

Consumption of wild edible plants in the Kofale and Heban-Arsi districts, West Arsi Zone, Oromia Regional State, Ethiopia

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Abstract

Background

Wild edible plants (WEPs) are neglected and have received little attention despite their significant contributions to the sustenance and livelihoods of rural communities. This study was conducted in the Kofale and Heban-Arsi districts of the Oromia Regional State, Ethiopia, to document the diversity of WEPs, their utilization, and threats facing them.

Methods

Ethnobotanical data were collected via semi-structured interviews, field observations, focus-group discussions and guided field walks. The interviews involved 290 informants who were selected via snowball sampling and systemic random sampling methods. Preference ranking values, direct matrix rankings, and use values (UVs) of selected species were computed.

Results

A total of 62 WEPs species belonging to 38 families and 56 genera were identified. The Moraceae family included 7 species, and the Fabaceae family included 4 species. Shrub was the dominant growth form (32 species), followed by herbs (13 species). The largest number (24 species) of WEPs was collected from grazing lands/fields, followed by forest habitats (17 species). The most widely used edible plant part was fruit (40 species) and leaf (11 species). Most WEPs were collected for consumption from March to May (30 species), and the majority of the species (48, 77.4%) were utilized in their raw state. A large number of WEP (41 species) were consumed only during periods of food shortage, and the remaining (21 species) were used as staple food supplements. Multiple other uses of WEPs in the study area have also been reported. Fifty-two species were mentioned for medicinal use, and the species that had the highest use value was *Cordia africana* Lam. (0.9). The direct matrix ranking results indicated that agricultural expansion was a principal threat to the WEPs in the study area.

Conclusion

This study indicated that WEPs are widely used during food shortages in the study area, but many WEP species are under threat due to growing pressure from various anthropogenic factors. Thus, public awareness and community-based management need to be encouraged at all levels to conserve and sustainably use these resources to address food insecurity.

Background

For generations, the majority of rural communities have used WEPs for food, medicine and other purposes [1]. According to the Food and Agriculture Organization (FAO), WEPs are defined as non-cultivated and non-domesticated plants [2]. In recent years, interest in the use of WEP resources has increased [3]. This might be due to the rising concern of global hunger attributable to the increasing human population and urban development [4, 5]. On the other hand, the replacement of traditional food products with imported or newly introduced foods, particularly those high in refined and processed ingredients, fats, and sugars, may lead to nutrient deficiencies and an increase in diet-related non-communicable diseases such as obesity, type 2 diabetes, and cardiovascular conditions [6]. Wild but naturally growing vegetables and fruits are considered healthier than cultivated vegetables because they are free of chemicals, such as residues from fertilizers and pesticides [7].

Malnutrition remains a persistent public health issue in sub-Saharan Africa, impacting health, mental well-being, productivity, and economic progress [8, 9]. Thirty-eight percent (38%) of Ethiopian children less than five years of age suffer from chronic malnutrition, and 22% of women of reproductive age are undernourished [10]. Several studies have suggested that the nutritional composition of WEPs is greater than that of agricultural crops [11]. They provide valuable nutritional supplements (nutraceuticals), including trace elements, vitamins, polyphenols, antioxidants, and flavonoids, and have very low lipid levels [12, 13]. Moreover, the utilization of WEPs enhances socioecological resilience for the sustainable development of communities [2]. Therefore, the integration of indigenous WEPs as sources of micro- and macronutrients could play an immense role in addressing the problems of prevailing malnutrition and food insecurity and advancing the sustainable development goal of ending hunger, as outlined by the United Nations [14]. Several studies [15–17] have highlighted the importance of WEPs in Africa, especially during famine or food shortages. In areas where food insecurity is prevalent during food shortages [18], most rural Ethiopian populations rely on WEP resources [11]. It was reported that WEPs have the potential to bridge food and nutritional deficits in food insecure households in Turkana County, Kenya [15]. Another study [16] reported that WEPs are an important source of nutrients and income for poor households and hence reduce vulnerability to food insecurity in rural areas of Tanzania [16]. A similar study also indicated that many people in rural communities of Nigeria rely on wild edible plants for food, especially during crop failures, famine or periods just before new crop harvests [17].

Ethiopia is endowed with approximately 6000 plus plant taxa because of its diverse agro-ecologies that favor high biodiversity [19]. Of these, 413 are WEPs [20]. However, there are many undocumented WEPs in the country. Recently, several ethnobotanical studies have been conducted in Ethiopia, primarily on medicinal plants [21]. Little emphasis has been given to WEPs, although these species address seasonal food shortages and nutritional

gaps in the country. Wide ranges of WEPs are used by local communities in rural areas of Ethiopia for food, medicine, and spices, as well as for cultural and ritual purposes. The WEPs in Ethiopia are threatened by deforestation and habitat deterioration through agricultural expansion [22, 23]. In the current study area, especially the lowlands of the Heban-Arsi district, where environmental degradation, drought, and famine frequently affect the indigenous community, the consumption of WEPs seems to be an important local survival strategy. Therefore, investigating wild food plants available in the area might help to improve the present situation of food shortages and for future preservation and sustainable use of these resources. To the best of our knowledge, no previous study has been conducted on the use and diversity of WEPs in the current study districts. Thus, the main aim of this ethnobotanical study was to document the diversity of wild edible plants, their uses, and the threats facing them in the study areas. This study is expected to contribute to the understanding of the ability of future generations of WEPs to fight hunger and malnutrition and to explore proximate analysis and nutritional and anti-nutritional factors of these plants for use as alternative and sustainable food sources during periods of food insecurity.

Materials and Methods

Description of the Study Area

The study was conducted in the Kofale and Heban-Arsi districts, West Arsi Zone, Oromia Regional State, and southeastern Ethiopia. Kofale District is geographically located between 6° 50'–7° 9' N and 38° 38'–39° 4' E, south of the capital Addis Ababa, with an elevation ranging from 1500 to 3000 m.a.s.l. (Kofale District Health Care Office (KDHCO), unpublished data), and the Heban-Arsi district is located at 7° 9'–7° 42' N and 38° 25'–38° 54' E, with an elevation ranging from 1250 to 2500 m.a.s.l. (Heban-Arsi District Agricultural Development Office (HADADO; unpublished data)) (Figs. 1 and 2).

Study sites and informant selection

Before conducting the actual data collection, study sites and informants were selected based on information gathered during reconnaissance survey from the administrative, agricultural, and natural resource management offices of the study districts by adopting a method previously used and reported in a similar study [24]. Study kebeles (the lowest administrative structures in Ethiopia) in the two districts were selected based on agro-ecological variations, history of use, and the availability of WEP in the area. Accordingly, eight kebeles, namely, Wege Abosa, Benjo Ashoka, Ilka Bebe, Sayimana Mudi, Chatimana Jangala, Guchi, Bulchana, and Garmama, from the Kofale district and four kebeles, namely, Argada Shaldo, Sanbaro Rogicha, Buku walda and Dawe, from the Heban-Arsi district were selected. The data were collected in parallel to a previously reported ethnobotanical study of medicinal plants in the same districts [25]. Accordingly, the data were collected by interviewing 290 informants. Among these, 104 were key informants who were selected using the snowball sampling method [26], 84 from the Kofale district and 20 from the Heban-Arsi district (Table 1). The remaining 186 informants (115 from Kofale district and 71 from Heban-Arsi district) were general informants who were selected by systemic random sampling methods.

Table 1
Sampled administrative kebeles with informants interviewed, altitudinal ranges, and agro-climatic zones

NO	Kebele (Sub district)	District	Altitude (m.a.s.l.)	Agro-climatic zone	No. HHs	key informants		General informants	
		Kofale				M	F	M	F
1	Garmaama	Kofale	1500–2660	ML	2726	18	1	20	2
2	Benjo Ashoka	Kofale	1918–1945	ML	1091	8	-	14	1
3	Sayimanna Muudi	Kofale	1938–1961	ML	1148	8	-	11	2
4	Chatimanna Jangala	Kofale	1970–2500	ML	1551	11	-	12	1
5	Bulchaana	Kofale	1989–2196	ML	1298	9	-	12	3
6	Wege Abosa	Kofale	2190–2300	H	1721	12	1	11	2
7	Guchi	Kofale	2200–2786	H	1262	8	1	11	1
8	Ilka Bebe	Kofale	2605–2867	H	957	6	1	10	2
9	Argada Shaldo	Heban-Arsi	1701–2000	ML	2476	4	1	20	2
10	Sanbaro Rogicha	Heban-Arsi	1600–1981	ML	2158	5	-	14	2
11	Buku Waldaa	Heban-Arsi	1250–1500	LL	1572	5	-	15	1
12	Dawe	Heban-Arsi	1300–1500	LL	1557	4	1	15	2
Total						98	6	165	21
Note: m.a.s.l. = meters above sea level, ML = middle land, H = high land, LL = low land, HHs = households									

Figure 2 Map of Heban-Arsi District, West Arsi Zone, Oromia Regional State, Ethiopia

Data Collection

Ethnobotanical data of WEPs were collected between February and September 2022 and November 2022 and April 2023 from the Kofale and Heban-Arsi districts, respectively. The methods and protocols proposed by Martin [30] were used to collect ethnobotanical data on the WEPs. Before conducting the interviews with key and general informants, a meeting was organized with the help of local administrators to discuss the objectives of the study and its importance for communities. Following consensus reached between researchers and informants on the objectives and importance of the study, oral consent was obtained from all participants. Ethnobotanical information about wild edible plants, including edible parts, growth habits, habitats, harvesting season, mode/form of consumption as food (fresh or processed) and other uses, was collected through semi-structured interviews, field observations, focus group discussions (FGDs) and guided field walks. Twelve FGDs, one in each kebele involving 5 to 6 participants, were organized and discussed on information focusing on the status and use of wild edible plants, plant species and their use, the degree of dependence on them for livelihood during prolonged drought and famine, threats to wild edible plants, and conservation status following standard method [27]. In addition, information on sociodemographic characteristics of the informants (age, gender, and education level) was also gathered [26]. The semi-structured interview questions were initially prepared in English and translated into Afan Oromo, the frequently spoken language in the area, and responses were translated back to English during documentation. The International Society of Ethnobiology Code of Ethics was taken into account in the interviews [28]. Plant samples were collected, labeled, pressed, identified using appropriate methods [29] and deposited at the Mini herbarium of the Aklilu Lemma Institute of Pathology and the National Herbarium of Addis Ababa University, Addis Ababa, Ethiopia.

Data analysis

The collected data were organized using Microsoft Excel spreadsheet 2016. Descriptive statistical methods were used to analyze and summarize the data using the Statistical Package for Social Sciences (SPSS) version 25. Comparisons of the effects of various sociodemographic factors on WEPs based on age and educational status were made using one-way analysis of variance (ANOVA), and differences in means with p values ≤ 0.05 were considered to indicate statistical significance. Comparisons of wild edible plant knowledge between male and female informants were made using a two-tailed independent sample t -test. Preference ranking and direct matrix ranking were applied to assess the degree of preference of selected WEPs [30] and the use priority of WEPs, respectively. The general WEP use values were calculated using all uses mentioned by informants for each cited species using an adapted formula [31], as used in [27].

Ethical considerations

The study proposal was reviewed and approved by the Addis Ababa University, Aklilu Lemma Institute of Pathobiology Institutional Research Ethics Committee (ALIPB-IRERC). Permissions were obtained from the study districts and Kebele administrators to carry out the fieldwork. Participants in this research were informed about the objectives and importance of this study. Oral consent was obtained before the interview. The ethical guidelines adopted by the International Society of Ethnobiology were followed during data collection.

Results

Demographic characteristics of the informants

In this ethnobotanical study, a total of 290 local inhabitants from two districts were interviewed to obtain information on diversity of wild edible plants used, parts of plants consumed, seasonal availability, use forms (fresh, dry and/or processed) and their threats. The respondents' sociodemographic data were also gathered (Table 2). The participants age ranged from 18 to 89 years, with the majority (145; 50%) falling between 41 and 60 years of age. Most of the informants were males (263, 90.6%), whereas 27 (9.3%) of them were females. Among the informants, 153 (52.9%) were illiterate (cannot read and write), and 137 (47.2%) were literate. Among the literate participants, 97 (71%) completed primary education, while 97 (71%) had completed secondary and higher education.

Comparison of WEPs knowledge between male and female informants using a two-tailed independent sample t -test revealed that there was a significant difference in knowledge between them ($P < 0.05$) (Table 1). There was also a significant difference in WEPs knowledge among the two informants' age groups ($p < 0.05$); older people knew more WEPs than the young people did (Table 1). From an educational status perspective, a significant difference in WEPs knowledge ($p < 0.05$) between literate and illiterate informants was observed, and the findings showed that more knowledge was held by illiterate respondents than by literate respondents (Table 2).

Table 2
Mean number of wild edible plants by the different social groups (n = 290)

Mean number of wild edible plants by the different social groups (n = 290)				
Category	Subcategory	Number of informants	No. of WEP reported Mean + SD	p value
Gender	Male	263	5.4	0.0001*
	Female	27	2,3	
Age category	29–40	70	2	0.0001*
	41–60	145	4.5	
	61–89	5	7	
Educational Level	Illiterate	153	6.	0.0001*
	primary	97	3	
	Secondary	34	2	
	Collage	6	1	
No. WEP reported from the two districts	Heban -Arsi	91	56	0.0001
	Kofale	203	39	
Note: SD = standard deviation of the mean				

Diversity of WEPs, their growth forms and habitats

A total of 62 WEP species belonging to 38 families and 56 genera were documented to be used as food sources during times of food shortage in the two study districts, such as prolonged drought and famine, and as dietary supplements. The family Moraceae was represented by 7 species, and was followed by Fabaceae

(4 species), Rubiaceae (4 species) and Lamiaceae (3 species). The families Amaranthaceae, Boraginaceae, Polygonaceae, Rhamnaceae and Apocynaceae were represented by two species each, while the remaining families were represented by a single species each. Table 6 provides the details of the utilized WEP species arranged in alphabetical order, including their scientific name, family name, voucher specimen number, local name, growth form, parts used, collection sites and uses.

Table 6
List of wild edible plants used in the Kofale and Heban-Arsi districts

Scientific name	Local name	Family	Habit/Habitat	Plant part used	Preparation	Collection moth	Other use	Use Value	Collection Number	District
<i>Acacia abyssinica</i> Hochst. ex Benth.	Lafto	Fabaceae	Shr/Gr land	Gum	Chewed by children	Dec, Jan	Medicine, firewood		GN-125	H
<i>Acacia tortilis</i> (Forssk.) Hayne	Dhadacha	Fabaceae	Shr/Gr land	Fruit	Ripen fruit eaten	Dec, Jan	firewood, fodder	0.05	GN-178	H
<i>Acacia seyal</i> Del.	wacu	Fabaceae	Shr/Gr. land	Gum	Chewed by children	Dec, Jan	firewood, fodder	0.74	GN-105	H
<i>Acokanthera schimperi</i> (A. DC.) Schweinf	Qararu	Apocynaceae	Shr/Gr land	Fruit	Ripen fruit eaten	Ma, Apr, Ma	Medicine, fodder, construction, firewood	0.14	GN-21	H

Table 6
(continued)

<i>Achyranthes aspera</i> L	Dargu	Amaranthaceae	Her/Gr. land	Leaf/seed	Young leaf is cooked, seeds are used as famine food	Ju, Aug	medicinal, fodder	0.18	GN-61	H/K
<i>Acacia etbaica</i> Schweinf.	Dodota	Fabaceae	Tr/Gr. land	fruit	Ripen fruit eaten	Mar, Apr, Ma	medical charcoal, firewood	0.09	GN-119	H
<i>Allophylus abyssinicus</i> (Hochst.) Radlk.	Hirqamu	Sapindaceae	Tr/Gr. land	Fruit	Ripen fruit eaten	Apr, Ma,	medicinal, firewood	0.3	GN-119	H
<i>Amaranthus dubius</i> Thell.	Raafu	Amaranthaceae	Her/Gr. land,	Arial part before flowering	Cooked and eaten	jun, jul, Aug	medicinal, fodder	0/13	GN-105	H/K
<i>Anethum graveolens</i> L	Harbu	Apiaceae	Her/Fa. land	leaf	Ripen fruit is eaten	Dec	medicinal, fodder	0.003	GN-173	H/K
<i>Asparagus africanus</i> Lam.	sariit	Asparagaceae	Her/R. bank	fruit	Ripen fruit	Sep-Nov	medicinal	0.4	GN-2	H/K
<i>Barassica nigra</i> (L) Kch	Goman	Brassicaceae	Her/Gr land	Arial part	Cooked and eaten	Jun, Jul, Aug	Medicine/fodder		GN-132	K/K
<i>Balanites aegyptiaca</i> (L.) Del.	Bedeno	Balanitaceae	Shr/Gr land	Fruit/shoot	Ripen fruit eaten/young shoot cooked during draught	Oct., Nov	medicinal, fodder, firewood	0.10	GN-23	H
<i>Carissa spinarum</i> L.	Agamsa	Apocynaceae	Shr/For	Fruit	Ripen fruit eaten	mar, Apr, Ma,	medicinal, foddeer, firewood	0.8	GN-102	H/K

Analysis revealed that 56 WEPs were consumed in Heban-Arsi district, while 39 were consumed in Kofale district. Of the total reported WEPs, 34 species were shared by the two study districts.

Shrub was the most frequently reported growth form (32 species, 51.6%), followed by herbs (13 species, 21%) and trees (12 species, 19.35%). The most widely used plant part was fruit (covering 40 species, 64.5%), followed by leaf (11 species, 17.7%). The greatest percentage of WEPs (24 species, 38.7%) were collected from grazing lands/fields, followed by forest habitats (17 species, 27.4%) (Fig. 3).

Habitats of wild edible plants, parts consumed and time of gathering

The people in the Kofale and Heban Arsi districts collected wild edible plants from various habitats, including grazing lands/fields (24 species), forest habitats (17 species), riversides (2 species), farm margins (2 species), roadsides (2 species), and woodlands (2 species) (Table 3).

Fig. 3 Growth forms of wild edible plants

Of the total documented edible parts, fruit was the most frequently consumed plant part, representing 38 (63%) species. Leaves occupied the second position, accounting for 11 (17.74%) species (Fig. 4). Few species were also consumed for their fruits and gum (2; 3.2%), leaf and seed (2; 3.2%), leaf and fruit (1; 1.6%), and fruit and shoot (1; 1.6%). Some plants have different/alternative edible parts, such as leaves and seeds (*Amaranthus dubius* Thell.), fruits and shoots (*Rumex nervosus* Vahl), and stems and fruits (*Phoenix reclinata* Jacq.).

Table 3
Habitats of wild edible plants in the study area

Habitat type	Number of species	Percentage (%)
Grazing lands/Fields	24	38.7
Farm margin	2	3.2
Forest	17	27.4
Roadside	2	3.2
Riverbank	2	3.2
Woodland	2	3.2

The study indicated that the harvesting periods of parts of plants used as food sources are dependent on the seasonal availability of the edible parts of WEPs in the districts. The majority of the WEPs in the study districts were harvested from March to May (48%), June to August (17.74%), and September to November (14.6%).

Mode of consumption

The majority of the species 48 (77.4%) were harvested and utilized in their unprocessed form. Fourteen (22.5%) of the species were consumed after chopping with a knife and cooking, while others were subjected to methods such as roasting, powdering and boiling. Fruits are largely collected and consumed by the community when they were ripened. The ripening stages of fruits are mainly indicated by changes in color of fruits for a wide variety of edible plants. Leafy vegetables, on the other hand, were reported to be consumed during their early developmental stage (very green stage). In the current research districts, WEPs were utilized during periods of food scarcity, such as prolonged drought and famine, as well as during normal periods. A significant portion of the WEPs (41 species, 66%) were exclusively consumed during periods of famine or food shortages, while 21 (34%) were used to supplement staple foods. Plants such as *Allophylus abyssinicus* (Hochst.) Radlk, *Balanites aegyptiaca* (L.) Del, *Carissa spinarum* L., *Capparis tomentosa* Lam, and *Ficus sur* Forssk. were consumed regularly as supplementary food. Conversely, plants such as *Acacia etbaica* Schweinf, *Ampelocissus* sp., *Euclea racemosa* subsp. *schimperi* (A.DC.) Dandly, *Gallium* sp., *Rumex nepalensis* Spreng. and *Asparagus africanus* Lam. were among the wild edible plants consumed specifically during times of food shortage (especially during prolonged drought and famine) in the study districts.

Preference ranking of selected wild edible plants

Preference ranking was conducted by eight key informants to rank eight commonly utilized WEPs based on their sweetness qualities and their safety. Based on the degree of preference by informants the plants were assigned values ranging from 1 to 5, with the highest rank, 5, attributed to the most favored plant and the lowest rank, 1, assigned to the least favored plant. Consequently, *Syzygium guineense* (Wild.) DC and *Ficus sycomorus* L. assumed the top two ranks, 1st and 2nd respectively, with *Ximenia americana*, *Carissa spinarum*, and *Allophylus abyssinicus* (Hochst.) Radlk. followed closely thereafter. (Table 4).

Table 4
Ranking of eight selected WEPs according to informant preferences

Wild edible plants	Respondents (R1–R8)								Total score	Ranking
	R1	R2	R3	R4	R5	R6	R7	R8		
<i>Syzygium guineense</i> (Willd.) DC.	3	4	3	4	5	2	4	3	28	1
<i>Carissa spinarum</i> L.	2.	3	2	2	2	4	3	3	21	6
<i>Ximenia americana</i> L.	3	3	4	3	1	3	2	4	23	4
<i>Allophylus abyssinicus</i> (Hochst.) Radlk.	3	4	4	2	3	3	2	4	26	3
<i>Balanites aegyptiaca</i> (L.) Del.	2	1	2	1	2	2	2	3	15	7
<i>Cordia africana</i> Lam.	3	3	3	5	4	3	3	3	27	2
<i>Grewia ferruginea</i> Hochst. ex A. Rich.	3	4	2	2	3	3	2	3	22	5
<i>Mimusops kummel</i> A. DC.	2	1	2	3	2	1	1	2	14	8

Direct matrix ranking

In addition to serving as a source of sustenance, indigenous populations have utilized WEPs for a wide range of purposes, such as firewood, fence building, house construction, medicine, farm tools, furniture and cultural uses. The cumulative utilization values for eight plant species reported to have diverse uses were computed based on direct matrix ranking. The findings indicated that the use values for medicinal purposes, fuel wood, construction of fences, and provision of fodder ranked first to fourth, respectively (Table 5). The finding of the direct matrix ranking exercise, *Cordia africana* Lam. was the top-ranked WEP for its diverse uses in the study area, followed by *Syzygium guineense* and *Acacia seyal* Del. (Table 5).

Table 5

Direct matrix ranking of eight wild edible plant species against ten use criteria (5 = best; 4 = very good; 3 = good; 2 = less used; 1 = least used and 0 = no value).

Use diversity	<i>Cordia africana</i>	<i>Carissa spinarum</i>	<i>Syzygium guineense</i>	<i>Ximenia americana</i>	<i>Ziziphus spina</i>	<i>Balanites aegyptiaca</i>	<i>Allophylus abyssinicus</i>	<i>Acacia seyal</i>	Total score	Rank
Bee food	2	0	4	0	0	1	3	4	14	7th
Fuel wood collection	4	3	4	3	4	3	3	5	29	2nd
Medicine	5	5	5	5	5	5	4	3	36	1st
Fodder	1	1	3	3	3	2	2	3	19	5th
Construction	5	1	1	0	0	1	2	1	11	8th
House Furniture	5	0	0	0	0	1	0	0	6	10th
Agricultural tools	0	0	2	1	0	2	1	1	7	9th
Fencing	2	5	4	4	2	3	2	4	28	3rd
Charcoal	1	2	3	1	2	2	2	5	17	6th
Shade	5	0	4	2	2	2	3	2	20	4th
Total score	31	17	30	19	18	22	23	28		
Rank	1	8	2	6	7	5	4	3		

Key: (use given from 0 to 5, (5 = best; 4 = very good; 3 = good; 2 = less used; 1 = least used and 0 = no value).

Use values (UVs)

The use values (UVs) for each species were calculated to determine their relative importance to the local people. The five species with the highest UVs were *Cordia africana* (0.9), *Syzygium guineense* (0.8), *Acacia seyal* Del. (0.74), and *Euclea racemosa* subsp. *schimperi*. (0.6) *Allophylus abyssinicus* (0.3) (Table 6). The species with the lowest UVs were *Acacia etbaica* Schweinf. (0.06), *Grewia ferruginea* Hochst. ex A. Rich. (0.03), *Dombeya torrida* (J.F. Gmal.) P. Bamps (0.02) and *Rumex nervosus* Vahl. (0.01) (Table 6).

Threats to Wild-Edible Plants in the Districts

The few remaining forests in the study districts with significant populations of WEPs are facing persistent deforestation by the local population. The primary drivers for the decline in WEPs within the area included the expansion of agricultural land, the collection of fuel wood, unsustainable practices, the impacts of climate change, and the introduction of non-native plant species. Among these factors, the expansion of agricultural land was identified as the most prominent, followed by fuel wood collection, as illustrated in Table 7.

Table 7
Priority ranking of threats against the WEP in the study districts

Factors	Informants										Total	Rank
	I ₁	I ₂	I ₃	I ₄	I ₅	I ₆	I ₇	I ₈	I ₉	I ₁₀		
Agricultural land expansion	5	4	3	5	3	2	5	3	4	5	39	1
Unsustainable use/overharvesting	3	3	4	2	2	1	2	1	2	2	22	3
Climate change	2	4	2	3	1	4	1	1	1	2	21	4
Introduction of invasive plants	2	2	1	1	2	2	1	1	1	2	15	6
Fuel wood collection	4	5	3	2	4	2	4	3	3	3	33	2
Overgrazing	1	2	1	2	1	1	1	5	1	2	17	5
Note: I ₂ -I ₁₀ = informers 1 to 10 used on their degree of destructive effects/values of 1–5 that were given: 1 is the least destructive threat and 5 is the most destructive threat.												

Discussion

The knowledge that local communities possess in the study area enables them to use local plant resources for food and medicine. Sociodemographic factors influenced the knowledge of WEP use in the study districts. A comparison of the effects of various sociodemographic factors on WEPs based

on age, gender and educational status revealed that males have more knowledge of WEPs than females, which might be due to cultural reasons in which males spend more time in the wild and in the forest than females in the study districts. There was a significant difference in WEPs knowledge between the informants' age groups and educational levels ($p < 0.05$). In this study, older and illiterate informants knew more WEPs than young and literate people, respectively, as was reported by other researchers in similar ethnobotanical studies [27]. This could be explained by the frequent contact of illiterate individuals with natural resources due to their occupation and lack of interest of the younger and literate generations in gaining knowledge of wild edible plants. In contrast to the current study, there was a report indicating that respondents aged between 20 and 29 years had better knowledge about wild edible fruits compared to other age groups in Tanzania [32]. This difference might be related to the cultural differences between different societies in different countries in terms of inculcating young people with indigenous knowledge of the uses of WEPs as well as differences in abundance, agro-ecological differences and practices related to the use of WEPs.

The findings of the present investigation revealed the widespread use of WEPs in times of food scarcity as well as food supplementation in the Heban-Arsi and Kofale districts, Oromia Regional State, Ethiopia, as evidenced by the extensive diversity of WEP species documented (Table 6). In this study, the Moraceae family exhibited the greatest representation of wild edible plant species, which contrasts with previous studies in Ethiopia, where a greater number of species from the Malvaceae family were reported [27]. Previous studies on WEPs also documented and reported a greater abundance of plant species from the Moraceae family in Ethiopia [24]. There was also a report of a high number of food plants belonging to the Moraceae family in Nepal [26]. A total of 62 species of WEPs were identified in the surveyed districts, surpassing the numbers reported in other regions of the country: 41 species [27], 38 species [32], and 54 species [33]. However, the number of WEPs reported by the current study was lower than those reported by previous studies by different researchers respectively reporting 71 [34], 64 [35] and 66 [11] WEPs in Ethiopia. Similarly, 354 WEPs were reported in Burkina Faso [36]. This disparity in the number of reported wild edible plants could be due to differences in culture, vegetation cover of the area, or climatic variation [37]. The greater number of WEPs in the study area indicates the diversity of WEP resources and the dependence of the local people on WEPs during food scarcity and as supplements [38], as well as strong interactions between plants and local communities [39].

Comparative analysis revealed that the greatest diversity of WEPs (56) was collected from the Heban-Arsi district, and 39 were collected from the Kofale district. More WEPs were consumed in the Heban-Arsi district than in the Kofale districts, which might be due to the availability of large areas of grazing land/fields. Thirty-four species were shared between the communities in the two districts. The edibility (use) of these species among the two communities of the districts indicates the existence of common knowledge across a range of subsistence groups of different cultures and/or geographic areas. The similarity in species use between the Heban Arsi and Kofale communities might be attributable to the overlap of their ecological niches, cultures and languages. Similar observations have also been reported elsewhere by several researchers [26, 40]. In comparison, more WEPs were recorded in Heban Arsi district than in Kofale district, and more species were collected from lowland and midland areas of Heban-Arsi district (between 1250 and 2000 m a.s.l.). A high abundance of WEPs in such agro-ecological zones was also reported elsewhere [11] in Ethiopia.

Shrub was the dominant growth form of WEPs in the study districts, which might demonstrate the better availability of WEPs for harvesting throughout the year. Similarly, the wide utilization of shrubs was also reported in other parts of Ethiopia [41–45].

The greatest number of WEPs (24 species) were collected from grazing lands/fields, followed by forest habitats (17 species). However, ethnobotanical studies on WEPs in different parts of Ethiopia have shown that the majority of WEPs are gathered from forest habitats, contrary to the present findings [46, 27].

In the study districts, fruits were the predominant component of the WEPs consumed (63%). In line with the current findings, the dominance of fruit use was also mentioned in other studies in the country [27, 33, 46]. The dominance of fruit part use might be due to the ease of consuming raw fruits, lack of processing, good nutritional value, and better taste and sweetness [11]. Similarly, the fruit parts of WEPs have high nutritional value and secondary metabolites compared to those of cultivated crops [11]. The consumption of multiple edible parts of a single plant (13.00%) was reported in the current study, consistent with previous finding [33]. These plants have a potent effect on food security because they provide alternative edible parts for different periods of the year for society, especially during prolonged drought and famine.

In the current study districts, WEPs such as *Allophylus abyssinicus* (Hochst.) Radlk., *Balanites aegyptiaca* (L.) Del and *Ficus sur* Forssk. were collected by children and consumed immediately while fresh in the field when they mature/ripen. On the other hand, herbaceous WEPs such as *Amaranthus dubius* Thell, *Barassica nigra* (L) Koch, *Erucastrum* sp. and *Physalis peruviana* L. were collected mainly by women and were processed (cooked) before consumption. WEPs were collected and consumed in different seasons of the year. The present findings revealed that WEPs were collected mainly in the months of March, April and May. Some WEPs were also collected in October, November and December. The months of March, April, and May were also reported as the major harvesting periods in Mieso district, eastern Ethiopia [27]. The main WEPs collected from March to May were *Balanites aegyptiaca* (L.) Del, *Carissa spinarum* L., *Capparis tomentosa* Lam., *Allophylus abyssinicus* (Hochst.) Radlk, *Ficus sur* Forssk. and *Ficus vasta* Forssk. Food scarcity is frequently observed in lowlands and some midland areas of the Heban-Arsi district from June to August. During this period, the majority of rural communities use WEPs as basic sources of food until cultivated agricultural crops mature. A similar report on the use of WEPs during food shortages and famine was also mentioned in another study in Ethiopia [11, 24].

The current findings indicated that the majority of WEPs identified have various uses beyond serving as food resources. Fifty-two WEPs were reported for their medicinal purposes (Table 6). The overlapping uses of WEPs both as food and medicine are well known in traditional systems of medicine

[47]. Leaf was the most commonly utilized plant part, with shrubs being the predominant growth form among the medicinal plants documented in the study districts.

Preference ranking exercise was conducted on the most commonly used WEPs based on their sweetness and safety. The perceived safety of WEPs according to informants was determined based on the absence of stomachache, bloat and vomiting after consumption. The findings of the preference ranking exercise indicated that *Syzygium guineense*, *Cordia africana*, *Allophylus abyssinicus*., *Ximenia americana*, and *Grewia ferruginea* were ranked from 1 to 5, respectively. This finding indicated that a more comprehensive investigation into the nutritional and safety aspects of these fruits is necessary to ensure their sustainable utilization through cultivation and propagation [24]. The sustainable use of such overlooked/uncultivated WEPs holds great importance for agriculture, which is resilient to climate change and consequently contributes to an improved quality of life due to its nutraceutical value as a food supplement [48].

Priority species were identified by species availability in the area and local indigenous knowledge on the use of the species [49]. The greater use value of *Cordia africana* Lam. in the districts was related to its multiple uses, such as medicine, construction, fuel, fence, house furniture, cultural value, shade, gum, spiritual, bee hive, fodder, soil holding, water accumulation/holding during drought and ecological significance. Panda (2012) also reported the multiple uses of WEPs for different uses. On the other hand, out of the listed use categories, utilization of WEPs for medicine, fire wood collection and fencing, were ranked 1st, 2nd, and 3rd, respectively. The extensive use of WEPs for multiple uses might be considered as the major threatening factors.

The findings of the present investigation showed that WEPs were significantly threatened by the expansion of agriculture into natural forest areas, the collection of fuel wood, and unsustainable harvesting of these plants for timber production. The ever-increasing loss of these WEPs might be linked to population overgrowth and the escalation of poverty levels in the study districts. The findings of this study are consistent with other reports in the country [37], which reported similar threats faced by WEPs in the Chilga District of northwestern Ethiopia. The strong reliance of local communities, particularly unemployed youth, on natural plant resources for generating income to support and sustain their families is a recurring observation in the study districts that poses a challenge to WEP biodiversity management efforts.

Conclusion

WEPs are important staple food sources for rural communities, especially during prolonged drought and famine. In addition to their food value, other uses of WEPs, such as their medicinal uses, make them more important to the livelihood of local people. Public awareness of the importance of WEPs must be heightened, and there is also a need to promote effective community-based management and conservation practices for WEPs. Increasing awareness of the importance of WEPs will encourage the conservation of traditional knowledge of indigenous populations and the diversity of these plants. It is imperative to conduct nutritional and pharmacological research on WEPs to endorse them as potential next-generation food resources that are organic and nutritionally rich. Thus, these plants might have potential food sources and could be part of a strategy for tackling food insecurity during prolonged drought and famine as well as providing sources of vitamins and minerals (food supplements).

Abbreviations

WEPS = wild edible plants,

HHS= households,

ANOVA= one-way analysis of variance

Us = use values

Declarations

Ethics approval and consent to participate

Ethical approval to conduct the study was obtained from the Aklilu Lemma Institute of Pathobiology Institutional Research Ethics Committee (ALIPB-IRERC). Before the collection of data, permission was obtained from the Heban-Arsi and Kofale Districts Administration, and verbal consent was obtained from the informants after elaborating on the aim of the study.

Consent for publication:

Not applicable.

Conflict of interest statement

There was no competing of interests.

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Author Contribution

Geritu Nuro conceptualized and collected the data; prepared the methodology; drafted , wrote and edited the manuscript; Ketema Tolossa and Mirutse Giday reviewed and edited the manuscript.

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Availability of data and materials

All the data generated or analyzed during this study are included in this published article. The plant voucher specimens were deposited at the mini-herbarium of Endod and Other Medicinal Plants Research Unit, ALIPB, AAU.

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Figures

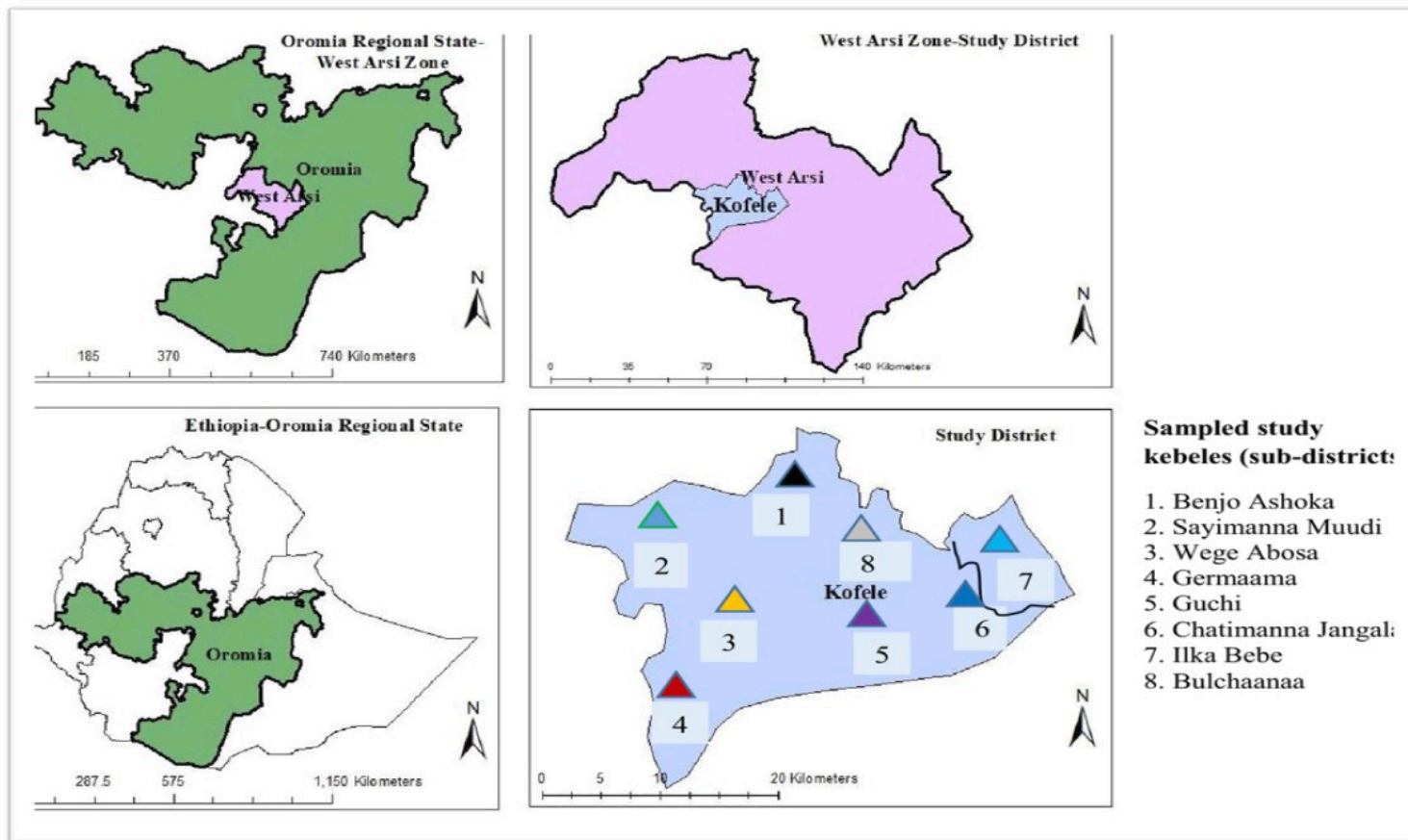


Figure 1

Map of Kofale District, West Arsi Zone, Oromia Regional State, Ethiopia

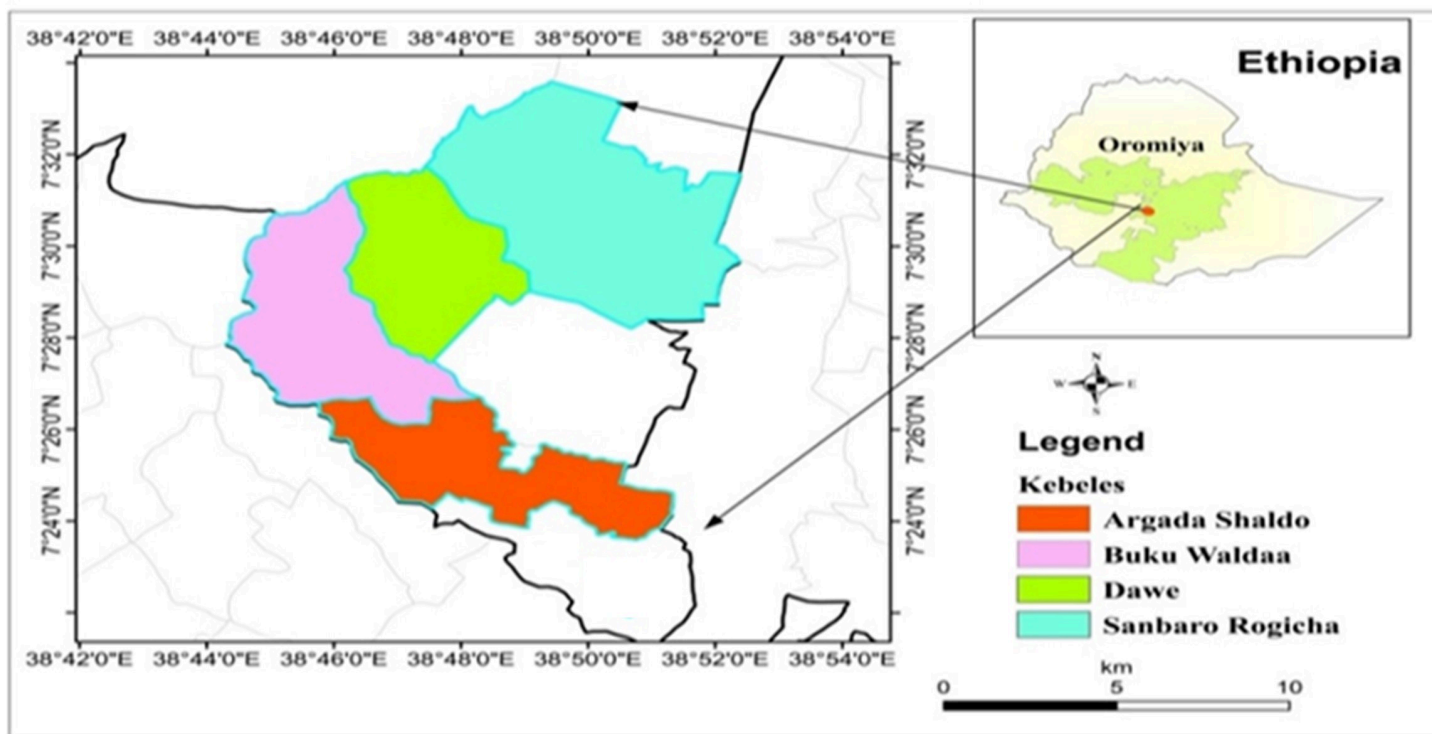


Figure 2

Map of Heban-Arsi District, West Arsi Zone, Oromia Regional State, Ethiopia

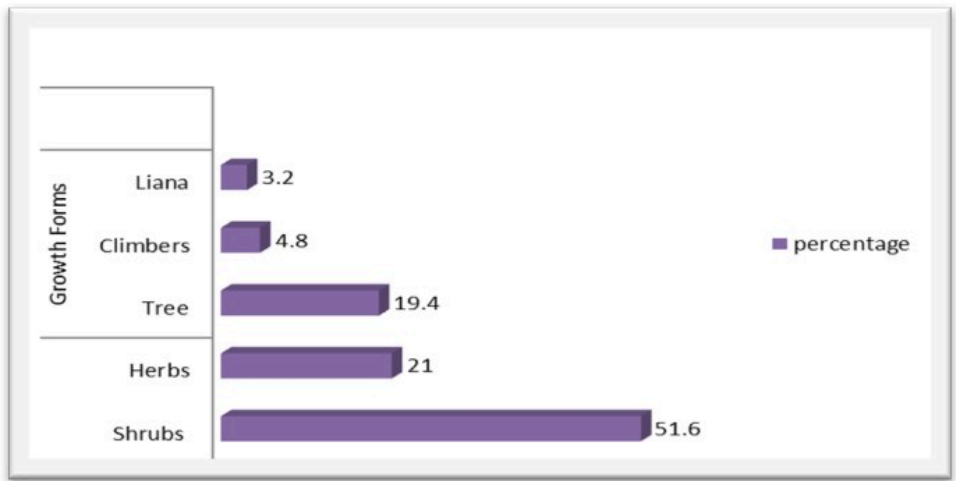


Figure 3

Growth forms of wild edible plants

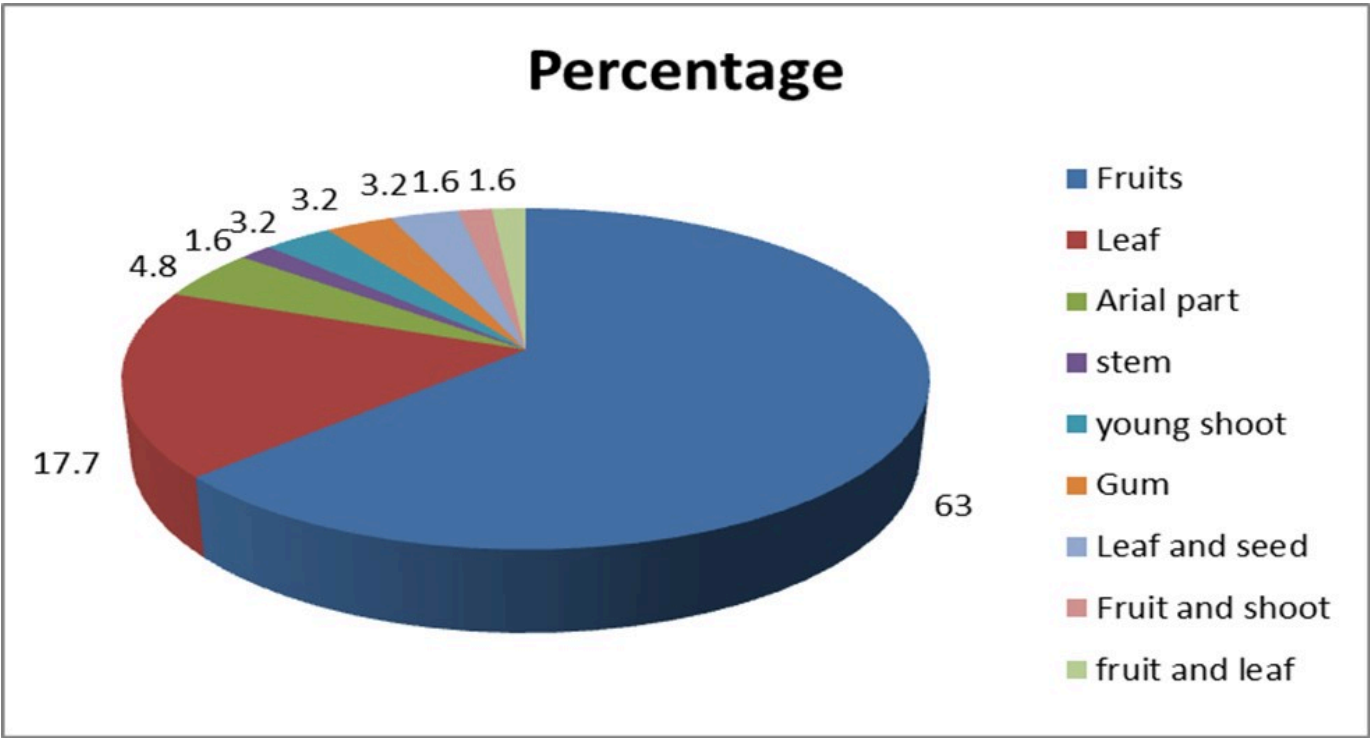


Figure 4

Edible parts of the reported wild edible plants