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Wild Edible plants study in a Dryland Ecosystem of Ethiopia

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ABSTRACT

The study was conducted in districts surrounding to Hirmi dryland, Northwestern Zone of Tigray region, to study the wild edible plant species (WEPs) type, use, threats, and conservation practices as well as associated community knowledge in the study areas. Six kebeles near Hirmi dryland were chosen to collect the necessary information, with 60 general informants and six key informants recruited. Data were collected through a semi-structured questionnaire, key informant interview, group discussion, and field walk. The collected data were analysed via descriptive statistics, preference ranking, and direct matrix ranking using their respective statistical and computer packages such as ANOVA and t-tests in SPS. A total of 41 wild edible plant species that belong to 35 genera and 28 families were recorded. The family Moraceae was represented by the highest number of species. Riverside was a good source (39%) of wild edible plants. 63% of the plants were eaten their fruit raw while it becomes riped. The informants identified Diospyros mespiliformis, Syzygium guineense, Vangueria madagascariensis, Ximenia americana, and Ziziphus spina-christi as the most abundant, diversified, and year-round wild food plants, accounting for more than 65% of WEP marketability. Deforestation, browsing, expansion of agriculture, over-harvesting, and timber production were the major threats to the wild edible plants. The community utilizes homegardening, awareness raising, selective fencing, and ecological restoration to combat these challenges. There was a significant difference (P 0.05) in the mean number of wild edible plants reported by informants of various ages, marital status, educational status, and experiences. There was no substantial difference between males and women, religion, or districts. Local peoples have indigenous knowledge and expertise in using and conserving wild edible pants, which necessitates participation in the government's sustainable forest management approach.

Keywords: Conservation, Ecological services, Hirmi, Indigenous knowledge, Wild edible plant

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1. INTRODUCTION

Wild edible plants are important components of natural vegetation that play an important role in guaranteeing food and livelihood security for countless families and communities worldwide (Lulekal et al., 2011). They play an important role in food security in arid and semi-arid regions (Assefa and Abebe, 2011). Traditional communities around the world have amassed a wealth of wild edible plant knowledge through extensive interactions with the natural environment (Cotton, 1996).

Indigenous knowledge about the functionality of food plants in Ethiopia has a very long history. Habitually the use of functional food plants is still widespread, acceptable, and popular in Ethiopia (Deribe et al., 2006). The knowledge, perception, use and management practice of edible plants in Ethiopia is being lost at an accelerated rate and disappearing with changes in lifestyle, occupational patterns of household members, and the death of knowledgeable persons (Garí, 2003). The other reason for the loss of indigenous knowledge and forest degradation is human interference such as an expansion of agricultural land, grazing, firewood and drought (FAO, 2010). Documenting the uses of plants as a supplemental value and source of food is noteworthy to understand the threats to the survival of the entire forest in general and wild edible plants in particular, with their means of management knowledge.

The forest around the study area is currently becoming scant and reduced because of various reasons, such as human intervention. A community in the study districts has day to day interaction with Hirmi forest. There is no doubt that, peoples in the study area has knowledge of the use and management practices of those edible plant species. However, it is obvious to occur a gap in the knowledge of sustainable utilization, conservation status, ecosystem services and socio-economical contribution of wild edible plants among the local community. In addition, collecting and documenting the Ethnobotanical uses of wild edible plants, conservation practices, and diverse uses of these plants by communities in the remote part of the country is inadequate (Soromessa et al. 2004; Lulekal et al., 2011). Hence the present study was conducted in a northern dryland landmass of the country, where no recorded document was there on this regard. Therefore, this study was conducted to meet the following the following objectives to: (a) document wild edible plant species, (b) determine the most popular wild edibe plants used, (c) assess the indigenous knowledge and utilization practices of wild edible plants by different social

groups, (d) evaluate the stastus and threats of wild edible plants species and (e) assess conservation practices of wild edible plants by the local community.

2. MATERIALS AND METHODS

2.1. Description of the study area

The present study was conducted in districts that surround to Hirmi forest (Fig. 1). The forest is surrounded by three districts of the north-western zone of Tigray namely; Asegde-Tsimbla, Tahitay-Koraro, and Medebay-Zana. It is situated at a latitude of 13º49'–14º04' N and a longitude of 38º14' –38º25'E, along the altitude ranges from 900-2200 meters above sea level (Girmay et al., 2020).

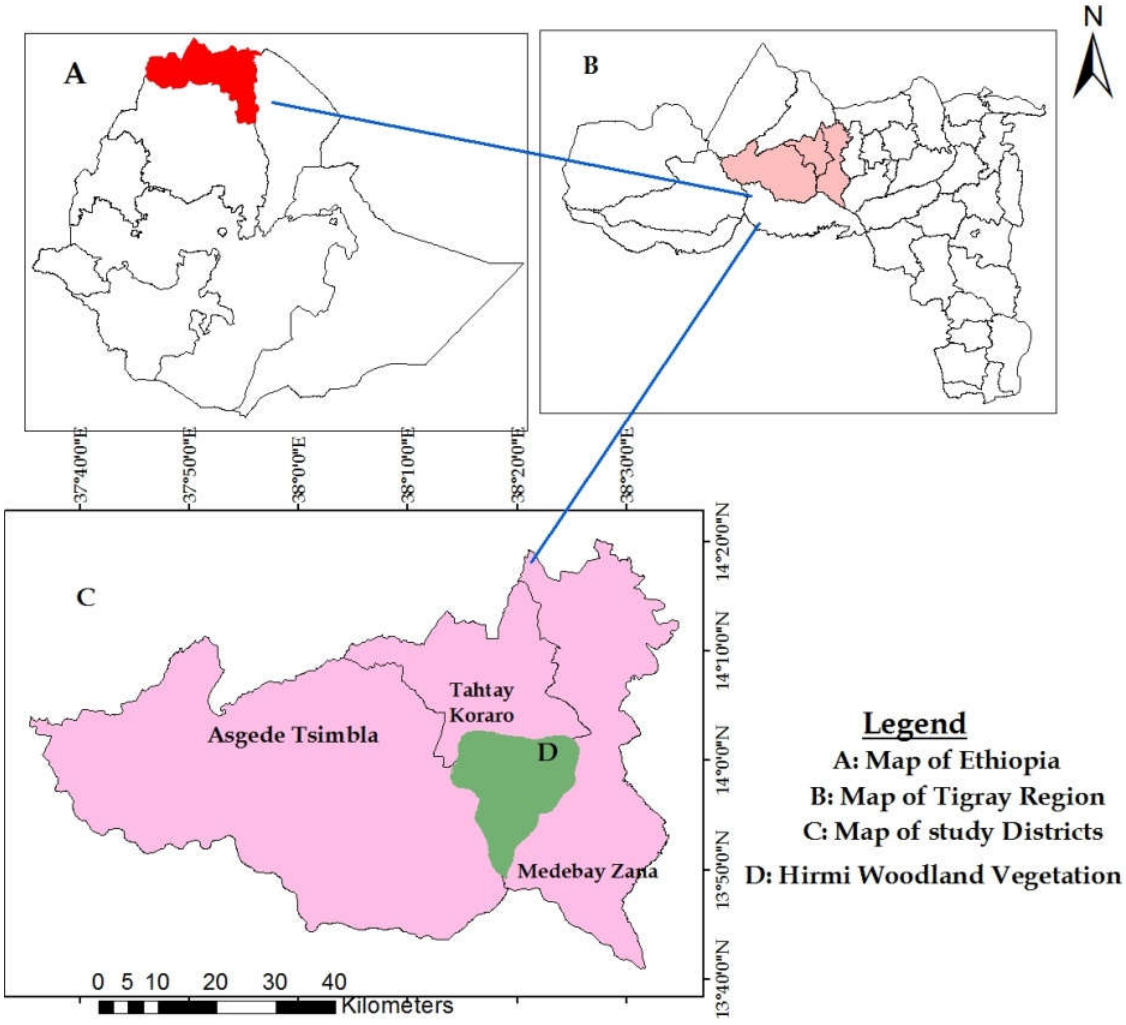


Figure 1: map of the study area(three districts)

2.2. Agro-ecology and climate

Hirmi vegetation is a dryland type landmass in northern Ethiopia, featuring Dry-evergreen mountain forests, Acacia-Commiphora, and Combretum-Terminalia woodland forest types. The study area has two climatic zones: lowlands (from 800-1500 masl) and intermediate altitudes (from 1501-2300 masl), with temperatures ranging from 14 to 35 degrees Celsius. The annual rainfall is between 720 and 1400 mm. Between June and/or up to mid-September, the research area has a high rainfall distribution (Girmay et al., 2020).

2.3. Socioeconemy, demography and land use type of the study area

Based on the 2015 national census conducted in the 3 woredas (in the 12 kebeles) where Hirmi forest falls, the total population of the area is 74,283 out of these 37,851 are males and 36,432 females (CSA, 2015). All (100%) of the local community in the study area are Tigrigna speakers. 98.02% of the study population are orthodox followers and the rest are Muslims.

2.4. Methods of data collection

A reconnaissance survey was carried out prior to collecting ethnobotanical and environmental data. The survey sought information/data on the area's agroecology, the status of wild edible plant species, and indigenous knowledge of local people in using plants for various reasons. Local leaders and certain informants were contacted during the survey, and the research site/Kebele/ was chosen.

The vegetation fell in three districts and twelve kebeles. Six kebele were chosen on purpose, with the Kebele closest to the forest being given precedence during the reconnaissance study. There were 4,868 householders in these kebeles, with a total population of 34,080. A stratified random sample was used to pick 60 general informants from the six kebeles of the three research Woredas (with age group above 18 years and by taking sex ratio into account). Purposive sampling was used to pick six key informants with good knowledge of wild edible plant consumption and management, as proposed by the local leader and locals in the study region (Alexiades, 1996; Addis et al., 2013).

Data were collected between September and October of 2020 using the Alexiades (1996) and Cunningham (1996) technique (2001). As a result, semi-structured interviews, guided field trips, and group discussions were used to collect indigenous knowledge about wild edible plants from the local people. All of the interviews were conducted using a checklist of questions developed in English and translated into Tigrigna, the local language of the residents. Following that,

interviews and conversations with informants and important informants were conducted. The debate focused on issues concerning wild food plants.

An interview is the basis of most ethnobotanical data collection methods (Addis et al., 2013). In this study, the ethnobotanical data of wild edible plants were collected using semi-structured interviews from randomly and purposively selected informants consists of knowledgeable elders, and youth of both sexes in the study area. It was an important tool for the collection of both qualitative and quantitative data on using and conservation of wild edible plans in the districts. Field observation and group discussion was made during the study about the status, acceptance, conservation and usage of wild edible plants by the local peoples. In each kebele, a small group discussion on the aforementioned topics was held with locals in general and important informants in particular. During the guided field visit with key informants, physical visits, walking chats, and photography of various wild edible plants were conducted. On-site, detailed notes on the manner of collection, landforms, significant risks, habits, and habitat were taken.

2.5. Methods of data analysis

The descriptive data analysis method was employed to summarize the information associated with wild edible plants obtained from the informants using an Excel spreadsheet. t-test and one-way ANOVA at a 95% confidence level was used to test the distribution of indigenous knowledge on wild edible plants among the informants. In addition, preference ranking was used to order wild edible plants based on their importance value across a community. The most important in the set is given the highest number, decreasing in number as the members of the set decrease in importance. Preference ranking was computed by taking six key informants to assess the degree of importance of those wild edible plants highly cited by the informants used as food at a particular time (Martin, 1995). Direct matrix ranking is also another method used to order wild edible plants by considering several attributes/uses for seven most frequently cited species by the informants. To recognize the wild edible plant species with multipurpose uses, values from 1–7 were given: the highest score has a high multipurpose value whereas the least score indicates species with a relatively small value.

3. RESULT AND DISCUSSION

3.1. Wild edible plant species in the study area

Wild edible plant specie has a significant role in filling the food insufficiency and insecurity gap in Ethiopia for a long time (Lulekal et al., 2011). The present study demonstrates the community that surrounding Hirmi forest has good knowledge and practice in using of plant and plant products as wild food. The study area is endowed with different wild edible plants which serve the local communities as food sources and for other purposes. It was recorded that 41 species belong to 35 genera and 28 families (Table 1). The families of Acanthaceae, Brassicaceae, Ebenaceae, Fabaceae, Rhamnaceae, Rutaceae, and Verbenaceae have the highest numeral of genera. In another regard, the plant family Moraceae was represented by the highest number (four) of species. The taxa *Ficus* species was the most common edible and diverse wild edible plant in the study area, showing the similarity with the study edible elsewhere by Hegazy *et al*. (2013). The wild edible plants found in the present study area have also been reported in different parts of the country by different investigators such as (Addis et al., 2013; Giday and Teklehaymanot, 2010).

3.2. Habit and distribution of wild edible plants

Of the recorded wild edible plants in the study area, shrubs were the most dominant wild edible plants used by the inhabitants with a quantitative proportion of 44%. Similar studies reported by Kebu Balemie and Kebebew (2006) in Derashe and Kucha districts reveal shrubs accounted for the highest part of wild edible plants in contrast with the rest of plant habits. This is because dry land agroecology is mostly endowed with shrubs and different bushs that adopt such type of landmass. Next to shrubs, trees cover 37% of the WEP's habit. A study conducted by Assefa and Abebe (2011) in South Omo agrees, trees and shrubs were the main sources of wild food in Benna Tsemay districts.

Table 1: list of wild edible plant species in the study destricts

Scientific name	**Family**	**Local name**	**Habit**	**Parts used**	**Mode of consumption**
Acacia abyssinica Hochst. Ex Benth.	Fabaceae	Chea	T	Gum	Raw
Acacia seyal Del.	Fabaceae	Keyihchea	T	Gum	Raw
Balanites aegyptiaca (L.) Del.	Balanitaceae	Mekie	T	Fruit	Ripe
Brassica carinata A. Br	Brassicaceae	Hamli Adri	H	AG	bioled/cocked

Carissa edulis (Forssk.) Vahl	Apocynaceae	Agam	S	Fruit	Raw
Citrus aurantiifolia (Christm.) Swingle	Rutaceae	Lemin	S	F	Raw
Cordia africana Lam.	Boraginaceae	Awhi	T	F	Raw
Cucurbita pepo L.	Cucurbitaceae	Duba	H	F	Via Cocking
Datura stramonium L.	Solanaceae	Mezerba'e	H	pollen nectar	Sucking Sucking
Dioscorea schimperiana Kunth	Dioscoreaceae		Cl	Root	Raw
Diospyros mespiliformis Hochst. ex A. DC	Ebenaceae	Aye	T	F	Raw
Euclea racemosa Murr.	Ebenaceae	Kuleo	S	F	Raw
Ficus hochstetteri A. Rich.	Moraceae	Tsekente	T	F	Raw
Ficus palmata Forssk. (Miq.)	Moraceae	Beleskola	S	F	Raw
Ficus sycomorus L.	Moraceae	Sagla	T	F	Raw
Ficus vasta Forssk	Moraceae	Daero	T	F	Raw
Flueggea virosa (Willd.) Voigt.	Euphorbiaceae	Harmazo	S	F	Raw
Hypoestes forskaolii (Vahl) R.Sch.	Acanthaceae		H	pollen nectar	Raw
Grewia ferruginea Hochst. exA. Rich.	Tiliaceae	Tsimkuya	S	F	Raw
Justicia schimperiana (Hochst. ex Nees) T. Anders.	Acanthaceae	Simieza	S	pollen nectar	Via Sucking
Lantana camara L.	Verbenaceae	Alalimo	S	F	Raw
Lepidium sativum L.	Brassicaceae	Shinfa'e	H	F	Crushed with other
Lippia adoensis Hochst. ex Walp.	Verbenaceae	Keskese	S	L	leaves with other
Mimusops kummel A. DC.	Sapotaceae	Kumel	T	F	Raw
Moringa oleifera Lam.	Moringaceae	Moringa	T	L	Via cocking
Opuntia ficus-indica (L.) Miller	Cactaceae	Beles	S	F	Raw
Phoenix reclinata Jacq.	Arecaceae	Siye	T	F	Raw
Rhamnus prinoides L'Herit.	Rhamnaceae	Gesho	S	L	Drink crushed leaf
Rhus retinorrhoea Oliv.	Anacardiaceae	Tetaelo	S	F	Raw drink
Rumex abyssinicus Jacq.	Polygonaceae	Mokmoko	H	Root	Drink with water
Rumex nervosus Vahl.	Polygonaceae	Mchicho	S	Young twing	eaten in raw
Ruta chalepensis L.	Rutaceae	Chena-Adam	H	L	leave with sauce
Sterculia setigera Del.	Sterculiaceae	Darle	T	Bark	Bioled/Raw
Syzygium guineense (Wild.)DC.	Myrtaceae	Liham	T	F	Raw
Tamarindus indica L.	Fabaceae	Humer	T	F	Raw
Terminalia catappa L.	Combretaceae	Wawa	T	F	Raw
Vangueria madagascariensis Gmel.	Rubiaceae	Guramayle	S	F	Raw
Woodfordia uniflora (A. Rich) Koehne.	Lythraceae	Lekemeja	S	pollen nectar	Sucking
Ximenia americana L.	Olacaceae	Mileo	S	F	Ripe
Ziziphus mucronata Willd.	Rhamnaceae	Abetere	S	F	Ripe
Ziziphus spina-christi L.	Rhamnaceae	Gaba	S	F	Ripe

Key: part of usd; F= fruit S= shrub L= leaf……..T= tree H= herb Cl= climber

3.3. Plant parts used and mode of consumption WEPs

The majority (63%) of the recorded wild edible plants in the study districts had their fruit eaten. Other parts included 11% for leaves, 10% for pollen nectar, and 5% for root and gum. As a result, the fruit was considered an important element of the wild food plant by the people in the study area. This was consistent with the findings of research by Asfaw and Tadesse (2001), Giday and Teklehaymanot (2010), and Addis et al (2013).

As previously stated, the fruit is the most significant component of the WEPs by the people. As a result, the most common mode of consumption (58%) indicates that wild items were consumed in uncooked form. Ripe fruit is simpler to consume and does not require any additional steps, making it superior to the other parts. This conclusion is consistent with prior research conducted in Southern Ethiopia (Assefa and Abebe, 2011), which found that 76.7% of WEPs were ingested raw or without further processing. Different Ethiopian researchers, including Wonidmu et al. (2006), Kebu Balemie & Fassil Kebebew, (2006), Teklehaymanot and Giday, have reported similar findings (2010).

3.4. Marketability and prefered season to collect WEPs

Only 30% of the WEPs have marketability value, the majority (70%) of species were used for local consumption. About 65% of the WEPs market was dominated by species such as *Diospyros mespiliformis*, *Syzygium guineense*, *Vangueria madagascariensis*, *Ximenia americana*, and *Ziziphus spina-christi*. This is due to these species being available all over the year and more diverse in the study area. A study conducted in a different part of Tigray on WEPs by Aregay et al. (2017) reports that plant species such as *Syzygium guineense*, *Balanites aegyptiaca, Ximenia americana*, and *Ziziphus spina-christi* were among the common wild edible plants both in local community and market which is more or less similar with the present findings. Alike this study, a few numbers of wild foods sold in the market were also reported by other studies made in Ethiopia **(**Asfaw, 1997; Balemie and Kibebew, 2006**;** Wondimu et al. 2006**).**

The wet season is the preferable season (55%) to collect WEPs followed by the dry season (27%) and all over the year (18%). This is because WEPs are more available in the rainy season than in the dry season. Similar studies were reported by Kebu Balemie and Fassil Kebebew (2006). Other findings reported by Aregay et al. (2017) showed, most of the fruits ripened at dry time (January to May) in contrast to the present study and almost all the vegetables ripened in the rainy season (June – August) i.e. similar to this study.

3.5. Other uses of WEPs

About 35% of the wild edible plant species are served only as wild food. The rest (65%) provides non-food ecological services such as medicinal value for human and livestock, fodder, fence, firewood, material culture, charcoal production, and other environmental services. Among the other use categories of wild edible plants, medicinal use has the highest score afterwards with material culture, firewood, and fence respectively (Fig. 2). A study conducted in the lower Omo river valley by Teklehaymanot and Giday (2010) divulges the highest other use categories of WEPs was medicinal value, i.e. comparable with the present findings. In line with this study, Berihun and Molla (2017) also reported that wild edible plants have different ecological services such as a fence, firewood, and material culture next to herbal medicine values.

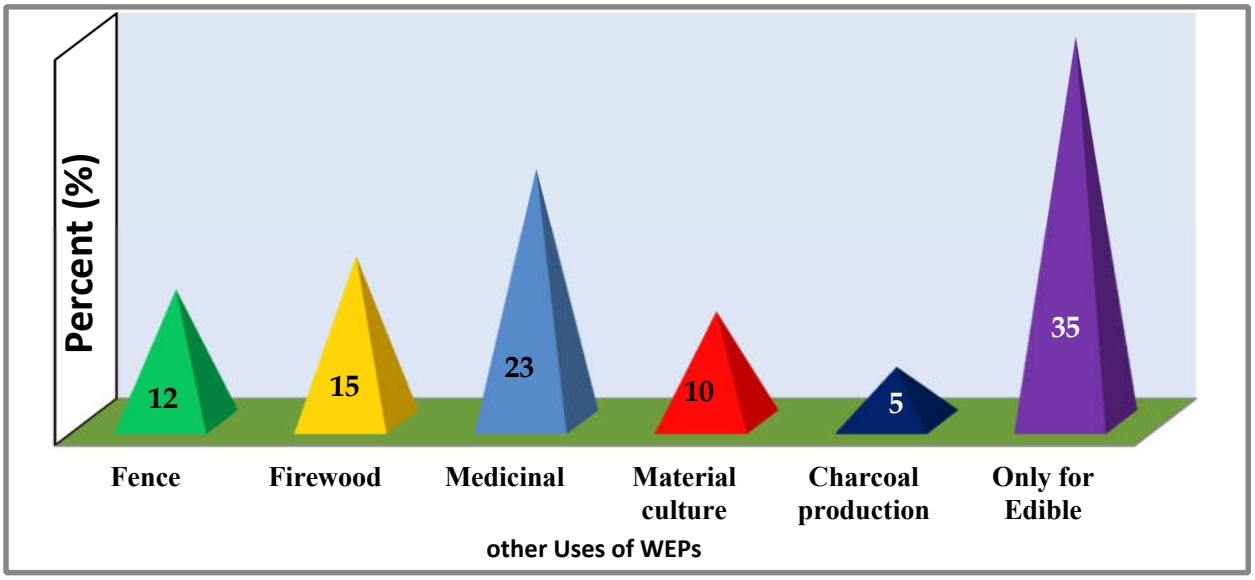


Figure 2: other uses of wild edible plant species

3.6. Threats and conservation of indigenous knowledge associated with wild edible plants

Overgrazing and deforestation were the major threats to wild edible plants which covers 23% each of the total threats followed by expansion of agriculture (17%), Over-harvesting (15%) fire, and timber production (7% each). This is because rapid human population and high demand for forest and forest products in the study area from time to time. Similar studies in other parts of the countries were reported by Giday et al. (2007); Regasa et al., 2014); Araya et al. (2015). It was investigated that, plant species such as *Phoenix reclinata, Balanites aegyptiaca, Sterculia setigera Mimusops kummel,* and *Woodfordia uniflora* are among the wild edible plants under

series threats and destruction status. The described above threats such as deforestation and agricultural expansion take a major role for this reason. Unless proper conservation way is committed to implementing in the study area, there will be a huge uncertainty to get foreign products and services for the inhabitants.

To conserve the wild foods plants in the study area inhabitants have used traditional practices such as growing in the home garden (27%), awareness rising (21%), and selective fencing (20%). Peoples around the study area has long experience and culture of plantation, terracing, water harvesting and ecological reclamation to conserve the wild edible plants and the entire forest in their surrounding. Community-based forest management, enclosure, reafforestation, afforestation activities, and supplying of alternative energy sources to the community will have a huge probability conserving of the wild edible plants as well as the entire frost.

3.7. Prefered and Multi-purpose of WEPs

Diospyros mespiliformis and *Ximenia americana* were the most preferable wild edible plants by the community in the study area followed by *Vangueria madagascariensis, Ziziphus spina-christi,* and *Syzygium guineense*, in descending order. This finding has more or less similar to a study conducted in different parts of Tigray reported by Aregay et al. (2017). Regarding the multiple use catagories of wild edible plant species, *Carissa edulis* was most popular followed by *Ziziphus spina-christ, Cordia Africana, Diospyros mespiliformis, Balanites aegyptiaca, Ximenia americana* and *Syzygium guineense* ranked 2nd, 3rd, 4th, 5th and 6th, respectively. among the other use categories of Wild edible plants, medicinal use has the highest score afterwards with material culture, firewood and fence respectively.

3.8. Distribution of indigenous knowledge on wild edible plants among the different social groups in the local community

For this study, a proportionate number of informants were recruited from each of the three districts. There were 34 (51.5%) males and 32 (48.5%) females among the total 66 informants chosen. In the study area, there was no significant difference in reporting of wild edible plants by gender (p-value 0. 869) (Table 2). This is comparable to the findings of Ashagre et al. (2016); (2017). There was also a significant difference between age groups (P-value 0.05). The older age group reported more wild edible plant species (56.1%). This demonstrates that the elderly have higher experience and understanding of wild edible plant species. A similar result was found in a study conducted by Wondimu et al. (2006), Regassa et al., (2014), and Ashagre (2017). In

contrast to the present study findings, there were more wild edible plants reported by youngsters than elders in Arsi-Ethiopian reported by Setalaphruk and Price (2007). This due to youngsters has high exposure in passing forests (far from their house residence) in keeping their cattle and goats.

Table 2. statistical test of significance on average number of wild edible plants among different informant groups in dstricts surrounding to hirmi forest

Parameters	Informant groups	N*(%)	Mean±SD	t - v alue	p–value
Sex	Male	34(51.5)	1.48± 0.50	23.95	0. 869
	Female	32(48.5)			
Age	18-30	26(39.4)	1.61± 0.49	26.5	0.000*
	>30	40(60.6)			
Marital status	Single	23(34.8)	1.65 ± 0.48	27.94	0.000*
	Married	43(65.2)			
Educational status	Literate	28(46.7)	1.52 ± 0.50	8.44	0.008*
	illiterate	38(53.3)			
Informants	General	60(90.9)	1.1 ± 0.29	30.59	0.032*
	Key	6(9.1)			
Religion	Orthodox	62(95.5)	1.05 ± 0.22	40.47	0.436
	Muslim	3(4.5)			
Destrict	Tahtay Koraro	21(31.8)	2.03 ± 0.82	20.06	0.229
	Medebay Zana	22(33.3)			
	Asgede Tsimbla	23(34.8)			

* = Significant difference ($p < 0.05$), ** t (0.05) (two tailed), N= Number of informants

Marital status was another factor of knowledge variation among informants. More wild edible plants were reported (65%) by married informants with a significance P-value of 0.00 (< 0.05). This is because married informants are elder and have long experience than the single informants. Illiterate people mentioned more (66.1%) wild edible plant species than the literate ones with a significance value of 0.008.

The number of wild edible plants reported by different informants varied significantly (P-value=0.032). Despite the fact that the key informats were fewer in number than the general informats, the key unformats mentioned 56.1% of the WEPs. In other words, key informants were shown to be more knowledgeable than the majority of the study's general informants. Ashagre made a similar discovery (2017). The districts were dominated by Christian Orthodox believers (>95%). According to the statistical study, there was no significant difference between the sampled Kebele and religion, with P-values of 0.229 and 0.436 (P-value>0.05).

Therefore, awareness raising, recording and transferring of typical knowledge of how to use and conserve wild food plants is a significant method in transferring and maintaining the ethnobotanical knowledge to the new generation for resolving food shortage at local and national levels both at present and future time.

4. Conclusion

The fundamental hypothesis of the study was the importance of Hirmi woodland vegetation as a source of wild food, the community's indigenous knowledge of conservation, and the utilization of wild edible foods in the study region. The aforementioned data and discussions support these and other hypotheses. The vegetation types in the research region include *Acacia* - *Commiphora* woodland, *Combretum* - *Terminalia* woodland, and Dry evergreen afromontane forest. The presence of distinct forest types in the research area resulted in the existence of a diverse range of wild edible plant species. These plants also provide multifunctional ecological services like medicine, fencing, firewood, and lumber production. Regarding ethnobotanical knowledge of wild edible plants by the informants, there was a significant difference between different age groups, educational status, marital status and between each informant. Elder people, illiterates, married and key informants have better knowledge. However, there was no significant knowledge difference among other social groups such as sex, religion, and districts. The community has no focus and understanding of sustainable conservation to the extent of utilization and consumption knowledge. 17% of the respondents said that they have no idea how to conserve and manage wild edible plants they use.

The finding of this study area shows that most wild edible plants consumed their fruit, which is the main reproductive part of the plants. This leads to the regeneration and sustainability of wild edible plant species under risk. Deforestation, browsing, expansion of agriculture, over-harvesting, drought, charcoal production, selective harvesting, and timber production was major challenges for the wild edible plants and entire forest in addition to communities deprived conservation mindset up. As a result, wild edible plant species such as *Balanites aegyptiaca, Sterculia setigera, Mimusops kummel,* and *Woodfordia uniflora* are under serious threaten and extinction status in the study area. Homegarden growing, awareness rising, selective fencing, general ecological reclamation were among the indigenous techniques used to conserve wild edible plants in the study districts.

4. Recommendations

Dryland is generally replenished by remnant vegetation and agricultural activity. The current investigation was conducted in dry terrain areas surrounding Hirmi woodland vegetation. The community is heavily reliant on the surrounding plant and plant products. Because of rapid human growth and agricultural expansion, the need for plants and their products is increasing, and vegetation coverage is expanding in both directions. The following proposals are presented in order to obtain various plant's ecological services on a long-term basis in the districts:

- Participatory forest management needs to be practised extensively and effectively in the study districts for the conservation of forests in general and wild edible plants in particular.
- Formal and informal education systems should be designed to create positive attitudes among the young by integrating tested and verified indigenous knowledge into the curricula about the traditional uses of plants in general and wild edible plants in particular.
- Stakeholders should be integrated with conducting relevant studies to conserve and sustainably use wild edible plants and fill the knowledge gap between generations through awareness rising and documentation.
- Decision makers and policy designers should involve traditional conservation practices such as *in-situ* conservation, homegarden and ecological restoration in their natural conservation program in line with appropriate scientific conservation techniques.

Ethical compliance and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data

The data used to support the findings of this study are included within the article.

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