An ethnobotanical study of traditional medicinal plants used for human ailments in Yem ethnic group, south Ethiopia

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Research

Abstract

Background: Medicinal plants (MPs) have been widely used traditionally for strengthening the health care among communities of low-income countries including Ethiopia. The Yem ethnic group in Ethiopia traditionally utilize MPs for treating human ailments since ancient times. However, MPs and the associated traditional knowledge are under erosion due to human-induced and natural factors. Therefore, documenting the plant biodiversity along with the associated indigenous knowledge is an urgent task for conservation.

Methods: This study was conducted between 2013 and 2016 with the objective of documenting MPs used for treating human ailments. Ethnobotanical data were collected using semi-structured interviews and guided transect walks. The data were collected from 69 informants that were selected by stratified random sampling and purposive sampling. Data were analyzed using paired ranking (PR), Informant consensus factor (ICF), Fidelity Level (FL (%)) and Direct Matrix Ranking (DMR).

Results: About 213 plant species that are used for treating 117 human ailments were recorded. Gastrointestinal & Visceral organs ailments scored the highest ICF value of 0.82. Analysis of FL revealed that species such as *Haplocarpha rueppellii*, *Carduus schimperi* and *Inula confertiflora* had a 100% fidelity, *Maesa lanceolata* 80% and *Rumex abyssinicus* 75% fidelity. Multipurpose medicinal species such as *Cordia africana*, *Juniperus procera* and *Podocarpus falcatus* were species locally threatened by use pressure.

Conclusion: The Yem ethnic group has rich traditional knowledge of utilizing diverse plant species for maintaining human health care. Conducting phytochemical screening and clinical trials of the species with high fidelity is suggested for their efficacy, safety, and standard uses.

Keywords: Asteraceae, gender, herbal experts, maceration, regression model, *Rumex abyssinicus,* Yemisa

Background

Medicinal plants have been used in healthcare since ancient times (Sofowora *et al.* 2013). They have been widely used for strengthening the health care systems in low-income countries (Ahlberg 2017) and contributed for

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manufacturing of 20% of drugs in modern medicine (Fabricant & Farnsworth 2001, Farnsworth & Soejarto 1991). People of Ethiopia in the SubSaharan Africa are dependent on natural flora for health care and earning livelihood (FAO 2010, UNESCO 2015). The diverse ethnicities of Ethiopia have millennia old ethnobotanical knowledge beliefs, and practices about plant species growing in different vegetation and land use types. Traditional medicine that mainly employs MPs has been normative and integral part of health care system in the country (Deribe *et al.* 2006, Levine 1974, Pankhurst 2001). Estimates show that about 80% of human population health care in the country is based on traditional MPs (Abebe & Ayehu 1993, WHO 2002). The ethnicities of the country are estimated to use about a third of the country's plant families in traditional medicine for maintaining their health care (Tadesse & Demissew 1992). Yem people are one of the ethnic groups of Ethiopia who are inhabitants of Dry Afromontane Region in southern part of the country and have a deep-rooted and ancient traditional knowledge of managing human ailments and health conditions using plant biodiversity. Even though the mainstream biomedical system showed better coverage than before, Yem people still use plants and consult local herbal experts for several human ailments and health conditions due to their accessibility, millennia old experimentation on the efficacy of traditional herbal medicines that led to cultural trust in them. However, the MPs and the associated knowledge are being seriously in danger due to deforestation for agricultural expansion, firewood and charcoal extraction, environmental degradation, modernization, and climate change that could ultimately undermine the primary healthcare options. Thus, urgent ethnobotanical studies and subsequent conservation measures are needed to restore MPs and the associated knowledge from further loss. The objectives of this study were to document of MPs and associated knowledge of human ailments and analyze effects socioeconomic variables on mpk among Yem ethnic group.

Materials and Methods

Description of the study area

Yem people live in Yem Special District in the north-western apex of Southern Regional State within coordinates of 7°37'N - 8°02' N and 37°40' E - 37°61' E (Figure 1). Four subdistricts of the Special District were sampled for this study, namely, Gorumina Hanigeri, Kesheli, Shemona Metelo and Saja Lafiten. Yem people speak its own distinct 'Yemisa' that is categorized in Omotic language group (Negash 2005). According to CSA (2007), the total population of Yem was estimated to be 80,647, of which 50.3% were males and 49.7% females and the population density was 111.30 persons per sq. km. About 71.24% of the population was said to practice Orthodox Christianity, 25.14% Muslim and 3.48% Protestants (CSA 2007). The ethnic group practices *enset*-based subsistence crop cultivation and livestock rearing (YDAO 2016). Metrological data received from Deri station in Yem showed that high rainfall was received between May to September whereas low rainfall recorded from November to February reaching the lowest of 25 mm in December within 13 years (2000-2012) (NMSA 2014), Similarly, the highest mean annual temperature was 21 °C recorded in May while the lowest mean annual temperature within 13 years was 7 °C recorded in December (NMSA 2014).

Data Collection

Ethnobotanical Data

For the ethnobotanical investigation and vegetation survey, four subdistricts shown in the map were selected purposively based on agroecological (climatic) barrier, one from highland (i.e. Kesheli), two from middle land (Gorumina Hanigari and Shemona Metelo), and one from lowland (Saja Laften) as used by Cadena-González *et al.* (2013). Ethnobotanical data were collected using semi-structured interviews and guided transect walks following Martin (1995). Ethnobotanical information was gathered from 69 informants of the four subdistricts. Forty-seven (68%) of the informants were general (lay) informants, who were selected using Stratified Random Sampling (SRS) and 22 (32%) were key (expert) informants that were selected purposively from the four subdistricts following (Martin 1995). Semi-structured interviews were conducted in 'Yemisa' (in three of the sub districts) and 'Oromiffa' (Oromo language) in Saja Laften, and then translated by the help of guides. The interviews were conducted using 'interview guide' that was prepared a priori as suggested by Martin (1995) and the responses were recorded in hard copy of the guide per informant. Oral consent of informants was sought before interview administration.

Identification of the plant species specimens were made by the investigator in the National Herbarium of Ethiopia (ETH) using the published volumes Flora of Ethiopia and Eritrea Volumes 1- 8 (Hedberg *et al.* 2009). Voucher specimens were stored in the ETH.

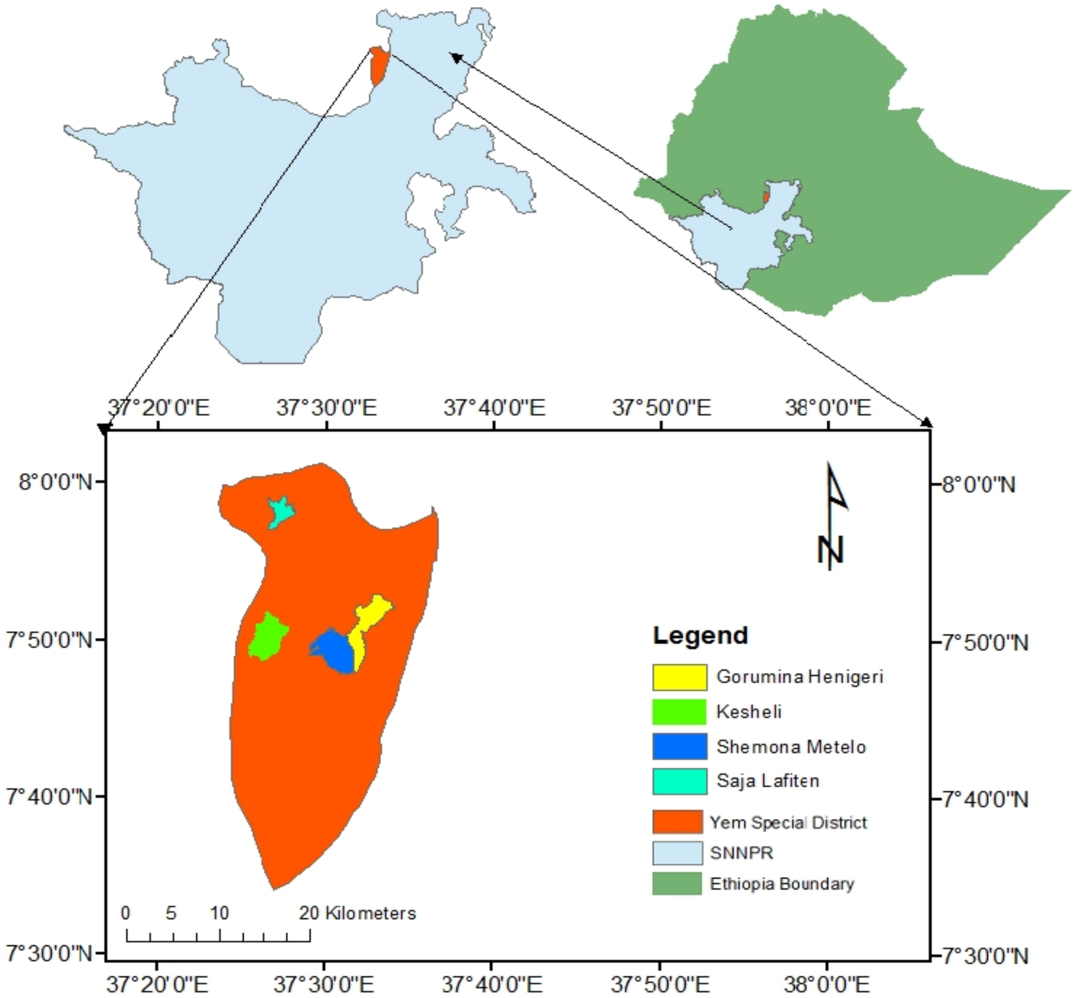

Figure 1. Location map of Yem Special District and subdistricts under study in Ethiopia

Analysis of Data

Ethnobotanical data were analyzed using quantitative tools listed below:

Paired ranking

Paired comparison of highly cited medicinal plants was done with randomly selected key informants following Martin (1995). Then, the scores of each species were summed up and ranked based on the preference of the key informants against a given disease.

Informant Consensus Factor (ICF)

The ICF of MPs which had highest citations for treating human ailments were calculated to evaluate the level of homogeneity of information provided by different informants following Trotter and Logan (1986). The index was calculated as the number of use citations in each category minus the number of species used divided by the number of use citations in each category minus one. The formula of the index is:

$$\text{ICF} = \frac{\text{Nur} - \text{Nt}}{\text{Nur} - 1}$$

where, Nur = number of use reports from informants for a particular plant-use category; Nt = number of taxa or species that are used for that plant use category for all informants. For the ICF analysis, ailments were grouped into nine categories as suggested by Cook (1995). The categories of ailments were: blood vascular & infectious, dermatological, gastrointestinal & visceral organs, miscellaneous, musculoskeletal, respiratory system, psychospiritual & cultural, reproductive & urogenital, and sensorial ailments and headache. Miscellaneous ailments are ailments whose sign and symptoms and specific body part could not be clearly stated.

Fidelity Level, FL (%) medicinal species
Fidelity Level (FL%) of medicinal species used for human ailments was calculated to identify species with highest healing potential. This index is calculated as the ratio between the number of informants who suggested the use of a species for the same major purpose (I_p) and the total number of informants who mentioned the plant for any use (I_U) (Friedman *et al.* 1986). The formula for fidelity level (FL) is:

$$\mathrm{FL} = \frac{\mathrm{Ip}}{\mathrm{Iu}}$$

where FL = Fidelity Level (FL%), I_p = the number of informants who suggested the use of a species for the same major purpose; I_U = the total number of informants who mentioned the plant for any use.

Direct Matrix Ranking
The exercise of Direct Matrix Ranking (DMR) of multipurpose MPs used for human ailments was performed separately with randomly selected 10 key informants to find out the threatened species by use pressure following Martin {1995).

Jaccard's Coefficient of Similarity (JCS)
The similarity of medicinal species used by the Yem were compared with ethnomedicinal investigations in other ethnic groups in Ethiopia was done using JCS following Kent and Cocker (1992).

$$\mathrm{JCS} = \frac{c}{a+b+c}$$

where a = no. of species in site A only, b = no. of species in Site B only, and c = no. of species in both sites.

Statistical Analyses of Data
Data were entered, organized, and analyzed in MS excel spreadsheet (Microsoft 2007). The ethnobotanical data were analyzed using MS excel and multiple regression analysis was used for testing socioeconomic variables that are significant predictors of medicinal knowledge of informants in Statistical Package for Social Sciences (SPSS) version 20 (IBM 2011).

Results

Ethnobotanical Data
Ailments freelisted, diversity, life forms and habitats of medicinal species used for treatment
In total, 117 human ailments and health conditions were freelisted by informants (Appendix 1) that were treated by 213 medicinal plant species, which were classified in 184 genera and 80 families (Appendix 2). Among ailments freelisted, abdominal pain was the highest cited, 130 (7.59%) followed by acute febrile illness 129 (7.53%) and foot swelling disease ('danifurutu'/'awachifebe?u') 69 (4.03%).

Herbaceous life forms were the most cited for treating ailments i.e. 97 (45%) followed by shrubs 54 (25%) and trees 33 (15%). About 56 (70%) of the families treated a single ailment and health condition while 24 (30%) of them treated more than a single ailment. Those families which were used to treat multiple human ailments include Asteraceae, Alliaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Rutaceae and Solanaceae. Asteraceae was the medicinal species richest family with 26 taxa followed by Lamiaceae 18, Fabaceae 19 and Euphorbiaceae 8. About 177 (83%) of medicinal species are known to be harvested from wild while 28 (15%) of them are cultivated. The medicinal species are known to be distributed in 13 different habitats (Figure 2). Forest constituted highest of 68 (32%) species followed by home garden 30 (14%) and living fence and fallow 24 (11%) each.

The number of taxa used per ailment
The findings showed that about 117 (55%) species were used to treat a single ailment while 96 (45%) of them were used to treat more than a single ailment. Among those species which treated multiple ailments, *Rumex abyssinica* was applied to treat as high as 9 ailments followed by *Artemisia abyssinica* and *Phytolacca dodecandra* each treated 6 ailments, *Allium sativum* and *Clematis longicauda* each treated 5 ailments (Appendix 2). For the rest of taxa, 3 species treated 4 ailments; 21 species treated 3 ailments; and 54 species 2 ailments. Vice-versa, the summary of ailments treated by number of taxa showed that 67 (57%) ailments were treated by a single species; 17 ailments by 2 taxa; 15 ailments by 4 taxa; 7 ailments by 5 taxa; 5 ailments by 6 taxa; 1 by 7 taxa; 3 ailments by 8 taxa, 2 ailments

by 9 taxa; 2 ailments by 11 taxa, 1 ailment by 13 taxa, 3 ailments by 14 taxa and a single ailment i.e 'mich' by 17 taxa.

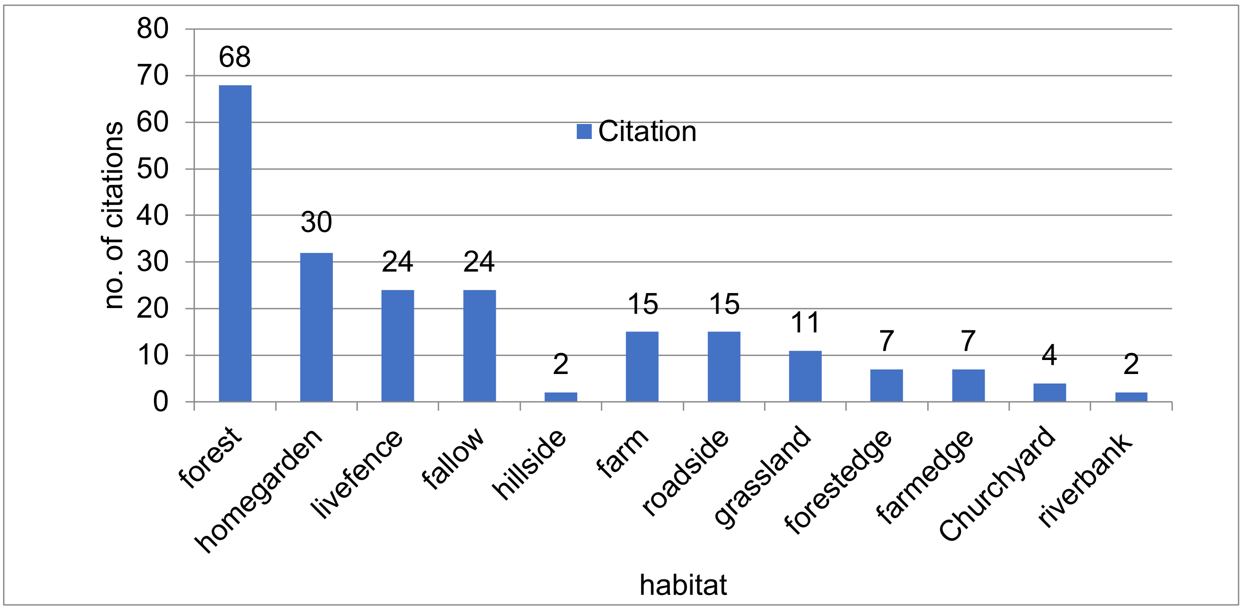

Figure 2. Habitat of MPs used for human ailments

Parts, methods of preparation, routes, and mode of application of medicinal plants

The results showed that leaf was the highest cited part for 197 (45%) preparations followed by root 83 (19%). About 10 different methods of preparation of plant remedies were reported among which maceration was the most used method with 201 (46%) remedies followed by decoction 85 (19%) and infusion 64 (15%) (Figure 3). About 296 (68%) remedies were taken via oral route followed by 71 (16%) dermal and 20 (5%) nasal. Drink was the most cited mode of application for the highest of 310 (71%) remedies followed by paint 26 (6%), inhale 25 (6%) and chew & swallow 20 (5%).

Informant Consensus Factor (ICF)

The results of ICF calculated depicted largest ICF value of 0.82 (Table 1) for Gastrointestinal & Visceral organs ailments category (GIV) which were treated by 91 species and had 506 use reports. There were 15 ailments under this category, the prominent ones being abdominal pain, hepatitis, diarrhea and taeniasis. The next category with highest ICF value was MiSc (ICF 0.81). Specific ailments and conditions treated under this category among others were 'mich', sudden ailment, febrile illness, and foot swelling ailment /'awachife'be'u'/'danifurutu'/. The third category with the next highest ICF was RS (ICF = 0.80). The category with the least ICF was BVI ailments scoring 0.67 (but treated by as high as 71 species).

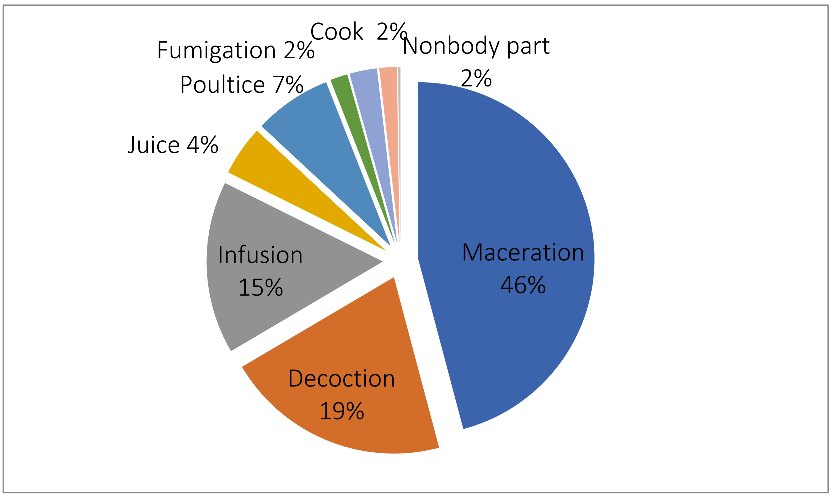

Figure 3. Methods of remedy preparation

Table 1. ICF values of MPs for human ailments

Category	UR	Spp.	ICF
BVI	211	70	0.67
DR	207	59	0.72
GIV	506	91	0.82
MiSc	277	54	0.81
MSK	114	31	0.73
PS	67	18	0.74
RUG	97	32	0.68
RS	143	30	0.80
SH	106	28	0.74

UR = no. of use reports, spp.= # of species used for treating ailments, BVI = Blood Vascular & Infectious, DR = Dermatological, GIV = Gastrointestinal & Visceral organs, MiSc = Miscellaneous, MSK = Musculoskeletal, RS = Respiratory System, PS = Psychospiritual & cultural, RUG = Reproductive & Urogenital, SH = Sensorial ailments & Headache)

Fidelity level, FL (%) of selected medicinal species

Species that scored large FL values include *Haplocarpha rueppellii* (used for treating abdominal pain), *Carduus schimperi* (used for acute febrile illness) and *Inula confortiflora* (used for sudden ailment) each 100%, *Maesa lanceolata* (used for abdominal worms) 80%, *Rumex abyssinicus* (used for hepatitis) 75%, *Verbena officinalis* (used for child diarrhea) 65%, *Brucea antidysenterica* (for abdominal pain & diarrhea) 65% and *Hagenia abyssinica* (used for taeniasis) 60% (Table 2).

Table 2. FL (%) of selected species with large values

Species	Ailment treated	Ip	Iu	FL(%)
Haplocarpha rueppellii	abdominal pain	40	40	100
Carduus schimperi	acute febrile illness	25	25	100
Inula confertiflora	sudden ailment	17	17	100
Maesa lanceolata	abdominal worms	13	16	80
Embelia schimperi	abdominal worms	12	16	75
Rumex abyssinicus	hepatitis	24	32	75
Verbena officinalis	child diarrhea	12	18	65
Brucea antidysentrica	sudden abdominal pain	9	14	64
Hagenia abyssinica	taeniasis	17	28	60

Average Direct Matrix Ranking (ADMR)

The analysis of ADMR revealed that *Cordia africana*, *Juniperus procera* and *Podocarpus falcatus* were species locally threatened multipurpose medicinal species ranking between 1-3, respectively, by activities of fuel wood, construction, and lumbering (Table 3).

Table 3. Average Direct Matrix Ranking of 10 multipurpose medicinal species

Species	Use category						T	R
	5	B	C	D	E	F		
Cordia africana		5	5	3	5	5	28	1
Croton macrostachyus	3	1	3	2	3	5	17	9
Erythrina brucei	1	1	2	2	3	2	11	11
Gardenia ternifolia	3	3	5	5	3	2	21	6
Hagenia abyssinica	3	2	5	4	4	4	22	4
Hypericum quartinianum	2	2	5	4	3	1	17	9
Juniperus procera	3	4	5	3	5	5	25	2
Olea europaea subsp. *cuspidata*	3	3	4	3	3	2	18	8
Olinia rochetiana	1	3	5	4	4	3	20	7
Podocarpus falcatus	5	4	5	2	5	5	26	3
Total	34	34	52	39	46	39		
Rank	5	5	1	3	2	3		

A = furniture, farming & household tools, B = fodder, C = fuel wood, D = charcoal, E = construction, F = lumber, R = Rank, T = total)

Indigenous medicinal plant knowledge (mpk) and socio-economic variables

The proportions of informants based on socio-economic variables (predictor variables) are given in Table 4.

Table 4. Proportion of informants by socioeconomic variables

Variable	Category	no.	%
Gender	male	38	55
	female	31	45
Age	young (18-35)	12	17
	middle (36-50)	19	28
	old (>50)	38	55
Religion	Orthodox	51	74
	Muslim	16	23
Education	non-educated	36	52
	elementary (1-8)	28	41
	high school & above	5	7
Informant proficiency	General informant	47	68
	Key informant	22	32

In the analysis of mpk among informants using multiple linear regression, the predictor variables were age, education, gender, informant proficiency and religion while the dependent variable was the number of medicinal plants.

The regression model showed that 31.10% of the variance was explained by the model with a modest correlation of 0.56 between the outcome and predictor variables (Table 5). The model was a significant predictor of mpk, $F(5,63) = 5.69$, $p < 0.001$ (Table 6). Two of the variables, namely, gender ($B = -6.13$, $p = 0.025$) and informant proficiency ($B = 10.08$, $p < 0.001$) significantly contributed to the model while age ($B = -0.28$, $p = 0.88$), religion ($B = -4.50$, $p = 0.09$) and education ($B = -0.36$, $p = 0.87$) did not (Table 7). Based on the model, there was a modest positive correlation between informant proficiency and mpk, $r = .46$ ($p < 0.001$), and a modest negative correlation between gender and mpk, $r = -.36$ ($p = 0.001$).

The regression model was equated as:

mpk = 21.24 - 6.13*gender - 0.28*age - 4.50*religion - 0.36*education + 10.07*informant proficiency.

Table 5. Model Summary of regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.56[a]	.31	.26	10.26

a. Predictors: (Constant), informant, religion, education, gender, age

Table 6. ANOVA of Regression model

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2997.071	5	599.41	5.69	.000[b]
	Residual	6630.17	63	105.24		
	Total	9627.25	68			

a. Dependent Variable: mpk
b. Predictors: (Constant), informant, religion, education, gender, age

Similarity of Yem MPs with other ethnic groups across Ethiopia

Comparison made with the MPs for human use reported from 14 cultures in Ethiopia showed the highest similarity of 37% traditional MPs used in Sheko ethnic group and West Shoa Oromo people (Table 8). The next closer similarity was with KembataTembaro ethnic group 31% and Dawuro 26%. The MPs by Gonder Amhara, Ankober Amhara and Tigre also had closer similarity with that of Yem. The least similarity of 5% was observed with Harer Oromo.

Table 7. Regression model coefficients

Model 1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	21.24	10.58		2.01	.049
gender	-6.13	2.67	-.25	-2.29	.025
age	-.28	1.79	-.02	-.16	.877
religion	-4.50	2.64	-.18	-1.70	.094
education	-.36	2.23	-.02	-.16	.871
Informant proficiency	10.08	2.76	.39	3.65	.001

a. Dependent Variable: mpk

Table 8. Jaccard Coefficient of Similarity (JCS) of Yem mps with other reports

Ethnic group	no. of MPs	JCS	Author/s
Gera Oromo	63	0.15	Gonfa *et al.* (2020)
Sheko	256	0.37	Kassa *et al.* (2020)
Tigre	173	0.21	Kidane *et al.* (2017)
Harer Oromo	83	0.05	Belayneh and Bussa (2014)
Gonder Amhara	135	0.23	Chekole (2017)
Dawuro	168	0.26	Agize *et al.* (2013)
Ankober Amhara	135	0.22	Lulekal *et al.* (2013)
KembataTembaro	145	0.31	Maryo *et al.* (2015)
Berebere Bale Oromo	70	0.13	Tolossa and Megersa (2018)
West Shoa Oromo	172	0.37	Regassa (2016)
Bale National Park	101	0.10	Yineger *et al.* (2008)
Debark Amhara	88	0.21	Abebe *et al.* (2011)
Goma Oromo	92	0.26	Etana *et al.* (2010)
Yem	213		Current study

Discussion

Diversity, abundance, and habit of MPs reported for human ailments

The findings showed that the Yem have rich traditional knowledge of MPs for treating several human ailments and conditions side by side with the biomedical health system. This rich traditional knowledge might have been acquired through long experiences and trial &error by forebears of the ethnic group leading to discovery of efficacious taxa used by the society. Moreover, the accessibility of MPs, cultural acceptance of natural remedies from plants, and the cost of the biomedical health care are drivers for extensive use of plant remedies for human primary health care. Similar to our finding, reports by Giday (2007) in Bench, Meinit and Sheko, Lulekal *et al.* (2013) in Ankober Amhara, Agize *et al.* (2013) in Dawuro, Maryo *et al.* (2015) in Kembata Tembaro, Regassa (2016) in West Shoa Oromo ethnic groups in Ethiopia, and in overseas, Casagrande (2002) in Tzeltal Maya, Hong *et al.* (2015) in Maonan people China and Reimers *et al.* (2018) in Zacatecas state Mexico, have also reported traditional use of plants for treating human ailments.

Few medicinal families such as Asteraceae, Alliaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Rutaceae and Solanaceae were found to treat more than a single ailment, which might be attributed to the popularity of these families among the community for treating multiple of ailments. Among these families, Asteraceae was a family used to treat the highest number of health problems, which might be attributed to big number of medicinal taxa it contains. Reports indicate that a big number of taxa of this family are proven to possess rich secondary metabolites such as steroids, terpenes and alkaloids which are used as anti-inflammatory, analgesic anti-pyretic and antioxidant agents that act against ailments in support with the traditional use of its taxa for human remedies (Desmarchelier & Witting-Schaus 2000, Ross 2005, Sílvia *et al.* 2015). The dominance of taxa of Asteraceae for human remedies in current finding agrees with other works in Ethiopia such that of Giday (2007), Maryo *et al.* (2015), Regassa (2016), and in overseas Hassan *et al.* (2017) in Pakistan, Hong *et al.* (2015) in China, Moerman *et al.* (1999) and Reimers *et al.* (2018) in Zacatecas state, Mexico.

Number of ailments treated, life forms, sources and habitat of MPs

The use of multiple therapeutic species for a single ailment in our finding was based on two folds of explanations. First, use of different species for a single human ailment might be in that informant of different subdistricts use different species for the same case based on the availability of therapeutic species and individual difference in knowledge. Secondly, most healers interviewed use concoctions for several ailments with a thought that the concoction better acts synergistically and promote healing potential of the combination of remedy. In support of the second explanation, reports indicate that the extracts of multiple of plant species may have an immunomodulatory effect, improving immune functions and some plant constituents may attenuate/reduce the side-effects of others (Ebong *et al.* 2008, Rasoanaivo *et al.* 2011, Tiwari & Rao 2002). On the other hand, the use of a single species for a single ailment may be safer with less likelihood of side effects, and a single medicinal plant may contain tens of bioactive compounds that is potent enough to react against ailing agents. There are also reports from other cultures that similarly indicated use of single and multiple species remedy per human ailment, in North Ethiopia (Abebe & Ayehu 1993, Beyene, 2015), in Zimbabwe (Maroyi 2011), Morocco (Ouhaddou *et al.* 2014), Nigeria (Ofuegbe & Adedapo 2015), Peru (Luziatelli *et al.* 2010).

The predominant use of herbs for human ailments in our finding might be attributed to their wider distribution as early successional plants including from soil seed banks in human managed land uses and where forest cover has been depleted. Their ease for use is another attribute for their selection as remedy. However, their seasonality and damage by herbivore grazing makes them less sustainable. The fact that most medicinal species obtained from wild sources has might rise concern of conservation from overexploitation and poor management practices of the wild grown taxa (Awas 2007, Cunningham 2001, Castle *et al.* 2013). The distribution of Yem MPs in diverse habitats might have positive impact on their sustainability as well as accessibility. Especially, forests are the habitat predominantly used for obtaining remedies. This is attributed to that there are several community forests near villages of Yem people.

Parts used and methods of preparation plant remedies

The finding that leaf was the most used part might be with a thought that it contains healing bioactive substances, its ease for collection and its availability for most seasons of the year. Other studies similarly reported predominant use of leaf in other cultures (Beyene 2015, Bussmann & Sharon 2006, Giday *et al.* 2009, Maroyi 2011). Maceration was the highest cited method of plant remedy preparation. By maceration method, the mixture of the damp solid plant material is pressed, then is strained, and the combined liquids are clarified by decantation or filtration after standing (Handa *et al.* 2008), There were no domestic studies which report maceration as a method of remedy preparation, albeit some studies from elsewhere similarly reported this method for remedy preparation in agreement with our finding (Eliseo 1983, Mowobi *et al.* 2016, Ouhaddou *et al.* 2014, Tugume & Nyakoojo 2019.

Paired Ranking, ICF, FL (%) and DMR of medicinal species

These tools showed that Yem area has high diversity of species that have popularity and cultural agreement among the communities. Hence, the species with highest values of these quantitative tools can be candidates for further phytochemical analyses and clinical trials for standardizing their employment in health system and development of drugs when possible. *Rumex abyssinicus* was the most preferred remedy for hepatitis. The Yem do not visit modern medical practitioners for this ailment, rather they use widely this species. The species is abundantly grown near homesteads that are well manured enset grounds as a weed, and rarely in forests in disturbed gaps. However, it is palatable for animals, which decimates its regeneration.

The highest ICF values obtained for gastrointestinal & visceral organs ailments category indicates the highest prevalence of the ailments mentioned in this category. The high ICF score further indicates high dependence of local people on the plants that are available in the local flora, and its use for selection of specific plants for further search of bioactive compounds (Heinrich *et al.* 1998, 2009, Andrade-Cetto & Heinrich 2011). The causes of high prevalence of ailments in this category might be attributed to poor hygienic living conditions such as absence of enough water for sanitation at home, drinking river water which might harbor some parasites, living along with domestic animals, feeding habits (for e.g., consuming uncooked foods such as raw meat, improper management of prepared foods, vectors such as flies, and lack of awareness, poor living conditions. According to Prüss-Üstün *et al.* (2008), the ailments associated with poor sanitation are particularly correlated with poverty which account for about 10% of the global burden of disease. In agreement with the current finding, there are other works that report prevalence of gastrointestinal diseases and internal organs disorders such as Garedew and Abebe (2018) in Yeki District Southwest Ethiopia, Bussmann and Sharon (2006) in northern Peru, Cheikhyoussef *et al.* (2011) in Namibia, Umair *et al.* (2017) in Hafizabad district, Punjab-Pakistan and Reimers *et al.* (2018) in Zacatecas state, Mexico.

The high-fidelity level values of species closer to 100% in this finding show that almost all use-mentions refer to the same purpose, that is, the plants are most preferred (Friedman *et al.* 1986). Generally, species with the highest fidelity level values are known to possess highest healing potential of ailments, and they are considered as model plants that can be employed for further phyotochemical investigation (Hassan-Abdallah 2013, Heinrich *et al.* 1998). The multipurpose MPs serve immense economic and sociocultural values and underpin the major ecosystem services. However, they are threatened by different livelihood activities such as agricultural expansion, extraction of fuel wood and charcoal, construction goods, and forage which violate their sustainable use. Therefore, it is important to monitor the impacts of such utility services, educate local communities on sustainable harvesting practices and cultivation of such species are some of the conservation measures suggested. Other studies also reported similar threats of multipurpose medicinal species (Adefa & Getaneh 2013, Hunde *et al.* 2015, Tolassa 2007).

Effects of socio-economic variables on mpk

The finding that gender was a significant predictor of mpk indicating that males were more knowledgeable than females in Yem might be attributed to difference in occupation. Yem males spend more times in farms that are closer to forests which contain more useful plant diversity and have much exposure for mpk while women work many times at home caring for children, preparing food, and localized near homesteads which might be less in plant species than forests. This occupation impact is cultural which cannot be changed easily and sooner. In agreement with our finding, there are other reports which indicted occupational difference in gender and dominance of males in mpk (Beyene 2015, Cheikhyoussef *et al.* 2011, Díaz-Reviriego *et al.* 2016, Fasil 2013, Reyes-García*et al.* 2010).

The significant difference in mpk among key and general informants, that the key informants knew more than the general informants might be attributed to specialization in herbal knowledge (Reyes-García *et al.* 2010). Regassa (2016) similarly reported that medicinal experts could list more treatments than lay informants.

In our finding, religion was not a significant predictor mpk might be due to the fact the two faiths: the Christian and Muslim religions in Yem permit the use of medicinal plants to cure illnesses besides their belief in faith healing depending on doctrine of their religion. This agrees with reports from other cultures in Ethiopia by Beyene (2015) and Demie *et al.* (2018). The finding that age and education were not significant predictors of mpk might be attributed to that mpk is commonly a public domain which might be related the fact that the Yem have annual festival of gathering MPs by mass from Bori Mountain, in which all age groups and education groups participate and share mpk openly (Woldemariam in press). This finding disagrees with some studies reported that age as a of predictor of mpk, and older people are more knowledgeable than the youngsters who distrust traditional medicine (Fasil 2013, Reyes-García *et al.* 2010). Our finding regarding education agrees with Birhanu *et al.* (2015) and Mathez-Stiefel and Vandebroek (2012) who reported that mpk is not affected by level of education. The negative coefficients of gender, age, religion, and education in the regression equation suggest negative correlation; as the values of these variables increase, the mpk decreases, notwithstanding the later three were not significant predictors. The positive coefficient in informant proficiency indicates positive correlation and increase of mpk with informant proficiency.

The highest similarity of traditional MPs used in Yem with that of Sheko (Kassa *et al.* 2020), West Shoa Oromo (Regassa 2016), KembataTembaro (Maryo *et al.* 2015), Dawuro (Agize *et al.* 2013) and Goma Oromo (Etana *et al.* 2010) ethnic groups might be attributed similar climatic and topographic factors that dictate species grown and closer cultural proximity among the cultures in applying the available species for similar and different human ailments. The lesser similarity of MPs used in Yem with Gonder Amhara (Chekole 2017), Ankober Amhara (Lulekal *et al.* 2013) and Tigre (Kidane *et al.* 2017) might be due variation in species composition cultural variation in species preference. The least similarity of MPs used in Yem with Bale N. Park (Yineger *et al.* 2008), Harer Oromo (Belayneh & Bussa 2014), Gera Oromo (Gonfa *et al.* 2020) and Berebere Bale Oromo (Tolossa & Megersa 2018) might also be due to variation in species composition and cultural distance among them.

Conclusion

The study revealed that Yem people use a high diversity of MPs for treating human ailments, which indicates that they own deep-rooted traditional knowledge of managing human health care. For the Yem, MPs are accessible, efficacious, and entrusted natural means of primary health care. They treat most of the ailments first with MPs at home, if there would not be betterment, they visit either consult herbal experts, or biomedical health care depending on the type of ailment. They prefer traditional MPs for treating some ailments such as 'awachifebe'u', cancer, hepatitis, evil eye, 'mich' and sudden ailments among others thinking that the biomedical treatment is not effective against such ailments. Except for home garden grown cultivated species, the Yem collect MPs from any land use types from private lots as well as communal lands/forests, which are good reservoirs for medicinal and useful plants. Gender and proficiency were found to be predictors of mpk among the Yem in support of null hypotheses of the variables while the hypotheses for age, religion, and education as predictors of mpk in Yem were rejected. Conducting phytochemical screening and clinical trials of the MPs with high informant consensus and FL including *Carduus schimperi, Haplocarpha rueppellii, Inula confortiflora*, *Maesa lanceolata* and *Rumex abyssinicus* is suggested in the first priority line for their efficacy, safety and standard uses in primary health care. The Ethiopian Biodiversity Institute needs to work with local community for promoting and conserving the knowledge the biota and indigenous knowledge.

Declarations

List of abbreviations: Not applicable.

Ethics approval and consent to participate: A letter of cooperation for conducting the research was written on the behalf the corresponding author from Department of Plant Biology and Biodiversity Management, Addis Ababa University to Yem Special District Administration. The local authorities acknowledged the letter and gave permission to conduct the research, gather data from informants and field and take plant samples from field. Additionally, informants were asked about their view if their name is openly accessed, and they have agreed to have their names and personal data to be published. Then, Addis Ababa University approved the research finding after it was presented for the thesis defense.

Consent for publication: Not applicable.

Availability of data and materials: All the data are presented in figures, tables and appendix in the manuscript and are available with the corresponding author.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: Woldemariam collected, analyzed the data and written the manuscript, and was the major contributor of the study. Demissew and Asfaw advised, reviewed, and approved the final manuscript.

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