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Wild Edible tree species in lowland, Ethiopia

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ABSTRACT

Aim of study: to provide baseline information about wild edible tree species (WETs) and their main threats, this will help to develop conservation and management strategies of important species in Ethiopia.

Area of study: It focused mainly on dry land part of Ethiopia where information about wild WETs is scanty and their status is unknown under the rampant degradation of the habitats.

Main results: documentation of important wild edible tree species, their main uses, and the conclusions related to their status, socioeconomic aspects and conservation needs as well as the factors affecting WETs and the way forward.

Research highlights: the study showed a total of 88 WETs and their utilization aspects among different ethnical groups in dry land area of the Ethiopia. Moreover, due to the diversity of WETs and the existing threats, effort has to be done for their future conservation to reach a food security strategy in the country. The associated knowledge with the WETs is also found to be important for the livelihood of the local communities. Thus, this paper can serve as baseline information and indicator for further studies and documentation of WETs in Ethiopia. This could also be useful in other dry land parts in developing countries with similar contexts.

Keywords: Wild edible trees, utilizations, diversity, ethnic groups, conservation, Ethiopia.

1. - INTRODUCTION

Forests provide a wide range of social, environmental and economic benefits to humankind. They play important roles in several food systems (Termote et al., 2009; De Caluwé, 2010). Over the world, more than 700 million people suffer from hunger (Tardio et al., 2006). In some cases, nutritional deficiencies due to a lack of diversity in the diet (Lachat et al., 2017) and a weak supply of micronutrients (Black et al., 2013). The consumption of wild tree foods has a large effect to contribute mitigating these deficiencies (Powell et al., 2015) and look to be with higher consumption of food group rich in micronutrients (Ickowitz et al., 2016). Studies have documented the relevance of wild forest foods consumption to the diet (Termote et al., 2012; Powell et al., 2013; Rowland et al., 2016) and proposed the link between forest cover and food quality (Johnson et al., 2013; Ickowitz et al., 2014).

Wild edible tree species (WETs) are those tree species collected in the wild to be consumed as food (Beluhan & Ranogajec, 2010). They have been an integral part of the human diet and their role in closing food gaps during shortage and maintaining livelihood security in a developing country is immense (Afolayan & Jimoh, 2009). The seasonal change is considered a key element of food availability, mostly in Sahelian countries. The distribution of wild edible plant species to the diet is important during of food shortage or lean season (Faye et al., 2010; Atato et al., 2011; Agúndez et al., 2016). Despite this, studies on the consumption and nutritional importance of WETs species in dry land areas are very limited (Rowland et al., 2015). In recent decades, WETs species became among the most important resources in the lean season to replace the essential plates and meals as the main food species within a shortage period (Jaenicke & Hoschle-Zeledon, 2006). Thus, there is currently renewed interest in documenting information on neglected wild edible food sources and WETs species (Bharucha & Pretty, 2010).

Ethiopia is the second most populated country in Africa (Gijsbers et al., 1994; Faye et al., 2010), with a large surface of many different habitats that offer a high number of endemic flora and fauna species. The country has about 5000 species of high plants, of which about 8% are endemic species (Hedberg et al., 2009), located in about 34 global biodiversity hotspots (CI, 2004). Forests, pastures, river environments, and wetlands are home to many of the country's wild species (Asfaw, 2009). They alsoprovide habitat for a high richness of food plants (Edwards, 1991), generating a significant food source.

In Ethiopia, seasonal food shortage is a common phenomenon. One way of reducing food insecurity in the country is to diversify food sources by considering the role of WETs that can contribute to adaptation options in the areas where crop production is a challenge. In most rural part of the country, the local communities depend on WETs (Lulekal et al., 2011; Hunde et al., 2010). The benefits of WETs as part of local vegetation, and as alternative food sources are worth considering towards realizing household food self-sufficiency in Ethiopia (Asfaw, 2009; Sabates-Wheeler et al., 2012). However, WETs are declining in most habitats of the country through degradation and deforestation as a result of anthropogenic factors such as land use changes and improper management of the resources (MoARD, 2007; Asfaw, 2009). The climate change and the increasing level of poverty in the country have also negatively affected the biodiversity at large scale, imposing negative implication on WETs or even lost irreversibly.

Different feeding cultures of different tribes found in Ethiopia (Balemie & Kibebew, 2006). Also, there is wide availability and use of WETs (Miles et al., 2006). Despite this, the different locality has a different technique of extracting WETs and their use, often

depending on the lean season (Teklehaymanot & Giday, 2010). However, the information and sensibility on cultural, socio-economic and nutritional values of Ethiopian WETs are limited. Therefore, there is still a need to study this area to reach the stability of the different tree species that help us in the dry season, food analysis and the adaptation of different wild-eating species to assist national efforts to combat food insecurity and ensure food diversity (Jones et al., 2017). Since the traditional way to pick up the edible tree, products are being eroded and the loss of plant biodiversity along with indigenous people and their awareness and cultural background, promoting research on wild tree species is important in order to protect this information for future generations (Asfaw, 2009).

In Ethiopia, studies, have been accumulating over the year; have provided information on indigenous wild edible fruits. However, they are mainly focused on botanical descriptions and provide limited information. Attention towards research and development on various aspects of WETs in general, e.g. conservation both in situ and ex-situ and management of WETs, their role in food security was inadequate. Taking these into consideration, the broad scope of this study was to provide baseline information about food tree species and their main threats in the studied Regions, which helps to derive benefits through management conservation strategies in Ethiopia. The specific objectives include i) to identify tree species that provide edible products to rural communities during the shortage period across nine eco-regions of Ethiopia, ii) to analyze the main threats affecting the most consumed wild edible tree species and iii) to assess how these threats varied across the studied eco-regions.

2. - MATERIAL AND METHODS

2.1. Study sites and their main socio economic characteristics

The study was conducted in the dry Agro-ecological zones found in six administrative regions of Ethiopia. The regions and ethnic groups surveyed in this study are described as follows;

Tigray: this region is found in the northern part of the country and predominantly inhabited by Tigrayan people. The language used here is Tigrinya, descended from an ancient Semitic language called ge'ez, which is now restricted in Ethiopian Orthodox Church. The local people in this region are dependent on agriculture, although the climatic condition of the region makes the task less productive (subsistence economy).

Amhara: the Amhara region is also found in the northern part of the country. Amharas are the dominant ethnic group inhabiting parts of the northern Ethiopia. They are mostly Orthodox Christians members of Ethiopian Orthodox Church. The economy of the region is also dominated by mixed agriculture, including both livestock rearing and crop cultivation.

Benishangul: this region is found in the western part, along the border of Sudan and Ethiopia. The Berta is, the ethnic group involved in this group, dominant ethnic group following the Gumuz, living in this region. They speak the language named Berta, which is a Nilo-Saharan language. They adopted Islam as a majority religion. The main economic activity is agriculture and they produce food crops like maize (grain), which they also use to prepare a local beer.

Gambella: this region is situated in the south-western part of Ethiopia. The region is dominated by Nuer and Anuak ethnic groups. Agro-ecologically, the region is dominantly lowland. Recession riverside agriculture is widely practiced. Livestock constitutes the

primary source of income. Wild food consumption from bush lands and natural forest resources is part of the daily dietary intake. Also, the local communities depend on complementary foods from hunting and fishing. The population here follows a complex age system and their law distinguishes the traditional council of elders.

Oromia: this region exists dominantly in the central part of the country. The Oromo constitute the most diverse ethnic group in this region. They follow both Muslim and Christian religion. The Oromo people also followed their traditional religion (Waaqeffanna). They use their own language which is called Afaan Oromo or Oromiña Like other part of the country, livestock rearing and crop production is the main economic sector of the region.

South Nations, Nationalities, and Peoples (SNNP): this region is found in the south western part of the county. Different ethnic groups are found this region. The Hamer people, the ethnic group involved in this study, live in this district, in the area of the River Omo and in the north of Lake Turcana. This is a tribe of grandparents' customs. They use their own language; they follow their own religion and beliefs. Hamer people are very hospitable, with unique rituals as jumping from the bulls. They are pastoralists.

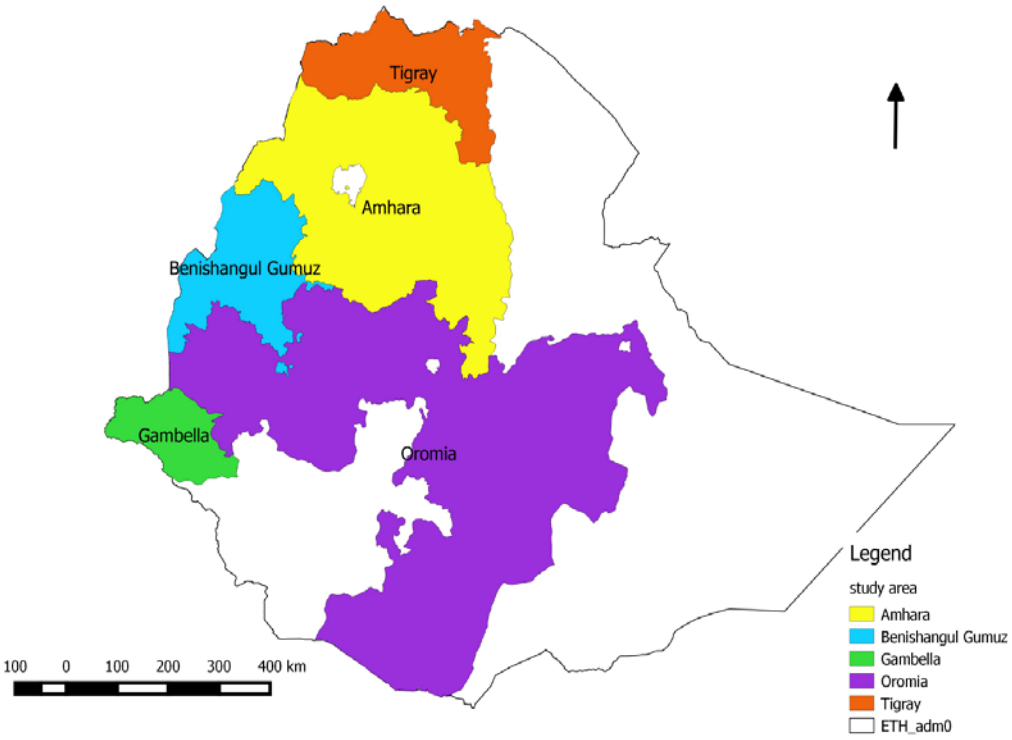

Figure 1. Map of the country and the studied administrative districts

2.2. Description of the studied population

A semi-structured questionnaire was used to collect the necessary information for this study. The questionnaires were divided mainly in two groups based on the informers which were focus groups, mainly composed by women, and key informants. Three focus groups and five key informants were surveyed per combination woreda/kebele when possible (Tables 1, 2).

Table1. Surveys conducted by regions, woredas and kebeles for Focus Groups

Region	Woreda/kebele	Surveys conducted	Surveys conducted
Amhara	Kobo/Gedemeyu	5	10
	Kobo/Adis kign	5	
Benishangul gumuz	Bambasi/Bambisa	5	32
	Bambasi/Sonka	5	
	Debate/Debate	3	
	Debate/Parzeit	3	
	Homosha/Sherkole	5	
	Hamosha/Tumet	5	
	Mandura/Duhansebeguna	3	
	Mandura/Edida	3	
Gambella	Gog/Puchala	5	20
	Gog/Gongjor	5	
	Lare/Ngour	5	
	Lare/Nip-nip	5	
Oromilla	Dolo Mena/Chirri	3	3
SNNPR	Hammer/Angode	5	20
	Hammer/Bita	5	
Tigray	Raya azebo/Kara Adisho	5	20
	Raya azebo/Hawelti	5	

Table 2. Surveys conducted by regions, woredas and kebeles for Key Informants

Region	Woreda/kebele	Surveys conducted	Surveys conducted
Amhara	Kobo/Gedemeyu	3	6
	Kobo/Adis kign	3	
Benishangul gumuz	Bambasi/Bambisa	3	20
	Bambasi/Sonka	3	
	Debate/Debate	2	
	Debate/Parzeit	2	
	Homosha/Sherkole	3	
	Hamosha/Tumet	3	
	Mandura/Duhansebeguna	2	
	Mandura/Edida	2	
Gambella	Gog/Puchala	3	12
	Gog/Gongjor	3	
	Lare/Ngour	3	
	Lare/nip-nip	3	
Oromilla	Dolo Mena/Chirri	2	2
SNNPR	Hammer/Angode	3	6
	Hammer/Bita	3	
Tigray	Raya azebo/Kara adisho	3	6
	Raya azebo/Hawelti	3	

2.3. Methodology

It is becoming increasingly popular that combinations of methods are to be employed in social research. It is usual for researchers to employ mixed method designs to investigate different aspects of the same phenomenon (Sarantakos, 1998). Data for this study were collected from both primary and secondary sources. Secondary sources included mainly published and unpublished sources, such as annual reports of the Woredas, and a literature review was also used to complement and refine the information that would be collected. On the other hand, the primary source included the socio-economic survey collected by semi-structured interview with individuals, focus group discussions and field observations.

2.4. Sampling technique and sample size

The respondents were selected using random sampling design methods. A total of 85 households were used for the sample ensuring the inclusion of at least 20% female headed households in the sample. The following criteria were used to select the ethnic groups in sampling: i) to have a high dependence of agriculture and forestry, ii) to suffer a humanitarian crisis caused by drought, iii) to have a high representation of the major ethnic groups and iv) the accessibility.

2.5. Individual survey

A face-to-face semi-structured and pre-tested interview was conducted to collect primary data from the sampled individuals. The questionnaire was pre-tested with 15 randomly selected households. Based on the results of the pre-test, a necessary modification was made. Enumerators who are knowledgeable about the area were recruited from the study areas and were trained on the objectives, methods of data collection and interviewing techniques. And finally, the interview was conducted at household level. For the purpose, the necessary information from sample households was collected including the socio economic conditions. The official language in Ethiopia is the Amharic language and the local people use their own languages. Thus the surveys were translated from English to Amharic and from Amharic to local languages. In some cases an interpreter was used to conduct the surveys to ensure that the meaning of the questionnaires was not changed.

2.6. Focus group discussion

A focus group discussion was conducted in the study areas. Then separate group discussions also organized and held. Each focus group consists of 10 women of all ages. The participants were selected randomly from each study area.

2.7. Data analysis

Descriptive statistics was used to show the basic information obtained from the questionnaires. A final list of food tree species used was obtained from the requested information. Clustering was used for the 30 most frequent species based on their used plant part and how it was consumed by the local communities. The cluster was based on average linkage between groups. The distance statistical significance was obtained by Chi square test. SPSS v.16 (SPSS, 2007) was used.

The Chi-square test was used for the 15 most frequented tree species in order to analyze the differences based on the following variables: shortage period, food availability, ease for locating, conservation practices and regeneration presence.

Kruskal-Wallis and Mann-Whitney U test were performed to analyze how the most frequent species were affected by different threats. Data analyses were made using STATISTICAv6 (StatSoft, Inc., 2002).

3. - RESULTS

3.1. Wild food tree species consumed

A total of 88 species were listed consumed by the local people in the studied areas. Of these, fifty-two were identified as wild edible tree species (Table 3).

Table 3. List of wild edible plants identified in study areas based on Wd (in the wild), Ld (in the land or homegarden), Pl (planted), Rw (Raw), Ck (Cooked) and Pr (Perserved) G (Gambella), T (Tigray), B (Benishangul gumuz), A (Amhara) and O (Oromilla).

Ref	Scientific name	Part used	Used	Obtained	Region
Ad	*Adansonia digitata L.*	Bark	Rw	Wd	G
Aeg	*Balanites aegyptiaca Delile*	Leaf/Fruit	Rw	Wd/Ld	T/A/B /G/SNNPR
Br	*Balanites rotundifolia Blatt.*	Leaf/Fruit	Rw/Ck/Pr	Wd /Ld	SNNPR
Bth	*Bauhinia thonningii Schumach.*	Bark	Rw/Pr	Wd	G/B /O
Baeth	*Borassus aethiopum Mart.*	Fruit	Rw	Wd	G
Bm	*Boscia mossambicensis Klotzsch*	Fruit	Rw	Wd	SNNPR
Cef	*Carissa edulis Forssk.*	Leaf/Fruit	Rw	Wd	T/A/B /G/O
Ces	*Casimiroa edulis S.Watson*	Fruit	Rw	Pl	B
Cab	*Celtis africana Burm. f.*	Fruit	Rw	Wd	G
Cse	*Commiphora schimperi Engl.*	Root	Ck	Wd	SNNPR
Cal	*Cordia africana Lam.*	Fruit	Rw	Wd /Ld	B
Cm	*Cordia monoica Roxb.*	Fruit	Rw	Wd /Ld	T/A
Csl	*Cordia sinensis Lam.*	Fruit	Rw	Wd	SNNPR
Cad	*Crateva adansonii DC.*	Root	Ck	Wd /Ld	G
Dm	*Diospyros mespiliformis Hochst.ex A.DC.*	Fruit	Rw	Wd	B/G
Da	*Dovyalis abyssinica (A. Rich.) Warb.*	Fruit	Rw	Wd	B
Fsf	*Ficus sur Forssk.*	Fruit	Rw	Wd	T/B /G/O/SNPR
Fsl	*Ficus sycomorus L.*	Fruit	Rw	Wd /Ld	B/G
Fvf	*Ficus vasta Forssk.*	Leaf/Fruit	Rw	Wd	T/A
Fvr	*Flueggea virosa (Roxb. ex Willd.) Royle*	Leaf	Ck	Wd	G
Gt	*Gardenia ternifolia Schumach. & Thonn.*	Fruit	Rw	Wd	B
Gb	*Grewia bicolor Juss.*	Fruit	Rw	Wd	SNNPR
Gf	*Grewia ferruginea Hochst.*	Fruit	Rw	Wd	B
Gvl	*Grewia velutina (Forsk.) Lam.*	Fruit	Rw	Wd /Ld	B
Gvw	*Grewia villosa Willd.*	Leaf/Fruit	Rw	Wd	T/A
Ht	*Hyphaene thebaica Mart.*	Fruit	Rw	Wd /Ld	G
Lh	*Lannea humilis Engl.*	Root	Ck	Wd	SNNPR
Ms	*Maytenus senegalensis (Lam.) Exell*	Fruit	Rw	Wd	SNNPR
Mk	*Mimusops kummel Bruce ex A.DC.*	Fruit	Rw	Wd	B/G
Mi	*Mitragyna inermis (Willd.) K.Schum.*	Fruit	Rw	Wd	B
Mm	*Morus mesozygia Stapf*	Fruit	Rw	Wd	B
Nl	*Nauclea latifolia Sm.*	Fruit	Rw	Wd	G

Oc	*Olea capensis L.*	Fruit	Rw	Wd	A/B
Os	*Oncoba spinosa Forssk.*	Fruit	Rw	Wd	B/G/O
Of	*Opuntia ficus-indica Mill.*	Fruit	Rw	Wd	T/A
Pr	*Phoenix reclinata Jacq.*	Leaf/Fruit	Rw/Ck	Wd	B
Pl	*Pistacia lentiscus subsp. emarginata (Engl.) Al-Saghir*	Fruit	Rw	Wd	B
Rm	*Racosperma melanoxylon (R.Br.) Pedley*	Fruit	Rw	Wd/Ld	G/O
Rn	*Rumex nervosus Vahl*	Fruit	Rw	Wd	A
Sc	*Saba comorensis (Bojer) Pichon*	Fruit	Rw	Wd	B
Sn	*Searsia natalensis (Bernh. ex Krauss) F.A.Barkley*	Fruit	Rw	Wd	T
Si	*Strychnos innocua Delile*	Fruit	Rw	Wd	B
Ss	*Strychnos spinosa Lam.*	Fruit	Rw	Wd	B
Sg	*Syzygium guineense DC. subsp guineense*	Fruit	Rw	Wd	B/O
Ti	*Tamarindus indica L.*	Fruit	Rw	Wd	B/G/O/SNNPR
Vp	*Vitellaria paradoxa C.F.Gaertn.*	Fruit/Bark/Sd	Rw/Ck/Pr	Wd /Ld	G
Vd	*Vitex doniana Sweet*	Fruit	Rw	Wd /Ld	B/G
Xa	*Ximenia americana L.*	Fruit	Rw	Wd	A/B/G/O/SNNPR
Xc	*Ximenia caffra Sond.*	Fruit	Rw	Wd	B/O
Za	*Ziziphus abyssinica Hochst. ex A.Rich.*	Fruit	Rw	Wd /Ld	G
Zm	*Ziziphus mucronata Willd.*	Fruit	Rw	Wd/Ld	SNNPR
Zs	*Ziziphus spina-christi (L.) Desf.*	Fruit	Rw	Wd	T/A/B/G/O/SNNPR

The thirty most frequent species listed by the locals were grouped according to the part consumed and consumption patterns (Figures 2 and 3). The clustering analysis indicated that commonly used plant parts included fruits, leaves, bark, roots and seeds. Of these, fruits were used for all the wild edible tree species found in this study. The eighteen tree species mainly used for their fruits were present in the main group (Figure 2). This group included also *Ximenia americana* and *Tamarindus indica* from which the local people used their roots for different purpose. Also, *Ficus sur*, *Celtis Africana* and *Racosperma melanoxylum* are considered as the three complementary species since their bark is used. The second group included eight species for which leaves were used. In this group, *Balanites aegyptiaca* is also mentioned as its bark is used as potential food by the locals. As independent species/groups, we found *Flueggea virosa* as their leaves are used (70% of positive answers) and *Vitellaria paradoxa* which was mentioned for its edible seeds.

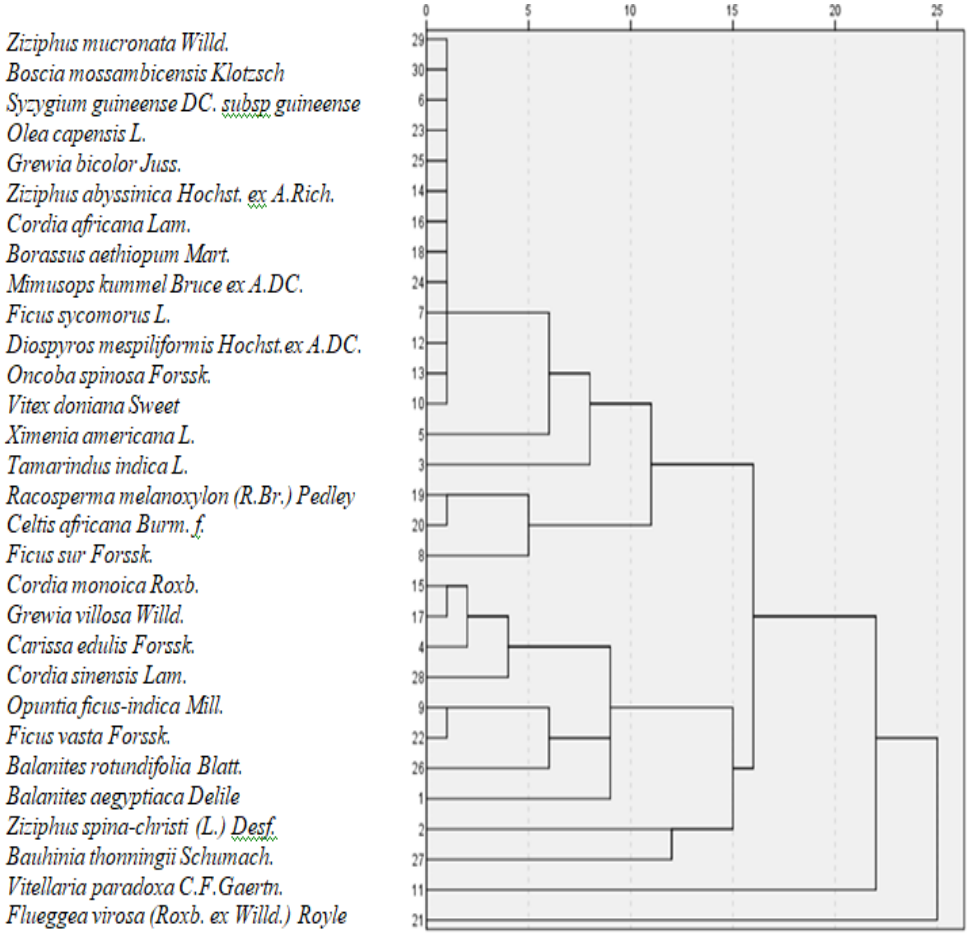

Figure 2. Dendrogram showing species use similarity according to part used.

The first 30 frequently mentioned species were also clustered in order to evaluate if there is a variation regarding their consumption. In this sense, we found three different consumption modes (Raw, Cooked, and Preserved) for each tree species.

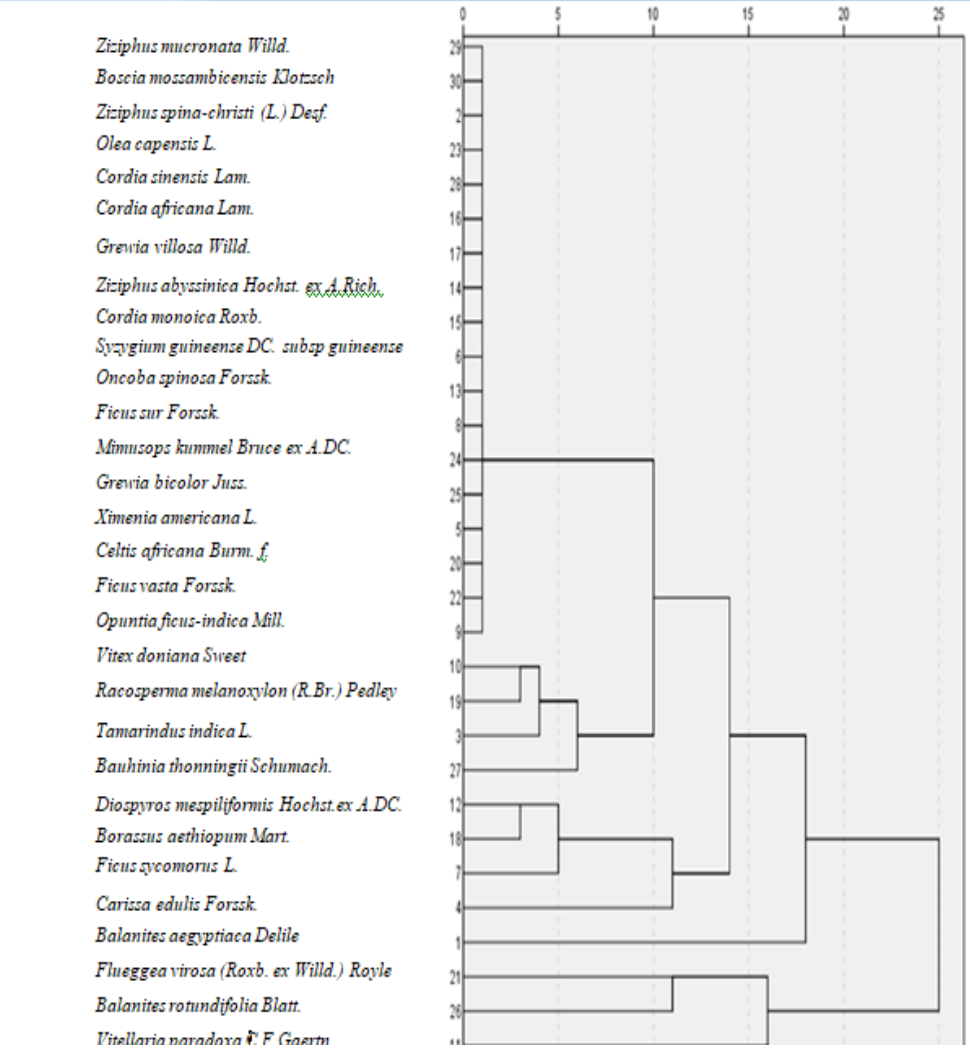

Figure 3. Dendrogram showing species use similarity according to Consumption.

Moreover, the thirty species were clustered according to their way of consumption as previously done for plant part used (Figure 3). Cluster I, includes a group of 22 species all of them are consumed as raw and none of them as cooked. In this group, *Tamarindus indica*, *Vitex doniana*, *Racosperma melanoxylon* and *Bauhinia thonningii* are also consumed as preserved. Cluster II consists of four species consumed as raw and cooked, but *Carissa edulis* is consumed as raw, cooked and also occasionally as preserved. *Balanites aegyptiaca* was clustered apart of the rest of species. This species was highly frequent consumed for all raw, cooked and preserved. Cluster IV includes *Flueggea virosa* and *Balanites rotundifolia*, both of them consumed as raw and cooked with the same percentage. *Vitellaria paradoxa* was also clustered apart of the other species. This species is also consumed in all the different options but the frequency consumption was significantly lower than in the case of *Balanites aegyptiaca*.

3.2. The importance of wild tree species per studied Region

Significant difference was found for both shortage period and availability of food per region (Chi-square Test; $p<0.05$). The shortage period strongly varied among regions. In Gambella, all the months were included in this period. However, in this region the months of March, April and May are found to have the values more than four times higher than in the other regions (Figure 4). The Oromiya region showed the lowest number of months and shortage period values. The most critical months for the other

regions were mainly May, June, July and August. During October, November and December almost no shortage was observed. It is worthy to highlight that in SNNPR the shortage period was observed earlier than in the other studied regions, reaching high values from February.

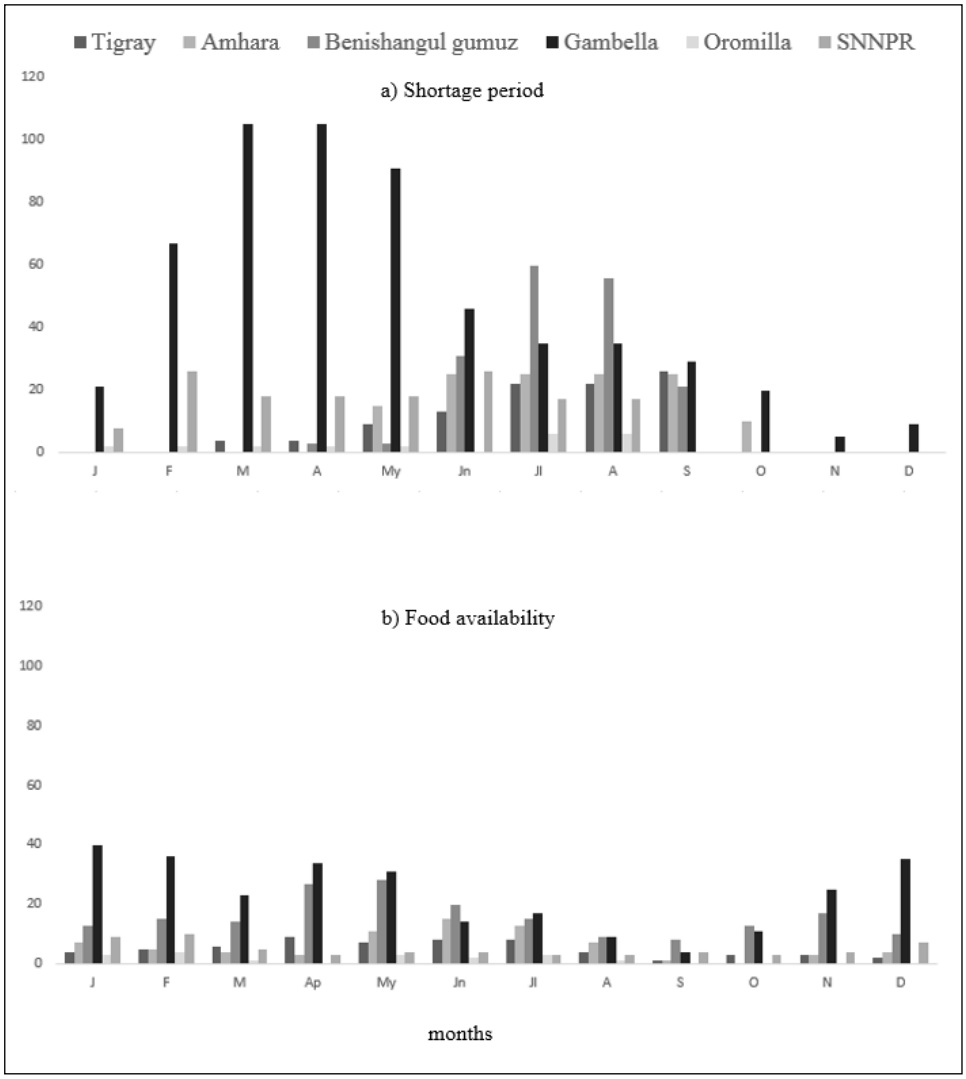

Figure 4. a) Shortage period and b) availability of food per Region

We also observed significant differences when analyzing both plant part used and consumption per regions (Chi-square Test; $p<0.05$). The most frequently part used in all the regions were the fruits and the highest values were observed in Gambella (Figure 5). In this region, the people also used leaves and barks of the plants. Leaves found to be consumed in Tigray and SNNPR. Roots were only used in Benishangul gumuz. We found also the correlation between plant part used and consumption. Thus, in Oromia and Amarha as the local people use fruits in raw. We could observe that in Beninsangul gumus and SNNPR, people use cooked and preserved products, which is linked to the use of roots and leaves in these regions respectively.

In Gambella, people use a high amount of fruit, leaves, bark and seeds. The use frequency for all these products is higher than those observed in the other regions. The local people in this region used the products as raw, cooked and preserved. Leaves are usually used as cook material within the period from October to December because of the scarce of other highest quality foods in this period.

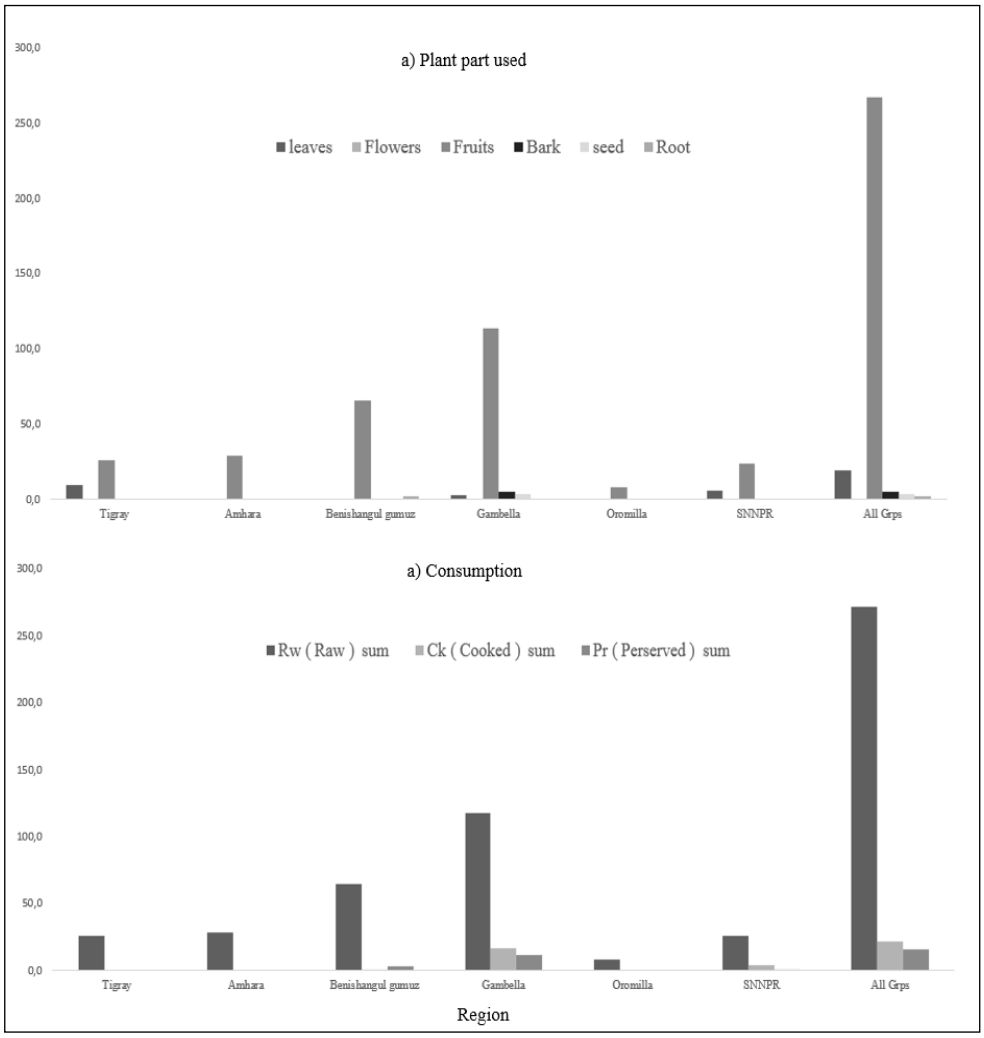

Figure 5. a) Plant part used and b) consumption per Region

3.3. Threats and conservation status for the main food tree species

The threats and conservation status were evaluated only for the most 15 frequently used food tree species observed in the study areas. All the threats showed significant influence on the food tree species (Table 5). Only grazing showed no significant influence (Kruskal-Wallis ANOVA Test; $p<0.05$). Pest and diseases, and soil fertility were cited as the two main threats affecting significantly twelve and eight WETs respectively.

On the other hand, grazing, leaves, bark and roots harvest showed no significant negative influence. We could also observe the effect of these threats on individual species. In this sense, *Celtis africana* was the most affected species reaching high frequency values for twelve of the fifteen threats analyzed. The most frequent observed species such as *Ziziphus spina-christi, Balanites aegyptiaca* and *Tamarindus indica* were significantly affected by the same number of threats (Mann-Whitney U test; $P<0.05$). These species were also strongly affected by pest and diseases, age of the trees and soil fertility.

Table 5. Frequences of threats for each species.

Name	Clear	Fire	Grazing	Timber	Leaves	Fruit	Flowers	Root	Bark	Charc	pest	Drought	Age	Soil	Other
Ziziphus spina-christi	2,05	1,57	1,83	2,11	1,55	1,86	1,48	1,57	1,54	1,68	2,28	1,98	2,35	2,58	1,26
Tamarindus indica	1,96	1,80	1,78	1,52	1,30	1,76	1,37	1,33	1,30	1,31	2,65	2,11	2,15	2,28	0,43
Balanites aegyptiaca	2,06	1,57	1,79	1,77	1,47	1,98	1,28	1,40	1,47	2,09	2,25	1,60	2,00	2,23	0,96
Ximenia americana	1,82	1,60	1,73	1,40	1,27	1,87	1,07	1,24	1,24	1,38	2,13	1,62	1,47	2,29	0,67
Carissa edulis	1,77	1,77	1,50	1,09	1,18	1,68	1,07	1,27	1,23	1,18	1,75	1,41	1,80	1,91	0,68
Grewia villosa	2,21	1,66	2,07	1,86	1,79	1,93	1,62	2,03	2,00	1,79	2,69	1,83	1,83	2,79	0,93
Ficus sycomorus	1,86	2,07	1,43	1,68	1,32	2,11	1,50	1,43	1,46	1,32	2,18	1,64	2,00	1,68	0,75
Syzygium guineense	2,36	1,67	1,58	1,33	1,04	1,33	1,13	1,13	1,00	1,17	2,08	2,46	2,58	2,63	0,00
Ficus vasta	1,87	1,17	1,87	1,43	1,39	1,61	1,17	1,35	1,52	1,30	1,52	1,35	1,35	1,43	1,22
Opuntia ficus-indica	1,95	1,20	1,65	1,15	1,35	1,65	1,05	1,40	1,25	1,10	2,00	1,25	1,80	1,25	1,50
Cordia monoica	2,15	1,00	1,55	1,50	1,45	1,50	1,15	1,50	1,30	1,50	1,60	1,35	1,40	1,45	1,50
Bauhinia thonningii	2,21	1,89	1,74	1,53	1,68	2,21	1,47	1,47	1,63	2,05	2,26	2,00	2,42	2,47	1,47
Mimusops kummel	1,83	2,44	1,72	1,28	1,06	2,06	1,11	1,44	1,28	1,17	1,78	2,06	2,11	1,94	0,17
Diospyros mespiliformis	1,44	2,17	1,33	0,94	1,22	2,11	1,11	1,00	1,00	1,00	2,06	1,61	1,33	1,78	0,00
Celtis africana	1,83	1,61	1,89	2,11	1,83	2,28	2,33	2,67	2,67	2,28	2,39	2,44	2,78	2,44	2,06
Kruskal-Wallis (p value)	0,004	0,000	0,139	0,000	0,003	0,009	0,000	0,000	0,000	0,000	0,002	0,002	0,000	0,00	0,00

Regeneration for the most frequent species was significantly different (Table 6; Chi-square Test; $p<0.05$). The highest values were found for *Ziziphus spina-christi, Balanites aegyptiaca, Ximenia americana* and *Tamarindus indica* (Figure 6). For most of these species, the number of positive answers was higher than three times the negative ones. However, *Tamarindus indica* showed lower rates of regeneration.

Table 6. Results from Chi-square Test.

	Presence of regeneration			**Ease for locating**			**Conservation practices**		
	Chi-square	df	p	Chi-square	df	p	Chi-square	df	p
Pearson	38,13284	df=14	p=,00050	117,4812	df=28	p=,00000	23,92841	df=14	p=,04676
M-L	42,11181	df=14	p=,00012	130,1758	df=28	p=,00000	26,96080	df=14	p=,01949

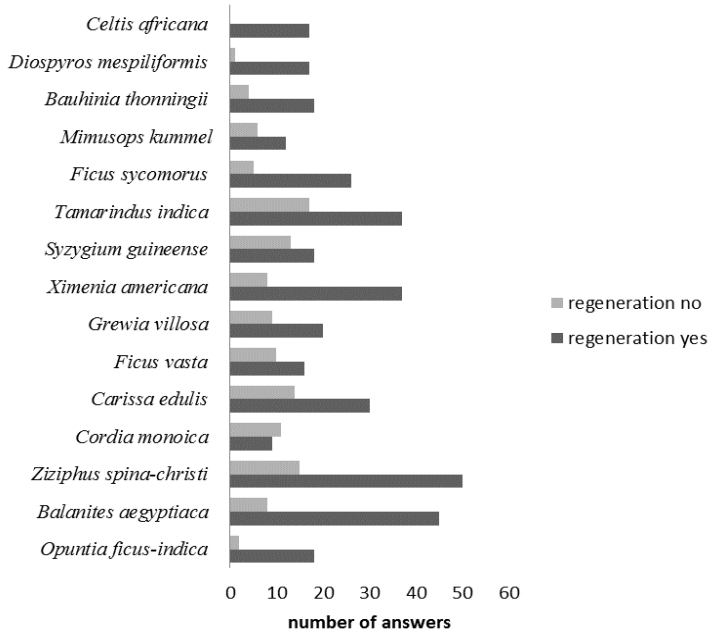

Figure 6. Presence of regenerated for the 15 species selected globally to the study

Easy to locate the species was also different depending on the main species (Chi-square Test; $p<0.05$). According to the locals' perception, *Celtis africana* is the most stable species since more than 90% of the key informants mentioned this species as in similar status than in previous years (Figure 7). Contrary result was found for *Opuntia ficus-indica* which is not in a so good condition than in previous years. The four most frequent species *Ziziphus spina-christi, Balanites aegyptiaca, Tamarindus indica* and *Ximenia americana* showed similar trends with a balanced number of answers between stable and harder.

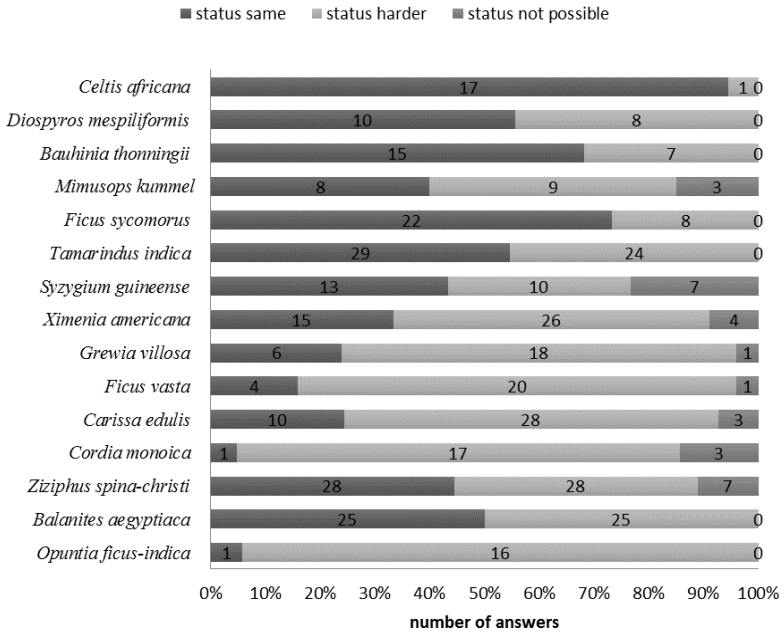

Figure 7. The average value of access difficulty for the 15 selected species

As we hypothesized, few positive answers related to conservation practices were found, despite statistical differences were observed among species (Chi-square Test; $p<0.05$). We could highlight *Carissa edulis* and *Ziziphus spina-christi* which showed the highest values for the variable (Figure 8).

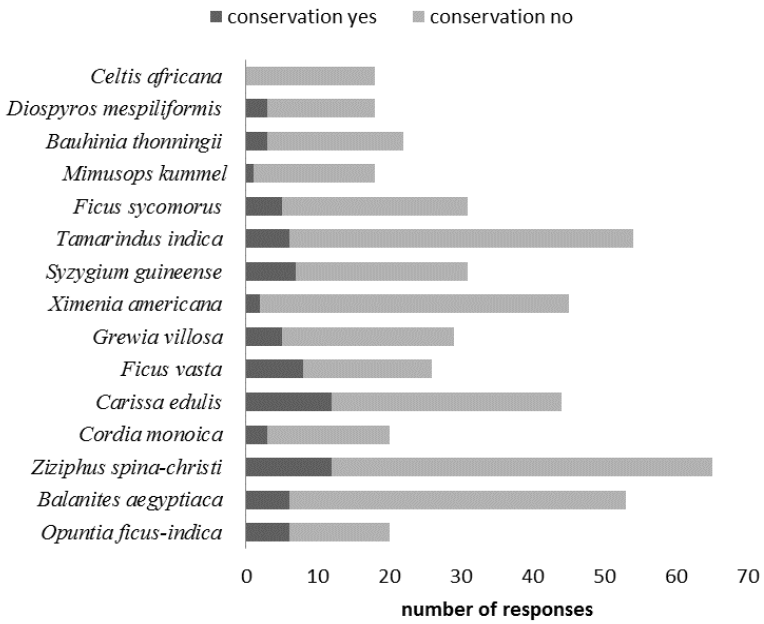

Figure 8. Existence of conservation practices

4. - DISCUSSION

4.1. Wild food tree species consumed

Wild edible tree species refer to species that are neither cultivated nor domesticated, but are available from their wild natural habitat and used as sources of food (Lulekal et al., 2011). They have been utilized as important sources of food by rural communities that mostly depend on forests for their livelihoods. In addition, during food shortage period wild food trees play an important role in maintaining livelihood security for many people in developing countries (Afolayan & Jimoh, 2009). However, these tree species have been overlooked as compared to domesticated plant food sources in the world or in Ethiopia in particular (Lulekal et al., 2011).

Ethiopia has a broad range of ecosystems, with a wide range of altitude, rainfall patterns and soil variability which contribute to the occurrence of different life forms in flora (Friis et al., 2010). The existence of high variation in macro- and micro-climatic conditions has also contributed to the formation of diverse vegetation types in the country. Thus, the country has 12 different vegetation types that range from Afro-alpine to savanna, scrubland and deserts (Friis et al., 2010), which holds valuable and rich types edible plants (Lulekal et al., 2011).

A total of 88 tree species have been listed as wild edible tree species by the local communities in different regions of the country. This is a relatively low number of species documented from the country in previous studies. (Assefa & Abebe, 2011) and (Balemie & Kebebew, 2006) reported a higher number of wild edible species in Southern Ethiopia. Other studies also documented the different tree species used by the different ethnical

groups over the country (Balemie & Kebebew, 2006; Asfaw, 2009; Mengistu & Hager, 2008; Teketay & Eshete, 2004). This shows that wild edible species are popular over the country even beyond the present studied areas. However, only few of them were previously addressed by the local knowledge related to use, especially in the dry land parts of Ethiopia (Addis et al., 2013).

4.2. The importance of wild tree species per studied Region

In Ethiopia, trees have been used as a source of food and medicine from immemorial time and they become an integral part of culture of the society (Pankhurst, 1965). In this study, we also identified wild food plants utilization, which is still a common practice by different local communities over the studied areas. Trees from wild habitats also contribute significantly to the livelihoods of the local people through their use as food, medicine, construction and other general utilities. Such diverse use of wild plants demonstrates that the people have a close relationship with local biological resources and their lives are based on the use and management of diverse plant species (Awas et al., 2010).

Fruit harvesting season and use vary from place to place, species to species and even from tree to tree. This might be due to climatic and intra-specific variations. In Ethiopia, seasonal food shortage is a common phenomenon in every part of the country, from July to September (Getachew, 2001). In most cases, this season is the time when the storage bins gone empty and the new crop is yet unready. It is reported that WETs are commonly used during hungry periods, seasonally during periods of scarcity or extreme famine, and to add variety of the diet. The extent of wild edible plants utilization varied also with respect to season. For example, in most part of the regions the food shortage period is in May, June, July and August. However, in Gambela, March, April and May are the most reported shortage period as compared to other regions. During these periods, the local communities depend on the WETs. There are some wild tree species used only when preferred alternatives are not available, and in cases where period of food shortage dominate (Getahun, 1974; Guinand & Lemessa, 2000; Balemie & Kebebew, 2006). Agropastoralists groups comented that shortage period of food is the major problem in several studied areas, and that wild edible tree species play an essential role for surviving within lean period (Assefa & Abebe, 2011).

Our findings also revealed that wild edible plants differ in their parts used by the local communities. The most commonly used parts are fruits, leaves, bark, roots and seeds. Fruits were used for the entire wild tree species analyzed in the studied area, in Oromia and Amarha where people use fruits and use it as raw. However, the preferred part varied according to season. For example, the plants consumed during famine may not be consumed during normal periods. Some species such us *Opuntia ficus-indica, Carissa edulis* and *Ximenia americana* in Amhara region and *Syzygium guineense* and *Carissa edulis* in Oromilla region were only consumed during times of food shortage. This might be due to the fact that the species are being well known by all communities in different parts of the country. Bell (1995) also mentioned that wild edible tree species are combined in the normal livelihood strategies of many rural people who are pastoralists, shifting cultivators, sedentary farmers or hunter-gatherers.

Wild edible tree species are generally included among the Non Timber Forest Products (NTFPs) for sale in Ethiopia, although mostly of the time they are collected for subsistence use (Yehuala, 2008). The major reason is that they are seasonal and their gathering could be conducted for the shorter period of time, mostly during the rainy season. Thus, people can collect from the wild for their own consumption. However, marketable edible plants such as *Ximenia americana*, *Syzygium guineense*, *Tamarindus indica*, *Balanites aegyptiaca*, *Opuntia ficus-indica* and *Mimusops kummel* can provide additional income to the local people when they sell them in the local markets (Baleme & Kebebew, 2006; Mengistu & Hager, 2008).

4.3. Threats and conservation status for the main food tree species

Many threats affecting wild edible tree species are similar to those that affect the biodiversity resources in Ethiopia (IBC, 2007). Of these, deforestation comes as a consequence of anthropogenic change to which global environmental and climate change also added (Lulekal et al., 2011). According to (Teketay et al., 2010), deforestation is immense and estimated between 150000 – 200000 ha of land per year. We evaluated the threats and conservation status for the most 15 frequent tree species observed in the studied regions. We observed the highest values/ranks for a number of multipurpose wild edible species including *Celtis africana, Ziziphus spina-christi, Balanites aegyptiaca* and *Tamarindus indica*. The result indicated that these plants were exploited more for their non-food uses than for reported food values. Overharvesting of these plant species for fuel wood, medicine, fencing, construction, and forage purposes were found the responsible factors aggravating degradation of these species in all the study areas. Moreover, the species were also affected by pests and diseases, which might have a direct implication on their status degradation. The diseases and pests usually occur when the local communities change from a pastoral into as agro pastoral way of life (Assefa & Abebe, 2011). Such effects of the factors also limit the benefits that can be derived from the management and conservation of wild edible food plants.

In general, due to the diversity of wild edible species, an important effort has to be done for their conservation and management to reach a food security strategy from the forest resources. The actions for conservation and management of wild edible species include the recognition of the limitations and the way forward searching. Although all species to various uses deserve attention (Belem & Nabaloum, 2017), the much appreciated food tree species in this study as *Celtis africana, Ziziphus spina-christi, Balanites aegyptiaca* and *Tamarindus indica* should be considered for their management strategies, given priority for their conservation and domestication. Moreover, overexploitation of the plant parts (roots, leaves, bark, and wood) could cause death or low productivity of the plants. Thus, the mode of unsustainable harvesting and product utilization should be considered as it can be a cause of depletion of the resources in their natural habitats. Also, their conservation should be encouraged and enhanced through the application of *in-situ* and *ex-situ* conservation programs, given special consideration to those species currently used by the local communities in the different parts of the country.

5. - CONCLUSION

This study attempts to provide baseline information that can be used in sustainable natural resource utilization in addition to documenting wild edible plants in Ethiopa. The result of this study highlights the existence of a valuable food tree species and their utilization aspects in the lowland parts of the country. Also, it reveals that trees from wild habitats contribute significantly to the livelihoods of the local people through their various uses. Such diverse use demonstrates local people have close relationship with their local biological resources. However, different factors are now affecting the wild edible food trees in the country, indicating that conservation practices should be enhanced through the application of management strategies, given special consideration to those species currently used by the local communities. Furthermore, the knowledge associated with the diverse edible tree species are important for the livelihood of the local communities over the country. Thus, the experiential knowledge of the different ethnic groups has to be documented, as it is important for the development and conservation of important tree resources in the country.

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