pteridium aquilinum* L.	Pteridaceae	EMSE FER	H	W	Ra	L	D	Fire burn	Dermal	2750	10° 31'11.4N 039° 47'06.8E	SW160
114	*Ranunculus stagnalis* Hochst. Ex A. Rich.	Ranunculaceae	GUDGN	H	W	C	L	F/D	Wart and "Kunchir", Eczema	Dermal	2951	10° 21'07.1N 039° 34'42.9E	SW029
115	*Pterolobium stellatum* (Forssk.) Brenan	Fabaceae	KENTEFA	S	W	M					2248	10° 12'32.4N 039° 31'46.1E	SW080
116	*Rhamnus prinoides** L'Herit	Rhamnaceae	GESHO	S	HG	C	L and Fr	F and D	Scabies , Uvulitia	Dermal Oral	2937	10° 17'52.2N 039° 34'54.2E	SW007
117	*Rhus natalensis* Krauss	Anacardiaceae	CHAKMA	S	W	Ra	L	F	Tape worm	Oral	2451	10° 13'28.1N 039° 33'11.8E	SW100
118	*Rhus retinorrhoea* Oliv.	Anacardiaceae	TLEM	S	W	M	L	F	Inborn Physical abnormality	Dermal	2292	10° 12'43.4N 039° 32'02.2E	SW116
119	*Rhus vulgaris* Oliv.	Anacardiaceae	EMBIS	T	W	C	R	D	Evil eye	Neck	2800	10° 23'28N 039° 29' 44.9E	SW068
120	*Ricinus communis** L.	Euphorbiaceae	GULO	H	HG	M	Fr and L	F and D	Cancer, Anal erolopi	Dermal Anal	2922	10° 17'53.4N 039° 34'53.8E	SW038
121	*Rosa abyssinica* Lindley	Rosaceae	KEGA	S	W	M	Fr	F	Ascaries	Oral	2815	10° 30'53.4N 039° 46'57.7E	SW127
122	*Rosa* x *richardii**'Rehd.	Rosaceae	TIGIEREDA	S	HG	Ra	R	F/D	Eye disease	Neck	2923	10° 17'53.6N 039° 34'48.2E	SW138
123	*Rubus steudneri* Schweinf.	Rosaceae	ENGORY	S	W	Ra	L	F	Anemia	Oral	2265	10° 12'31.9N 039° 31'47.8E	SW093
124	*Rumex abyssinicus* Jacq.	Polygonaceae	MEKMEKO	H	W	M	R	F	Tinea versicolor, Hypertension	Dermal Oral	2961	10° 18'28.7N 039° 34'52.1E	SW006
125	*Rumex nepalensis* Spreng.	Polygonaceae	TULT	H	W	C	R	F	Acute mountain sickness haemorrhage	Oral Dermal	3121	10° 18'56.4N 039° 40'57.6E	SW013
126	*Rumex nervosus* + Vahl	Polygonaceae	EMBACHO	S	W	M	L	F	Circumcision wound, Leech	Dermal Oral	2836	10° 15'00.8N 039° 31'03.2E	SW052
127	*Ruta chalepensis** L.	Rutaceae	TENADAM	H	HG	C	Fr	F	Hypertension, , Diabetes ,	Oral Dermal	3098	10° 18'56.5N 039° 40'08.3E	SW002

Appendix 1. Contd.

128	*Saccharum officinarum** L.	Poaceae	SHENKORA AGEDA	H	HG	Ra	St	F	Cough	Oral	2266	10° 13'18.4N 039° 31'48.7E	SW088
129	*Salvia nilotica* Juss. ex Jacq.	Lamiaceae	HULEGEB	H	W	C	L	F	Fibril illness	Oral	2973	10° 20'58.9N 039° 34'30.6E	SW033
130	*Salvia schimperi* Benth.	Lamiaceae	DIBREQ	H	W	M	Se	D	Diarrhoea	Oral	2881	10° 17'40.9N 039° 35'05E	SW001
131	*Sansevieria ehrenbergii** Schweinf. ex Baker	Dracaenaceae	WONDIE-KACHA	H	HG	Ra	R	D	Impotency	Oral	2900	10° 21'46.2N 039° 33'17.9E	SW025
132	*Satureja abyssinica (*Benth.) Brig.	Lamiaceae	TATMOT KOYGN	H	W	M	L	F	Fibril illness	Dermal	2432	10°13'16.4N 039° 32'57.4E	SW122
133	*Schinus molle** L.	Anacardiaceae	KUNDO BERBERE	T	HG	M	Fr	D	Abdominal pain	Oral	2806	10° 23'28N 039° 29'44.6E	SW070
134	*Sida schimperiana*+ Hochst. ex A.Rich.	Malvaceae	CHIFREG	S	W	M	R	D	Evil eye, Rh factor	Oral and Nasal	2984	10° 17'53.8N 039° 34'50.8E	SW008
135	*Sideryoxylom oxyacanthum*** Baill.	Sapotaceae	DAMZA	S	W	M	R	D	Evil eye	Oral and Nasals	2432	10° 17'53.8N 039° 32'36.1E	SW120
136	*Silene macrosolen* A. Rich.	Caryophyllaceae	WOGERT	H	W	M	L and R	F and D	Tape worm Headache	Oral and Nasal	2924	10° 21'09.6N 039°34'28.4E	SW035
137	*Solanecio gigas****+ (Vatke) C. Jeffrey	Asteraceae	YE SHEKOKO GOMEN	T	HG	Ra	L and R	D	Cough and Ascaries , "Eyenewog"	Oral	3090	10° 18'54.6N 039° 39'58.3E	SW076
138	*Solanum anguivi* Lam.	Solanaceae	ZERCH EMBOUY	S	W	M	Fr and R	F and D	Scabies, Diarrhoea, Syphilis	Dermal	2963	10° 21'03.1N 039° 34'39.4E	SW074
139	*Solanum benadirense* Chiov.	Solanaceae	TEREKUS ENCHET	S	W	Ra	Wh	D	Evil eye	Oral and Nasal	2436	10° 13'15.7N 039°32'47.7E	SW095
140	*Solanum marginatum***+ L.f.	Solanaceae	GEBRE EMBOUY	S	W	M	L	F	Tape worm Body lice	Oral Dermal	2965	10° 20'59.1N 039° 34'28E	SW036
141	*Sphenoslylis Stenocarpa* (Hochst. exA.	Fabaceae	YAYT HAREG	H	W	Ra	R	D	Ascaries	Oral	2289	10° 12'39.6N 039°31'58.3E	SW091
142	*Stephania abyssinica* (Dillon. and A. Rich.)	Menispermaceae	ENGOCHIT	Cl	W	M	L	F and D	Tinea nigra, Emergency	Dermal Oral	2834	10° 14'12.8N 039°30'38.3E	SW043
143	*Tagetes minuta '* L.	Asteraceae	GIMIE	H	W	Ra	L	F	Black leg	Oral	2293	10° 12'43.9N 039° 32'00.3E	SW115
144	*Tephrosia bracteolata'* Guill. and Perr.	Fabaceae	GERENGERIE	H	W	Ra	L	F	Body lice	Dermal	2344	10°12'43.2N 039° 32'16.7E	SW119
145	*Thymus schimperi**** Ronniger	Lamiaceae	TOSIGN	H	W	C	L	D	Lung tuberculosis Vomiting	Oral	2809	10° 14'06N 039° 40'42.2E	SW048
146	*Tragia cinerea* + (pax) Gilbert and Radcl.- Smith	Euphorbiaceae	ALEBLABIT	Cl	W	Ra	R	D	Impotency, Epilepsy, "Eyenewog"	Oral	2279	10° 13'18.7N 039° 31'49.2E	SW092

Appendix 1. Contd.

147	*Trigonella foenum-graecum** L.	Fabaceae	ABISH	H	W	C	Se	D	Melasma, Gastritis	Dermal Oral	2906	10° 17'52.7N 039° 34'5E	SW062
148	*Urtica simensis*** Steudel	Urticaceae	SAMA	H	HG	C	L	F	Gastritis and Heart failure	Oral	3006	10° 29'03.4N 039° 46'56.5E	SW003
149	*Verbascum sinaiticum* + Benth.	Scrophulariaceae	YE'AHIYA JORO	H	W	C	R	F	Allergic dermolitia , Retained placenta	Dermal	2924	10° 17'52.4N 039° 34'53E	SW037
150	*Verbena officinalis* L.	Verbenaceae	ATUCH	H	HG	Ra	L	F	Uvulitia, Toung disease	Oral	2888	10° 21'45.9N 039° 33'16.3E	SW023
151	*Vernonia amygdalina* Del.	Asteraceae	GIRAWA	S	W	Ra	L	F	Acute sickness and Abdominal pain	Oral	2744	10° 31'11.5N 039° 47'07.8E	SW097
152	*Vernonia bipontini* + Vatke	Asteraceae	MUZIGN	H	W	C	L	F	Nasal bleeding Diarrhoea	Nasal Oral	2895	10° 21'47N 039° 33'16.6E	SW149
153	*Viscum tuberculatum* + A.Rich.	Viscaceae	YEMRENZ TEKETSLA	S	W	Ra	L	D	Evil eye "Eyenewog"	Oral and Nasal	2299	10°12'42.1N 039° 32'05.6E	SW113
154	*Withania somnifera**+ (L.) Dunal in DC.	Solanaceae	GIZIEWA	S	W	Ra	R	D	Impotency "Eyenewog"	Oral	2315	10° 13'23.2N 039° 31'49E	SW054
155	*Zehneria scabra* (Linn. f.) Sond.	Cucurbitaceae	BUHAREG	Cl	HG	C	L	F	Eye disease, Wart	Oral Dermal	2928	10° 17'53.5N 039°34'53.3E	SW073

Cultivated medicinal -*, Endemic medicinal plant-**, Both cultivated and endemic medicinal plant-***, Climber-Cl, Herb-H, Shrub-S, Tree-T, Wild- W, Home garden- HG, Medium-M, Common-C, Rare-Ra, Abundance –Ab, Condition of Preparation –CP, Plant Parts used for Aliment treatment-PU, Friut-Fr, Root-R, Stem-St, Leaf-L, Flower-Fl, Seed-Se, Bark-Br, Bulb-Bu, Latex-Lt, Fresh-F, Dried-D, For Both human & livestock -+, for Animals only-'.

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Evaluating the antipyretic activities of aqueous and ethanol extracts of leaves of Artemisia *Annua* in mice

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Phytomedicines obtained from herbal sources are in great demand as they are able to cure many infectious diseases. *Artemisia annua* is an herbaceous plant that belongs to Composite family. As traditional medicine, it is used for cancer, ulcer, rheumatic pain and other ailments including fever in children. The objective of the present study was to evaluate the antipyretic activities of the aqueous and ethanol extracts of leaves of *A. annua* in mice. Rectal temperatures were recorded before and after inducing pyrexia as well as after administration of the respective extracts every half an hour for three hours. Parallel experiments were conducted with the standard antipyretic (aspirin) and the negative control (distilled water). Both extracts showed significant antipyretic activity at the specified dose levels except for 100 mg/kg aqueous extract. The antipyretic activities for both extracts were found to be dose dependent. No significant potency difference was observed for aqueous and ethanol extracts though the effects of aqueous extract were not statistically significant to the end of the experiment.

Key words: Antipyretic activity, *Artemisia annua*, extraction.

INTRODUCTION

Pathophysiology of fever

The febrile response is a complex physiologic reaction to disease involving a cytokine-mediated rise in body temperature, generation of acute-phase reactants and activation of endocrinology and immunologic systems. Understanding the basic mechanisms underlying this phenomenon helps to formulate rational approaches to treatment (Schafer et al., 2000).

Phytomedicines

Phytomedicines obtained from herbal sources are in great demand as they are able to cure many infectious diseases. These plant based drugs provide outstanding contribution to modern therapeutics. They have proved efficacy and safety for primary health care. They also offer therapeutics for age-related disorders like memory loss, osteoporosis, and immune disorders. The integration of phytomedicines into the health system should be developed in such a way to bring harmony between the traditional and modern system of health care with minimum threat to each other (Pandey et al., 2011).

Artemisia annua

A. annua L. is the plants from temperate regions, but can be developed in the tropics through breeding. In Indonesia

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demand for artemisinin is very large and all are imported, therefore, the development of cultivation of *A. annua* L. in Indonesia is a pretty big opportunity (Cao et al., 2010). *A. annua*, belongs to the family Composites, and is a fragrant shrub that grows widely in the Arabian area. Phytochemical analysis shows that it is a rich source of flavonoids including apigenin, cirsimaritin, and various novel compounds (Abdalla and Abu-Zagra, 1987; Schned and Silver, 1981). Approximately, 42% of the total artemisinin compounds are found in upper leave. The highest artemisinin compounds are found in plant aged 12 to 13 weeks (Breder et al., 1988). *A. annua* is used in the treatment of gastrointestinal disorders, enhanced eyesight, cardiovascular health, capillary strength, and structure of connective tissue, appearance of skin, and immune systems as well as decreased risk of atherosclerosis, cancer, fever and arthritis (Huh and Lichtiger, 1987). *Artemisia* family extract showed significant higher antioxidant effect (Grgesina et al., 1995). There are also evidences that *Artemisia* family can improve diabetes mellitus in addition to their antimicrobial and anti-fungal effects but the antipyretic activity is not well investigated and documented. The purpose of this study was, therefore, to evaluate the antipyretic activities of aqueous and ethanol extracts of dried leaves of *A. annua* in mice

MATERIALS AND METHODS

Collection of the plant material

After getting a support letter, to Ankober Woreda development association, the leaves of *A. annua* were collected from Ankober (170 km to the north from Addis Ababa) in October 2013. The plant was authenticated by an expert taxonomist and a specimen representing this collection was deposited in the Addis Ababa University Herbarium, Addis Ababa, for further reference (AA1500).

Chemicals and drugs

Chemicals and Drugs used were: distilled water, ethanol (70%), powder of acetyl salicylic acid (Barer Schering pharma AG, Germany) and yeast extract powder (Lot. Number0000076357.

Experimental animals

The experiment was performed in house bred albino mice (both sexes weighing 25-35 g) which were obtained from Department of Pharmacology, School Of Medicine, Addis Ababa University. They were kept in cages in animal house with a 12-h-natural light: 12-h-dark cycle. They fed on pellets and drank clean water *ad libitum*. Mice were allowed to adapt to the experimental room 1 h hour before experiments.

Preparation of the extract

800 g of the herbal material was air dried and coarsely powdered. 400 g of the powdered material was macerated with distilled water for 14 days with occasional shaking. The remaining 400 g was macerated with ethanol. Both the aqueous and ethanol extracts were filtered. The aqueous extract was placed in deep freeze to solidity. The solidified aqueous extract was placed in lyophilizer machine and a gummy residue with a calculated yield of 2.5% was obtained. The ethanol extract was placed in oven for three days. After the ethanol was removed, it was solidified in freeze and kept in lyophilizer machine and powder with a yield of 3.7% was obtained. The gummy residue and the powder extracts were properly stored and finally reconstituted in distilled water to get the desired concentration for administration in to mice.

Acute toxicity study

The aqueous and ethanol extracts of *A. annua* dried leaves were studied for acute oral toxicity as per revised OECD guidelines No.423 (Organization for Economic Cooperation and Development Guidelines No. 423 (200); Revised draft guideline for testing of chemicals, Paris).

Antipyretic activity study

Antipyretic activities of both aqueous and ethanol extracts were evaluated by yeast extract induced pyrexia model in mice as described by (Naveed et al., 2012). Mice were fasted over night with water *ad libitum* before the experiments. The initial rectal temperature was measured by using digital thermometer. Then pyrexia was induced in all mice by injecting 30%w/v yeast extract powder suspension subcutaneously (10 ml/kg) for 16 h after the injection, the rectal temperature of each mouse was measured for the second time. Only mice that showed an increase in temperature of at least 0.5°C were used for the experiment. Animals were divided in to 8 groups (each containing 6 animals). Group one served as control (received equal volume of distilled water); Group two received the standard drug (aspirin 100 mg/kg); Group three received aqueous extract (100 mg/kg); Group four received aqueous extract (200 mg/kg) and the last group for aqueous extract received 300 mg/kg. The remaining three groups (6, 7 and 8) received 100, 200 and 300 mg/kg ethanol extracts respectively. Finally, the temperature for each mouse was measured at 0.5, 1, 1.5, 2, 2.5 and 3 hours after extracts administration.

Determination of LD_{50} from the acute toxicity study

The LD_{50} for both aqueous and ethanol extracts of leaves from *A. annua* was determined as per revised OECD guide line no 423 (limit test). A total of 20 mice (both sexes) were used. The highest dose levels (500 and 2000 mg/kg) were reasonably selected for administration in to mice. On the first day of the experiment, mice fasted overnight were given aqueous and ethanol extracts of leaves of *A. Annua* in a dose of 500 mg/kg (five mice for each extract). Then, mice were observed for 24 h for any lethality. On the next day both aqueous and ethanol extracts were administered orally in to the remaining ten mice (five mice for each extract at a dose of 2000 mg/kg). Then mice were observed for 24 hours.

Statistical analysis

All the values are expressed as mean± standard error of the mean and analyzed for ANOVA and post hoc dunnet's t-test (SPSS version 20).

RESULTS AND DISCUSSION

The results are presented in Tables 1 and 2 (change in

Table 1. Effects of oral aqueous extract of dried leaves *Artemisia annua against* yeast induced pyrexia in mice (mean± standard error of the mean) (n=6).

Group	Dose (mg/kg)	T0	TY	0.5HT	1HT	1.5HT	2HT	2.5HT	3HT
Control (Distilled water)	…	36.45± 0.11	37.18± 0.29	37.20±0.12	37.23±0.11	37.23±0.12	37.18±0.09	37.18±0.09	37.01±0.04
Standard (aspirin)	100	36.56± 0.09	37.32± 0.25	36.23± 0.10a	36.20±0.27 a	36.30± 0.14(b)	36.20± 0.28 a	35.26± 0.37b	35.50± 0.22a
Aqueous	100	36.43± 0.12	37.35± 0.28	36.71± 0.13n.s	36.81± 0.15n.s	36.91± 0.11n.s	36.78± 0.07n.s	36.66± 0.14n.s	36.61± 0.14n.s
Aqueous	200	36.58± 0.13	37.28± 0.30	36.33± 0.15a	36.13± 0.26a	36.53± 0.10b	36.05± 0.23b	35.71± 0.26n.s	35.81± 0.44n.s
Aqueous	300	36.48± 0.15	37.18± 0.29	36.12± 0.24b	36.15± 0.27a	36.41± 0.15b	36.25± 0.27a	35.60± 0.51a	35.80± 0.28n.s

0.5HT, rectal temperature after 0.5 hour of treatment; 1HT, rectal temperature after 1 hour of treatment; 1.5HT, rectal temperature after 1.5 hour of treatment; 2HT, rectal temperature after 2 hour of treatment; 3HT, rectal temperature after 3 hour of treatment; n.s,not statistically significant; a,significant ($p<0.05$) when compared with the corresponding value of control; b, extremely significant ($P<0.005$) when compared with the corresponding value of control; ….Equal volume (1 ml).

Table 2. Effects of oral ethanol extract of dried leaves *Artemisia annua against* yeast induced pyrexia in mice (mean± standard error of the mean) (n=6).

Group	Dose (mg/kg)	T0	TY	0.5HT	1HT	1.5HT	2HT	2.5HT	3HT
Control (distilled water)	-	36.45±0.11	37.18±0.29	37.20±0.12	37.23± 0.11	37.23± 0.12	37.18± 0.09	37.18± 0.09	37.01± 0.04
Standard (aspirin)	100	36.56±0.09	37.32±0.25	36.23±0.10[a]	36.20± 0.27[a]	36.30± 0.14[b]	36.20± 0.28[a]	35.26± 0.37[b]	35.50± 0.22[a]
Ethanol	100	36.56±0.14	37.43±0.26	36.36±0.18[a]	36.08± 0.25[a]	36.45± 0.19[a]	36.65± 0.06n.s	36.05± 0.34n.s	36.58± 0.14n.s
Ethanol	200	36.45±0.12	37.32±0.34	35.98±0.14[b]	36.10± 0.17[a]	36.28± 0.11[b]	36.16± 0.12[a]	35.68± 0.40[a]	35.65± 0.39[a]
Ethanol	300	36.73±0.27	37.42±0.47	35.75±0.24[b]	35.70± 0.17[b]	36.01± 0.12[b]	36.15± 0.22[a]	35.48± 0.24[a]	35.50± 0.13[a]

0.5HT, rectal temperature after 0.5 hour of treatment; 1HT, rectal temperature after 1 hour of treatment; 1.5HT, rectal temperature after 1.5 hour of treatment; 2HT, rectal temperature after 2 hour of treatment; 3HT, rectal temperature after 3 hour of treatment; n.s,not statistically significant; a,significant ($p<0.05$) when compared with the corresponding value of control; b, extremely significant ($P<0.005$) when compared with the corresponding value of control; ….Equal volume (1 ml).

body temperature; time in hour). The ethanol extract of leaves of *A. Annua* showed a decrease against yeast induced fever at all doses employed (Table 2).

Aqueous extract (200 and 300 mg/kg) also showed a reduction in yeast induced pyrexia whereas the 100 mg/kg aqueous extract was not statistically significant for the whole period of the experiment (Table 1). This significant difference in antipyretic activities between aqueous and ethanol extracts at 100 mg/kg dose level might be due to the difference in the chemical nature of active constituents between the two extracts. Since water is polar solvent, it is expected to isolate polar components only. Unlike water, ethanol has predominant hydrophilic and some lipophilic properties that is ethanol is capable of extracting both polar and non-polar components from *A. annua* dried leaves. These non-polar constituents of ethanol extract (100 mg/kg) might be responsible for lowering rectal temperature in mice (Titus and Kalu, 2008).

The antipyretic activities for both extracts were found to be dose dependent. The antipyretic activities for ethanol extract (at 200 and 300 mg/kg dose levels) were comparable with the antipyretic activity of aspirin (100 mg/kg) but the lowest dose level of ethanol extract was observed to be less potent than aspirin. The aqueous extract at 200 and 300 mg/kg dose levels showed similar degree of antipyretic activity during the initial period of measurement whereas at the end of the experiment, aspirin was found to be more potent than aqueous extract at all doses employed. This time dependent antipyretic activity observed for aqueous extract might indicate that the active constituents in aqueous extract have short duration of action than aspirin.

Time dependent antipyretic activity was also observed for ethanol extract (decreased with time). This result also provides some clue regarding onset of action for both aqueous and

ethanol extracts. Both extracts at specified dose levels (except 100 mg/kg aqueous extract) exhibited antipyretic activity immediately after administration in to mice indicating that both extracts possess rapid onset of action.

Significant potency difference was observed between aqueous and ethanol extracts. The ethanol extract at all doses administered was found to be more potent than the aqueous extract with respect to the corresponding dose levels.

Regarding the duration of action secondary metabolites which are found in ethanol extract might have longer duration of action than those in aqueous extract because significant antipyretic activity was observed for ethanol extract (at high dose levels) long time after administration.

Both aqueous and ethanol extracts possess a significant antipyretic activity which is comparable to the standard antipyretic drug aspirin. Previously, around 100 active ingredients have been identified in this plant (Ghasemi et al., 2013). Among those constituents, the flavonoids were reported to be responsible for most of pharmacological effects (Shakeri et al., 2012). Like the previous reports, the antipyretic activities of this plant might be due to the presence of flavonoids and the probable mechanism for lowering temperature in yeast induced pyrexia may be by decreasing the synthesis of prostaglandins and other mediators secondary to inhibiting the enzymes responsible for prostaglandin production.

The acute oral toxicity study of both aqueous and ethanol extracts of dried leaves of *A. annua* was carried out as per OECD guide line number 423 (Organization for Economic Cooperation and Development Guidelines No. 423 (200); Revised draft guideline for testing of chemicals, Paris). At the end of the study, both extracts were found to be safe in mice when given large dose up to 2000 mg/kg by oral route. The LD_{50} for both extracts was also determined from the acute toxicity study based on OECD guide line.

Based on the guide line, mice were initially given 500 mg/kg dose then observed for 24 h for lethality. Since both extracts were safe at 500 mg/kg, the remaining mice were provided with 2000 mg/kg aqueous and ethanol extracts and observed for 24 h. At the end of the observation, no mouse died even at 2000 mg/kg indicating that the LD_{50} for both aqueous and ethanol extracts was greater than 2000 mg/kg.

In the present pharmacological evaluation, the aqueous and ethanol extracts of dried leaves of *A. annua* were extensively investigated for antipyretic activities against yeast extract induced pyrexia model in mice. The statistically processed result supports that both extracts possess antipyretic activities. The statistically processed result showed that both extracts of leaves from *A. annua* possess antipyretic activity against yeast extract induced pyrexia in mice. This positive result initiates the need to conduct further studies on the same plant regarding the mechanism of action at molecular level, the particular active ingredient responsible for antipyretic activity and determination of LD_{50} (from the current acute toxicity study, the LD_{50} is greater than 2000 mg/kg). Spectroscopic characterization is proposed to study the constituents of both aqua and ethanol extracts of *A.* annua.

Ethical approval

Ethical approval was obtained from the ethics review board of Debreberhan University, Debreberhan, Ethiopia. The care and handling of animals was as per the internationally accepted ethical guidelines (9).

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CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

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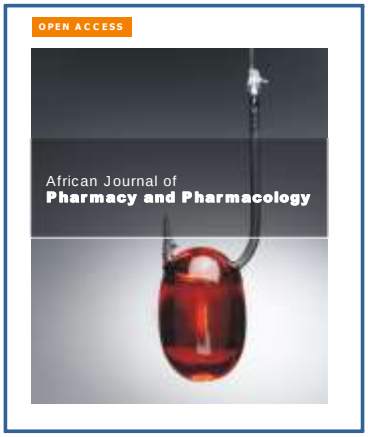

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