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Full Research Article

Wild Edible Plant Bio-diversity and Utilization System in Nech Sar National Park, Ethiopia

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Abstract

Nech Sar National Park is one of the wildlife conservation areas of Ethiopia. The park is a very scenic and accessible. Wild edible plant biodiversity and utilization system was investigated in Nech Sar National Park from June 1, 2014 to May 30, 2015. A total of 60 informants between the ages of 20 and 80 were identified using prior information. Data were collected using semi-structured interviews, guided field walk, discussions, market surveys and field observation. A total of 51 wild edible species were identified by members of the local communities. Of these, 10 species were reported only by the Gamo community, eight by the Koera community, and seven by the Gujji community; while the remaining 26 were reported by three of them. Preference ranking indicated that the fruits of *Moringa stenopetala* are the most preferred edible plant by the local communities. The local people access the National Park for some of the wild edible plants as they are largely depleted from the surrounding areas. The yet untapped potentials of the wild edible plants as food sources in the area need better attention in future research plans. The poor communication system, on the other hand, has hindered the knowledge transfer from elders to youngsters and among different genders. The issue of conservation of wild edible plants is unquestionable to ensure household food security, dietary diversification and local communities' income, which also contributes to the bio-diversity.

1. Introduction

Bio-diversity is highly significant in securing different fundamental human needs. Since time immemorial; people have gathered plant resources to fulfill various daily requirements (Yadav et al., 2012) Hundreds of millions of people, mostly in developing countries, derive a substantial part of their subsistence and income from wild plant products. Wild Edible Plants (WEP) provides staple food for indigenous people, serve as complementary food for non-indigenous people and offer an alternative source of cash income (Gemedo et al., 2005; Yadav et al., 2012). WEP are important nutrient and vitamin supplements for indigenous people (Ali et al., 2008; Onyekwelu et al., 2015; Sneyd, 2015). Therefore, wild food resources reduce the vulnerability of local communities to food insecurity and provide a buffer in times of food shortage.

Millions of people in many developing countries do not have sufficient food to meet their daily requirements furthermore they are deficient in one or more micro nutrients (FAO, 2005; Stephenson et al., 2010). However, wild plant species offers varieties in family diet and contributes to household food security (FAO, 1999; Redzic, 2006). Thus, in most cases the rural communities of developing countries depend on wild edible plants to meet their food requirements during periods of food shortage.

Ethiopia is a country with varied a topography and a wide spectrum of habitats presenting a large number of endemic plants and animals. The country flora has approximately 6000 species of higher plants, of which about 10% are endemic (Azene et al., 1993; Sebsebe and Nordal, 2010; Hedberg et al., 2009). The country is known as the biodiversity hotspot and center of origin and diversification for a significant number of food plants and their wild relatives (Tesfaye, 1997; CI, 2004). The wide range of climatic and edaphic conditions permitted to the growing of variety of wild food plants (Addis et al., 2005). Current studies revealed that about 8% of the nearly 6000 of higher plants are edible (Zemede and Mesfin, 2001).

Some studies on the utilization of wild edible plants in Ethiopia indicated that many rural peoples are endowed with the knowledge of how to use the wild plants. This is particularly true for the use of medicinal plants (Abebe and Ayehu A, 1993) and wild edible plants that are consumed at times of famine, war and other hardships (Guinand and Dechassa, 2000; Salih

and Ali, 2014; Addis et al., 2005; Bell et al., 2015). In this regard, the elder community members are mostly the key sources or "reservoirs" of plant knowledge (Amare, 1974).

However, there has not been sufficient research carried out about the wild edible plant resources in Nech Sar National Park (NNP). However, forest depletion and degradation in the study area are major threats to the current loss of these wild edible plants and the knowledge associated with their uses. This suggests that there is a need to implement appropriate conservation measures on these threatened wild edible plants and on the knowledge of their utilization through conducting Ethnobotanicalstudies of the present type. Therefore, the present study aimed at investigating and documenting the diversity and use of wild edible plants by indigenous communities around Nech Sar National Park, Ethiopia.

2. Materials and Methods

2.1. Description of the study area

The study was conducted in NNP, one of the National Parks of Ethiopia. Located at about 510 km away from Addis Ababa, in the Amaro Special Woreda and Arba Minch Zuria Woreda of the Southern Nation Nationalities and Peoples Regional State (SNNPRS). It is situated to the east of Arba Minch. Its 514 square kilometers of territory include the "Bridge of God" (an isthmus between Lakes Abaya and Chamo), and the Nechisar (English: white grass) The Park is situated at 5°51′–6°10′ N and 37°32′–37°48′ E (Figure 1) with altitude ranges of 1108 masl at Lake Chamo and 1690 masl at the peak of Geda hill. The Park covers an area of 514 km^2 of which 436 km^2 is covered by land. The remaining area, 78 km^2 is water. As described by Demeke (2006), there exist four vegetation types. These includes: ground water forest, riverine forest, dense thickets (bush land) and grassland ecosystem in Nech Sar plains. NNP harbors a variety of mammalian, avian, amphibian, reptilian and fish fauna.

2.2. Sampling and data collection

A reconnaissance survey was made from June 1, 2014 to May 30, 2015. Since there is no permanent human settlement found within the NNP, informants and key informants were sampled from selected sites and brought to the study area in order to carry out the investigation. In this case, key informants refer to informants having better indigenous knowledge regarding wild edible plants than informants. Accordingly, Ethnobotanical data were gathered and the selection of informants and key informants was carried out based on prior information obtained from clan and religious leaders, knowledgeable elders, Park scouts (i.e., who have served in the NNP for more than 8 years and members of either the Gamo (Arba Minch forest), Koera (around hot spring) or Gujji (Nech Sar Pains) communities), pastoralists and agro-pastoralists. Other informants included individuals from different age groups, gender and ethnicity as well as field observation. Consequently, the informants were sampled almost in equal proportions from the Gamo, Koera and Gujji communities based on the vicinity of their kebeles and associated impact to the Park.

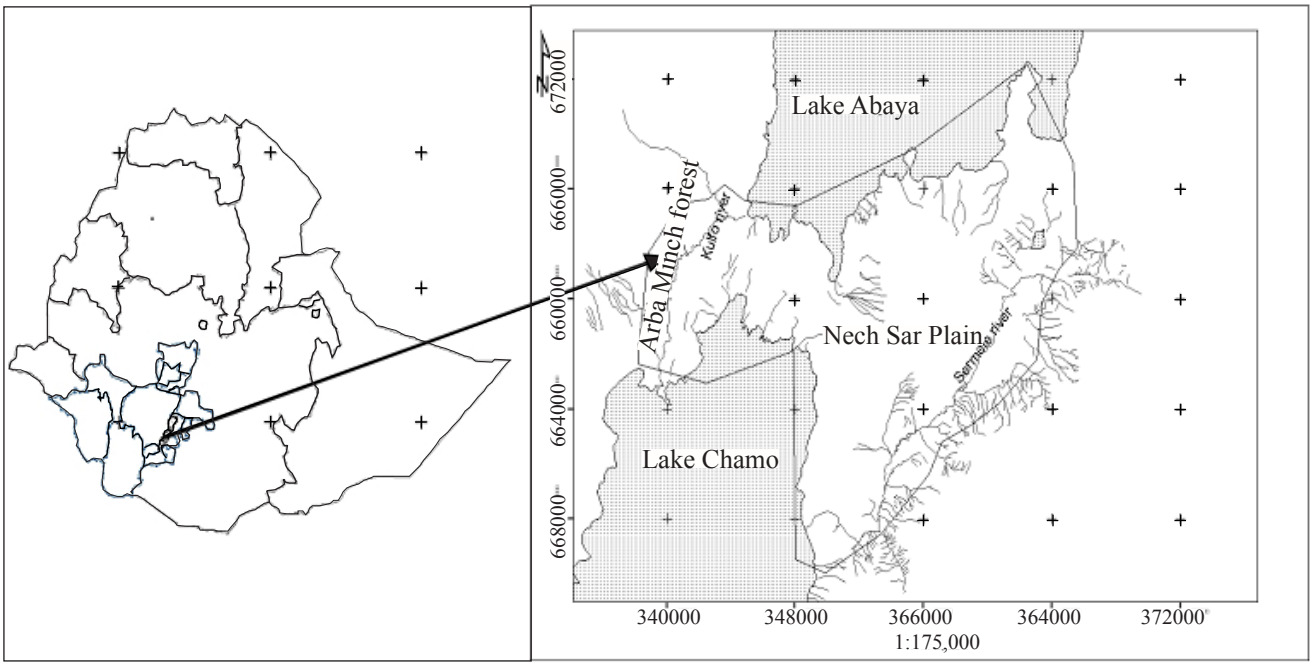

Figure 1: Map of the study area , NNP (Ethiopia) (Source: Aramde et al., 2012)

Interviewees were selected from three sites in the Gamo, Koera and Gujji. A total of 60 informants (20 from each study site) constituting 45 men and 15 women, between the ages of 20 and 80 were, identified by systematic/stratified random sampling. Out of these, 20 key informants (15 men and 5 women) were selected. Following this, Ethnobotanical data were collected, following Martin (1995), Cotton (1996) and Cunningham (2001). Semi-structured interviews, guided field walk, discussions, market surveys and field observation, with informants and key informants were applied based on a checklist of questions prepared ahead of time. The interviews were administered in the local languages, the Gamo, Koera and Oromo languages, with the help of native speakers as translators.

The relevant data about the indigenous use and management of wild edible plants included. Items such as local names, plant use (s), part (s) used, mode of consumption, their management and other related aspects were collected. Voucher specimens of the wild edible plant species identified by informants were collected, pressed, dried and their names were determined by using the different volumes of Flora books of Ethiopia and Eritrea at the establishing herbarium of Arba Minch University. Further identification and reconfirmation task was also carried out at the National Herbarium (ETH), Addis Ababa University and finally stored in the Arba Minch University Herbarium.

2.3. Data analysis

Ethnobotanical data were summarized and analyzed using simple frequency tables and figures as well as preference ranking method, following Martin (1995) and Cotton (1996). In preference ranking method, 10 out of the total key informants (i.e., 20) were randomly selected and participated in the ranking exercise. Accordingly, each of them ranked the selected seven most popular wild edible plants based on their taste qualities.

3. Results and Discussion

3.1. Transfer of indigenous knowledge of wild edible plant species

The study showed that the knowledge associated with edibility of wild plants is generally in the public domain with both direct and indirect ways of transfer. The knowledge flow from elders to children and its enrichment thereafter is directly conveyed through observation, imitation, freeflow of information, oral history, and myths among community members. Riddles in local languages are the indirect way of transferring indigenous knowledge in the community. The knowledge is used to identify the edible plant parts, taste, and preference for consumption. All rounded description of the wild edible plants including their nomenclature, morphology, habit, and usage during traditional ceremonies, diversity, and preference are mostly transferred through folklore. In this study folklore was also used as means of gathering Ethnobotanical information. Some examples of conveying knowledge associated with wild edible plant species (WEPs) through folklore include, habitat, taste, side effect to consume the plant.

3.2. Wild edible plant species used by peoples of the study area

The study area is endowed with diverse and rich sources of wild edible plants and these serve to the local communities as food sources and other multipurpose values. Fifty one species distributed in 38 genera and 29 families were identified by local communities within the study area as wild edible plants (Table 1). With respect to the diversity of the species gathered, the highest number of wild edibleplants was recorded in the family Fabaceae and Tiliaceae, 4 species each, followed by Amaranthaceae, Anacardiaceae, Moraceae, Rhamnaceae and Solanaceae were represented by three species each. Araceae, Boraginaceae, Celastraceae, Flacourtiaceae, Olacaceae, and Rosaceae were represented by two species each. The rest of the families were represented by one species each (Figure 2). This result showed that Nech Sar National Park is rich in wild edible plants as shown by the presence of 51 species exhibiting wide taxonomic diversity. The relative high number of wild edible plant in the study area may be due to the more intensive utilization of plants by the local communities. This number of diverse taxonomic groups of wild edible plants have been observed in different regional state of Ethiopia (Benta and Hewan, 2015**;** Kidane et al., 2014; Molla et al., 2011).

3.3. Growth habit of the wild edible plants

Of the recorded wild edible plants in the study area, shrubs were the highest life forms with 23 species, followed by trees with 17 species and herb with 9 species from the total wild edible plants. On the other hand, climbers were the least life forms with 2 species. Trees and shrubs make up the highest proportion (40) of the wild edible species (Figure 3). This could be related to the fact that they are often harvested from a variety of habitats ranging from deciduous bush land and Thicket, riverine forest, ground water forests, freshwater swamp and aquatic vegetation and grass land distantly located from resident areas. The finding agrees with the general pattern of dominance of shrub species seen in most edible wild plant inventories in Ethiopia and other countries (Assefa and Abebe, 2014; Kebu and Fassil, 2006; Tebkew et al., 2014; Teketay et al., 2010). With the current effect of climate change, shrub and tree species of wild edible plants could play a significant role among poor people to alleviate the problem of hunger, food shortage and malnutrition. Since the wild edible plants have adapted to the area, they have greater ability to cope with the extreme climate change and adverse effects.

Table 1: List of wild edible plants

Sl. No.	Family	Scientific names	H	Plant part used	Preparation
1.	Fabaceae	*Acacia polyacantha* Willd.	Tr	Fr	Raw
2..	Amaranthaceae	*Amaranthus caudata* L.	H	L,Ysh	Cooked vegetables
3.	Amaranthaceae	*Amaranthus cruentus* Thell	H	L ,Se	Cooked vegetables
4.	Amaranthaceae	*Amaranthus hybridus* L.	H	L	Cooked vegetables
5.	Balanitaceae	*Balanites aeygyptiaca* (L.)Del.	Tr	Fr	Raw
6.	Asteraceae	*Bidens pilosa* L.	H	L	Cooked as vegetables
7.	Burseraceae	*Boswellia neglecta* S.Moore.	Tr	Fr	Raw
8.	Cactaceae	*Cactus* spp.	Sh	Fr	Raw
9.	Capparidaceae	*Cadaba farinosa* Forssk.	Sh	L	Cooked
10.	Fabaceae	*Cajanus cajan* Adans.	Sh	Fr	Raw
11.	Solenaceae	*Capsicum annuum* L.	Sh	Fr	Raw, cooked with vegetables
12.	Apocynaceae	*Carisa spinarum* (Forssk) Vahil.	Sh	Fr	Raw
13.	Ulmaceae	*Ciltis africana* Brum.f.	Tr	Fr	Raw
14.	Rutaceae	*Citrus aurantifolia* (Christm.) Swingle.	Sh	Fr	Raw
15.	Araceae	*Colocasia esculenta* (L.) Schott.	H	Rt	Boiled
16.	Boraginaceae	*Cordia africana* Lam.	Tr	Fr	Raw
17.	Boraginaceae	*Cordia monoica* Roxb.	Sh	Fr	Raw
18.	Solanaceae	*Datura stramonium* L.	Sh	Fn	Raw
19.	Ebenaceae	*Diospyros abyssinica* (Hiem) F. Wite	T	Fr	Raw
20.	Flacourtiaceae	*Dovyalis abyssinica* (A.Rich.) Warb.	Sh	Fr	Raw
21.	Moraceae	*Ficus sur* Forssk	Tr	Fr	Raw
22.	Moraceae	*Ficus sycomorus* L.	Tr	Fr	Raw
23.	Moraceae	*Ficus Vasta* Forssk	Tr	Fr	Raw
24.	Euphorbiaceae	*Flueggea virosa* Guill. & Perr.	Sh	Fr	Raw
25.	Tiliaceae	*Grewia bicolar* Juss	Sh	Fr	Raw
26.	Tiliaceae	*Grewia ferruguinea* Hochst.ex A.Rich	Sh	Fr	Raw
27.	Tiliaceae	*Grewia mollis* Juss	Sh	Sb	To make juice
28.	Tiliaceae	*Grewia villosa* Willd.	Sh	Fr	Raw
29.	Malvaceae	*Hibiscus cannabinus* L.	H	Fr	Raw
30.	Verbenaceae	*Lantana camara* L.	Sh	Fr	Raw
31.	Anacardiaceae	*Mangifera indica* L.	Tr	Fr	Raw
32.	Celastraceae	*Maytenus arbutifolia* (A.Rich.) Wilczek.	Sh	Fr	Raw
33.	Celstraceae	*Maytenus senegalensis* (Lam.) Excell.	Sh	Fr	Raw
34.	Moringaceae	*Moringa stenopetala* (Bak.f.) Cuf.	T	L	Cooked
35.	Oliniaceae	*Olinia rochetiana* Thunb.	Sh	Fr	Raw
36.	Flacurtiaceae	*Oncoba spinosa* Forssk.	Sh	Fr	Raw
37.	Fabaceae	*Prosopis juliflora* (SW.) DC	Sh	Fr	Raw
38.	Anacardiaceae	*Rhus glutinosa* A. Rich. *subsp. Abyssinica* (Oliv.) M. Gilnert	Sh	Fr	Raw
39.	Anacardiaceae	*Rhus natalensis* Krauss.	Sh	Fr	Raw
40.	Rosaceae	*Rosa Abyssinica* R.Br.ex lindl.	Cl	Fr	Raw

Continue...

Sl. No.	Family	Scientific names	H	Plant part used	Preparation
41.	Rosaceae	*Rubus apetalus* Poir.	Cl	Fr	Raw
42.	Solonaceae	*Solanum nigrum* L.	H	Fr, L	Raw, cooked vegetables
43.	Myrtaceae	*Syzygium guineense* (Wild.) Dc. ssp. *guineense*	Tr	Fr	Raw
44.	Fabaceae	*Tamarindus indica* L.	Tr	Fr	Raw
45.	Typhaceae	*Typha angustifolia* L.	Gr	Fn	Raw
46.	Araceae	*Xanthosoma sagittifolium* (L.) Schott	H	Rt	Boiled
47.	Olacaceae	*Ximenia americana* L.	Tr	Fr	Raw
48.	Olacaceae	*Ximenia caffra* Sond.	Sh	Fr	Raw
49.	Rhamnaceae	*Ziziphus abyssinica* Hochst	Tr	Fr	Raw
50.	Rhamnaceae	*Ziziphus mucronata* willd.	Tr	Fr	Raw
51.	Rhamnaceae	*Ziziphus spin-christi* (L.)Wild.	Tr	Fr	Raw

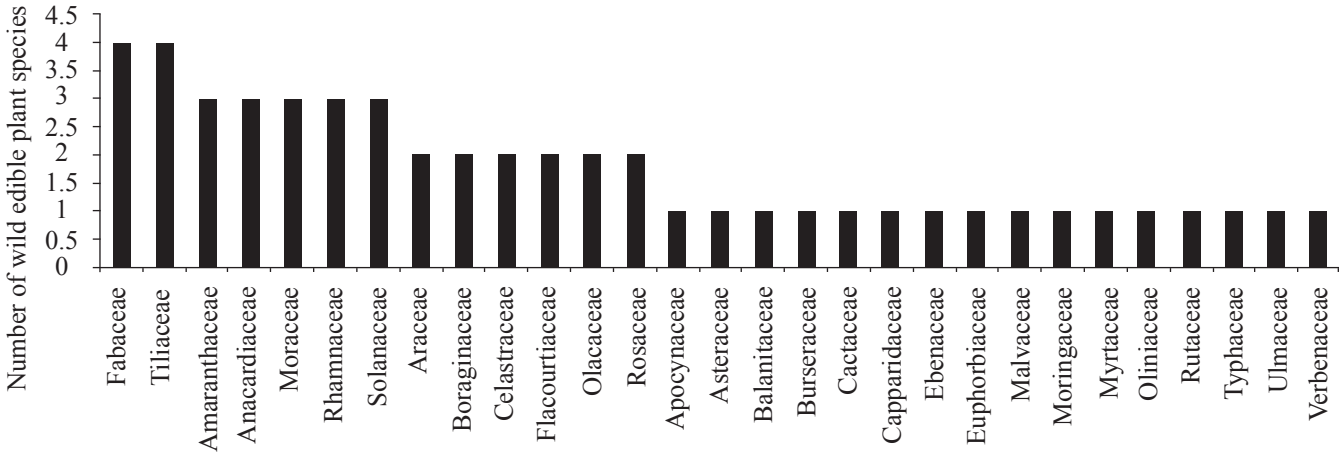

Figure 2: Species frequency of among each family

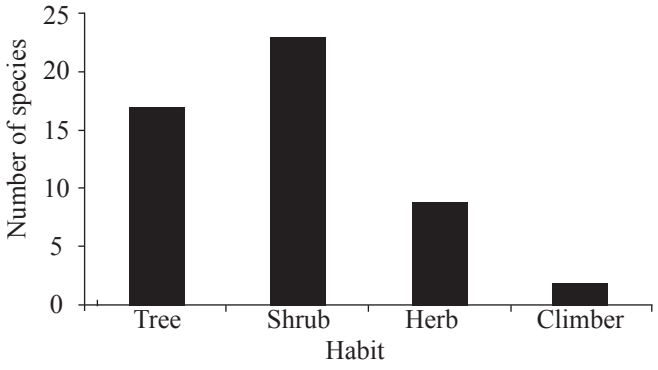

Figure 3: Frequency of wild edible plant taxa arranged by life forms

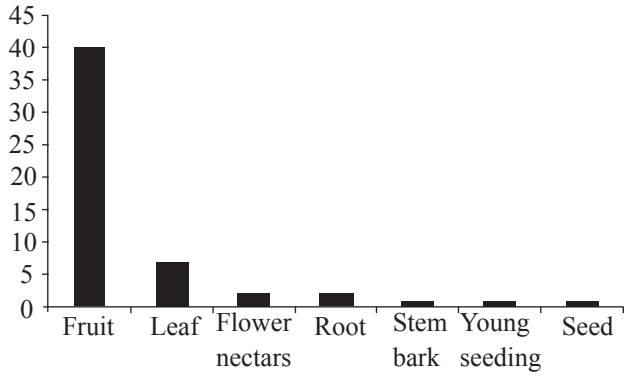

Figure 4: Number of wild edible plant parts used by the local people

3.4. Wild edible plant parts used as food value

The study showed that a total of 7 edible parts were recorded from 51 wild edible plant species implying that more than one parts of a species are consumed by humans. From the part of the wild edible plants, about 40 were fruits, 7 were leaves and 2 were roots and flower nectars each while the rest 3 were seed, young shoot and stem bark (Figure 4). This may show how simple is that to collect and use wild edible plant fruits and green leafy vegetables as compared to cultivation of domestic food crops. The increased use of wild fruits compared to other part of the plant indicates that the plants are used more during season of food shortage since eating

fruit do not take much time to prepare. Those who feel hungry harvest from the natural growing environment and eat without waiting for cooking or preparation. This further explains why the communities have much knowledge about the increased number of wild fruit plants. Similar trend has been reported in Sidama Zone, Hula Districts (Benta and Hewan, 2015), Amhara National Regional State (Fentahun and Hager, 2008), Derashe and Kucha Districts, South Ethiopia (Kebu and Fasil, 2006), Chelia District of Ethiopia (Regassa et al., 2015), Konso, Chilga (Tebkew et al., 2014). The majority of wild edible plants (i.e., 79.6%) have reproductive parts (fruits and/or seeds) as edible parts, while only 20.4% of them are vegetative parts (leaves, stems, barks, roots, etc.) reported as edible parts. The finding agrees with the general pattern of dominance of reproductive part seen in most edible wild plant inventories in Ethiopia (Zemede and Mesfin, 2001). Harvesting of these reproductive structures, i.e., fruits and/or seeds generally have alow impact on individual plants as compared to vegetative parts, i.e., leaves, stems, roots.

3.5. Preparation and mode of consumption

In terms of mode of consumption most of the wild edible plant parts, i.e. 42 were consumed as raw without any further processing (cooking and spicing) by the local communities, 8 as cooked, 2 as boiled and 1 in juice form (Figure 5). The highest number of raw mode of consumption can be explained by the fact that wild fruits are more favored by scout, firewood and grass collectors from the park. For example, the fruits of *Syzygium guineense, Cordia africana, Ficus sycomorus* are used by scout, firewood and grass collectors. The high consumption of wild edible plants in the form of fruit and vegetable might be explained by their nutritional value and their desirable taste (Addis et al., 2013; Benta and Hewan, 2015; Getachew et al., 2013). Discussion with the community revealed that gathered fruits and vegetables were used as basic food components in the past. These wild edible plants are currently replaced by cabbage, mango, apple and banana. Still many poor families rely on the wild vegetables mixed with corn. Most of the identified wild edible plants also have wide usage in the other part of Ethiopia (Benta and Hewan, 2015; Lulekal et al., 2013; Molla et al., 2011; Regassa et al., 2015; Tebkew et al., 2014).

3.6. Community preference for wild edible plants

Individual preference of wild edible plants consumption varies from one locality to the other. The condition or time where by each plant is consumed also varies. Some plants are consumed always even in the presence of appreciable food stock, some others consumed at times of acute food shortage and scarcity (Addis et al., 2005; Assefa and Abebe, 2014; Tebkew et al., 2014). Plants that are consumed at normal periods are highly valued during periods of food scarcity at all levels. The preference ranking of seven most important wild edible plants indicated that *Moringa stenopetala* attained the highest total score and ranked 1st, followed by *Syzygium guineense* and others (Table 2). These species were frequently selected by all age groups of the local people and have good market value due to their good taste quality and source of income. It was observed in the field that children and women collect some of the more popular fruits including *Syzygium guineense, Balanites aegyptiaca, Boswellia neglecta,* and *Ximenia americana*as well as the leaf of *Moringa stenopetala*, thereby

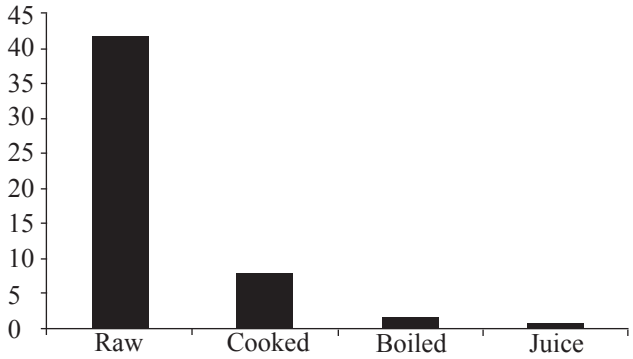

Figure 5: Mode of preparation and consumption of the different edible plant parts

Table 2: Preference ranking of seven most popular wild edible plants based on their taste qualities as perceived by key informants in the study area

Sl. No.	Wild edible plants	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	Total score	Rank
1.	*Balanites aegyptiaca*	4	5	5	4	3	5	6	5	4	5	46	3rd
2.	*Boswellia neglecta*	2	1	3	5	2	1	3	4	5	2	28	5th
3.	*Ficus sycomorus*	3	3	6	3	5	4	1	2	2	1	30	4th
4.	*Moringa stenopetala*	7	7	7	7	7	7	7	6	7	7	69	1st
5.	*Syzygium guineense*	5	6	4	6	6	6	5	7	6	6	57	2nd
6.	*Tamarindus indica*	1	2	1	1	2	2	4	1	3	3	20	7th
7.	*Ximenia americana*	6	4	2	2	1	3	2	3	1	4	28	5th

selling the excess at the town, road sides and in the nearest local markets. On the other hand, exotic but naturalized plant species such as *Lantana camara* and *Prosopis juliflora* also serve as sources of food. Similar trend has been reported in Semi-arid of Ethiopia (Debela et al., 2011b), Dheeraa town (Tigist et al., 2006), and Indigenous communities in and the buffer area of Awash National Park (Tinsae et al., 2013).

3.7. Side effect of wild edible plant parts for consumption

The majority of the wild edible plant parts did not have any side effect either during collection or preparation and consumption. However, of the edible plant parts were mentioned as unsafe by most of the community members such as pregnant women, children, and the elderly member. Among the adverse effects mentioned by respondents, incidence of abdominal pain, hallucinogenic was reported as the highest followed by diarrhea and constipation. Health problem are pronounced especially when unripe fruits are eaten or taken in excess amount. This finding is significantly similar with other findings from other regions of Ethiopia, Northern Amhara National Regional State (Addis et al., 2005), Southern Ethiopia (Guinand and Ugas, 1999) and Derashe and Kuche districts (Kebu and Fasil, 2006). However, people practice a variety of local preparation methods such as cooking for long hours, use of more salt to mask disgustingtastes, roasting, adding neutralize agents (such as lime) to remove some the sickening effects before eating. Sometimes wild plants have also different side effects on domestic animals. As reported by the local communities, a very grave case is goats' instantaneous death caused by the consumption of seeds of *Syzygium guineense*. Moreover, the consumption of exocarp of the *Syzygium guineense* fruit could also accidentally poison children's. Accidental poising by consumption of wild plant is common elsewhere in Ethiopia, especially during times of famine (Guinand and Dechassa, 2000; Kebu and Fasil, 2006 and Olani, 2001).

3.8. Traditional medicinal and other uses of wild edible plants

Of the recorded wild edible plants in the study area, 18 species serve the local community both as sources of food and as traditional medicine. These nutraceutical plants are used to treat 14 human aliments or health problems (Table 3). Leaves and fruits were predominately used to prepare remedies for ailments. For example, the fruits of *Balanites aegyptiaca* got priority by the local communities to relive abdominal pain. The fruit of *Cordia africana* is also mentioned as treatment for diarrhea; the leaves of *Solanium nigraum* to treat abdominal pain and the roots of *Carissa spinarum* as a remedy of tape worm. Of these, three nutraceutical plants were reported by Tilahun and Mirutse (2010) in the Lower Omo River Valley, four species by Debela et al. (2011a) in east Shewa Zone and six species by Tinsae et al. (2013) in the Indigenous communities in and the buffer area of Awash National Park. The high representation of medicinal wild edible plant from trees can be explained the culture and tradition of the people in the study area, where medicine is considered as secret to other local people. This is to increase the medicinal effect of the collected plants, as the locals believes that talking about the medicine reduces the medicinal value and curative effect of the plants. This could be related to the fact that trees are easily accessible to the nearby town and villages. This finding is significantly similar with other findings from other regions of Ethiopia, where trees dominating the medicinal plants (Benta and Hewan, 2015; Tinsae et al., 2013).

Table 3: List of wild edible plants with Nutraceutical values

Scientific name	Habits	Part used	Disease treated
Amaranthus caudata	Herb	Leaf	Scrofulous sores
Balanites aegyptiaca	Tree	Fruit	Abdominal pain and Snake bite
Bidens pilosa	Herb	Leaf	Snake bites and Wound
Cadaba farinosa	Shrub	Leaf	Stomach ache and Snake bite
Capsicum annuum	Shrub	Fruit	Stomach ache
Carisa spinarum	Shrub	Fruit	Gonorrhea
Citrus aurantifolia	Shrub	Fruit	Stomach ache and hypertension
Cordia africana	Tree	Fruit	Diarrhea
Datura stramonium	Shrub	Flower	Dandruff
Diospyros abyssinica	Tree	Leaf	Malaria and Dys-entery
Ficus sycomorus	Tree	Sap	Hepatitis
Lantana camara	Shrub	Leaf	Mosquito repel-lent
Moringa stenopetala	Tree	Leaf	Hypertension and Diabetes
Solanum nigrum	Herb	Leaf	Abdominal pain
Tamarindus indica	Tree	Fruit	Diarrhea
Ximenia americana	Tree	Fruit	Abdominal pain
Ziziphus mucronata	Tree	Leaf	Dandruff
Ziziphus spin-christi	Tree	Leaf	Dandruff

3.9. Market values of wild food plants

Market assessment of wild edible plant species showed that most of the edible plants are not sold only for food purposes but also for other purposes such as for timber, agricultural tools, construction, and fuel wood purpose. Some of the wild edible plant part (s) such as fruits of *Syzygium guineense, Balanites*

aegyptiaca, Boswellia neglecta, and *Ximenia americana*, the leaves of *Moringa stenopetala*are most commonly sold by women and children and and provide the opportunity to supplement household income in the study area (Table 4). Most of the identified wild edible plants were marketed in the other part of Ethiopia (Kebu and Fasil, 2006; Tinsae et al., 2013). Of the recorded species, fruits and leaves stood first and second, respectively. The same result was reported by Kebu and Fasil (2006) in Southern Ethiopia. The other economically important and marketable species is *Cordia africana*. It is the most preferred timber species with higher value and price at local markets. In general income derived from the sale of wild plant species is of particular importance to the poor household

Table 4: List of marketable wild edible plants at villages, roadsides and the nearest local markets in the study area

Scientific name Wild edible plants	Habits	Parts marketed
Amaranthus caudata	Herb	Leaf
Balanites aeygyptiaca	Tree	Fruit
Boswellia neglecta	Tree	Fruit
Colocasia esculenta	Herb	Root
Moringa stenopetala	Tree	Leaf
Syzygium guineense	Tree	Fruit
Ximenia americana	Tree	Fruit

to supplement their food product items and needs. As a result, the poverty level of the community could partly be alleviated. This scenarios indicated the importance of wild edible plants for food security and poverty reduction if managed in a proper manner.

3.10. Collectors and consumers of wild edible plants

Many of the informants reported that wild edible plant collection by the local communities is age dependent. The study revealed that there is significant difference between the age and sex of the informants and the number of wild edible plants they know. This means as the age of informant increases, the indigenous knowledge of people on wild edible plants clearly increases. Elders knows more wild edible plants than youngsters. The majority of the community agreed that wild edible plant species are consumed by all household members and largely collected by women (42.5%) (Table 5). Therefore, the utilization of wild plants for various purposes is a common practice in the study area and concurs with previous reports from other parts of Ethiopia (Addis et al., 2005; Bell, 1995; Benta and Hewan, 2015). The collection of green leafy vegetables are considered as the main task of women except in the cases where men are living alone in their houses. Surprisingly, some men are reluctant to admit their involvement in gathering the green leafy vegetables due to fear of public humiliation. On the other hand, much of the wild fruits were found to be consumed by children than elderly ones i.e. fruit consumption decreases from young to adult people. This is because as people grow up and consume wild plants they are considered to have lower status by the society. The finding agrees with the previous reports in Ethiopia and other African country (Benta and Hewan, 2015; Fentahun et al., 2005; Guinand and Dechassa, 2000; Mandu et al., 1999).

3.11. Seasonal availability of wild edible plants

The time of harvesting varies from plant to plant depending on its availability, and from place to place due to ecological and climatic conditions. The annual pattern of rainfall in the region is bimodal, with a long rain season during March to May, and a short rain season during September to November. Because of their fruiting time variability and seasonal availability, the majority of wild edible plant part(s) are gathered and consumed from September to December and April to August. While, the smallest number of wild edible plants was gathered in November, January, February and Marchas the amount of rain fall decreases during this time (Figure 6). Some species ripe at narrow ranges of time (e.g. *Solanum nigraum, Cordia africana*); others stay longer at fruiting (e.g. *Syzygium guineense*). Some plant fruits also ripe twice per annum^{-1} (e.g. *Ficus species* and *Carissa spinarum*). As a result of this, some fruits are available almost throughout the year as compared to the green leafy vegetables except *Moringa stenopetala*. The majority wild edible plants were consumed during times of food scarcity and starvation. This result is in agreement with earlier studies by Benta and Hewan (2015) in Hula Districts, by Debela et al., (2011b) in Sami-arid Ethiopia and by Olani (2001) in Ethiopia. This indicates that the year round availability of a series of different wild edible plants within and across the study area provides opportunities for food and nutrition supplement. This situation could motivate local people to conserve wild food plant resource and encourage domestication.

Table 5: Main consumers and gatherers of wild edible plants in the study area

Respondents	Who consume wild edible plantsin the family most?	Who collects wild edible plants inthe family most?
All household members	41.60%	-
Elderly people (old) aged	16.60%	-
Men	4.30%	16.70%
Women	25%	42.50%
Children	12.50%	40.80%

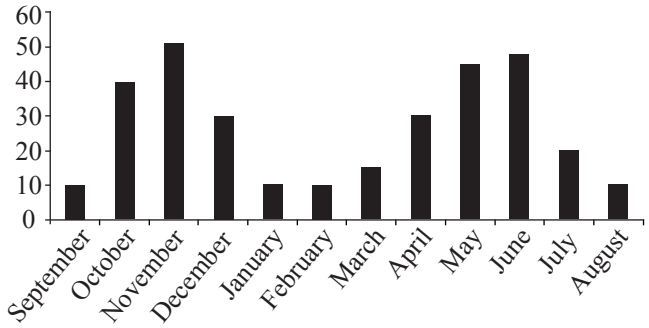

Figure 6: Number of wild edible plants consumed and time of gathering within a year

3.12. Habitat of wild edible plants

The study revealed that wild edible plants are widely distributed in diverse habitats. Shrub lands, bush lands and some grassland having scattered shrubs and bushes yielded more species, which accounted for 20 wild edible plants. For example, *Acacia polyacantha, Grewia* species, *Ziziphus* species, *Balanites aegyptiaca*, *Ximenia americana* are wild edible plants commonly found in these habitats. These were followed by the Kulfo riverine vegetation and ground water forest that comprised with 25 plant species. These included, *Cordia africana, Ficus sycomorus Ficus vasta*, *Tamarindus indica*, *Ximenia americana* and the rest, 7 species form different habitats of the park. This shows that the wild edible plants are adapted and distributed in the different habitats of the study area. Such differences in distribution in species diversity and richness of wild edible plants are mainly due to differences in soil and topography (Asfaw, 2009; Azene, 2007; Tinsae et al., 2013).

3.13. Multipurpose use of wild edible plants

Apart from their food and medicinal value, most of the wild edible plants identified in the study area are used by the community for different purposes. They are commonly used as firewood, construction material, for furniture, fencing, and agricultural tools and as fodder to animals. This practice was actually observed by the researchers in the study areas where some of the wild edible plants were sold at local market. As a result eight plant species that are used for different purposes were identified by the community. Direct matrix ranking was undertaken in order to evaluate these multipurpose tree species and their relative importance to the local people and the extent of the existing threats related to their use values (Table 6). The result of use diversity indicates that *Cordia africana, Syzygium guineense* and *Ficus sycomorus* ranked 1st 2nd and 3rd respectively because they are used for different purposes in the study area. This shows that the local people harvest the wild edible plants not only for food but mostly for construction, firewood, and furniture. This might be a reason for the scarcity and rarity of some of the wild edible plants especially outside of the NNP. Such a problem was similarly described in other parts of Ethiopia (Bayafers, 2000; Tigist et al., 2006; Tinsae et al., 2013). The utilization of these plants for the top ranked uses (construction, fuel wood, and furniture) linked with the daily life activities of the community. In order to have a sustainable utilization of these plants, the best practical solution is to launch conservation measures. This could be done by encouraging the plantation of other trees (non-edible wild plants) using agro-forestry practices in degraded areas along roadsides, home garden and agricultural fields.

3.14. Threats to wild edible plants

Since the local community have an intimate relationship towards their natural environment, they are familiar with the threats on wild edible plants. Therefore, during both group and individual discussions, key informants identified the major threats to wild edible plants. This is attributed mainly to human population pressure and its associated effects. Accordingly, removal of wild edible plants for different purposes (e.g. firewood and charcoal production, building and construction, fencing materials, etc.), overgrazing/over browsing, human settlement, agricultural expansion, over harvesting and burning forests were the major threats. Some or most of the above

Table 6: Average score for direct matrix ranking of the 11 wild edible plant species on eight use criteria (use given from 0 to 4, 0: no used; 1: least used; 2: good; 3: very good; 4: excellent

	Edible plant species and ranking*										
	1	2	3	4	5	6	7	8	9	10	11
Edibility	2	2	1	2	2	3	4	3	2	3	1
Medicine	3	2	0	2	2	1	4	0	1	1	1
Construc-tion/building	0	0	1	2	1	2	0	2	0	0	0
Furniture	0	0	0	4	1	3	0	2	0	0	0
Agricultural tools	1	1	2	3	2	2	0	2	1	0	0
Fuel wood collection	1	2	2	2	3	1	0	3	2	0	0
Fodder	1	2	1	0	1	1	0	1	0	0	0
Fencing	2	2	1	1	0	0	1	1	0	1	1
Total score	10	11	8	16	12	13	9	14	6	5	3
Rank	6	5	8	1	4	3	7	2	9	10	11

*Key, 1: *Balanites aeygyptiaca*; 2: *Carisa spinarum*; 3: *Ciltis africana*; 4: *Cordia africana*; 5: *Diospyros abyssinica*; 6: *Ficus sycomorus*; 7: *Moringa stenopetala*; 8: *Syzygium guineense*; 9: *Tamarindus indica*; 10: *Ximenia americana*; 11: *Ziziphus spin-Christi*

results are also reported in different areas of Ethiopia (Debela et al., 2012; Kebu and Fassil, 2006; Teketay et al., 2010 and Tinsae et al., 2013). Due to these reasons, plant species such as *Cordia Africana* and *Ficus* species are identified as threatened and near-threatened species respectively in NNP.

3.15. Conservation of wild edible plants and associated knowledge

The local communities in the study area have various indigenous management strategies of wild edible plants conservation. For example, many wild edible plants are left to widely grow in farmlands, farm boundaries watershed areas, homesteads as live fence, shade, along road sides and degraded areas. This practice was actually observed by the researchers in the study areas. For example, *Cordia africana*, *Ziziphus mucronata* and *Ziziphus spina-christi* were widely grow in farmlands, farm boundaries and watershed areas and others frequently appear around homesteads as live fence (*Lantana camara, Prosopis juliflora* and *Balanites aegyptiaca*), shade (*Ficus Vasta*, *Prosopis juliflora* and *Balanites aegyptiaca*) and along road sides and degraded areas. Similar trend has been reported in the Indigenous communities in and the buffer area of Awash National Park (Tinsae et al., 2013). Besides, personal observation and communication revealed that children and livestock herders bring the seeds after consuming the fruits back to homes and cultivate them around homesteads and fence the seedlings saved from livestock foraging. This gives some hint for the possibility of conservation and domestication of wild edible plants. These are sustainable modes of resource use that need to be encouraged and applied by blending them with standard modern management practices.

4. Conclusion

The knowledge about edibility, habitat distribution and other uses of wild edible plant species is still maintained among the study communities. There is a need to blend indigenous knowledge with modern science to promote sustainable development, and sustained utilization of these uncultivated sources of nutritious food. The habit of eating vegetables, root, stem bark, flower nectar and fruits are major reasons to accept or reject the wild edible plants.

5. Further Research

Further research is undergoing to characterize the nutritional quality or nutritional analysis of wild edible plants in Nech Sar National Park.

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