Ethnobotany of wild edible plants in Yilmana Densa and Quarit Districts of West Gojjam Zone, Amhara Region, Ethiopia

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Databases and Inventories

Abstract

Background: Wild edible plants are an essential source of supplementary foods in many parts of Ethiopia. Currently, these plant resources have faced major threats because of anthropogenic factors in different parts of Ethiopia. Thus, the purpose of the study was to record and document wild edible plants with their habits, habitats, edible parts, collecting households, use diversities and threats in Yilmana Densa and Quarit districts, West Gojjam Zone, Amhara Region, Ethiopia to pave a way for further research and conservation.

Methods: Semi-structured interviews, focus group discussions and observation were the data collection methods. Preference ranking *was conducted to rank the wild edible plants based on their use preference whereas* direct matrix ranking was used to measure the use diversity of multipurpose wild edible plants. Market surveys were also conducted to record the availability of wild edible plants and their type, price, and market potential.

Results: Thirty-two wild edible plants were reported in the two districts. Most of the species were reserved in forests and most of them were herbs. The major (53.1%) edible parts were fruits and most of the wild food was collected by males.

Conclusion: The findings showed that districts are the reservoirs of an appreciable number of wild edible plants like many other parts of Ethiopia. Also, the consumption practice of the species is low. Therefore, conducting awareness-raising in the areas should be the primary task.

Keywords: Threats, use category, wild edible plants, collecting households

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Background

Wild edible plants one of the main non-timber forest products and possess up to 96% of the value of forests (Mallika and Charlie 2019). Wild edible plants are non-cultivated edible plants collected from wild habitats (Termote et al. 2011). These plant resources are collected outside of agricultural areas mainly from forests for human consumption (Addis *et al*. 2013a). Wild edible foods may be consumed as raw or prepared into vegetables (Tiwari et al. 2010), and they are the crucial source of wild foods for the rural communities in different parts of the globe (Addis *et al*. 2013a). It is estimated that one billion people worldwide use wild edible plants to complement their nutrients in their diet to improve the deliciousness of staple foods (Burlingame 2000).

According to Shackleton and Shackleton (2004), wild foods have great nutritional values. Thus, especially, at times of critical food shortages because of droughts, as well as during famines brought by market fluctuations, political unrest, and military conflict, wild foods play a great role to diversify food sources, mitigate malnutrition, and generate alternative incomes (Mathys 2000; Gordon and

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Enfors 2008; McGarry and Shackleton 2009). This is because wild foods are rich with micronutrients (Singh 2011) which are essential especially to children, pregnant, and breastfeeding women (FAO 1995). Wild edible plants are also the source of proteins and fats (Aberoumand and Deokule 2009), phenols and carotenoids, and vitamins such as vitamin E and C (Bouba *et al.* 2012). Sometimes wild foods may have comparable or higher nutritional contents than those of cultivated fruits (Mahapatra et al. 2012; Nayak and Basak 2015). Thus, they are good promising alternatives to many cultivated fruits to supplement nutrients (Deshmukh and Rathod, 2013; Nayak and Basak, 2015). They further have additional uses such as fodder, firewood, construction, ceremonial uses (Bussmann 2006), and in income generation that the local communities of the country may get money from the sale of wild edible plants (Neudeck *et al.* 2012).

African populations, especially poor households in rural areas, have depended on wild edible plants to reduce spending of limited cash resources on energy, shelter, food, and medication (Grivetti and Ogle 2000). Ethiopia as part of Africa its people, especially the rural people, has good knowledge on the use of wild edible plants because of the presence of a common consumption practice in the country (Abebe and Ayehu, 1993). This common consumption practice is also because the plants requiring low investment practices since they can be easily collected by women and children from wild habitats (Lemessa 1999). Great deals of ethnobotanical studies have been conducted in different parts of Ethiopia. The review of these studies by Lulekal *et al.* (2011) showed that 413 wild edible plants exist in the country. By taking the presence of still unexplored areas of the country and this figure, it is possible to say the country is the source of the highest number of wild edible plants that are hosted in diverse habitats of the country. These plant resources have a great role, particularly, as a supplementary role in household food security (Assefa and Abebe 2011; Hunde *et al.* 2011; Kidane *et al.* 2014; Teklehaymanot 2017), as a staple food to supplement staple foods (Tebkew *et al.* 2014).

Despite having these essential roles, the wild edible plants of Ethiopia have been lost because of agricultural land expansion (Mengistu and Hager 2008; Leulekal *et al.* 2011; Kidane *et al.* 2014; Tebkew *et al.* 2014; Regassa *et al.* 2014). Thus, recording and documenting the wild edible plants of the country by exploring unexplored areas of the country was crucial for the conservation of the resources of the areas. Also, it was essential to document the traditional conservation activities of the areas for the strengthening of the activity. The study also might aid to create further awareness of wild edible plants for the community. The result of the study might also be a primary data source to undertake nutritional analysis studies on wild foods of the areas. Finally, the study might serve as baseline data for local management systems and national policymakers that ensure their sustainable availability in their wild habitats, and in turn, it might help to promote the rich wild edible plants of the areas for giving priority to conservation. Thus, the study of wild edible plants in Yilmana Densa and Quarit districts of West Gojjam Zone, Amhara Region, Ethiopia, had such purposes.

Materials and Methods

Study area description

Yilmana Densa and Quarit districts are one of the districts of West Gojjam Zone, Amhara Region, Northwest Ethiopia. The districts are bordered by each other (Yilmana Densa is bordered by Kuarit district, on the south). Yilmana Densa district is also bordered by Bahir Dar Zuria on the north, Abay River on the east by which separates it from the South Gondar Zone. The major town of Yilmana Densa is Adet which is 42 kilometers far from Bahir Dar (the capital of Amhara Region). Quarit is also bordered on the east by the East Gojjam Zone. The major town is Gebez Maryam / Dabi (Fig. 1). Both two districts have two agroclimatic zones namely Weyna Dega and Dega zones. Weyna Dega ranges from 1500 m to 2300 m above sea level and Dega ranges from 2300 m to 3200 m above sea level. The amount of annual rainfall in dry Weyna Dega is less than 900 mm, in moist Weyna Dega it ranges from 900 mm to 1400 mm whereas in wet Weyna Dega is above 1400 mm (Hurni 1998). Total annual rainfall is comparatively very high with a long term mean of 1366 mm per annum. The rainy season is relatively long and lasts from May to October (Fig. 2). Though the districts have plains, mountains, valleys, and undulating areas, most of the areas of the districts are covered by undulating areas and mountains respectively. The mainland covers in the study areas are settlements surrounded by *Eucalyptus* trees, cultivated land, grassland, woodland, and shrub/bushland. It also includes evergreen and semi-evergreen, small trees, and occasionally larger trees. Besides, there are a few scattered trees such as *Acacia* spp., *Cordia africana*, and *Croton macrostachyus* on the farmlands whereas *Eucalyptus camaldulensis* is grown around the homestead (ALP 2005).

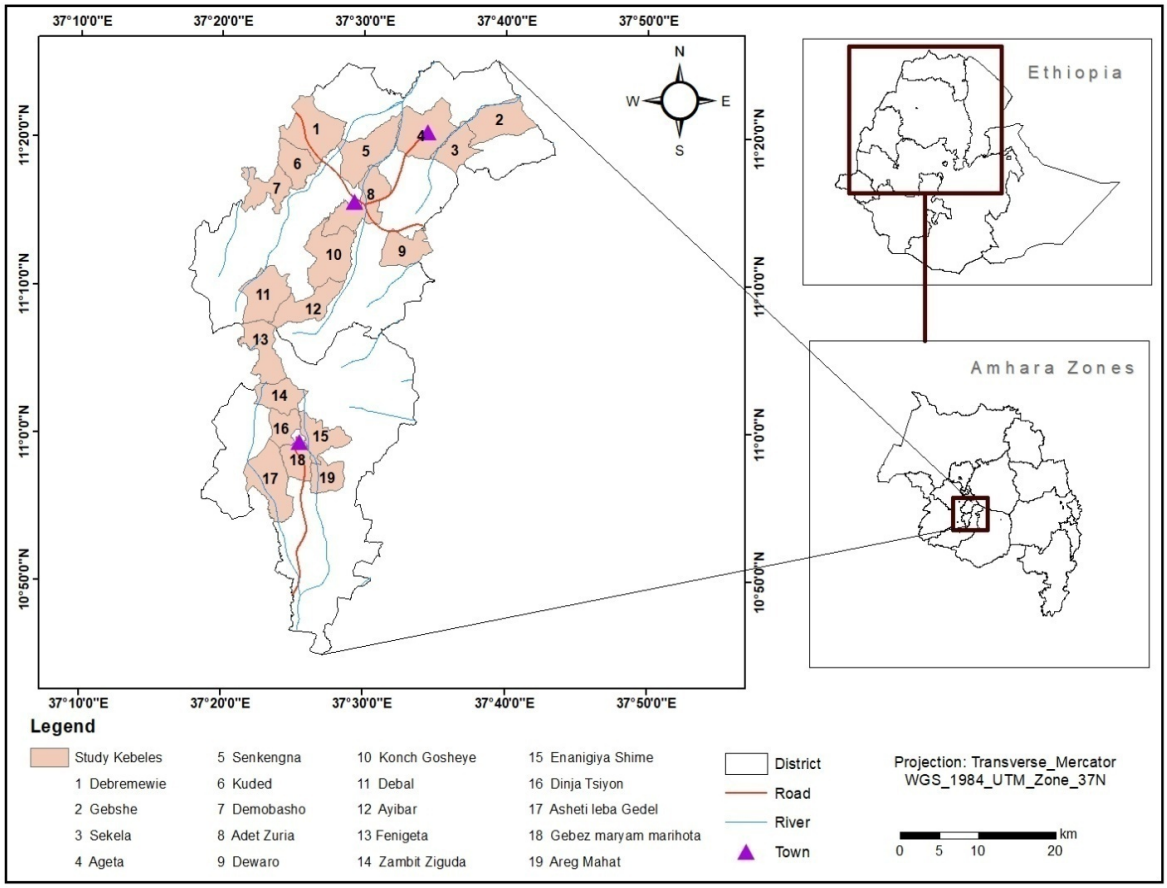

Figure 1. Location of the study **kebeles** (smallest administrative units) in the districts of West Gojjam Zone, Amhara Region, Ethiopia (Drawn by using Arc GIS ver. 10.5)

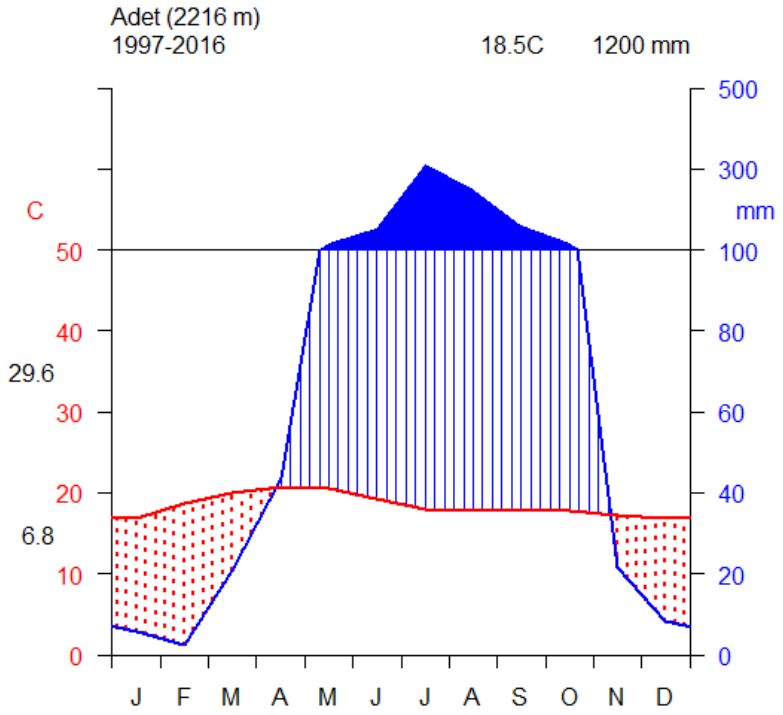

Figure 2. Climate diagram of Adet

According to CSA (2007), the Yilmana Densa district has a total population of 214852, of whom 107010 are men and 107842 women whereas Quarit district has a total population of 114771, of whom 56,767 are men and 58004 women respectively. The majority (98.19%) of the inhabitants of the Yilmana Densa district practiced Ethiopian Orthodox Christianity. The majority of the population resides in rural areas whereas the least number are urban inhabitants. The districts are inhabited by 99.9% of Amhara people and Amharic was spoken as a first language by 99.96% (CSA 1994). The populations of the districts have several livelihoods. The first one is traditional farming by using oxen rarely by using heifers, cows, horses, and mules (Personal observation). Crop production is entirely rain-fed, except in a small number of kebeles where small scale water harvesting practices have been recently introduced by the office of agriculture and rural development. There is only one rainy season (summer) and it is important for the cultivation of both long and short cycle crops (ALP 2005).

Data collection

Nineteen rural kebeles (sub-districts) were selected during the reconnaissance survey (Fig. 1). The 19 rural kebeles were selected based on the presence of relatively dominant vegetation covers. The total number of informants involved in the survey of wild edible plants was 268 men and 127 women. The age of the informants ranged from 20-81 years (139 were from 20-40 (adults) whereas 256 were > 40 years old (elders)). Data were collected in different seasons over different years to collect plant specimens during the respective flowering and fruiting seasons. Ethnobotanical data were collected during four different field visits conducted between 15 September 2016 and 30 June 2018. Market surveys were conducted between 10 December 2017 and 7 May 2018. Semi-structured interviews, focus group discussions, field observation, and market surveys were used to collect ethnobotanical data in the manner recommended by Martin (1995). A semi-structured interview and focus group discussion were by using a checklist of questions prepared beforehand in English and presented by translating into the local language (Amharic). Informants were interviewed individually in the local Amharic language. All semi-structured interviews were followed by independent walk in the woods exercises to gain further a detailed discussion with the informant and the practical identification of traditionally used wild edible plants in the natural environment. Field observations were performed with the help of local guides, as well as some respondents of the local community. Also, one Focus Group Discussion (FGD) (consisting of 7 participants) per kebele was undertaken to gain detailed information on wild edible plant knowledge at the community level and to supplement the information collected through semi-structured interviews as indicated by Martin (1995). The informants were asked about local names, habitats, use diversity, parts used, collecting households, condition of plant part used (fresh/dried), ingredients used, mode of preparation, the threats, and traditional conservation practices (if any) of wild edible plants (Alexiades 1996).

Plant Specimen identification.

Wild edible plant specimens were collected, pressed, dried, numbered, labeled, identified, and deposited at the National Herbarium (ETH) in Addis Ababa University. Identification of specimens was performed both in the field and by using Flora of Ethiopia and Eritrea. Plant specimen collection and preparation were made using the methods of Alexiades (1996).

Preference ranking and direct matrix ranking

A preference ranking *exercise was conducted to rank the wild edible plants based on their use preference by the community.* Sixteen key informants from two districts were also involved in ranking 8 wild edible plants regarding their taste quality and income generation based on the personal preference or perceptions of the key informants following the procedure elucidated by Martin (1995) and Cotton (1996). Each rank was given a value of 1, 2, 3, 4, 5, 6, 7, and 8. The procedure is described by Martin (1995). Direct matrix ranking exercise was used to measure the uses of multipurpose wild edible plants of the study areas. It also helped to clarify whether which multipurpose wild edible plants were under pressure in the areas and to identify the factors that threaten the species. In direct matrix ranking, the informants were asked to assign values to different uses of wild edible plants as firewood, construction, agricultural tool, medicine, charcoal, timber, food, and fence, and based on the degree of uses (i. e. 5 = best; 4 = very good; 3 = good; 2 = less used; 1 = least used and 0 = no value). The total scores given by the respondents/informants were used to compare the multipurpose wild edible plants of the areas, and it was also used to identify the main factor to the loss of the species as stated by Cotton (1996).

Use diversity study

Ethnobotanical data obtained using various ethnobotanical data collection methods were all documented to assess overall use values and use a diversity of species following (Phillips 1996; Byg and Balslev 2001). All informants of the study were interviewed at the same time for their knowledge *of the additional local use* or use *of a diversity* of plants cited for one or more uses following (Martin 1995;

and Cotton 1996). Six key informants were also involved in direct matrix exercise of five wild edible plants (*Acacia abyssinica*, *Carissa spinarum*, *Cordia africana*, *Olea europaea* subsp. *cuspidata,* and *Rosa abyssincia*) with additional uses (environmental use, forage, fuel, medicine, and social use). These species were ranked based on five use criteria (5 = Best; 4 = Very good; 3 = Good; 2 = Less used; 1 = Least used and 0 = No value). *In* the exercise of direct matrix ranking, Focus Group Discussion (FGD) was conducted to know the degree of preference based on multipurpose criteria on the plants.

Descriptive statistics and Sorensen's similarity analysis

The method of descriptive statistics was also applied to identify the number and percentage of species, genera, and families of wild edible plants used, their growth forms, proportions of parts used while Sorensen's similarity analysis was conducted to analyze the presence and absence of wild edible plants in each agroclimatic zones (Weyna Dega and Dega) of the two districts.

Market surveys

Market surveys were conducted at Adet and Bir Gebeya (in Yilmana Densa district), and Dabi / Gebez Maryam (in Quarit district) to record, document, and analyze the availability, price, and unit of measurement, the extent of use, and income-generating potential of wild edible plants found in these markets following Alexiades (1996).

Results and Discussion

Wild edible plants in Yilmana Densa and Quarit districts

Thirty-two wild edible plants were recorded in the two districts. These species were grouped in 30 genera and 24 families. Rosaceae and Polygonaceae were recorded with 3 species representation (9.4% each) followed by Anacardiaceae, Fabaceae, Lamiaceae, Moraceae, and Solanaceae (2 species, 6.3% each). The remaining 16 families were represented by single species each (1 species, 3.1%) (Table 1).

Table 1. Species and family names, habit, edible part, mode of consumption and additional uses of wild edible plants

Scientific name	Amharic name	HT	Edible part and mode of consumption	Additional uses
Acanthaceae				
Acanthus sennii Chiov	Kosheshle	S	Nectar	Fence, firewood, fodder
Anacardiaceae				
Rhus glutinosa A. Rich.	Kamo	T	Fresh ripe fruit	Firewood, medicine
Apiaceae				
Ferula communis L.	Inslal	H	Fresh leaf	Medicine, firewood
Apocynaceae				
Carissa spinarum L.	Agam	S	Fresh fruit	Firewood, live and dry fence, medicine, fodder
Asteraceae				
Vernonia amygdalina Del.	Grawa	S	Fresh immature leaves	Fodder for bee and cattle, house construction, firewood
Boraginaceae				
Cordia africana Lam.	Wanza	T	Fresh fruit	Firewood, house construction, fodder, timber, rope, house tools
Cactaceae				
Opuntia ficus-indica (L.) Miller	Beles	S	Fresh fruit	Fence, firewood
Commelinaceae				
Commelina sp.	Yebere Qolet	H	Fresh root	Fodder, soil conservation
Cyperaceae				
Cyperus rigidifolius Steud	Angicha	H	Stolen	House construction, rope, fodder, medicine, soil conservation
Fabaceae				
Acacia abyssinica Hochst.	Grar	T	Resin	Firewood, charcoal, rope, agricultural tools, fence, house construction
Trifolium schimperi A. Rich.		H	The fresh ripe fruit	Fodder, soil conservation

Flacourtiaceae				
Dovyalis abyssinica (A. Rich.) Warb.	Koshim	S	Fresh fruit	Firewood, medicine
Lamiaceae				
Ocimum urticifolium Roth	Checho	S	The fresh leaf or inflorescence/flower	Medicine, firewood, aesthetical, income
Thymus schimperi Ron.	Tosgn	H	The fresh leaf	Medicine, soil conservation
Moraceae				
Ficus sur Forssk.	Shola	T	Dry the fig then immerse with water	Firewood, house tools, income, to prepare local liquor
Ficus vasta Forssk.	Warka	T	Fresh fig	Firewood, house tools
Musaceae				
Ensete ventricosum (Welw.) Cheesman	Enset	H	Fruit	Baking materials
Myrsinaceae				
Embelia schimperi Vatke	Enkoko	S	Fresh fruit	Medicine, firewood, to prepare local liquor
Myrtaceae				
Syzygium guineense (Wild.) DC.	Dokma	T	The fresh ripe fruit	Firewood, house tools
Olacaceae				
Ximenia americana L.	Enkoy	S	The fresh ripe fruit	Fence, medicine, firewood
Oleaceae				
Olea europaea L. subsp.*cuspidata* (Wall. ex G.Don) Cif.	Woira	T	Dried leaf or root	Firewood, fumigation, house tools, house construction, agricultural tools, to prepare local liquor
Poaceae				
Cynodon dactylon (L.) Pers.	Serdo	H	Fresh stem	Soil conservation, fodder
Polygonaceae				
Persicaria nepalensis (Meisn.) Miyabe	Lanbut	H	Fresh stem	Fodder
Rumex abyssinicus Jacq.	Mekmeko	H	The pounded dried root	Firewood, dyes, as a spice for butter
Rumex nervosus Vahl	Ambacho	H	Fresh young stems	Medicine, firewood
Rosaceae				
Hagenia abyssinica (Bruce) J.F. Gmelin	Koso	T	The pounded fresh fruit	Firewood, medicine
Rosa abyssincia Lindley	Qega	S	The ripe fruit	Fumigation, fence firewood, fodder, walking stick
Rubus apetalus Poir.	Enjori	S	The fresh ripe fruit	Firewood, fence, medicine
Sapotaceae				
Mimusops kummel A. DC.	Ishe	T	The roasted or fresh fruit	Firewood, house construction, agricultural tools
Solanaceae				
Datura stramonium L.	Astenagir	H	Nectar	Medicine, poison
Solanum nigrum L.	Awut	H	The fresh ripe fruit	Medicine
Urticaceae				
Urtica simensis Steudel	Sama	H	The cooked young leaves with flour	Medicine, live fence, rope

Note: HT = Habits; S = Shrub, T = Tree, H = Herb

The species were recorded to be herbs, shrubs, and trees. Herbs were reported to be the primary source of wild food with a percentage distribution of 40.6% (Fig. 3). The comparison of the results further showed that there is some variation in the record of wild edible plant species. Such variations in the richness of WEPs between the study areas and other parts of Ethiopia might also because of cultural variation among the community of the country in the consumption of wild foods. This means that plants that were edible in some parts of the country might be non-edible in other areas. Thus, it might result in variation in the number of WEPs in that area. For example, many species of WEPs that were recorded as wild edible plants in the Konso community by Addis *et al*. (2013a) were non-edible in the current study areas. This was a cultural difference in selecting wild food plants as a source of food. This means that some communities in Ethiopia might have a consumption habit of some wild edible foods but some others might ignore some others. Thus, the choice of selection of WEPs as a source of wild food

might bring species number variation (Mengistu and Hager, 2008). The other reason for WEPs number variation among different areas might be due to variation in vegetation cover in the areas of the country. The results also further showed that most of the edible species are herbs. This contradicted the result of some research findings that revealed trees as the dominant edible species (Teklehaymanot and Giday 2010; Tebkew *et al*. 2014; Berihun and Molla 2017); shrubs as the dominant edible species (Alemayehu *et al*. 2015; Anbessa 2016; Ayele 2017) in other areas. This might be the result of the presence of cultural differences among the local communities of the country. This means that the community had a culture of eating herbaceous species in preference of trees and shrubs. Also, it might show the presence of selective cutting of trees and shrubs in the areas.

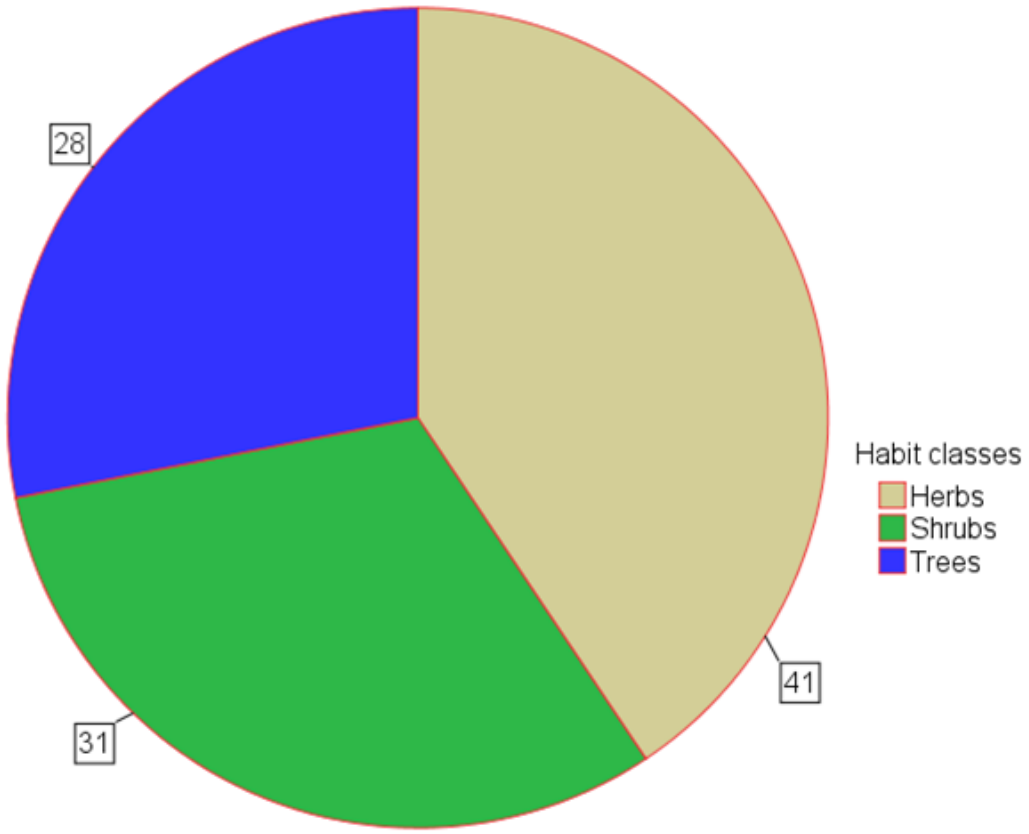

Figure 3. Percentage distributions of habit classes (Herbs, shrubs and trees)

Edible parts of wild edible plants

Nine edible parts were reported to be used as a source of food. Fruits composed the highest edible parts (17 species, 53.1%) followed by leaves (6 species, 18.8%). The other 7 edible parts contributed to 28.2% of wild food sources (Fig. 4). In agreement with the current study, fruits were also recorded as the main source of wild food in other parts of the country (Teklehaymanot and Giday 2010; Addis *et al*. 2013a; Alemayehu *et al*. 2015; Anbessa 2016; Berihun and Molla 2017). The reason for the preference of fruits as the primary source of wild food might be because of their possession of the highest nutritional value than other edible parts (Mahapatra *et al*. 2012; Nayak and Basak 2015). The results of the nutritional analysis of the fruits of some WEPs indicated that fruits contain appreciable nutrients and energy that are useful for food supplements (Addis *et al.* 2013a).

Collection sites and collecting households

Farmlands, grazing lands, bare lands, roadsides, forests, and home gardens were reported to be the major collection sites (Fig. 5). Some WEPs (*Urtica simensis*, *Vernonia amygdalina*, *Cordia africana*, *Ensete ventricosum*) were also reported to be collected only in homegardens. Most of the harvesters of wild foods were reported to be young males (shepherds). Approximately, 72% of food sources were collected by males whereas 28% were by females. The result of the study revealed that WEPs were collected from various habitats. This indicated that the edible species are highly distributed in the study districts. This agreed with other research works conducted in several parts of Ethiopia (Balemie and Kebebew 2006; Addis *et al*. 2013a; Kidane *et al*. 2014; Regassa *et al*. 2014; Anbessa 2016; Ashagre *et al*. 2016).

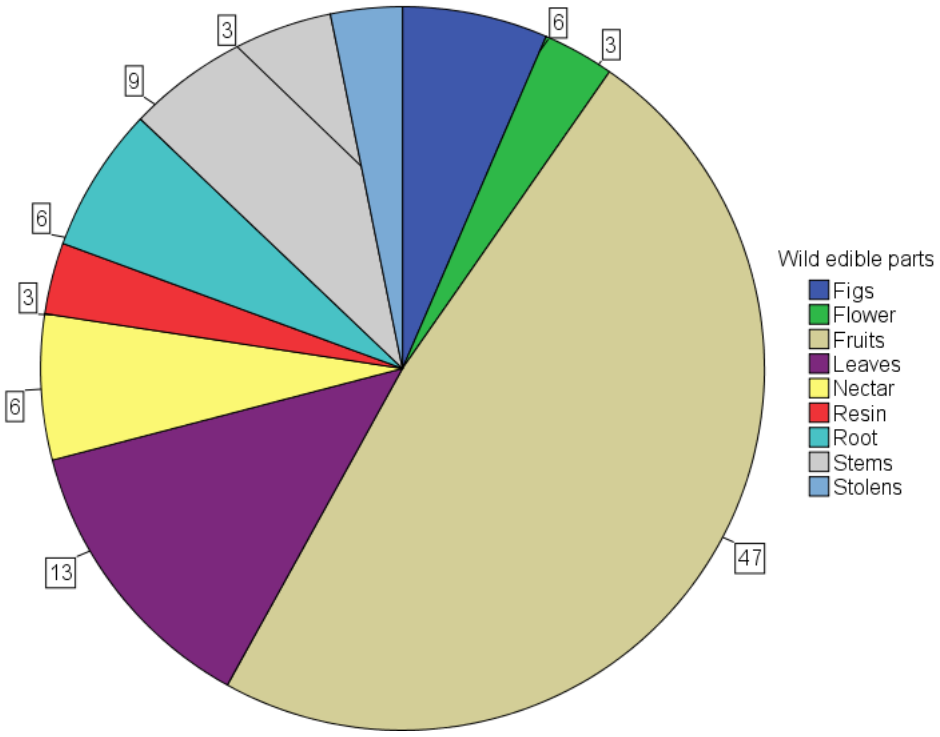

Figure 4. Percentage distribution of wild edible parts

A. *Acacia abyssinica* gum (on the stem) from Asheti Leba kebele

B. *Rubus apetalus* fruit collected by a young boy in Dambash kebele

C. *Cordia africana* fruit collected by young females in Konch Gosheye kebele

D. *Rosa abyssinica* fruit in Gebez Maryam kebele forests

Figure 5. Some wild edible plants of Yilmana Densa (B, C) and Quarit (A, D) districts (Photo by the researcher)

Also, the results showed that only limited edible species were managed by the local community of the districts. The management of these species was not for the sake of their edible role but concerning their role as timber (*Cordia africana*), fence (*Carissa spinarum*). The result also showed that most of the collectors of edible parts of the species were males. This might be due to the presence of a division of labor in households. That means females might mostly work in the house whereas males might mostly work outside their houses that led males to be more experienced with wild edible foods in the farmlands, forests, and other habitats, and thus, the opportunity of the collection of wild foods by males was higher. Males also might develop the ability of climbing and griping the tallest wild edible plants such as *Cordia africana*, *Ficus sur*, *and F. vasta*. Thus, more burden of the collection might lie down on males than females. The reason might be the hunger of shepherds who might expend much of the daytime in the field which is too far from their residence. Contrary to the current findings, in the Bullen district, females were the major household members of the collection of wild foods (Regassa *et al*. 2014; Berihun and Molla 2017).

The results further indicated that some species of wild edible plants such as *Mimusops kummel*, *Ficus sur,* and rarely others such as *Ximenia americana*, *Ficus vasta*, *Ensete ventricosum* were sold in local markets. A similar result of a low record of marketable species was reported in east Shewa (Hunde *et al.* 2011). This indicated that the local community of the districts has a low culture of using WEPs as a complementary food. This might be one of the reasons that WEPs are mostly consumed by households while there is a collapse in the harvest of cultivated food crops because of drought as reported in other areas (Asfaw 1997; Balemie and Kebebew 2006; Wondimu *et al*. 2006). Thus, the absence of a culture of using WEPs as a staple food in the local people of these districts might be due to the opportunity of lack of repeated occurrence of drought in the districts in the past time. Even if this was the case, in Quarit district, *Rubus apetalous* was reported as it was used as a source of staple food during a shortage of staple foods at one time in the past. According to (Hunde *et al*. 2011), the low affinity in using WEPs as staple food indicates a need for awareness-raising on the use and management of WEPs.

The preference of uses

The result of the study showed that *Ficus sur* is the most preferred wild edible plant with a total score of 111 (Table 2), in agreement with other findings (Assefa and Abebe 2011; Alemayehu *et al*. 2015). Furthermore, according to Addis *et al*. (2013a), *Ficus sur* was recorded as the most threatened species (with many use diversity) indicating that it is one of the most preferred edible species. The result further showed that WEPs have 6 additional roles for the local people. In agreement with the current findings, WEPs were reported to be used as a source of traditional medicine in other parts of Ethiopia (Teklehaymanot and Giday 2010; Alemayehu *et al*. 2015). They were also reported to be used as a source of fodder, firewood, charcoal, and construction in other parts of the country (Balemie and Kebebew 2006; Alemayehu *et al*. 2015; Ashagre *et al*. 2016). The result also showed that WEPs were used primarily for firewood. This also agreed with the result of Alemayehu *et al*. (2015). Other findings also showed that WEPs were reported to be used primarily as a source of traditional medicine in other areas of the country (Teklehaymanot and Giday 2010). The findings of Ashagre *et al*. (2016) also showed that WEPs are primarily used for fodder. This showed that even if WEPs were recorded with diverse uses, their preference for use among different communities in different parts of the country is greatly varied.

Use diversity of wild edible plants

The uses of WEPs were grouped into 6 use categories, namely environmental uses, fodder, fuel, medicine, poison, and social use categories, and the uses of most species (22 species, 36%) fall under the fuel use category (Fig. 6). Environmental use included soil conservation and the increase of its fertility (decomposing parts of the species such as leaves), fence (dry and live fence). Approximately, 15% of WEPs were recorded to be grouped under this category. *Acanthus sennii*, *Carissa spinarum*, *Opuntia ficus-indica*, *Urtica simensis* and *Rosa abyssincia* were reported to be the most commonly used species for live fences while *Cordia africana* was reported to be the most commonly mentioned species for soil fertility. Forage use category also included forage plants for cattle and bees (becoming a source of nectar for bees). The most commonly reported edible plant to be used as a source of food for bees was *Vernonia amygdalina.* It was also reported to be the most commonly used forage plant together with *Cordia africana*, *Rosa abyssynica*, *Cyperus rigidifolius*, *Persicaria nepalensis*, *Acacia abyssinica* and *Acanthus sennii.* The main reported edible parts for most of the forage plants were leaves.

Table 2. Preference ranking of 8 wild edible plants by 16 key informants based on income generation potential

Preference of WEPs based on income generation	Informants labeled A to P																Total score	Rank
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P		
Carissa spinarium	1	1	1	2	3	2	1	1	2	1	1	2	3	2	1	2	26	8th
Cordia africana	6	8	7	6	8	6	7	5	5	6	8	6	8	6	7	6	105	2nd
Dovyalis abyssinica	3	2	5	4	2	4	4	2	1	3	2	4	2	4	4	3	49	6th
Ficus sur	8	7	8	6	7	5	8	6	8	8	7	6	7	5	8	7	111	1st
Ficus vasta	4	3	2	1	1	1	2	3	3	4	3	1	1	1	2	4	36	7th
Rosa abyssinica	7	6	6	7	6	7	6	7	6	7	6	7	6	7	6	5	102	3rd
Rhus glutinosa subsp.*glutinosa*	2	4	3	3	4	3	3	4	4	2	4	3	4	3	3	1	50	5th
Rubus apetalus	5	5	4	5	5	8	5	8	7	5	5	5	5	8	5	8	93	4th

Note: Each rank was given a value of 1, 2, 3, 4, 5, 6, 7 and 8.

Table 3. Direct matrix ranking of 5 WEPs based on 5 use criteria by 5 key informants

Uc	Wild edible plants																													
	Acacia abyssinica						*Carissa spinarum*						*Cordia africana*						*Olea europaea*						*Rosa abyssincia*					
	Informants (I) (1-6)						I						I						I						I					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
eu	3	3	3	3	3	3	5	4	3	5	4	3	0	1	1	2	1	2	3	3	2	4	2	3	4	3	4	3	2	4
fg	2	2	2	2	2	2	2	1	1	2	1	1	3	3	2	3	2	3	0	0	0	0	0	0	2	2	1	1	2	3
fl	4	4	4	4	4	4	1	2	2	1	2	2	1	1	2	2	1	1	2	2	4	3	1	2	2	2	1	1	2	1
md	0	0	0	0	0	0	4	5	4	5	5	4	0	0	0	0	0	0	1	2	3	4	5	3		4	3	3	4	4
su	5	5	5	5	5	5	3	3	5	2	3	5		5	5	5	5	5	5	5	5	5	5	5	4	5	4	3	2	4
it	15	16	17	18	19	20	16	17	18	19	20	21	5	12	13	16	14	17	12	14	17	20	18	19	13	18	16	15	17	22
g	105						111						77						100						101					
r	2nd						1st						5th						4th						3rd					

Note: (5 = Best; 4 = Very good; 3 = Good; 2 = Less used; 1 = Least used and 0 = No value). Environmental use (eu) = fence; forage (fg) = fodder; fuel (fl) = firewood, charcoal; medicine (md); social use (su) = (rope, agricultural tools, house construction, house tools, fumigation, walking stick, timber); g = grand total; it = informant total, uc = use categories, r = rank

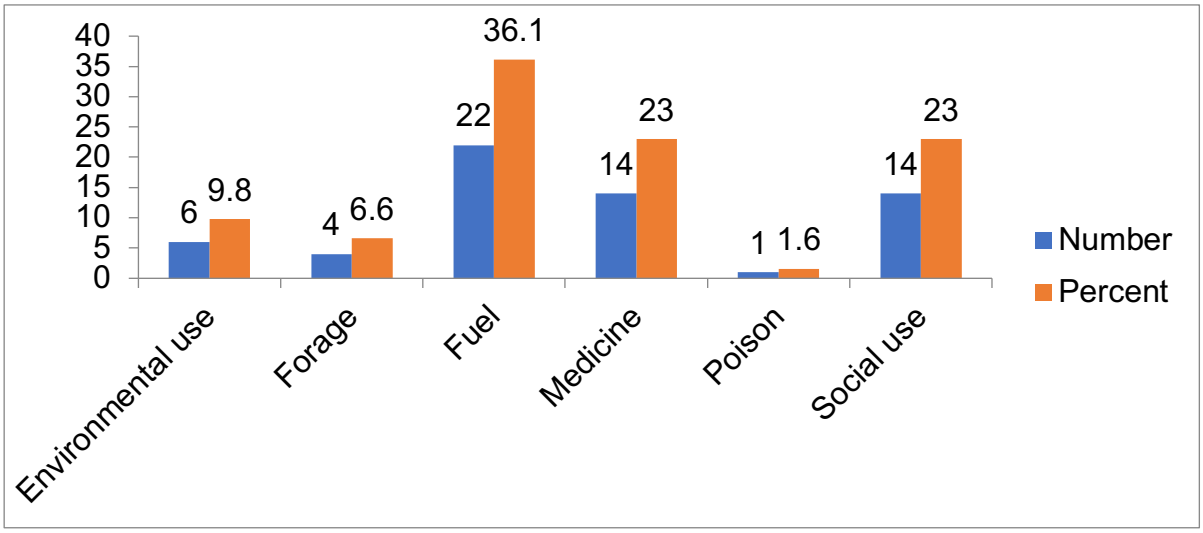

Figure 6. Percentage distributions of wild edible plants on different use categories

Fuel and social uses are the other use categories under the use diversity of wild edible plants. Fuelwood category included firewood and charcoal uses of wild edible plants. *Acacia abyssinica*, *Mimusops kummel*, *Ficus vasta*, *F. sur,* and *Cordia africana* were reported to be the main sources of fuelwood although the remaining wild edible plants were reported to be sometimes used as sources of fuelwood (Table 3). The role of wild edible plants in house construction, rope and agricultural tool preparation, timber, baking, and fumigation were also included under the social use categories of the species. *Acacia abyssinica* was reported to be the most commonly used species for agricultural tools such as arms and plowing rope whereas the timber plant, *Cordia africana,* was the most commonly used species for timber. The leaves of *Ensete ventricosum*, the peels of *Acacia abyssinica,* and *Cordia africana* were also reported to be the most commonly used parts for baking bread and in rope preparation respectively.

Wild edible plant species similarity between two agroclimatic zones

The analysis results of Sorenson's similarity coefficient (Ss = 0.86) (Table 4) showed that most of the wild edible plants have a common occurrence in the two agroclimatic zones of the districts. This might indicate the community of the districts living in the highlands (Dega agroclimatic zone) and in the lowlands (Weyna Dega agroclimatic zone) has a common consumption habit of similar wild edible plants.

As the results showed that the study districts generally reserved comparable edible species to the other parts of Ethiopia (Table 5).

Market surveys

Three WEPs (9.4%) (*Ficus sur*, *Mimusops kummel,* and *Olea europaea* subsp.*cuspidata*) were reported to be sold in local markets of the districts. The figs of *Ficus vasta,* and the fruits *Ximenia americana* and *Ensete ventricosum* were reported to be rarely sold in the local markets. The remaining species (81.3%) were non-marketable. *Mimusops kummel* was observed in the Adet market between November-April. *Olea europaea* subsp. *cuspidata* was observed at this market too. Figs of *Ficus sur* were found in markets especially in Bir Gebeya, Adet (in Yilmana Densa district), and Dabi / Gebez Maryam (in Quarit district) markets rarely in small marketplaces between March-May. The fruits of *Mimusops kummel* were reported to be sold in a can (containing about ½ kg). A single can of its fruits was sold for 3 Birr or by count 10 fruits were sold by 1 Birr. The results showed two main points: 1) wild edible plants had low availability in the local markets compared to the cultivated fruits such as banana, avocados, guajava. 2) Wild edible plants had a low price compared to cultivated fruits. For example, a single fruit of banana costs 5 Birr (Ethiopian currency) whereas 50 fruits of *Mimusops kummel* were sold for 5 Birr. In agreement with the current findings, the low availability and marketability of wild edible plants were also recorded by (Wondimu *et al.* 2006); Kidane *et al*. 2014; Anbessa 2016; Alemayehu *et al.* 2015). This showed that most wild edible plants are non-marketable in many parts of Ethiopia. Thus, wild edible plants are non-traded wild food sources of the country.

Table 4. Sorenson's similarity coefficient of the wild edible plants in the region. agroclimatic zones of the districts.

Agroclimatic zones	Unique species	Number	No. of common species	Ss* = Sorensen's similarity coefficient (Ss = 2a/ (2a+b+c)
Dega	*Hagenia abyssinica* *Thymus schimperi* *Urtica simensis*	3	24	0.86
Weyna Dega	*Acacia abyssinica* *Opuntia ficus-indica* *Mimusops kummel* *Syzygium guineense* *Ximenia americana*	5		

Note: * Ss = 2a/ (2a+b+c), Ss = Sorensen's similarity coefficient; a = Number of species with simultaneous occurrence in two agroclimatic zones 1 and 2; b = Number of species that occur only in agroclimatic zone 2; c = Number of species that occur only in agroclimatic zone 1.

Table 5. Comparison of the number of WEPs records in some parts of Ethiopia

Parts of Ethiopia	The recorded number of species	Researchers
Yilmana Densa and Quarit Districts	32	The present study
Yalo district	106	[25]
Bullen district	77	[26]
Kamash district	60	[27]
Chelia district	58	[28]
Berehet district	53	[29]
Burji district	46	[30]
Quara district	36	[31]
Chilga district	33	[32]
Bule Hora district	29	[33]

Threats and conservation

The results showed that agricultural expansion and firewood were the major threats for WEPs of the study areas in agreement with other findings done in other parts of Ethiopia (Balemie and Kebebew 2006; Assefa and Abebe 2011; Addis *et al.* 2013a; Tebkew *et al.* 2014; Anbessa 2016; Ashagre *et al.* 2016). Besides, it showed that there is a replacement of wild edible plants by fast-growing monoculture exotic species (*Eucalyptus camaldulensis)*. This replacement was because the monoculture tree species have diverse uses such as the source of charcoal and cash earnings. For example, a single stem of *Eucalyptus camaldulensis* with a DBH value of 10 cm was sold for 100 Birr which exceeded the cost of most wild edible plants with low-income generation values. Besides, most species of wild edible plants were nonmarketable, and even some marketable wild edible plants had low cost is non-comparable with this one. Thus, the local community might expend much of the efforts in the plantation of fast-growing monoculture species rather than taking care of the wild edible plants. The results also showed that cultivating wild edible plants for income generation, fence, timber, aesthetic, shade, and soil conservation were the other indirect conservation activities of the species. *Cordia africana* (wild edible fruit-producing plant), a well-known timber plant, was conserved by such indirect conservation activities.

Conclusions

The districts have *appreciable wild edible plants*. The remnant forests of the districts were also the home for most of the collected edible species. Thus, conservation priority should be given to the forests of the areas. The other main point here is that the culture of the people in using wild edible plants as supplementary food is low. Thus, there should be an extensive awareness *rising* in using wild edible foods. This might be also an incentive *for* the local people to appraise for conservation.

Declarations

List of abbreviations: DBH: Diameter at Breast Height; FGD: Focus Group Discussion; CSA: Central Statistical Agency of Ethiopia; WEPs: Wild Edible Plants

Ethics approval and consent to participate: The data were collected with respect to confidentiality and consent. All respondents were informed about the aim of this study.

Consent for publication: Not applicable

Availability of data and materials: The data was included within the article.

Competing interests: The author declares no conflict of interest.

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