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ETHNOBOTANICAL STUDY OF TRADITIONAL MEDICINAL PLANTS AND THE ASSOCIATED INDIGENOUS KNOWLEDGE OF GAMO PEOPLE: THE CASE OF BONKE WOREDA, SOUTHERN ETHIOPIA

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ABSTRACT: Ethnobotanical study of traditional medicinal plant species was conducted from September 2016 to June 2018 in Bonke Woreda, south Ethiopia. The purpose of the study was to document traditional medicinal plant species and the associated indigenous knowledge. Data was collected through semi-structured interviews, field observation, and group discussion from the community members and local herbalists. The data were analyzed using descriptive statistics, informant consensus, and simple linear correlation. A total of 53 medicinal plant species representing 49 genera and 30 plant families were recorded. Out of the total species, 79% were used for treating human diseases, 11% for treating livestock diseases, and 10% for treating both humans and livestock diseases. Lamiaceae, Rutaceae, and Asteraceae were the most dominant plant families reported. The most common diseases affecting humans and livestock were stomach ache and cough, respectively. Sixty % of medicinal plants were collected from the wild habitat while the rest were collected from home gardens. Leaves were the most frequently mentioned plant parts used to prepare traditional medicine. Oral administration (70.5%) was the most dominant route. *Ocimum lamiifolium* was the most preferred medicinal plant to treat headache followed by *Echinops kebericho* and *Salvia nilotica*. Our result mainly showed that most of the medicinal plants were obtained from natural forest and home garden agroforestry systems. This indicates need to give priority to the conservation of the habitats most preferred by the medicinal plants of the study area together with awareness raising activities on the community.

Key words/phrases: Ethnobotany, Human health, Indigenous Knowledge, Livestock, Medicinal Plants.

INTRODUCTION

The plant resources have been used throughout the world as people are depending on locally available and easily accessible plants in their wisdom of indigenous knowledge (Tesfaye Awas and Sebsebe Demissew, 2009). According to FAO (1997), more than 3.5 billion people in the developing world rely on traditional medicines of plants for the treatment of both human and livestock diseases. The majority of people (70–80%) in Africa consult traditional medical practitioners for their health care (Vasisht and

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Kumar, 2004). Regarding these medical systems in sub-Saharan Africa, thousands of kilograms of medicinal plants are collected and used by healers for treatment of different human and livestock health problems (Parvez and Yadav, 2008).

This valuable traditional knowledge on utilization of plants for medicinal purpose was unwritten in Africa and hence, most of the knowledge acquired by the local people has been passed on to generations by word of mouth (Nyamwaya, 1992). Such orally preserved information if left undocumented, will be liable to loss rather than be conserved for future use, and in most cases some of the lore is lost at each point of transfer (Martin, 1995). Ethiopian plants have shown very effective medicinal value for some ailments of human and domestic animals; thus medicinal plants and knowledge of their use provide a vital contribution to human and livestock health care needs throughout the country (Endashaw Bekele, 2007). Thus, this brings about the need for systematic documentation of such useful knowledge through ethnobotanical research (Martin, 1995; Cotton, 1996).

Gidey Yirga (2010a) wrote that these traditional medicinal remedies are sometimes the only sources of medical remedies for nearly 80% of human population and 90% of livestock in Ethiopia. Out of these, 95% are of plant origins (Dawit Abebe, 1986). Several authors (Wondwosen Teshome, 2005; Kebede Deribe *et al*., 2006) also indicated that the majority of the population that lives in the rural and the poor people in urban areas rely mainly on traditional medicines to meet their primary health care needs. Endashaw Bekele (2007) gave several reasons on why medicinal plants are demanded in Ethiopia, like indigenous knowledge and culturally linked traditions, the trust the communities have in their medicinal values, inaccessibility of modern medical systems and relatively low costs in using them. Especially in developing countries, traditional medicine is still essential for health care and well-being (Alves and Rosa, 2007). The availability and accessibility to qualified medical doctors in Africa is limited, just one doctor for a population of 40,000 whereas the ratio of traditional healers to population amounts 1:500 (WHO, 2017). Hence, native healers are important for primary health needs in rural areas. Several studies have been carried out on traditional medicinal plants at global national and local levels; it is known that local and culturally-specific knowledge vary greatly with variations in cultures, the most important factors for this may arise out of the simple fact that physical and cultural environments vary a great deal across the globe. The main purpose of this study was to investigate and document traditionally-used medicinal plants, and the

associated indigenous knowledge of the Bonke Woreda people, in southwestern Ethiopia.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Bonke Woreda, Gamo Gofa Zone, southern Ethiopia, from September 2016 to June 2018. Bonke Woreda is located in Gamo Gofa Zone, southern Ethiopia within latitude: 5.955863 N, longitude: 37.213605 E, and latitude 6.0220623 N, longitude 37.299186 E and altitude range of 600–4,200 m.a.s.l. The land area of the woreda is estimated to be 85,940 km^2 and bordered on the south by the Dherashe and Alle woredas, on the west by the Weito River which separates it from Kemba, on the northwest by Deramalo, on the north by Dita, and on the east by Arba Minch Zuria woredas. The agro-ecology of the woredas is classified into three zones: Dega/highland (46%), Woina Dega/midland (30%) and Kola/lowland (24%). The mean annual rainfall and the mean annual temperature of the woreda are 1,400 mm and 13.05°C, respectively. The estimated human population of the woreda was about 205,739 of which 102,458 are males and 103,281 are females.

Sampling of study sites (kebeles) and informants

Study sites were selected during a reconnaissance survey carried out in Bonke Woreda (district), during which potential study sites were identified. Availability of traditional healers was the basis of selection of study kebeles. Informants and knowledgeable traditional medicinal practitioners were selected using purposive sampling approaches in the manner described by Martin (1995). First of all, information was gathered about knowledgeable people, elders, and agricultural development agents, which were communicated to obtain information used to select a total of 100 respondents (85 males and 15 females; 20 respondents from each of the 5 kebeles) in order to carry out interviews and group discussions. Of these, 29 key informants were purposively selected following Martin (1995), Alexiades (1996), and Tongco (2007) while the 71 general informants and healers were nominated by the key informants.

Ethnobotanical data collection

Ethnobotanical data was obtained from general informants and key informants/traditional healers through semi-structured interview, group discussion, field observation, and market survey following methods described by Martin (1995) and Alexiades (1996). Informants were

interviewed individually in their local language, 'Gamogna'. Semi-structured interviews were used to address issues regarding name, age, gender, level of education, occupation, religion, local names of medicinal plants, ailments treated, habitat of the species, parts used, condition of plant part used (fresh/dried), methods of remedy preparation, dosage measurement, existing threats and others were compiled following the works of Ermias Lulekal *et al.* (2014).

Medicinal plant specimen collection and identification

Voucher specimens of some medicinal plant species unfamiliar by the investigator employed to treat both human and livestock ailments were collected from home gardens and the natural/semi-natural habitats, as indicated by the healers. The collected specimens were numbered, pressed, dried and taken to the herbarium of Arba Minch University for taxonomic identification. Identification of these plant specimens was carried out by personal expertise and using the different published Volumes of Flora of Ethiopia and Eritrea (Hedberg and Edwards, 1989; Phillips, 1995; Edwards *et al*., 1995; 1997; 2000; Hedberg *et al*., 2003; 2006; 2009; Mesfin Tadesse, 2004). The identified specimen were deposited in the herbarium of Arba Minch University.

Data analysis

Ethnobotanical data were analyzed by methods including preference ranking, paired comparison and direct matrix ranking following Martin (1995) and Alexiades (1996). Informant consensus, use value/relative importance and informant consensus factor were also computed to obtain an overview of most used and preferred medicinal plant species utilized by the study community. Simple linear correlation test was performed to assess the association between medicinal plant knowledge and age of informants as well as between medicinal plant knowledge and educational background of informants. Microsoft Excel and SPSS (Statistical Package for Social Sciences, Version 16.0) were used to summarize and present the data in the form of tables, charts, and Pearson correlation coefficients.

RESULTS AND DISCUSSION

Gender of the informants

In this study, males accounted for comparatively higher proportion of the total respondents. Likewise, similar studies (Etana Tolasa, 2007; Sintayehu Tamene, 2011) indicated that males played a dominant role in the traditional medical system and were better in revealing pertinent information. This is

mainly due to cultural influences prevailing in Bonke Woreda and elsewhere in Ethiopia as women do not open up to outsiders and may make significant account for their limited participation.

Ages of the informants

The highest age category was those above 60 (29%) followed by 50–59 (24%) and 40–49 (22%). On the contrary, the age groups 20–29 and 30–39 were represented by the lowest number of respondents (Table 1). Similar age categories pattern were also used by Tesfaye Hailemariam *et al*. (2009) in the ethnobotanical investigation of Konta Woreda, southwest Ethiopia. The majority of informants interviewed in this study were in the age class of 41–50.

Educational levels

The educational status of informants showed that 59% of the respondents were illiterate while the remaining 33%, 5%, and 3% attended primary, secondary and above secondary school, respectively. Only a few number of respondents (4%) were single while the majority (96%) were married (Table 1). Although most of the participants were illiterate which coincided mainly with age group above 40, they are generally considered as an important repository of traditional knowledge including the wisdom of utilizing plants for human and veterinary purposes.

Table 1. Background of respondents (n=100).

Variables	Frequency	Percentage (%)
Male	85	85
Female	15	15
Age category		
20–29	11	11
30–39	14	14
40–49	22	22
50–59	24	24
≥ 60	29	29
Educational background		
Illiterates	59	59
Primary (first cycle (1–4 grade))	17	17
Primary (second cycle (5–8 grade))	16	16
Secondary high school (9–10 grade)	5	5
Above grade 10 (>10th)	3	3

Traditional medicinal plants diversity documented in this study

A total of 53 ethnomedicinally important plant species distributed in 49 genera and 30 families were recorded in this study. Among the families represented by several species, Lamiaceae stood first (8 species) followed

by Rutaceae (5 species), and others while Myrtaceae, Oleaceae, and Boraginaceae had two species each. This result is similar to studies by Reta Regassa (2013), which indicated Lamiaceae, Rutaceae, and Asteraceae contributing most of the medicinal plant species in their study area. On the other hand, this result is different from the findings of Mohammed Adefa and Berhanu Abraha (2011) who reported Fabaceae, Rosaceae, and Solanaceae were among the important families of medicinal plant species. This may suggest that there is a wide utilization of medicinal plant species that belong to the six families (Lamiaceae, Rutaceae, Asteraceae, Fabaceae, Rosaceae, and Solanaceae).

The consumption of such substantial number of medicinal plants by the people of the study area may indicate that the majority of the local people still employ and possibly may continue to use plant resources for medicinal purpose. Consequently, this indicates that traditional medicine plays a significant role in the health care system of the Bonke Woreda.

Proportion of traditional medicinal plants used against human, livestock ailments and against both human and livestock ailments

Of the total of 53 medicinal plants collected in the study area, the majority (79%) were used to treat human diseases (Fig. 1). This may indicate that there is a wide usage and aged cultural practice of herbal medicinal mainly in solving health problems of humans. The results from this study are in line with a number of studies (e.g., Ermias Lulekal *et al*., 2008; Mirutse Giday *et al*., 2009; Tesfaye Hailemariam *et al*., 2009; Gidey Yirga, 2010c; Reta Regassa, 2013; Engedasew Andarge *et al*., 2015; Getu Alemayehu *et al*., 2015).

The findings of the present study revealed stomach ache as a common disease in the area followed by headache, wound, and common cold (Table 2). On the other hand, important livestock diseases reported in the study area are cough, poor milk yield, and stomach ache.

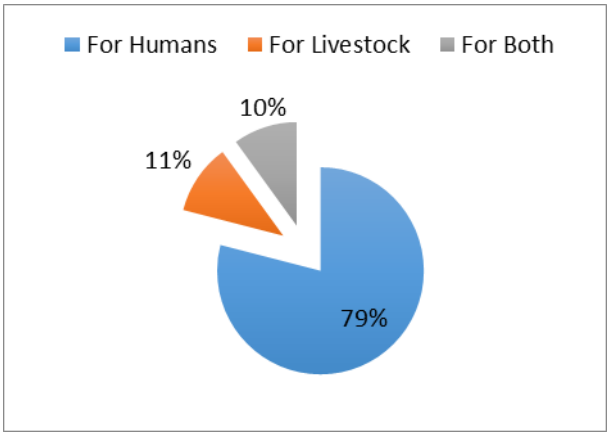

Fig. 2. Percentages of the total medicinal plant species used for treating human, livestock, and both human and livestock ailments.

Table 2. The most common human and livestock diseases in Bonke Woreda.

Disease category	Disease type	Local name	Frequency	%
Human	Stomachache	Qantse sako	13	16.0
	Headache	Huphe qoxo	9	11.1
	Wound	Maduntsa	5	6.2
	Common cold	Oshincha	4	4.9
	Gastritis	Chogara	3	3.7
	Toothache	Ache harge	3	3.7
	Skin allergy	Galba harge	3	3.7
		Total	**40**	**49.4**
Livestock	Cough	Qufe	3	27.3
	Poor milk yield	Miza matsa guutso	3	27.3
	Stomachache	Qantse sako	2	18.2
		Total	**8**	**72.7**

Most 32 (60%) medicinal plants were obtained from natural and/or semi-natural habitats while the remaining 21 (40%) were collected from cultivated land and/or home gardens (Fig. 2). Evidently, sizeable fraction of the total medicinal plants is still collected from the wild (near farmland, forest, around grazing land, close to streams/river, grassland and fallow land). Similar findings were reported by other related studies (e.g., Etana Tolasa, 2007; Ermias Lulekal *et al*., 2008; Fisseha Mesfin *et al*., 2009; Reta Regassa, 2013; Ermias Lulekal *et al*., 2014; Getu Alemayehu *et al*., 2015). This may indicate that the majority of medicinally important plants were not yet intentionally cultivated by the traditional healers (as well as the local residents). On the other hand, this may also indicate the importance of protecting natural and or semi-natural habitats for the conservation of

traditional medicinal plant species as well as enhancing their cultivation in human modified habitats like home gardens and field margins.

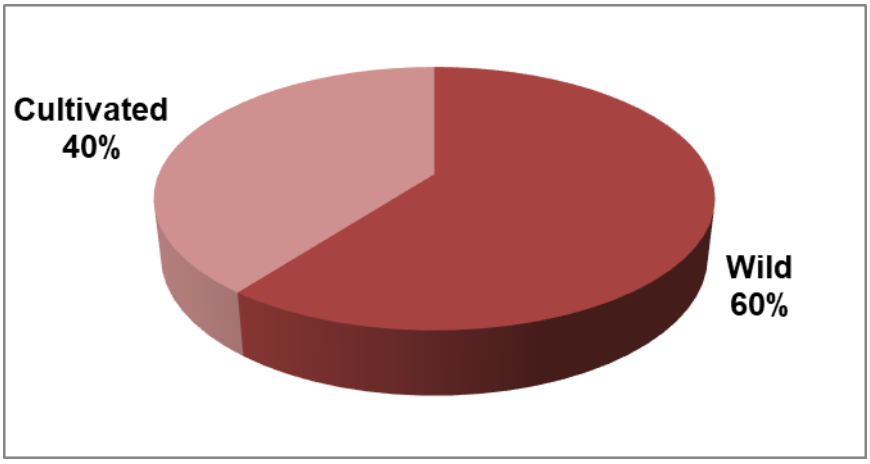

Fig. 3. Percentage distribution of the sources of medicinal plants used to treat human and livestock diseases in Bonke Woreda.

In similar studies, Ermias Lulekal *et al*. (2008) and Yalew Addisie *et al*. (2012) found that local practitioners depend on the wild source of medicinal plants and hence, the activity of managing and conserving natural and/or wild habitats of medicinal plants in a particular area is not easy, especially if the plants are over exploited. In this study, we have observed that there is a trend of cultivating the traditional medicinal plants in home gardens. However, the major habitat of the medicinal plant species, the forest ecosystem, which is shrinking, as already known to happen elsewhere in the world and in the country.

Herbs constituted the highest fraction (34%) of the total species collected closely followed by both shrubs and trees (each with 32%), and climbers were the least (with only 2%) (Fig. 3). Balcha Abera (2014) reported comparable composition with regard to habits of medicinal plants collected from Ghimbi District, southwest Ethiopia, which were herbs (37%), trees (32%) and shrubs (31%). Evidently, the current data exhibited that herbs are still considered as the most important source of therapeutics for the treatment of both human and livestock ailments. Various studies (e.g., Etana Tolasa, 2007; Mirutse Giday *et al*., 2009; Mengistu Gebrehiwot, 2010; Mohammed Adefa and Berhanu Abraha, 2011; Reta Regassa, 2013; Balcha Abera, 2014; Engedasew Andarge *et al*., 2015) showed that herbs were the most harvested plant forms for the treatment of diseases of humans and livestock.

Key informants as well as the traditional medicine practitioners also revealed that collection of medicinal plants is usually carried out during and shortly after the rainy season due to the increased abundance of herbs. On the other hand, it is worth noting that the shrubs and trees are also key contributors towards the traditional ethnomedicine and ethnoveterinary practices of the Bonke Woreda people and possibly elsewhere in Ethiopia as well as in the world. Apparently, the woody plants could serve as important sources of curatives specifically during the dry seasons and wet seasons as well.

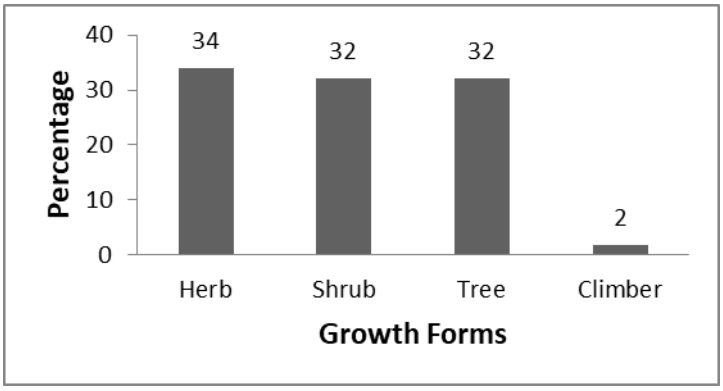

Fig. 4. Percentage distribution of growth forms of medicinal plants used to treat human and livestock ailments.

The most commonly used plant parts during the preparation of curatives were leaves (49.2%) followed by roots, fruits, and seeds (equally represented each with 9.2% (Fig. 4). This finding is in agreement with several ethnobotanical studies (Etana Tolasa, 2007; Haile Yineger and Delenasaw Yewhalaw, 2007; Gidey Yirga, 2010c; Sintayehu Tamene, 2011; Gidey Yirga *et al*., 2012; Yalew Addisie *et al*., 2012; Mengistu Gebrehiwot, 2010; Reta Regassa, 2013; Engedasew Andarge *et al*., 2015; Getu Alemayehu *et al*., 2015) carried out in different parts of Ethiopia and elsewhere across the globe (Grace *et al*., 2004; Musa *et al*., 2011). Nevertheless, other studies (Debela Hunde *et al*., 2004; Kebu Balemie and Fassil Kebebew, 2006; Ermias Lulekal *et al*., 2008; Fisseha Mesfin *et al*., 2009) found that roots were the most widely used plant part in the preparation of traditional curatives.

The most probable reason for the widespread usage of leaves in the preparation of traditional remedies may be the comparative ease of harvesting (Mirutse Giday *et al*., 2009) and simplicity of remedial preparations (Sintayehu Tamene, 2011). Collecting leaves do not pose a

greater danger to the existence of an individual plant as compared with the collection of roots, barks, stems or whole plants and hence do not affect sustainable utilization of the plants (Engedasew Andarge *et al*., 2015).

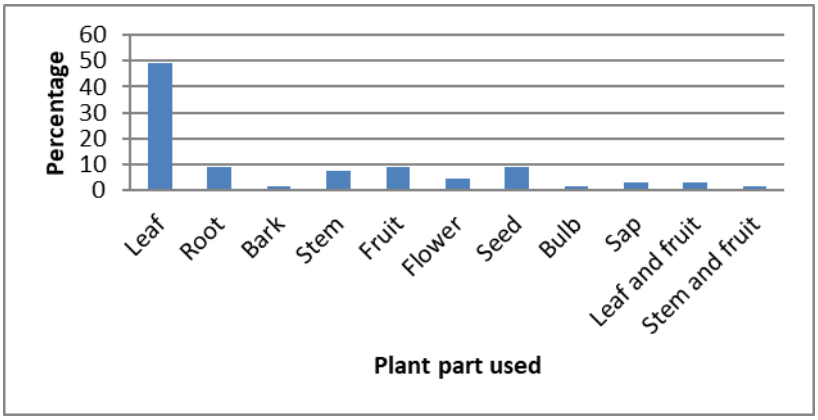

Fig. 5. Percentages of plant parts used in preparation of therapeutics for human and livestock diseases.

According to the informants of the study area, medicinal plants were formulated immediately after harvest in the fresh forms (66%) while 18% were prepared after drying, 16% used in either fresh or dry forms to treat human and livestock ailments (Fig. 5). This result agrees with other studies (e.g., Mirutse Giday *et al*., 2009; Gidey Yirga, 2010b; Mengistu Gebrehiwot, 2010; Yalew Addisie *et al*., 2012; Reta Regassa, 2013; Balcha Abera, 2014; Ermias Lulekal *et al*., 2014; Engedasew Andarge *et al*., 2015) that also reported in their ethnobotanical investigations that high proportions of the respective medicinal plants were used in fresh form. In line with Mirutse Giday *et al*. (2009), the common use of freshly processed remedies may signify the availability of comparatively good stock of plant materials in the study area that could be collected whenever the need arises. On the other hand, this may indicate better efficacy of fresh preparations than dried or stored preparations. Efficacy of medicinal plants may decrease with increasing time of storage as Engedasew Andarge *et al*. (2015) reported that there is a widely held belief by local people that fresh materials are more efficacious than their dry counterparts as the active ingredients are kept in the former. Mirutse Giday *et al*. (2009) also suggested that the frequent use of fresh materials might be due to an effort not to lose volatile oils, the concentration of which could deteriorate during drying. This needs further research and investigation.

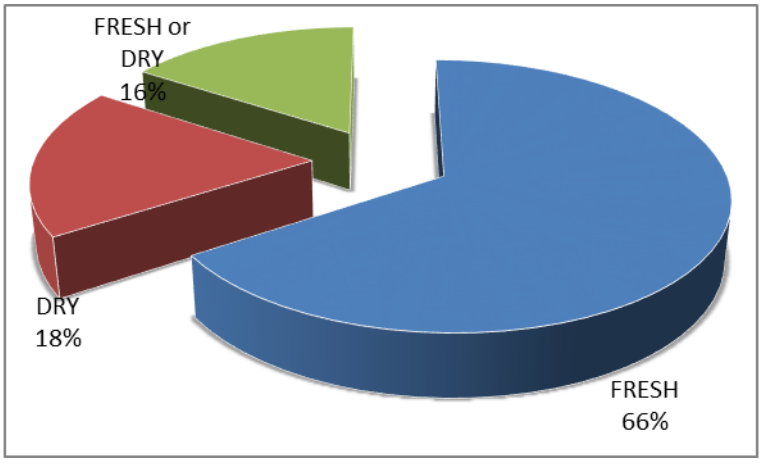

Fig. 5. Conditions of medicinal plants used in preparation techniques.

The study also showed that the preparation of traditional therapeutics in the study area involved the use of a single or a combination of two or more plant species (Table 3). However, the use of a single species was the most dominant (79.2%), followed by formulations from two or more medicinal plant species (20.8%). Other similar studies (Teferi Gedif and Hahn, 2002; Debela Hunde *et al*., 2004; Etana Tolosa, 2007; Sintayehu Tamene, 2011; Engedasew Andarge *et al*., 2015; Getu Alemayehu *et al*., 2015) showed that most of the medicinal plant preparations involved the use of single plant species for treatment of a particular ailment.

Table 3. Number of plant species involved as reported for the remedial preparations of human and livestock diseases.

Composition	Frequency	Percentage
Preparation from single species	42	79.2
Preparation from two or more species	11	20.8
Total	53	100

Methods of preparation of medicinal plants

The results of the study revealed that the most dominant methods of preparation were pounding and crushing (42.3%) followed by chewing (19.2%) and squeezing (14.1%) for the treatment of various diseases affecting humans and livestock in the study area (Table 4). Similar findings about crushing and pounding as the predominant method of medicinal preparations were also reported by Etana Tolosa (2007), Mengistu Gebrehiwot (2010) and Yalew Addisie *et al*. (2012). Apart from this, Haile Yineger and Delenasaw Yewhalaw (2007) indicated that the principal methods of remedy preparation were crushing (37.31%), squeezing (29.85%) and powdering (16.42%) of the various parts of medicinal plants.

Likewise, Reta Regassa (2013) found that crushing (28.2%), chewing (12.27%), squeezing (12.27%), and powdering (9.2%) were the predominant ways of preparing therapeutics in Hawassa city, southern Ethiopia.

Table 4. Preparation methods of traditional medicinal plants.

Preparation methods	**Frequency**	**Percentage (%)**
Pounding and crushing	33	42.3
Chewing	15	19.2
Squeezing	11	14.1
Maceration	7	9.0
Decoction	7	9.0
Powdering	5	6.4
Total	77	100

The study also revealed that the practitioners of the study area commonly diagnose each health problem by interview and visual inspection of the patients. Patients or their attendants are commonly interviewed for symptoms observed and the duration of the health problem. Some of the symptoms considered by the healers to determine the health problem type include changes in eye, urine and skin colour, tongue and throat appearances, body temperature, presence or absence of swelling on body, edemas, coughing, blooding, diarrhea, vomiting, discharging parasites (through fecal observations), and appearances of sores. Earlier studies conducted in Ethiopia (e.g., Teferi Gedif and Hahn, 2002; Kebede Deribe *et al*., 2006) found that there are different diagnostic methods which essentially pivot on the level of experience and knowledge of traditional medicinal practitioners.

In Bonke Woreda, traditional medicine practitioners employ various measurement units and durations to determine the dosage of curatives. The amounts of remedy and prescription rates were generally dependent on the degree and duration of the ailments. The data obtained from respondents revealed that traditional medicine dosages such as numbers of leaves, seeds and fruits; pinch for powdered plant parts; and finger length for root, root bark, stem and stem bark. This trend of measurement is similar to reports of other studies (Etana Tolasa, 2007; Tilahun Teklehaymanot and Mirutse Giday, 2007; Reta Regassa, 2013; Ermias Lulekal *et al*., 2014). Apart from this, informants of the study area also indicated that the doses were prescribed through estimation in terms of for instance, ¼, ½, 1, 1.5, and 2 spoon, cup of coffee, cup of tea, litre, palm of hand and other determinations depending on the age of the patient being treated. Comparable measurement of medicinal plant preparations were also mentioned in Ermias Lulekal *et al*. (2008).

Our study also revealed that most of the medicinal plant preparations given did not have standardized doses that may vary depending on the patients' conditions, like sex and age and disease conditions (severity and chronic). This result agreed with findings of Dawit Abebe and Ahadu Ayehu (1993), Etana Tolasa (2007) and Tesfaye Hailemariam *et al*. (2009) in which the lack of precision and standardization of dosage still remain as a major drawback in the traditional health care systems. Apparently, in most cases dosages were determined according to the age and physical appearance of the patient (Etana Tolasa, 2007; Tilahun Teklehaymanot and Mirutse Giday, 2007; Ermias Lulekal *et al*., 2008; Reta Regassa, 2013), sociocultural explanation of the illness, diagnosis and experience of individual traditional medicine practitioner (Tilahun Teklehaymanot and Mirutse Giday, 2007). As indicated in Dawit Abebe and Ahadu Ayehu (1993), the limitation of a fixed dosage for a given preparation is the ongoing problem of traditional medicinal plant remedies in various parts of the country, as well as elsewhere in the world.

On the other hand, additive substances like coffee, tea, honey, sugar and soup are necessary while preparing some plant remedies in the study area. Manipulations of such additives were also being practiced elsewhere in Ethiopia (Mirutse Giday, 2001). The substances improve the flavour of the preparation and enhance its palatability while reducing the adverse effects like vomiting and abdominal discomfort due to some heavier remedies and improve the healing power of remedies (Mohammed Adefa and Berhanu Abraha, 2011).

The study also revealed that among the different routes of application utilized, oral application was the most widely used (70.5%) followed by dermal or topical (20.5%), and nasal (7.7%, Fig. 6). These findings agree with those report by earlier works (e.g., Tilahun Teklehaymanot and Mirutse Giday, 2007; Mengistu Gebrehiwot, 2010; Reta Regassa, 2013; Engedasew Andarge *et al*., 2015). The informants who participated in the present study revealed that oral application of remedies is painless and an easy way of taking the medicines. On the other hand, ocular route accounted only for about a percent of the total reported administration route. Likewise, Tilahun Teklehaymanot and Mirutse Giday (2007) found that ocular application of traditional remedies was the least (accounting only for 2.1%) employed administration route.

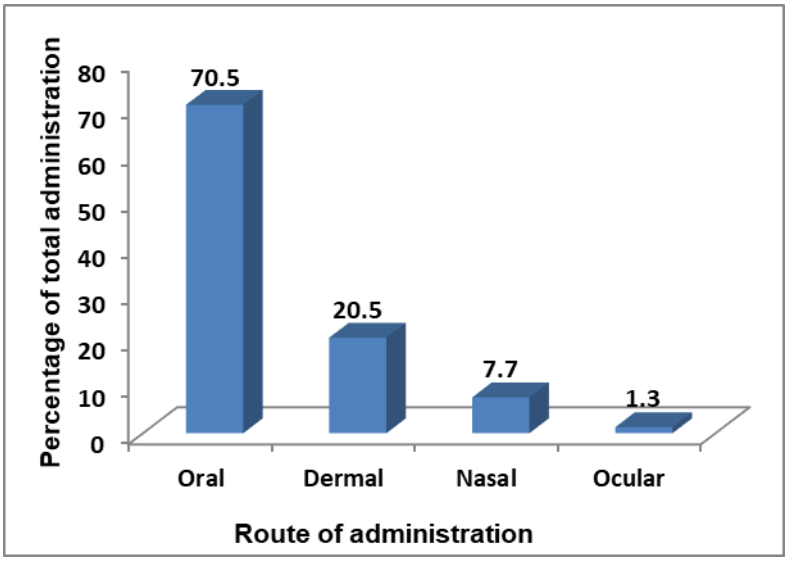

Fig. 6. Route of administering traditional medications in the study area.

Preference ranking

Ten key informants were selected to identify the most preferred medicinal plants among the five selected medicinal plants for the treatment of the most frequently reported human disease (stomach ache) with recourse to their personal preference which is based on the respective efficacy. *Fagaropsis angolensis* scored the highest and stood first, followed by *Leonotis nepetifolia*, and *Ajuga integrifolia*. *Teclea nobilis* attained the last rank (Table 5). Consequently, these species were deemed as the most effective medicinal plants against stomachache which is the most prevalent human disease in the study area from the other ailments documented in this study. Thus, from preference ranking, it could be understood that the most favoured species are usually the most effective at least in the context of the community who exploit them as medicines for a particular ailment. According to Etana Tolasa (2007), information on preference ranking suggests that the essential and time honoured knowledge that the participants managed to acquire throughout their life could enable to identify the best medicinal plants among the selected few plants that can still be used for same problem.

Table 5. Preference ranking of selected medicinal plants based on their efficacy to heal the most common human disease (stomachache) with recourse to the perception of the 10 key informants (R_1-R_{10}).

Medicinal plants	**Key informants**										**Total score**	**Rank**
	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}		
Ajuga integrifolia	4	1	3	4	4	3	4	1	4	3	31	3
Fagaropsis angolensis	5	4	4	5	3	5	5	4	5	5	45	1
Leonotis nepetifolia	3	3	5	3	1	4	3	5	3	4	34	2
Rosa abyssinica	2	5	2	2	4	3	2	3	1	2	26	4
Teclea nobilis	1	2	1	1	2	5	1	2	2	1	18	5

Scores in the table indicate ranks given to medicinal plants based on their efficacy. Highest number (5) represents a medicinal plant which informants thought to be the most effective in treating stomachache and the lowest number (1) depicts the least effective plant.

R with sub-script represents each key informant involved in the ranking exercise.

Medicinal plant knowledge versus age of the respondents

The study showed that the age of informants and the knowledge of traditional medicinal plants by the informants had strong positive correlation (r=0.74812, Fig. 7). Tesfaye Awas and Sebsebe Demissew (2009); Mengistu Gebrehiwot (2010); and Mohammed Adefa and Berhanu Abraha (2011) reported that as people become older and older their knowledge of traditional medicine would essentially increase. Tesfaye Hailemariam *et al*. (2009) also pointed out that ethnomedicinal knowledge is concentrated in the senior members of the community. Thus, elderly people of the study area knew more traditional medicinal plants than the younger ones.

On the other hand, the relatively lower medicinal plant knowledge exhibited by the younger population of the community might be due to the relative difficulties of knowledge transfer from elders to the young generation (Tesfaye Hailemariam *et al*., 2009). This might also cause the loss of interest by the young generation about indigenous knowledge (D'Avigdor *et al*., 2014). Tesfaye Hailemariam *et al*. (2009) pointed out that medicinal plant knowledge and transfer of knowledge to the young generation have been influenced by modernization (having access to modern education and health service) and environmental changes. This agrees with the findings of this study that most of the knowledge of traditional medicine is concentrated on the elders, and may accelerate the loss of indigenous knowledge related with traditional medicinal plants.

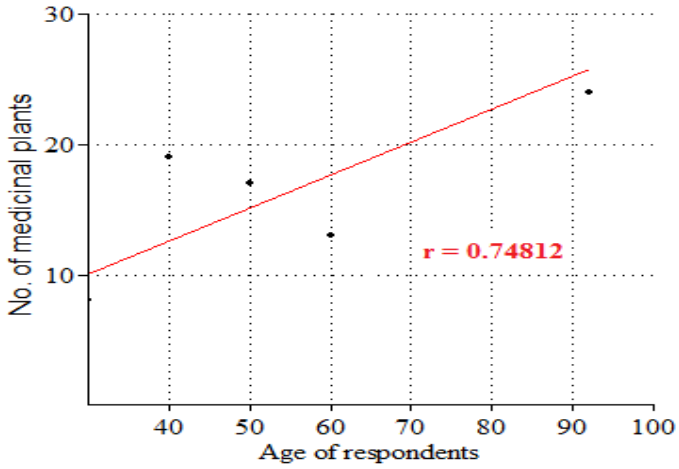

Fig. 7. Age of respondents versus number of medicinal plants collected in the Bonke Woreda, Ethiopia.

Medicinal plant knowledge versus educational background of the respondents

The results showed that there was a relatively strong negative correlation between educational background of respondents and the number of medicinal plants they have managed to report (Pearson correlation, r=-0.87029 (Fig. 8)). A similar trend was also observed by Tesfaye Awas and Sebsebe Demissew (2009). Engedasew Andarge *et al*. (2015) indicated that influence of modern education is among the potential factors which eventually lead to the slow disappearance of indigenous knowledge on medicinal plants. As a rule, the new generation takes advantage of opportunities such as attending school and living in urban areas in which the interest towards ethnobotanical knowledge could eventually disappear (Tesfaye Awas *et al*., 1997 cited in Tesfaye Awas and Sebsebe Demissew, 2009).

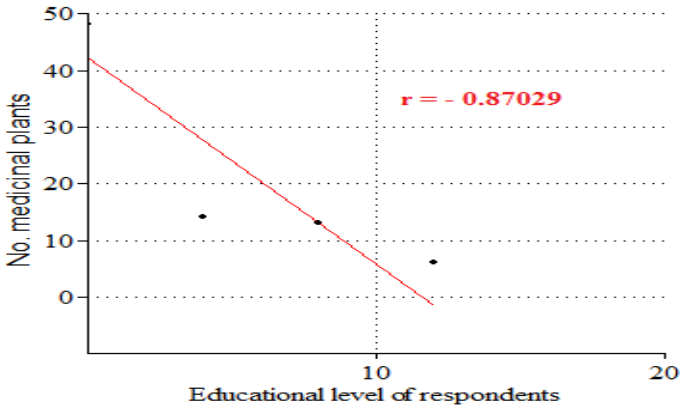

Fig. 8. Pearson correlation (r = -0.87029) between number of medicinal plants and educational level of respondents in Bonke Woreda, Ethiopia.

CONCLUSION

The study revealed that the Bonke community observably used traditional medicine to treat both human and livestock diseases, with a total of 53 wild and cultivated medicinal herbs, shrub and tree species which were distributed over 30 plant families and 49 genera. Lamiaceae had the largest number of medicinal plants in the study area (8), followed by Rutaceae (5), and Asteraceae (4). Seventy nine, 11, and 10% of the total species were used for treating humans, livestock, and both humans and livestock diseases, respectively. The most common diseases affecting humans and animals were stomach ache and cough. Sixty percent of medicinal plants were collected from natural and semi-natural habitats, while 40% of the same were harvested from home gardens. Herbs constituted the highest fraction (34%) of the total species and leaves were the most commonly used plant parts during the preparation of remedies. Freshly harvested plant materials are mostly used in the preparation of remedies which strongly indicated the availability of plant materials in the vicinity.

Pounding and crushing (42.3%) followed by chewing (19.2%) and squeezing (14.1%) dominated the mode of preparation of medicinal plants. On the other hand, oral application (70.5%) was the most widely used route of administration followed by dermal or topical (20.5%) and nasal (7.7%) routes.

Toothache followed by diarrhea and dysentery, respiratory and throat infections, and headache, malaria and feverishness were prevalent and well known by community members of Bonke Woreda, which were treated with relatively few medicinal species. *Fagaropsis angolensis* followed by

Leonotis nepetifolia, and *Ajuga integrifolia* were the most effective medicinal plants against stomach ache, a widespread human disease in the study area. *Ocimum lamiifolium* was the most preferred medicinal plant used for treating headache followed by *Echinops kebericho* and *Salvia nilotica*.

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