

Ethnobotanical Study of the Traditional Use and Maintenance of Medicinal Plant Species and Indigenous Knowledge by the Konso People, Southern Ethiopia

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ABSTRACT

Background: For thousands of years, indigenous people have developed their own localized knowledge of plant use, management, and conservation. However, this rich traditional knowledge on plant utilization was not well documented, and most of the indigenous knowledge acquired by the local people was verbally passed from generation to generation. The people of Konso in South Ethiopia use and maintain traditional medicinal plant species, according to their specific ethnobotanical pharmacopeia. **Methods:** A total of 80 informants aged 25 to 87 years old were chosen (10 individuals of which 5 healers and 5 clients) from the 24 key informants were identified representing 6 from each kebele. The present study explores the unique indigenous knowledge that enables the community to identify medicinal plants, prepare medications, and then apply the cures used to treat a variety of human diseases as dangers to their long-term use. This study was carried out from September 2018 to July 2019. **Results:** Some medicinal plant species are more popular than others *Lepidium sativum*, *Hagenia abyssinica* and *Allium sativum* were cited by all the 80 informants for their medicinal value. Powdered form was directly used from 40.0% of the medicinal plant species, while 51.4% are chewed, extracted with water, and / or with butter (17.1 % each) and 8.6% are extracted with local beer. Of the herbal remedies used in the study area, 68.6% were applied orally and 31.4% were applied externally. Roots are the parts mostly used (35.7%), followed by leaves (32.9%), combination of parts (18.6%), root bark (5.7%), fruit (2.9%), in that order, respectively. It was known that highest source of the medicinal plants was the forest (45.3%). **Conclusions:** Home gardens and agro forests together contribute 41.86% of the medicinal plants. This study was undertaken to bring awareness towards community-based in-situ and ex-situ conservation actions, attracting younger generations to grab the indigenous knowledge from the parents and ancestors and strengthening home gardens and other agro-forestry systems be used as repositories of medicinal plant species and alternative conservation sites to preserve the traditional medicinal plant species of the study area.

Key words: Ethnobotany, Indigenous knowledge, Traditional healers, Medicinal plant species.

INTRODUCTION

Over the years, indigenous people have established their own unique expertise in the use, management, and conservation of plant resources.¹⁻³ These cultures store such knowledge among people, families, or communities.² Indigenous knowledge or traditional knowledge is a broad term for the complex information, values, and customs that evolve and alter over time and space. As a result, indigenous (traditional) knowledge incorporates tested approaches that evolved through human contact with the environment.⁴⁻⁷ The documentation, analysis, and dissemination of knowledge about the relationship between biodiversity and human society, as well as how different communities value biodiversity and how it is impacted by human activity, are all made possible by ethnobotanical studies.⁸ Medicinal plants play an important role in the basic medical care of people all over the world. Drug use has increased due to population growth, inadequate drug supplies, high treatment costs, side effects of some synthetic drugs, and the development of drug resistance to infectious diseases. Plant materials are increasingly being used as a source of medicines.⁹ According to the World Health Organization, around 21,000

species of plants, which 80 percent of people around the world can use as medicinal herbs for part of their basic health care.¹⁰⁻¹²

Indigenous cultural systems are often viewed as backwards by the dominant cultural system and have no respect among younger generations. This generally leads to a decrease in young people's desire to learn from their elders. The disappearance of indigenous knowledge about plants and the appropriate management systems can lead to mismanagement, especially when applying development plans that do not always correspond to local conditions.^{13,14}

Many rural ethnic cultures still practice traditional medicine today, though its prevalence has not been thoroughly investigated.¹⁵ Approximately 85 percent of Ethiopians rely on traditional medicine.^{12,16-18} Many practitioners of traditional medicine are aware of and use a variety of plants in the nation,¹⁹ but knowledge is easily distorted during the process of transfer. In general, each generation loses a growing amount of information about therapeutic plants.^{20,21} Despite the fact that Ethiopia is blessed with a multi-ethnic culture that has developed within environments with a diversified flora, medicinal plants have not been sufficiently researched, evaluated, or recorded.²²

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Due to urbanization, overgrazing, fuelwood harvesting, deforestation, and agricultural development, many medicinal plants and accompanying traditional knowledge are being severely depleted.²³⁻²⁷ Additionally, the majority of the indigenous information that traditional healers still possess is either lost or only passed down orally. Furthermore, one of the often-cited issues in the research region is the dearth of proper documentation of information about indigenous medicinal plants.²⁸⁻³⁰ This study was undertaken to fill the gap left by the lack of documentation of indigenous knowledge of Konso people's medicine and preservation of medicinal plants for future generations.

MATERIALS AND METHODS

Description of the study area and the people

The study was conducted in Konso Woreda, South Ethiopia, from September 2018 to July 2019. The Konso special Woreda (currently became Konso Zone) is in the Southern Nations Nationalities and People's Regional State (SNNPRS), situated about 600 km and 360 km southwest of Addis Ababa and Awassa respectively. The Konso land is located between 5°12'0" N - 5°22'30" N and 37°10'30" E - 37°21'0" E. Konso is bordered by Burji Special Woreda and Arero Zone of Oromia Regional State to the east, South Omo Zone to the West, Arero and South Omo Zones to the South and Derashe Special Woreda to the north (Figure 1). The area of the Woreda is estimated to be 2000 km² with total population of 200,000 (Konso Special Woreda Agricultural Desk Annual Report 1996). Of the total population of the study area, 96.5% resides in 44 rural peasant associations while the remaining 3.5% resides in Karat and Segen towns. Male represented 49% of the total population and 51% is female.

METHODS

Sampling the study sites and informants

Four study Kebeles: Dhokatu, Sorobo, Fasha, and Maderiya-Gizaba, were selected based on altitude, topography and population density all

of which were carried out during the reconnaissance survey. Snowball sampling or chain-referral sampling was used to obtain the informants (snowball sampling is defined as a non-probability sampling technique in which the samples have traits that are rare to find). Snowball sampling is a convenience sampling method which applied when it is difficult to access subjects with the target characteristics.³¹ In this method, the existing study subjects recruit future subjects among their acquaintances. Sampling continues until data saturation.^{32,33}

A total of 80 individuals between the ages of 25 and 87 were selected from each site or kebele (10 individuals 5 or 6 healers and 5 or 4 clients). Snowball sampling was made to select the healers and systematic random sampling was made to select the clients from each Peasant Association, the list of which is found in the respective Peasant Association offices. From the total of 80 informants, 24 key informants, six from each study site, were also selected. The key informants included healers, elders and knowledgeable persons in these areas. The ages of the key informants were selected between 35 and 85. The choice of informants was made in accordance with the procedures outlined by.⁸ The selection of the knowledgeable people was based on unstructured interviews with randomly encountered members of the society. Thus, one whose name was mentioned by at least three to five encountered people as a knowledgeable person in the area was selected as a key informant.

Data collection

Ethnobotanical data collection: Ethnobotanical data were collected using both open ended and semi-structured interviewing, observation and focus group discussions (FGD). Semi-structured interview,³⁴ was conducted in Konso language (Afa Konso) through a translator. In most cases such interviews are conducted with single informant and allows expressing personal viewpoint freely without being interrupted.^{2,8} During the interview, data on local names of the medicinal plants, medicinal uses, parts used, methods of preparation, modes of application, and other related issues were collected. Moreover, plant habitats, management aspects; threats to the plants and other related ethnobotanical information were recorded using the prepared format.

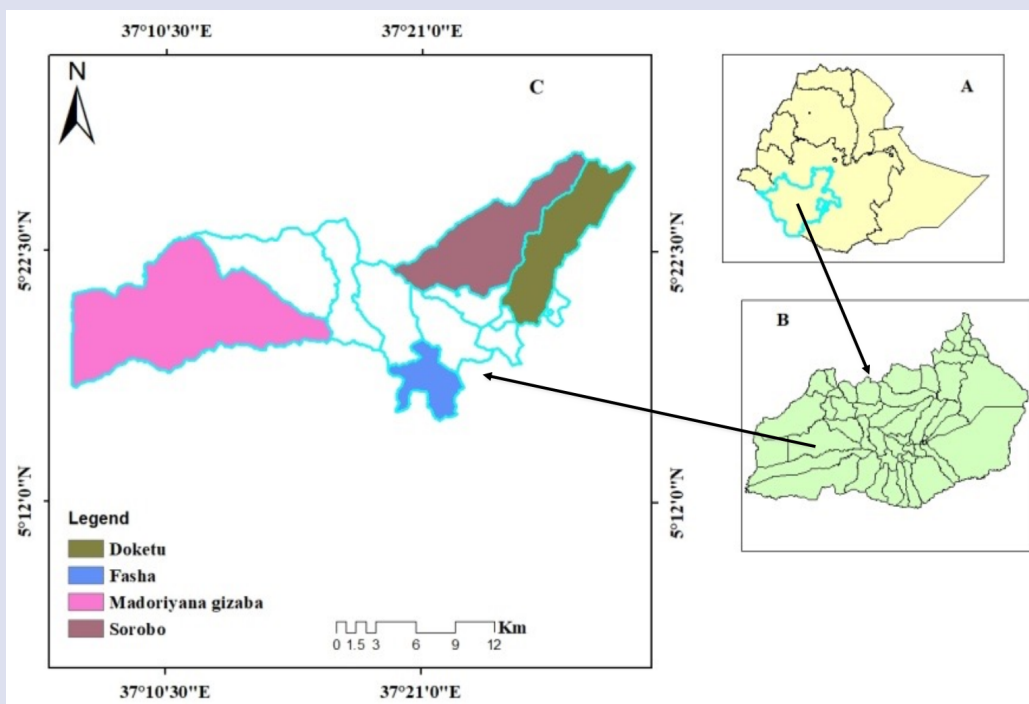


Figure 1: Map of the study area. Location of Konso Special Woreda Zone Southern Nations Nationalities and People's Regional State (SNNPRS), Ethiopia. Data Source: Ethio-GIS collected by ECSA (Ethiopian Central Statistics Authority, 2014), Software Arch-GIS 9.2 used.

During the study, each informant was visited three times to verify the reliability of data obtained. If what was said during the first visit concerning the use of a particular medicinal plant by any informant didn't agree with what was said or told during the second or third visit, the information was considered unreliable and had to be discarded. Repeated visits also helped to get some additional information that was not mentioned during the early interviews.

Medicinal plant specimen collection: Plant specimens of medicinal plant species reported as remedy to a given health problem by the healers and other informants were collected from their habitats guided by the healers. The collected specimens were numbered, pressed, dried and taken to the National Herbarium of Ethiopia (ETH), Addis Ababa University for taxonomic identification using the different published Flora Volumes of Ethiopia and Eritrea.³⁵⁻³⁹ Finally, the identified voucher specimen was confirmed and deposited at the National Herbarium.

Preference ranking and paired comparison for medicinal plant efficacy

Preference ranking and paired comparison exercises were conducted during fieldwork for two groups, each containing five medicinal plants used to treat two most common human health problems in the study area. For the preference ranking, the informants were given the plants and asked to arrange these medicinal plants according to their importance to treat the selected health problem more effectively. They were told to arrange each species giving high value (5) to the medicinal plant they thought most effective and lowest value (1) to least effective medicinal plants. Hence rank was determined for each one of the five medicinal plants based on total score of each species.

For the paired comparison, the medicinal plant species are compared two at a time for their efficacy to treat the selected health problem. Each of the ten respondents assigned 5 to the best, 4 to the very good one, 3 to the good one, 2 to the one considered fair and 1 to the least effective. Finally, the values of each medicinal species are added and given ranks.

Data analysis

During the survey, different informants indicated the same plants and same uses especially for some widely used medicinal plants. The informant consensus is helpful to see the similarity of information given by the informants during the first and the second visits. It also can be used to confirm the authenticity of information by comparing it with other information given by other informants on the same topic.

RESULTS

Informant consensus

Based on the informant consensus, those plant species cited as medicinally important by 40% and above of the informants or the top fifteen medicinal plant species were selected and described based on the different published volumes of the Flora of Ethiopia and Eritrea and other available sources. The medicinal applications against the health problems, methods of preparation and administrations are given according to the descriptions. The results of the study showed that some medicinal plant species are more popular than others. Accordingly, *Lepidium sativum*, *Hagenia abyssinica* and *Allium sativum* took the lead as each was cited by all the 80 informants (100%) for their medicinal value. *Croton macrostachyus* was cited by 78 informants (97.5%), *Andrachne ephmera* G. Gilbert, was cited by 77 informants (96.3%). *Achyranthus aspera* L. and *Ocimum lamifolium*, each was cited by 75 informants (93.8%). Fifteen medicinal plant species with 40% and above informant consensus are described in the following section (Table 1).

Table 1: Based on the informant consensus those plant species cited as medicinally important by 40% and above of the informants, NI=number of informants.

Botanical Name	NI	(%)	Rank
<i>Hagenia abyssinica</i>	80	100	1 st
<i>Lepidium sativum</i>	80	100	1 st
<i>Ruta chalapensis</i>	80	100	1 st
<i>Allium sativum</i>	80	100	1 st
<i>Croton macrostachyus</i>	78	97.5	5 th
<i>Andrachne ephmera</i>	77	96.3	6 th
<i>Achyranthes aspera</i>	75	93.8	7 th
<i>Ocimum lamifolium</i>	75	93.8	8 th
<i>Terminalia brownii</i>	56	70	9 th
<i>Pteroccephalus frutescens</i>	45	56.3	10 th
<i>Oxalis anthelmintica</i>	45	56.3	11 th
<i>Vangueria madagascarensis</i>	39	48.8	12 th
<i>Silene flamulifolia</i>	35	43.8	13 th
<i>Rubia cordifolia</i>	35	43.8	14 th
<i>Caeslpina volkensii</i>	32	40	15 th

Distribution, diversity, and therapeutic values

In this study, a total of 70 medicinal plant species belonged to 59 plant genera and 36 plant families used by Konso people were recorded (Table 2) and most of the species were herbs (76%), followed the very best, by shrubs (11%), trees (13%) (Figure 2). According to the results, 46 medicinal plants are used as only one plant part, 16 medicinal plants are used as two or more combinations of the plant parts and 3 medicinal plants are used as whole plant. The most commonly used plant parts were leaves (46%), followed by root (24%), root and bark (9%), whole plant (5%), flower, root and leaf (5% each), seeds and seed (3% each), fruit (3% each) respectively (Figure 3). The number of health problems that are possibly treated by traditional medicinal plants in the study area is about thirty-six. Further the study showed that retained placenta are the most frequent and the most serious health problem in the study area that it can even be fatal if not effectively treated. According to the informants (85%), they cannot be cured by applying modern medical treatment unless treated using traditional herbal remedy. Healers (100%) also had similar opinion that retained placenta can be treated more effectively using traditional medicinal plants than modern medical treatment.

Preference ranking for the efficacy of medicinal plants

The preference ranking for five medicinal plant species used to treat retained placenta showed that *Andrachne ephmera* is the most preferred followed by *Cordia moonoica*, *Ocimum gratissimum*, *Senna italica* and *Saturejia biflora* (Table 3).

Paired comparison and direct matrix ranking

Out of the eleven medicinal plant species used to treat swelling, five with the highest informant consensus were selected and compared to know their ranks as used medicinally using paired comparison. *Withania sominifera* stood first among the others, followed by *Croton macrostachyus*, *Indigofera spicata*, *Kohautia platyphyla* and *Oxalis anthelmintica*, respectively (Table 4). Direct matrix ranking results for multipurpose use of medicinal plant species showed that *Croton macrostachyus* was the most multipurpose plant species, followed by *Terminalia brownii* and *Moringa senopetala* and others (Table 5).

Preparations of traditional medicinal plant species as herbal remedies

Medicine was prepared from twenty-six medicinal plants while fresh, and twenty-nine plants are dried before use, on the other hand sixteen

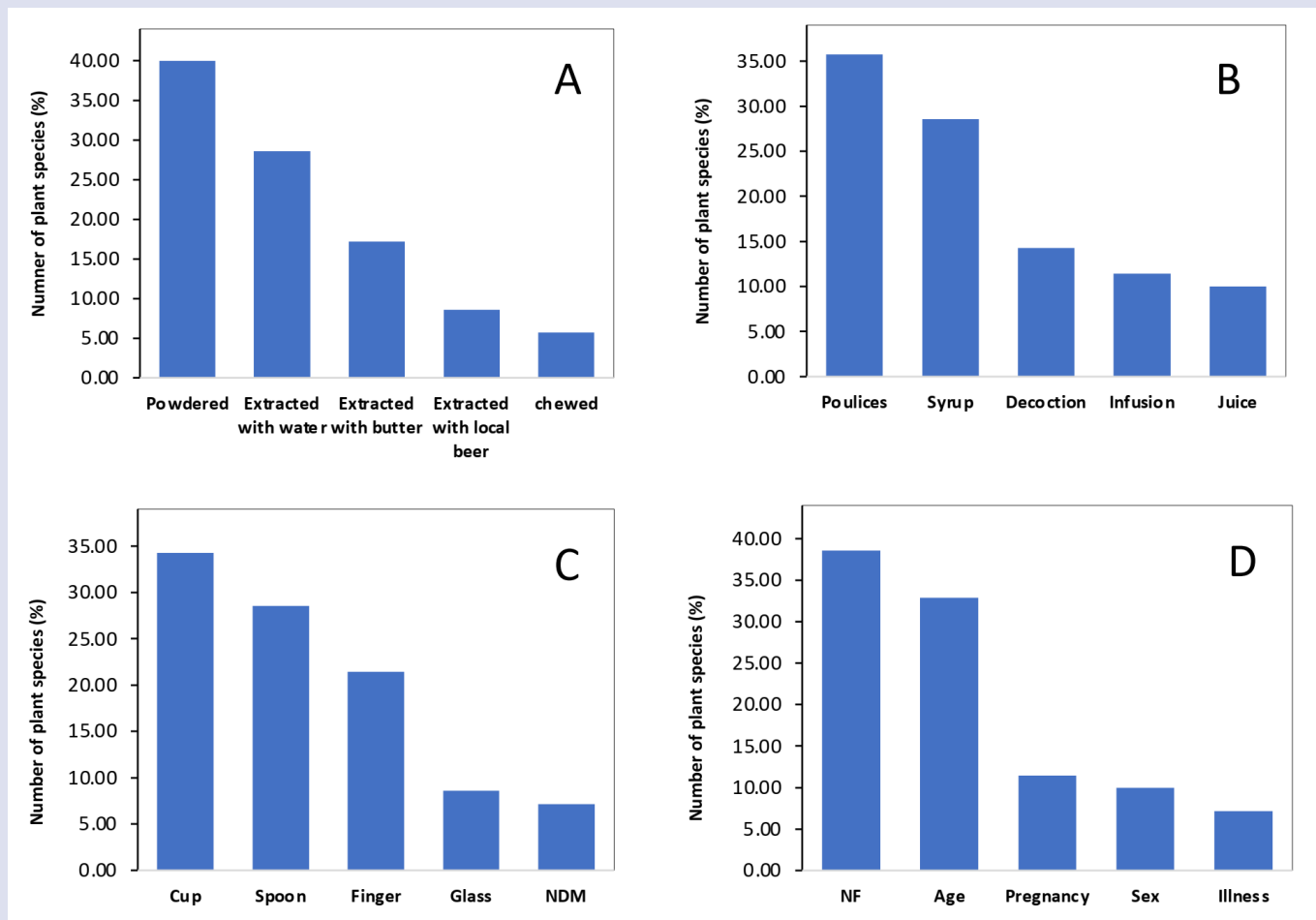


Figure 2: A: Modes of preparation, B: Types of preparation of plant remedies, C: Different ways of measuring the dosages of herbal medicinal preparations, D: Factors determining the dosages of medicaments.

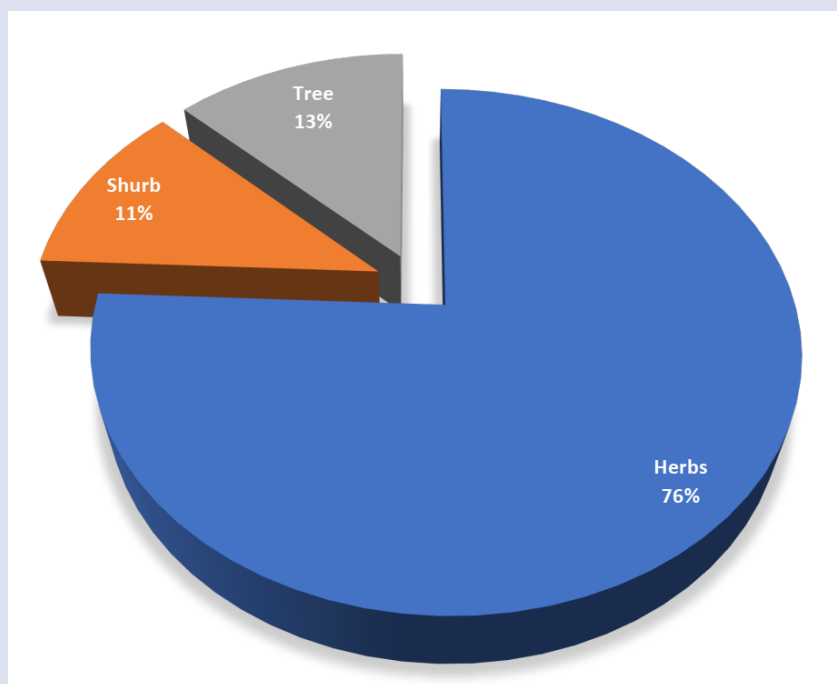


Figure 3: Percentage distribution of growth forms of medicinal plants used to treat human ailments.

Table 2: List and description of traditional medicinal plant species used for the treatment of Human in the study area. Hb=habit, H=herb, S=shrub, T=tree, Pu=part used, Cd=condition, Rt=root, Rb=root and bark, F=fresh, D=dry, L=leaf, Fr=fruit, Fl=flower, Sd=seed, W=whole part of plant, St=stem, B=bark, Ab=abundant, R=rare.

Botanical/Scientific Name	Family	Local Name	Hb	Pu	Cd	Preparation Method	Disease Treated	St
<i>Achyranthus aspera</i> L.	Amaranthaceae	Sardoda	H	L	D	1. Leaf, together with the root of <i>W. sominifera</i> are mixed and powdered, mixed with butter and massaged on the swelling. 2. Leaf is crushed and enclosed with cotton and placed on the teeth, the juice is swallowed.	Swelling, Tetanus	Ab
<i>Allium sativum</i> L.	Alliaceae	Nech shinkurt (Amh.)	H	B	FD	Three to five cloves of <i>A. sativum</i> (as many as possible for malaria) are chewed and swallowed.	Influenza, headache and malaria	
<i>Andrachne ephemeria</i> G. Gilbert	Euphorbiaceae	Ukisha	H	L	FD	1. Fresh or powdered leaf is mixed with water and drunk. 2. Leaf is powdered and mixed with butter and placed on the painful area.	Evil eye	
<i>Anethum graveolens</i> L.	Umbeliferae	Telbka	H	L	D	Leaf is powdered and mixed with water and drunk	Spasm	
<i>Artemisia abyssinica</i> Sch. Bip. Ex A. Rich.	Asteraceae		H	Rt	D	Root is crushed and powdered and mixed with water and placed over the wound	Wound	
<i>Astripomea</i> sp.	Convolvulaceae	Urganbayda	H	Rb	D	Root bark is powdered, mixed with local beer and rubbed on the body.	Rheumatism	Ab
<i>Asystasia amphilina</i> Ensermu	Acanthaceae	Rando	H	L	F	Leaf and root are crushed and rubbed over the teeth surface	Gigg	R
<i>Asystasia riparia</i> Lindau.	Acanthaceae		H	L	FD	Leaf is crushed and placed over the swelling	Swelling	Ab
<i>Barleria orbicularis</i> Hchst. ex. T. And.	Acanthaceae	Kibila	H	L	D	Leaf is powdered and mixed with water and drunk	Immunization of fetus in a pregnant woman against gigg	R
<i>Calpurnia aurea</i> (Ait.) Benth.	Fabaceae	Digitta	S	Fr	F	Nine fruits for adult and seven for children are mixed with coffee and drunk.	Diarrhea	Ab
<i>Caesalpina volkensii</i> Harms	Fabaceae	Taasha	T	Fr	D	Fruit is toasted and ground, powdered and mixed with butter and rubbed on the hair.	Dundruff	Ab
<i>Carica papaya</i> L.	Caricaceae	Papayatta	H	L	D	Leaf is crushed and dried, powder added on the wound.	Wounds	
<i>Chenopodium schraderianum</i> Schult.	Chenopodiaceae	Olindarbaya	H	L	F	Leaf, flower and fruit are mixed and powdered and placed over the site of	Stubbing pain on the lungs	Ab
<i>Clerodendrum myricoides</i> (Hochst.) Vatke	Verbenaceae	Punitopurgaya	H	L	D	Leaf is powdered and mixed with coffee and drunk.	Rheumatism	R
<i>Combretum aculeatum</i> Vent.	Combretaceae	Gnifrida	T	Rb, Fl, Fr & Sd	D	1. Root bark, flower and fruit are powdered together and mixed with coffee and drunk early in the morning before breakfast, for the treatment of intestinal parasites. 2. Seeds are eaten to remove ascaris.	Intestinal parasites	Ab
<i>Croton macrostachyus</i> Del.	Euphorbiaceae	Maskanta	T	Rb	FD	Root bark is crushed, powdered and mixed with butter and placed on the swelling or rubbed on skin surfaces for rheumatism. For ear pain with pus, the powder is added into the ear. For spasm, it is mixed with water and drunk.	Swelling, Rheumatism, Ear pain,	Ab
<i>Duosperma eremophilum</i> Milne Redh.	Acanthaceae		H	Rt	D	1. Leaf is powdered and mixed with coffee and honey, and drunk. 2. Bathing the wound with water and the powder is added.	Spasm	R
<i>Echinops macrochaetes</i> Fresen.	Asteraceae		H	L	FD	Leaf, together with that of ginger is crushed and dried or fresh, mixed with water and drunk.	Evil eye	R
<i>Encostema axilare</i> (Lam.) A. Raynal	Gentianaceae		H	Rt	F	When spine enters the foot sole, root is crushed and placed on it.	Spine entering foot sole.	R
<i>Euclea schimperi</i> (Dc.) Dandy	Ebenaceae	Dodoho	S	Rt & Fr	F	Fresh root of the plant, boiled in water, the resulting tea is drunk.	Fibrile illness	R
<i>Euphorbia indica</i> Lam.	Euphorbiaceae	Dhetungayda	H	Rt	D	Root is powdered and mixed with butter and rubbed on the skin surface.	Measles	R
<i>Euphorbia inaequilatera</i> Sond.	Euphorbiaceae	Dhetungayda	H	L	D	Leaf is powdered and mixed with butter and rubbed on the chest.	Measles	
<i>Foeniculum vulgare</i> Mill	Umbeliferae	Fisha	H	Rt	D	Root is powdered and mixed with water and drunk	Urine retention	Ab

<i>Gardenia ternifolia</i> Schumach & Thonn.	Rubiaceae		T	Rb	FD	Root bark is crushed and mixed with water and drunk.	Jaundice	Ab
<i>Galinsoga parviflora</i> Cav.	Asteraceae		H	L	F	Leaves and flowers are chewed together and the juice is swallowed.	Tonsillitis	R
<i>Gomphocarpus</i>	Aselpidaceae		S	L	FD	Leaves together with those of ginger are crushed and dried or fresh, mixed with water and drunk	Evil eye	R
<i>Gossypium arboreum</i> L.	Malvaceae		H	Fl	D	Flower bud is crushed and dried, powdered and placed over the wound and tied with the stem slash of <i>T. brownii</i> .	Wound	Ab
<i>Hagenia abyssinica</i> (Bruce) J. F. Gmel.	Rosaceae	Koso	T	Fl	FD	Flower part is crushed, mixed with water and ground, diluted by the addition of water and drunk early in the morning before breakfast.	Tania (koso or tapewarm)	R
<i>Hyptis pectinata</i>	Lamiaceae	Kirrikabayta	H	L	FD	Powdered and mixed with water and placed on the stabbing site.	Stabbing pain.	Ab
<i>Hypoestes forskaolei</i> (Vahl.) R. Br.	Acanthaceae	Kuyneta	H	L & Rt	F	Leaf and root are pounded together and mixed with water and drunk.	Snake bite.	Ab
<i>Ipomoea kituiensis</i> Vatke	Convolvulaceae	Laalata	H	Rt	FD	Root is powdered and mixed with butter and rubbed on the swelling. 2. Root is crushed and mixed with water and drunk.	Swelling	R
<i>Indigofera lupatana</i>	Fabaceae	Arkabyda	H	Rt	FD	Root is crushed or powdered, mixed with local beer and rubbed over body surface and drunk		
<i>Indigofera spicata</i> Forssk.	Fabaceae	Korsita	H	L	D	Leaf is powdered and mixed with butter and is massaged on the swelling.	Swelling.	Ab
<i>Justicia flava</i> (Vahl) Vahl	Acanthaceae		H	L	D	Leaf is crushed and placed on the teeth surface.	Gigg	Ab
<i>Kohautia platyphylla</i>	Rubiaceae		S	L	FD	Leaves, crushed, dried and powdered, mixed with butter and rubbed on a swelling	Swelling	Ab
<i>Lagenaria siceraria</i> (Mlina) Standl	Cucurbitaceae	Dhahanata	H	L & St	D	Leaf and stem with those of <i>Cordia monica</i> Roxb. And <i>H. pectinata</i> are powdered and mixed and with butter and local beer and/or coffee and drunk.	Retained placenta.	Ab
<i>Lepidium sativum</i> L.	Brassicaceae	Feto	H	Sd	D	Seeds are chewed to cure throat diseases (tonsillitis and cough). For febrile illness, the chewed seed are spitted and spread over the skin and left there for some length of time (one night) and washed away.	Febrile illness, Tonsillitis, Cough	Ab
<i>Leucas mertinicencis</i>	Lamiaceae	Keesi	H	L	F	Leaf, crushed and mixed with water and drunk	Evil eye	Ab
<i>Leucas neuflyzeana</i> Courbon	Lamiaceae	Kuba	H	W	D	Whole plant is powdered and placed on the tonsillitis.	Tonsillitis	
<i>Moringa stenopetala</i> (E.G.Baker) Cufod.	Moringaceae	Shelqata	T	L	F	Leaves cooked and eaten	Hypertension	Ab
<i>Nymphaea nouchali</i>	Nymphaeaceae		H	L	F	Leaf is crushed and placed on the top of and infants teeth.	Gigg	R
<i>Ocimum lamiifolium</i>	Lamiaceae		H	L	F	Leaf is crushed and rubbed over the body and also smelled	Fibrile illness	Ab
<i>Ocimum urticifolium</i> (Vahl) R. Br.	Lamiaceae		H	W	FD	1. Whole part of the plant is chewed and juice is swallowed. 2. Powdered and stored for future use	Spasm	Ab
<i>Oxalis anthelmentica</i> . A. Rich	Oxilidaceae	Malkisa	H	L	F	Young leaf bud is chewd and placed on the eye of the patient by the healer. Leaf is crushed and placed on the swelling or the wound.	When a white substance is formed on the black of the eye. Swelling Fire burning	R
<i>Pentas schimperiana</i> (A. Rich) Vatke	Rubiaceae	Shunqayta	H	L	F	Leaf is mixed with coffee leaf tea and boiled and drunk. Toasted salt is added.	Liver problem.	R
<i>Phyllantes pseudoniruri</i> Muel.	Euphorbiaceae		S	Rt	F	Root is crushed and mixed with coffee and dunk.	Amoeba Bloody diarrhea	R
<i>Plectranthus barbatus</i> Andr.	Lamiaceae	Harkidbinesha.	H	Rt	D	1. Root is powdered and mixed with butter and rubbed on the swelling. 2. Root is crushed and mixed with water and drunk.		
<i>Polichia campestris</i> Ait.	Carryophyllacea	Dhindhinsha.	H	L & Rt	F	Leaf and root with that of <i>T. zeylanica</i> and <i>I. spicata</i> are crushed together and are placed on the skin surface.	Scabis	Ab
<i>Polygala erioptera</i> DC	Polygalaceae		H	L	D	Leaf is crushed and powdered and placed on the tonsillitis	Tonsilitis	R

<i>Pterocephalus frutescens</i> Ryding.	Dipsacaceae	Dokobaha.	H	L	F	1. Leaf is crushed with the fingers and squeezed to add drops into the eye. 2. Root is chewed and the juice is swallowed.	Trachoma and white thing forme d on the eye Diarrhea	Ab
<i>Rubia cordifolia</i> L.	Rubiaceae	Kotkotata	H	Rt	F	Root is crushed and squeezed and the resulting juice is drunk.	Eviley	R
<i>Rumex</i> sp.	Polygonaceae	Fitilita	H	Rb	D	Root bark is powdered and mixed with coffee drunk. For children only external application on the swelling.	Swelling.	Ab
<i>Ruta chalapensis</i> L.	Rutaceae	Tenadam (Amh.)	H	L	F	Leaf is chewed and juice is swallowed for spasm and for evil eye.	Spasm Evleye.	Ab
<i>Sansevieris</i> sp.	Agavaceae		H	Rt	F	Root is chewed and swallowed. The dry is bitter.	Sanke bite spasm	Ab
<i>Saturejia biflora</i> Birq.	Lamiaceae	Escata	S	W	D	The powder is mixed with any type of syrup and drunk.	Retained placenta.	Ab
<i>Senna italica</i> Mill.	Fabaceae	Kikibayta	H	Rt	D	Root, together with the root of <i>I. Iuptana</i> are crushed and powdered, mixed with local beer and massaged on the painful body part.	Gigg, Rheumatism Retained placenta .	Ab
<i>Solanum tettense</i> Klotsch	Solanaceae	Arba	H	L	D	Leaf is powdered and mixed with local beer and placed on the swelling.	Swelling	Ab
<i>Solanum incanum</i> L.	Solanaceae	Timbiloda	H	Rt	F	Root is chewed and the juice swallowed.	Spasm	Ab
<i>Sorghum bicolor</i> (L.) Moench	Poaceae	Mashilla	H	Sd	D	Dried seed is powdered and a thin pancake – like fermented bread is prepared and is eaten by the patient.	Diarrhoea	Ab
<i>Spilanthus maurutiana</i>	Asteraceae	Tabnata	H	Fl	F	Lowers are collected and chewed and swallowed.	Spasm	R
<i>Senna singueana</i> (Del) Lock	Fabaceae	Hanqarara	H	L	F	Leaf is crushed and squeezed to add drops into the eye.	When the milk of E. tirucali enters the eye	Ab
<i>Silene flamulifolia</i> A. Rich.	Caryophyllaceae	Wawa	H	Rt	FD	Root is smelled for headache. Leaf is powdered and mixed with water and drunk for amoeba.	Headache, Amoeba	Ab
<i>Tamarindus indica</i> L.	Fabaceae	Kore	T	Rt & Fr	FD	The root and the fruit are soaked in water and the infusion is drunk.	Stomach ache	R
<i>Terminalia brownii</i> Fresen.	Combretaceae	Olpatata	T	L	FD	Leaf is dried and powdered added on a wound and tied up by its stem bark.	Wound	Ab
<i>Trichodesma zeylanica</i> R. Br.	Boraginaceae	Kutata	H	L & Rt	F	Leaf and root of this plant, <i>P. campestris</i> and <i>I. Spicata</i> are crushed together and placed on the skin surface.		
<i>Vangueria madagascarensis</i> Gmelin	Rubiaceae	Mudhungayda	S	Rb	F	Root bark is crushed and mixed with butter and placed on the swelling.	Swelling	R
<i>Vernonia amygdalina</i> Del.	Asteraceae	Birmayda	S	L	F	Leaf bud is collected and crushed, mixed with water and drunk. Ella is the antidote against the vomiting that immediately follows.		
<i>Withania sominifera</i> Birq.	Solanaceae	Chomatita	H	Rt	D	Root is powdered and mixed with butter and placed on the swelling.	Swelling	Ab
<i>Zanthoxylum chalybeum</i> Engl.	Rutaceae	Katata	T	Rt	D	Root is powdered and enclosed with cotton and placed on the teeth.	Tooth pain	R

Table 3: Values for preference ranking based on their degree of treating retained placenta for five Medicinal Plant Species (MPS) in the study area.

MPS	A	B	C	D	E	F	G	H	I	J	Total	Rank
<i>Saturejia biflora</i>	3	2	1	4	3	5	4	4	2	1	29	5 th
<i>Ocimum gratissimum</i>	5	4	3	5	2	4	1	3	3	4	34	3 rd
<i>Senna italica</i>	3	3	4	5	2	1	4	5	2	3	32	4 th
<i>Cordia monoica</i>	4	3	5	2	5	4	3	2	4	4	36	2 nd
<i>Andrachne ephemera</i>	5	4	3	4	3	2	5	4	3	5	38	1 st

Table 4: Paired comparison of Medicinal Plant Species (MPS) used to Treat Swelling; 5- best, 4- Very good, 3- Good, 2- Fair, 1- Least, R 1- 10 are different respondents, S- Stands for the species in Paired Comparison and subscripts 1,2,3,4 and 5 indicate the species.

MPS	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Total	Rank
<i>Oxalis anthelmintica</i> (S ₁)	4	2	1	1	3	3	5	2	4	1	26	5 th
<i>Croton macrostachyus</i> (S ₂)	4	4	5	4	5	5	3	4	5	4	43	2 nd
<i>Kohautia platyphyla</i> (S ₃)	5	4	3	1	4	1	1	2	3	5	29	4 th
<i>Withania sominifera</i> (S ₄)	3	5	4	5	5	4	4	5	5	5	45	1 st
<i>Indigofera spicata</i> (S ₅)	5	3	4	2	5	3	2	4	1	3	32	3 rd

Table 5: Direct matrix ranking for randomly selected five Medicinal Plant Species (*Terminalia brownie*, *Croton macrostachyus*, *Lagenaria siceraria*, *Moringa stenopetala*, *Anetum. Sativum*) in the study area (total scores of ten informants).

Multiple uses	T. brownii	C. macrostachyus	L. siceraria	M. stenopetala	A. sativum
Building	40	40	0	20	0
Medicine	25	40	35	35	40
Firewood	35	30	0	25	0
Fodder	40	30	35	38	0
Edible	0	30	40	40	40
Charcoal	30	30	0	0	0
Grand	170	200	110	158	80
Rank	2 nd	1 st	4 th	3 rd	5 th

Table 6: Numbers and percentages of different ways of traditional medicinal plants use knowledge acquisition or inheritance.

Source of acquisition	No of acquisitions	Percentage
Father	16	38.1
Traditional healer	5	11.9
Other means	4	9.5
Grand father	4	9.5
Self-trial and error	3	7.1
Father in law	2	4.8
Friend	2	4.8
After illness (healer)	2	4.8
Grand mother	1	2.4
Elder brother	1	2.4
Aunt	1	2.4
Mother	1	2.4

Table 7: Healers' Transfer of knowledge of the use of medicinal plants.

To whom transferred (Inheritor)	Number, transfers	Percentage
Eldest son or daughter	12	28.6
Beloved son or daughter	6	14.3
To everybody freely	6	14.3
All children of the healer	4	9.5
Youngest child of healer	3	7.1
Son in Law	2	4.8
Daughter in law	2	4.8
Wife	2	4.8
Neighboring person	2	4.8
Second child	2	4.8
All members of the family	1	2.4

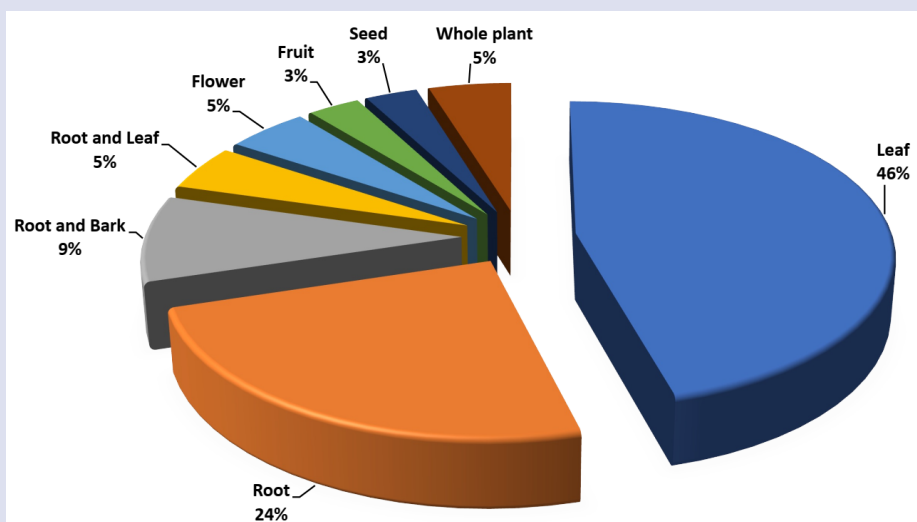


Figure 4: Plant parts use by the community as remedy categorized as single part, combination of two or more parts, whole plant and fruit/seed.

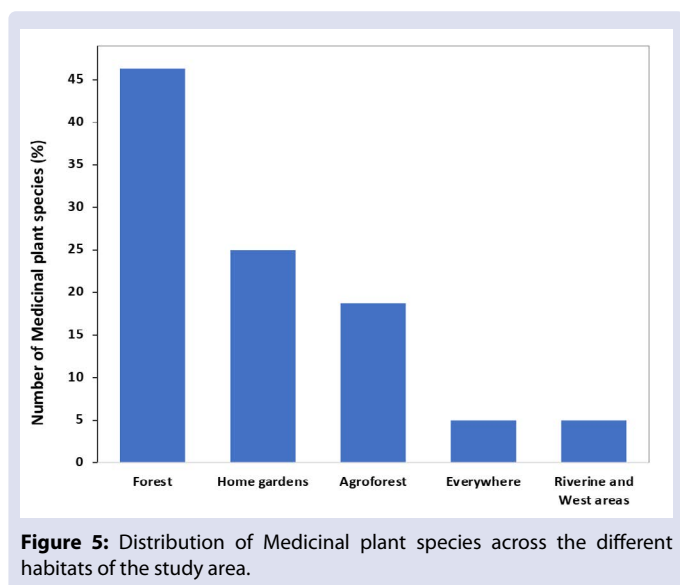


Figure 5: Distribution of Medicinal plant species across the different habitats of the study area.

plants are used either fresh or after drying out of 70 medicinal plants. Medicine in powdered form was used in 40% of the medicinal plant species directly and of the remaining 51.4% are chewed, extracted with water, and / or with butter (17.1% each) and 8.6% are extracted with local beer (Figure 4A). Moreover, drinking is the highest mode of administration (45.1%) followed by ointment (31%), chewing, and swallowing. The results showed that poultices are the most common type of preparation (35.7%) followed by syrup (28.6%), decoction (15.7%), infusion (14.3%), juice (12.9%) in that order (Figure 4B). The most frequently used type of measurement of the dosage of medicament is by cups (36.7%) and the second type of measurement is by finger (28.6%). In some cases, the dosage is administered without measurement (Figure 4C). The dosage of herbal remedies is not affected by any factor in a larger percentage (38.6%). Age affects the dosages of 36.7% of the plants; pregnancy affects 10% of the dosages of the medicaments (Figure 4D). The root of application of herbal remedies used in the study area, 68.6% were applied orally and 31.4% were applied externally. Only three medicinal plant species preparations have a vomiting side effect when administered and all the remaining plants have no known side effects as explained by the traditional healers. Antidotes were not needed for those that have side effects. For evil eye, for instance, after the medicine is administered, vomiting follows immediately. This, according to the healer, is a symptom that the medicine has worked properly, immediately followed by the sudden resumption of consciousness (cure) of the patient.

Age distribution, knowledge acquisition and knowledge transfer of the traditional healers

The ages of the healers lie between the youngest age being 28 years and the oldest age being 87 years. The highest number of healers lies in the age group between 51 and 70 and it comprises around 50% of the total number of healers. This means that healers' numbers increase with increasing age up to certain age limit, between 70 and 80 and decreases as we go above 80 years of age and below 50 years of age. The highest number of traditional medicinal knowledge is that which is inherited from father, which is 38.1% of the total ways of acquisition (Table 6). Most of the traditional healers prefer to keep their traditional healing practices secret. However, the highest proportion (28%) of transfer of knowledge of traditional medicinal plants use was to the eldest son or daughter (Table 7). All of the healers (100%) do not document their knowledge of the use of traditional medicinal practices, both the acquisition (inheritance) and transfer of the knowledge of traditional

medicinal practices is done by a word of the mouth as top secret in the presence of only the healer and his inheritor.

Habitat sources of the medicinal plants to the healers

The results showed that the highest source of the medicinal plants was the forest (45.3%). Home gardens and agro forests together contribute 41.86% of the medicinal plants. The traditional medicinal plant species documented in this study were classified into four availability categories. Accordingly, 41.9% of the medicinal plants are present everywhere, 32.6% are present in very far places, 17.4% are available only where forests are found and 8.1% have already disappeared from their usual places (Figure 5). Most of the healers have made no attempt to conserve the medicinal plants they use, and few have made some attempts to conserve the plants.

DISCUSSION

Traditional medicinal plant species richness documented in the study area

A good number of medicinal plants have been documented in this study used for the treatment of human health problems by the indigenous people of Konso. This result is larger in similar studies, for example in a study carried out on Zay people in the Rift Valley of Ethiopia by⁴⁰ three species of medicinal plants have been recorded and in a similar study conducted on Berta people in the Benshangul Gumuz Region in Western Ethiopia results documented 24 medicinal plant species.⁴¹ Similarly,⁴² stated that in the Sheka zone, 77% of medicinal plants were utilized to cure human illnesses, and that the remaining 19% were used to treat illnesses that affected both people and animals. According to the current findings, the majority of the medicinal plant species that were gathered and identified in this study were also used elsewhere in the nation.^{17,18,43,44} These findings imply that the local Ethiopian population has a widespread tendency to use the same medicinal plants and this may be a sign of the true therapeutic benefits of these plants as well as indigenous knowledge of medicinal plants and to some extent prolong their potency.

Health problems, indigenous knowledge and herbal/ medicinal plants use

Like many other communities in Ethiopia, the Konso people use herbal medicine for their primary health care systems. In this community, the herbal practitioners are consulted to attend to common ailments such as spasm, headache, retained placenta, rheumatism, mouth thrush, wounds, tonsillitis, urine retention, anthrax infection, snakebite, and evil eye. This is true in many other traditional set up.^{2,27,30,43,45} The use of plant remedies to treat this line of ailments, is common in indigenous communities when compared with modern drugs which are often used to treat disorders of cardiovascular and nervous systems, neoplasm and microbial ailments.^{2,46-48} This trend is attributed to the fact that, indigenous people can easily detect inflammations, skin diseases and gastrointestinal disorders as compared to cancer and cardiovascular diseases.

The diversity of medicinal plants recorded in this study indicates that although the area is losing its natural vegetation, there are still many medicinal plants available to the users. There is also broad indigenous knowledge on the remaining vegetation and the medicinal plants. A rich knowledge of medicinal plants has also disappeared because most of the specialized healers failed to transfer the knowledge properly to the next generation. The healers of the study area have a strong tendency to keep their knowledge secret. According to the results of this study, more than 65% of the healers did not want to share their knowledge on traditional medicinal plants use to anyone except to only one chosen person and this is done only when they come to the verge

of death. Similar results were observed by.^{41,49} Reasons not to share knowledge of traditional medicinal practice to community members include loss of healing power by the medicines, cultural restrictions, loss of source of income, and even if a person obtains the knowledge, it will not work to affect curing unless it is applied by the hands of the proper traditional healer, i.e. only the 'healers hands' are endowed with a healing power and other people's hands are not. Many of the traditional healers or practitioners prefer to reveal their knowledge only to members of their own family and never to outsiders because they consider their knowledge as professional secret. The family members who have inherited the traditional medical knowledge sometimes find it hard to carry through to the next generation, especially with the increasing acculturation process.⁵⁰ Consequently, with the passing of each successive generation the information gets irretrievably lost or becomes distorted.⁵¹ According to four informants of the field survey, the identity of one medicinal plant, which was used as a remedy against snakebite, was lost because the healer died without revealing the identity of the plant to anyone else.

Hunde *et al.*⁵² found that those who are acquiring higher education are not showing willingness to learn the indigenous knowledge from their parents, which might indicate the gradual disappearance of traditional knowledge. This trend is also observed in the Konso Woreda. Ethnomedicinal knowledge diminishes with the death of elderly people in the society, since less and less young people are willing to acquire the knowledge. The same author has noted out that another reason for the disappearance of knowledge of medicinal plants is also connected with at least three factors: 1) healers showing strong tendencies to keep their knowledge secret, 2) when they are willing to pass their knowledge to someone else, it is done verbally and it includes vernacular names of the medicinal plants, method of preparation, disease(s) treated and habit of the plant, which is difficult for the learner to memorize all these facts, 3) aged healers passing the knowledge are not considered proper in most cases due to doubtful authenticity of the description they provide. These notions are also relevant in Konso.

Acceptance and knowledge of traditional medicinal practice by the community

The results of the study showed that out of the 42 informants, 31 (73.8%) believe that traditional medicinal practice has higher acceptance by the community than modern medicinal practices. Different types of herbal medicines were used by 70.9% of the participants either by themselves or through visiting traditional healers at least once in their lifetime. The family members of the participants were 22.7% experiencing adverse effects due to traditional medicine therapy. A study done in Merawi town showed that where 61.5% of study participants had good knowledge about traditional medicines. 28.3% of the study participants prefer to use traditional medicines rather than modern health services.⁵³ Another study was done in Jara Town, Bale Zone, Southeast Ethiopia, where 96.3% of the respondents heard about traditional medicine, 43.91% of the respondents have planned to use traditional medicine in the future, 54.61% of the respondents believe that traditional medicines can cure diseases that are not cured by modern medicine, 63.6% suggest that herbal medicine users should consider herbal medicine is safe to use, 39.85% had positive attitude towards traditional medicine, 50.18% of the respondent accept traditional health practice, and 73.8% of the respondents have used traditional medicine at least once in their lifetime.⁵⁴

Medical herbalism was the most common traditional practice (79.47%). The respondents prefer to keep their knowledge as a secret was 35.76% whereas, 72.85% of the respondents manage their acute/chronic illnesses by both self-medication and visiting traditional medicine practitioners, 66.89% of the respondents were selecting

both traditional medicine and modern medicine for curing illness. The most of 71.52% of the respondents prefer to visit traditional medicine practitioners first whenever they fall sick, and also most of the respondents prefer traditional medicine to modern medicine due to affordability, accessibility, and acceptability. Management of their acute chronic illness by both self-medication and visiting traditional medicine practitioners was practiced by 72.85% of the respondents.⁵⁵

Reasons for the acceptance of traditional medicinal practice by the community

The results showed that 64.3% of the informants believed that the reason for more acceptances to the traditional medicinal practice by the community is because they believe that it is more effective and cures many health problems than modern health remedies. Lack of access to modern health centers has been mentioned, as the main reason for the acceptance of traditional medicinal practices by 28.6% of the informants and 7.1% of the healers believe that traditional medicine can be obtained at a cheaper price. Traditional medicines are still accepted and counted on by 59.2% of the participants in the community and 49.5% of the participants agree that the reason is cultural acceptability, 42.2% of the participants after the use of traditional medicines had shown good outcome,⁵⁶⁻⁵⁹ due to its long period of practice and existence, traditional medicine has become an integral part of the culture of Ethiopian people.^{22,50} Plants have been used as a source of traditional medicine in Ethiopia to combat different ailments and human sufferings and due to its long period of practice and existence, traditional medicine has become an integral part of the culture of Ethiopian people.^{18,22,53,60,61}

Gender and age distribution of indigenous knowledge

Out of the total healers sampled, 12 (28.6%) were female healers. This is a relatively significant proportion of women participation in the traditional healing system in the study area, as compared to that in the study areas elsewhere.⁵³ Abebe and Hagos,⁶² reported that the practice of traditional medicine in Ethiopia is dominated by men. (Debella *et al.*⁵⁰ has found out only seven women healers in the study of traditional medicinal plants in Bosati Woreda, Wolenchiti area indigenous people. The knowledge of herbal remedies is largely found in the middle-aged members (70% of them are between the ages of 41 and 70) of the community mostly as herbal practitioners and knowledgeable people and not among the youths. According to most (80%) of the informants the youth are not willing to learn the healing skill and view it as something primitive. This attitude is attributed due to the influence of modernization and western education and other exotic ideas. Accordingly,⁶³ reported in Shopa Bultum that 36.42% of the respondents had good knowledge and of an older age and lower educational level.

Preference ranking and paired comparison

When there are different species prescribed for the treatment of the same health problem, people show preference of one over the other. Of the several species used for the treatment of retained placenta people showed preference of one over the other. Furthermore, they have shown their comparative choices of some medicinal plant species used for treating swelling. From the paired comparison and preference ranking it could be understood that the most favored species are the most efficacious, at least in the context of the people who use them. In addition to this, it shows the credibility and continuity of the ethnomedicinal information obtained from indigenous people. The informants also informed that they believe that there is no any modern medical treatment against swelling and retained placenta.⁵⁴ From their ethnobotanical study in Jara Town, Bale Zone, Southeast Ethiopia, reported that 79.47% of the respondents believe that traditional medicine can cure diseases better than modern doctors.

Habits of the medicinal plants and parts used

About 76.5% of the remedies were reported to have been obtained from herbs, 11.8% from shrubs and 11.8% from trees. This high percentage of herbs used as remedies of health problems in the study area may be due to the fact that the degradation of the vegetation and the trees being found as scattered relics in agro forests and a number of remnant patches as traditional protected areas in the study area. This finding agrees with the findings of,⁵⁰ who suggested that the people have started to rely on herbs because they are relatively common in the study area as compared to tree species. Yirga,¹⁸ compiled 51 medicinal plants used in the traditional health care system in Ethiopia of which 30 species (56%) were herbs.

Source habitats of medicinal plants

The most widely used medicinal plant species for the preparation of remedies in the area are harvested from the wild. This is also true in many parts of the country. Awas and Asfaw,⁴¹ reported that 71% of the medicinal plants of the Berta people in western Ethiopia are obtained from the wild. Whereas,⁶³ reported that only 6% of the plants maintained in home gardens in Ethiopia are primarily cultivated for their medicinal value even though many other plants grown for non – medicinal uses turn out to be important medicines when some health problems are encountered. This directly indicates that most of the medicinal plant species are under threat as long as the destruction and fragmentation of wild habitats continues.

Availability status of traditional medicinal plant species in the study area

The results of the study showed that the traditional medicinal plant species documented in this study had varying levels of availabilities, which were classified into four availability categories. Accordingly, 41.9% of the medicinal plants are available everywhere, 32.6% are available in very far places, 17.4% are available only where forests are found and 8.1% have already disappeared from their usual places. Except the first availability category, which consisted of 41.9%, the rest categories can be considered as not sufficiently available. However, studies that experimentally examined the abundance of medicinal plants frequently concentrated on limited geographic regions or certain species.^{64,65}

Plant survival and harvested plant part

The results showed that there is a relatively larger amount of root harvest (35%) followed by leaf parts harvest (32.9%). However, collecting leaves alone could not pose a lasting danger to the continuity in life of individual plant as compared with the collection of underground parts, stem or whole plant. Studies have shown that the removal of upto 50% of tree leaves does not significantly affect the growth of the species studied.⁶² The harvest of roots as remedies in large amounts is detrimental to the availability and survival of the medicinal plant species. For example, *Croton macrostachyus* is used as a remedy against more than six different ailments and all the preparations involve root bark harvest. It has been reported by the informants and from personal observation that this plant species is declining in number and its distribution in the area because the harvest from root bark results in the death of the whole plant. Whole plant harvest comprised only 4% of the total plant harvest in the study area and thus it cannot be considered as a major threat to the survival of the medicinal plants of the study area in general.

CONCLUDING REMARKS

The present study was undertaken in Konso woreda to characterize the threats that medicinal plants are facing in the study area and to evaluate

the indigenous knowledge that enables the community to identify the medicinal plants, formulate the medicines, and subsequently administer the curatives used to treat various human ailments. A total of 70 medicinal plant species belonging to 59 plant genera and 30 plant families used by Konso people were recorded. The number of health problems potentially treated by traditional medicinal plants in the study area is approximately thirty-six. The use of traditional medicinal herbs is claimed to be a more effective cure for their health issues by healers (100%) than using contemporary medical methods. The retained placenta is the most serious health problem and can even be fatal if not treated effectively. The preference ranking for five medicinal plant species used to treat placental residue showed that *Andrachne Ephemera* is the most preferred, followed by *Cordia moonoica*, *Ocimum gratissimum*, *Senna italica* and *Satureja biflora*, in the order. The majority of therapeutic plants over forty five percent were gathered from forests, whereas just 25% of the medicinal plant species were taken from backyard gardens. Most plant species are herbs (76%), and leaves are the part of the plant most commonly used for preparation of remedies. The most of plant materials utilized in treatments are collected from nearby plant resources from which either freshly collected leaves or dried plant materials is used. The recommendation drawn from our study includes that by improving traditional medicines and raising awareness among younger members of the community about the significance and conservation of traditional medicinal plant species and the associated indigenous knowledge, which is urgently needed, attention should be paid to the standardization of the unit quantification, contraindication, and hygiene of these medicines prepared from plants. Moreover, effective conservation approaches must be designed and put into practice in order to use the medicinal flora sustainably and the preservation of traditional knowledge.

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AUTHOR CONTRIBUTIONS

TG and BC conceived and designed the study. TG, DSVC and BC analyzed the data. TG, DSVC, and BC contributed to the writing of the manuscript. TG, DSVC, BC agree with manuscript results, conclusions and developed the structure and arguments for the article. Authors reviewed and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Before the interviews, all participants provided prior, and informed consent.

DATA AND MATERIALS AVAILABILITY

Data from the first author is available.

DECLARATION OF CONFLICTING INTERESTS

There are no competing interests, according to the authors.

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