Ethnobotanical Assessment of Wild and Semi-Wild Edible Plants in Northwestern Tigray, Ethiopia

Abstract

Wild and semi-wild edible plants play a vital role in food security by supplementing dietary needs. This study explored the types of wild and semi-wild edible plants consumed, their management practices, consumption modes, marketability, and major threats in the lowland and midland agroecological zones of Northwestern Tigray, Northern Ethiopia. A total of 234 informants were involved through focus group discussions, key informant interviews, household surveys, and field observations. In total, 27 wild and semi-wild edible plant species were identified: 8 in the lowland zone, 11 in the midland zone and 8 common to both. Trees were the dominant life form (65.62%), followed by tree-shrub combinations (18.75%) and shrubs (15.65%). The Malvaceae and Moraceae families were the most represented, with four species each. Fruits were the most commonly consumed part (96.6%), while leaves (3.1%) and seeds were rarely used. Consumption was primarily raw, with 74.53% of fruits in the lowland areas and 96.75% in the midland areas consumed outdoors. Overconsumption of certain fruits can lead to side effects such as abdominal bloating, nausea, heart disease, constipation, and urinary discomfort. Children were the primary collectors and sellers of these plants, using methods like plucking or long sticks for harvesting. Market analysis revealed that only 25% of these edible plants were sold locally, with Tamarindus indica, Balanites aegyptica (L.) Del., Ziziphus spina-christi (L.) Desf., and Syzygium guineense (Willd.)DC. being the most preferred. These plants provide multiple benefits, including enhancing food security, serving as energy sources, construction materials, medicines, and household utensils, as well as offering ecological services and aesthetic value. However, agricultural expansion, fuel wood collection, and overgrazing are major threats to their sustainability. Therefore, it is crucial that appropriate utilization and conservation measures are implemented by all stakeholders to ensure their long-term availability.

Keywords: Conservation, Consumption, Management, Marketability, Threat

1. Introduction

Natural forests, woodlands, and wildlife have long served as primary food sources for early hunter-gatherer societies and forest-dependent communities (Seyoum et al., 2015). Among these resources, wild edible plants have provided essential sustenance since pre-agricultural times, even before the domestication of modern crops (Amente, 2017). Globally, around 3 million people rely on non-timber forest products, highlighting the significant value of wild and semi-wild edible plants (Anbessa et al., 2024). In Ethiopia alone, people consume over 300 different wild edible plant species (Asfaw, 2008). Key habitats for these wild plants include forests, wooded grasslands, scrublands, riverine environments, and cultivated land across the country's diverse vegetation zones (Asfaw, 2008).

Wild and semi-wild edible plants play a critical role in food security, providing supplementary dietary needs (Teklehaymanot and Giday, 2010; Seyoum et al., 2015). They also serve as valuable sources of income for local communities (Tahir et al., 2023) and are important in traditional medicine (Guinand and Lemessa, 2001). Studies have shown that many wild edible species contain higher concentrations of vitamins and nutrients compared to domesticated agricultural plants (Asfaw, 2008). In addition to their nutritional benefits, these plants provide forage for livestock, fuelwood, and materials for construction and tools, supporting rural households (Amente, 2017; Berihun and Molla, 2017). Furthermore, they play a vital role in biodiversity conservation and environmental protection, integrating ecological systems with human livelihoods (Ruffo et al., 2002). Traditional communities worldwide have accumulated extensive indigenous knowledge regarding the use and management of wild and semi-wild edible plants, passed down through generations of interaction with their natural surroundings (John, 1993). In Ethiopia's rural areas, elders are the primary custodians of this valuable knowledge, especially in relation to the availability and management of these plants (Abebe and Ayehu, 1993).

Despite their significant roles, wild and semi-wild edible plant species in Ethiopia face numerous threats, including deforestation, forest degradation, inadequate management practices, and population pressure (Belete et al., 2021). Moreover, comprehensive studies on wild edible fruit-bearing woody species have not been adequately conducted across many regions of the country (Belete et al., 2021; Regassa et al., 2014). Therefore, identifying and documenting these species across diverse ecological settings is essential to maximize the benefits for local communities, guiding the development of management practices that ensure the conservation and sustainable use of these valuable resources (Belete et al., 2021).

In the Tigray region, similar to other areas of Ethiopia, people rely on wild and semi-wild edible trees and shrubs for income, medicinal purposes, and as a survival strategy during food shortages and throughout normal seasons. However, despite the widespread use of these plants, few studies have been conducted to document the ethnobotany of wild and semi-wild edible plants in the region (Giday and Teklehaymanot, 2023). The aim of this study was to identify and document the wild and semi-wild fruit-bearing woody plant species found in the midland and lowland areas of northwestern Tigray.

2. Materials and Methods

2.1. Study Area

The study was conducted in Northwestern Tigray, northern Ethiopia, to assess the availability, utilization, and management of wild and semi-wild edible plants. The study area was stratified into two distinct agroecological zones, based on the framework by Hurni et al. (2016): the Lowland region (500-1500 meters) and the Midland region (1500-2300 meters). To ensure representative coverage, two districts from each zone were purposefully selected due to the known presence of wild and semi-wild edible plants. These districts were Tahtay Adiyabo and Tselemti in the Lowland region, and Tahtay Koraro and Medebay Zana in the Midland region (Figure 1). Within these districts, four peasant associations were randomly chosen: Adi Hageray (Tahtay Adiyabo), Mayteklit (Tselemti), Beles (Tahtay Koraro), and Bahra (Medebay Zana). The site selection was conducted in collaboration with researchers, woreda experts, development agents, and local administrators to ensure a diverse and representative sample.

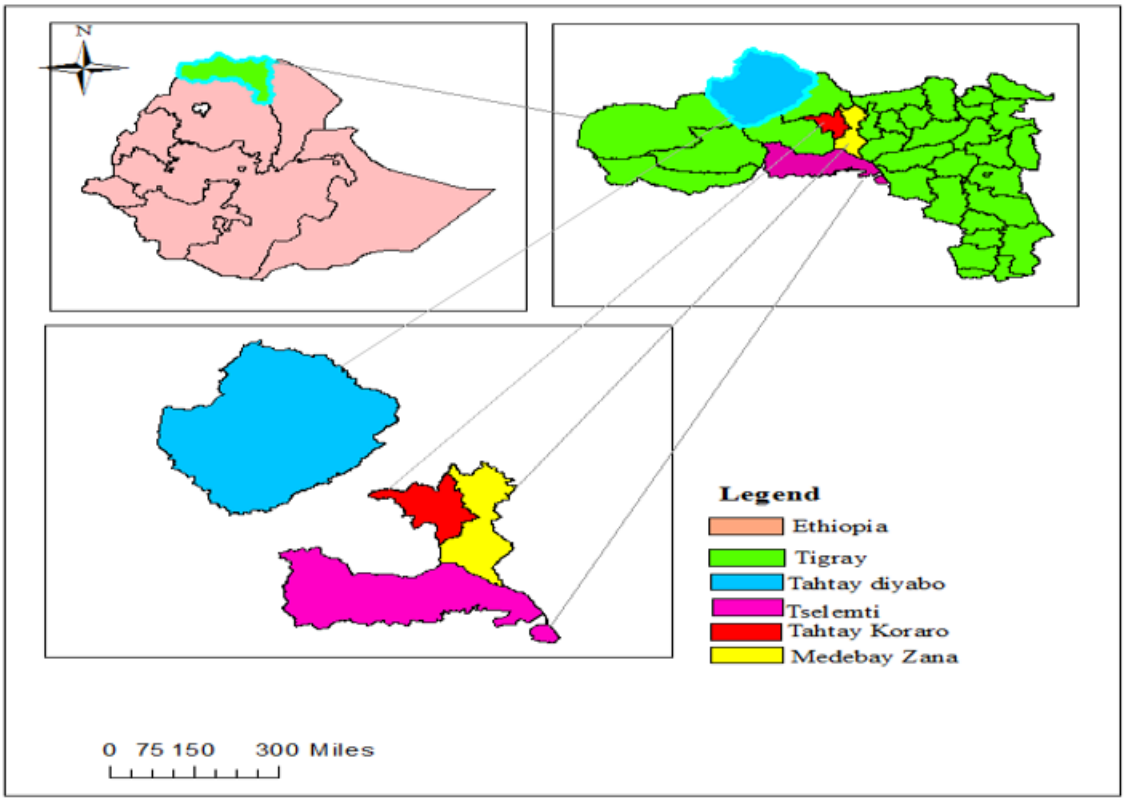

Figure 1: Study area map

2.2. Sampling procedure and Sampling size determination

The study employed a mixed-methods approach to assess the availability, utilization, and management of wild and semi-wild edible plants across various community groups. A total of 20 key informants were purposefully selected, with the assistance of development agents, from four study sites (5 informants per site). These key informants were instrumental in categorizing the wealth status of household participants, verifying recorded data on wild and

semi-wild edible plants, and providing insights into the historical background of the community's utilization, conservation, and management practices related to these plants.

In addition, a random sample of 241 households was surveyed (as detailed in Table 1). The households represented a diverse cross-section of the community, including adults and elders, literate and illiterate individuals, women and men, as well as people from various socio-economic backgrounds (rich, medium wealth, and poor) and different religious affiliations. Sample size was calculated with the simple random sampling method based on proportional to household number presented below using formula (Kothari (2004)).

$$n = \frac{Z^2 * N * P * Q}{E^2 * (N -) + Z^2 * PQ} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Eq.(1)$$

Where, n=Sample size, N= Number of household, E= Allowed error which is 5 %=0.05, P=level of precision which is 5 %=0.05, Q=1-P=1-0.05=0.95, Z^2=Confident interval 95, 1.96 from Z table

Table 1: lists of selected household in the study area

List of selected Kebele	Agroecology	No of Household	Sample size	Gender	
				Male	Female
Bahra	Midland	2097	59	54	5
Beles	Midland	2275	64	34	20
Adi Hageray	Lowland	1450	48	38	10
May Tekelit	Lowland	2488	70	48	22

2.3. Data collection

The study utilized checklists and semi structured interview questionnaires as data collection tools. Information was collected on various aspects of wild and semi-wild edible plant species, including their growth forms, utilized parts, natural habitats, propagation methods, fruit harvesting techniques, annual yields, conservation statuses, consumption patterns, market value, management practices and major threats to their survival. These key informations were collected from focus group discussion, key informant interview, household interview and filed observation.

2.4. Data analysis

The data were analyzed using descriptive statistics with Microsoft Excel and Stata software version 15**.** Closed-ended questions were examined using tables and percentages to enable result comparisons, while open-ended responses, including interviews and observations, were analyzed descriptively.

3. Result and Discussion

3.1. Demographic and socio economic characteristics of the households

Most respondents were male-headed households and married. In the lowland agroecology, 55% of respondents were illiterate, unable to read or write, compared to 42.4% in the midland agroecology. The remaining respondents had completed either primary or secondary education (Table 2). Farming was the primary occupation in the study area, with 100% of households in lowland regions and 93.22% in midland regions relying on agricultural practices (Table 1). The residents had lived in the area for periods ranging from 1 to 81 years, with farming experience spanning 10 to 60 years. Similar studies in other regions have reported that the majority of communities rely on subsistence farming as their primary income source. (Musa et al., 2023; Regassa et al., 2015).

Table 2: Respondents information and demographic characteristics

Variables		Lowland Agro ecology		Midland Agro ecology	
		Frequency	Relative Frequency (%)	Frequency	Relative Frequency (%)
Gender	Male	86	72.88	98	79.67
	Female	32	27.12	25	20.33
	Total	118	100	123	100
Age	20-30	14	11.86	16	13.01
	31-40	41	34.75	23	18.70
	41-50	20	16.95	29	23.58
	50-60	25	21.19	35	28.46
	>60	18	15.25	20	16.26
Marital status	Single	10	8.47	10	9.76
	Married	88	74.58	96	78.05
	Divorced	14	11.86	10	6.50
	Widowed	6	5.08	8	5.69
Family size	0-3	18	15.25	21	17.07
	4-6	47	39.83	54	43.90
	>7	53	44.92	48	39.02
Education	Illiterate	52	44.07	38	30.89
	Primary	42	35.59	60	48.78
	Secondary	24	20.34	25	20.33
Occupation	Farming	118	100	110	89.43
	Farming and Trade	0	0	8	6.50
	Farming and Guard	0	0	2	1.63
	Government employee	0	0	3	2.44
Wealth status	Poor	68	57.63	57	46.34
	Medium	30	25.42	35	28.46
	Rich	20	16.95	31	25.20

3.2. Identified wild and semi wild edible plants and life forms

The study area is endowed with various wild and semi-wild edible (WSWE) plants that serve as both timber and non-timber forest products. A total of 27 WSWE plant species were identified across both agroecologies: 8 in the lowland, 11 in the midland and 8 in both. The number of WSWE plants recorded was higher in the midland agroecology compared to the lowland agroecology. This finding aligns with those reported by Woldemedhin et al. (2021) in the Ensaro district of the Amhara region. The growth habits of WSWE plants in the study area reflect a clear dominance of tree species, which make up 65.62% of the total vegetation, followed by tree/shrub species at 18.75%, and shrubs at 15.63% (Table 3). This dominance of trees is consistent with findings from other studies (Anbessa et al., 2024; Emire et al., 2022; Musa et al., 2023; Tariku and Eyayu, 2017; Demise, 2020). However, this result contrasts with studies by Woldemedhin et al. (2021), Anbessa (2016), Lulekal et al. (2011), Regassa et al. (2015), Biri et al. (2024), and Tahir et al. (2023), which reported a dominance of shrubs over other life forms of WSWE plants.

The families Malvaceae and Moraceae had the highest number of species, with four species each (12.5%). These were followed by Arecaceae, Ebenaceae, and Rhamnaceae, each with two species (6.25%). The remaining families were represented by only one species each. The dominance of species from the Moraceae family in the study area is consistent with findings from other parts of Ethiopia (Girmay et al., 2022; Regassa et al., 2015; Tariku and Eyayu, 2017). Additionally, the prevalence of Malvaceae and Moraceae**,** followed by Arecaceae**,** Rhamnaceae**,** Boraginaceae**,** Anacardiaceae and Rubiaceae, aligns with observations by Dejene et al. (2020). The number of WSWE plants identified in this study is comparable to those reported in other regions of Ethiopia (Musa et al., 2023), but it is lower than the numbers documented by Anbessa et al. (2024), Dejene et al. (2020), Biri et al. (2024), Tariku and Eyayu (2017), and Emire et al. (2022). The lower number of WSWE plants found in this study may be attributed to climatic and environmental conditions that could have limited the availability of wild edible plants, as well as differences in traditional knowledge and practices related to the use of WSWE plant species.

Table 3: List o of the WSWE plants and life form

Botanical name	Local name	Family	Edible	Life form
Hyphaene thebaica (L.) Mart	Arkokobay	Arecaceae	Fruit	Tree
Dovyalis abyssinica (A. Rich.) Warb.	Ayahada	Salicaceae	Fruit	Tree/shrub
Adansonia digitata L.	Dima	Malvaceae	Fruit	Tree
Grewia villosa Willd.	Haben	Malvaceae	Fruit	Tree
Tamarinudus indica L.	Humer	Fabaceae	Fruit	Tree

Balanites aegyptica (L.) Del.	Meqie	*Zygophyllaceae*	Fruit	Tree
Euclea schimperi (A. DC.) Dandy	Kiliow	Ebenaceae	Fruit	shrub
Syzygium guineense (Willd.)DC.	Liham	Myrtaceae	Fruit	Tree
Phoenix reclinata Jacq.	Siye	Arecaceae	Fruit	Tree
Rhus natalensis Bernh.	Tetaelo	Anacardiaceae	Fruit	Tree/shrub
Grewia ferruginea Hochst. ex A.Rich.	Tsimquya	Malvaceae	Fruit	Tree
Vangueria edulis Vahl	Guramayle	Rubiaceae	Fruit	shrub
Ficus ingens/glutinosa Miq.	Tsekente	Moraceae	Fruit	Tree
Securinega virosa (Roxb. ex Willd.) Baill.	Harmazo	Phyllanthaceae	Fruit	Shrub
Ficus sur Forssk.	Kodo	Moraceae	Fruit	Tree
Ziziphus abyssinica Hochst. ex A.Rich.	Abetere	Rhamnaceae	Fruit	Tree/shrub
Carissa edulis Vahl	Agam	Apocynaceae	Fruit	Tree/shrub
Diospyros mespiliformis Hochst. ex A.DC.	Aye	Ebenaceae	Fruit	Tree
Ficus vasta Forssk. Forssk.	Daero	Moraceae	Fruit	Tree
Cordia africana Lam.	Awhi	Boraginaceae	Fruit	Tree
Ziziphus spina-christi (L.) Desf. (L.) Desf.	Gaba	Rhamnaceae	Fruit	Tree/shrub
Grewia bicolor Juss.	Mesoqa	Malvaceae	Fruit	Shrub
Ximenia americana L.	Milio	Olacaceae	Fruit	Tree
Ficus sycomorus L.	Sagla	Moraceae	Fruit	Tree

Mimusops kummel Bruce ex A.DC.	Kumel	Sapotaceae	Fruit	Tree
Moringa oleifera Lam	Moringa	*Moringaceae*	Leaf	Tree
Verbascum sinaiticum Benth.	Tinkako	*Scrophulariaceae*	Fruit	Tree

3.3. Habitat, propagation and conservation status of WSWE

3.3.1. Natural habitats

Natural forests, grasslands, riverine environments, protected areas, cultivated land, shrublands, woodlands, and wetlands are home to various WSWE plants in Ethiopia. The results indicated that WSWE plants exist in different habitat types (Table 4). The majority of these species were found in riverine areas (27.97%), followed by woodlands (16.95%), exclosures (10.17 %), home gardens (8.47%), and cultivated land (8.47%) in the lowland area. In the midland area, the majority were found in riverine habitats (27.64 %), followed by woodlands (13.82%), home gardens (13.01%), exclosures (8.94 %), and cultivated land (5.69%). Other habitats are indicated in Table 3. Previous studies have also identified cultivated land as a low reservoir for WSWE plants, whereas scrublands and woodlands were found to be the primary reservoirs for these plants (Woldemedhin et al., 2021).

Table 4: Natural habitats of the WSWE plants in the study area

Habitat	Lowland Agroecology		Midland Agroecology	
	Frequency	Relative frequency	Frequency	Relative frequency
Woodland	20	16.95	17	13.82
Cultivated land	10	8.47	7	5.69
Riverine	33	27.97	34	27.64
Home garden	10	8.47	16	13.01
Exclosure	12	10.17	11	8.94
woodland and Farmland	2	1.69	4	3.25
woodland and riverine	2	1.69	7	5.69
Cultivated land and homestead	1	0.85	3	2.44
woodland and homestead	1	0.85	1	0.81
woodland, farmland, riverine and homestead	10	8.47	7	5.69
woodland, farmland and riverine	1	0.85	1	0.81
woodland, cultivated land and homestead	1	0.85	3	2.44
Homesteaded and exclosure	12	10.17	9	7.32
Riverine and homestead	1	0.85	1	0.81
Riverine and exclosure	2	1.69	2	1.63
Total		100		100

3.3.2. Propagation methods of WSWE

Proper propagation techniques are essential for maintaining plant populations, restoring degraded habitats, and ensuring a continuous supply of edible, medicinal, and culturally significant plants. In the study area, 100% of respondents in the lowland region and 96.75% in the midland region propagate WSWE plants using seeds (Table 5). In addition to seed propagation, *Ziziphus spina-christi (L.) Desf.* is propagated using rhizomes, while *Ficus sycomorus L.* and *Ficus vasta Forssk.* are propagated through cuttings.

Table 5: Propagation methods of WSWE

Propagation methods	Lowland Agroecology		Midland Agroecology	
	Frequency	Relative frequency (%)	Frequency	Relative frequency (%)
Seed	118	100	119	96.75
Cuttings	0	0	1	0.81
Rhizome	0	0	2	1.63
Seed and cutting	0	0	0	0.00
Seed and rhizome	0	0	1	0.81
Seed and grafting	0	0	0	0.00

3.3.3. Conservation status and demands

WSWE plants are essential for biodiversity, food security, and medicinal and cultural values, and they require dedicated conservation measures. In the study area, however, the conservation status of WSWE plants faces mounting threats from habitat loss, overharvesting, climate change, agricultural expansion, population pressure, and charcoal production. A significant percentage of respondents 88.52% in the lowland and 78.30% in the midland agroecology, indicated an urgent need for conservation efforts for WSWE plants (Figure 2). Similar studies in other areas have also recommended implementing comprehensive conservation measures, as well as the domestication and cultivation of WSWE plants (Anbessa et al., 2024; Biri et al., 2024; Dejene et al., 2020; Musa et al., 2023; Tariku and Eyayu, 2017).

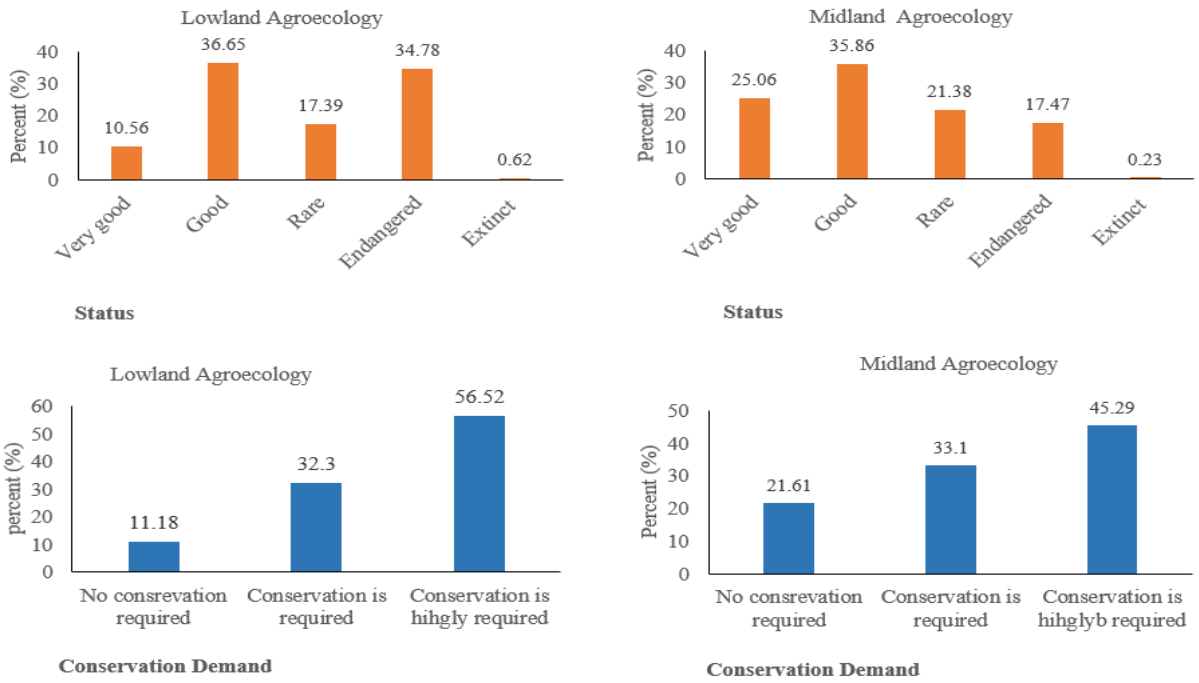

Figure 2: current status and conservation demands of the WSWE in lowland and midland agroecology

3.4. Harvesting Methods of the WSWE fruits

In the study area, the community employs various WSWE fruit harvesting techniques, including plucking, shaking the tree, cutting branches, using a long stick to pick the fruit, and throwing stones to dislodge the fruit. Among these, plucking, followed by picking the fruit with a long stick and shaking the tree, was the most common method in both agroecologies (Table 6). This finding aligns with the research of Yiblet and Adamu (2023) and Ojelel et al. (2019), who reported that plucking was the most common harvesting technique in Tach Gayint district, Amhara region, Ethiopia, and the Teso-Karamoja region, Uganda, respectively. The use of techniques such as branch cutting, stoning, and using long sticks to pick fruit may hinder the growth and survival of the mother tree. Additionally, these methods can reduce fruit quality by damaging both ripe and unripe fruits, increasing their exposure to diseases and pathogens.

Table 6: Harvesting techniques of the WSWE

Fruit harvesting Techniques	Lowland Agroecology		Midland Agroecology	
	Frequency	Relative frequency	Frequency	Relative frequency
Plucking	80	67.80	73	59
Shaking	13	11.02	1	1.15
Picking by stick	14	11.86	12	10.12
From felled	1	0.85	4	3.45
Cutting branches	3	2.54	3	2.59
Plucking and shaking	2	1.69	3	2.53
Plucking and picking by stick	1	0.85	11	8.97
Plucking and from felled	0	0.00	1	0.69
Plucking, picking by stick and shacking	0	0.00	11	9.2
Plucking, shaking and from felled	0	0.00	1	0.92
Picking by stick and from felled	0	0.00	1	0.69
Plucking, shaking, picking by stick and from felled	0	0.00	0	0.23
Plucking , picking by stick and from felled	0	0.00	0	0.23
Shaking and from felled	0	0.00	0	0.23
Shaking and picking by stick	3	2.54	0	0
Stoning	1	0.85	0	0

3.5. Fruit collector and seller groups

In the study area, the results showed that household members participated in WSWE fruit collection, with children being the primary fruit collectors, followed by other household members (Table 7). Consistent with these findings, women and children (or youngsters) were documented as the major WSWE fruit gatherers, followed by other household members (Biri et al., 2024; Musa et al., 2023; Regassa et al., 2015). Demise (2020) also reported that younger age groups were more actively involved in wild edible fruit collection compared to other household members. Additionally, the market assessment indicated that children were the primary sellers of WSWE fruits in the local markets of the study area (Table 6). The low participation of household heads in selling fruits may be attributed to cultural influences, community perceptions, and individual interests.

Table 7: WSWE fruit collector and seller groups

	Household members	Lowland Agroecology		Midland Agroecology	
		Frequency	Relative frequency (%)	Frequency	Relative frequency (%)
Fruit collectors	Husband	0	0.00	1	0.46
	Children	100	84.75	68	55.24
	Women and children's	3	2.54	9	7.59

	Husband, Women and children	15	12.71	44	36.09
	Husband and children's	0	0.00	1	0.62
Fruit sellers	Husband	0	0.00	1	0.46
	Women	5	4.24	1	0.62
	Children	112	94.92	115	93.56
	Husband, Women and children	1	0.85	6	5.13
	Husband and Women	0	0.00	0	0.23

3.6. Plant parts used and consumption mode

Fruits, seeds, and leaves are the edible parts of WSWE plants recorded in the study area. Fruits were the most commonly consumed part, constituting 96.6% of consumption, followed by leaves at 3.1% (Figure 3). All household members consumed WSWE fruits during times of food shortage and in normal seasons. In contrast to our study area, people in other parts of Ethiopia also utilize the roots and barks of WSWE plants, in addition to the fruits, seeds, and leaves (Musa et al., 2023). This suggests that different regions have distinct cultural practices and traditional knowledge regarding the use of WSWE plants. Overall, many studies have shown that fruit is the major part consumed by communities (Anbessa, 2016; Anbessa et al., 2024; Musa et al., 2023; Regassa et al., 2015; Guzo et al., 2023; Emire et al., 2022; Demise, 2020), which is consistent with the present findings.

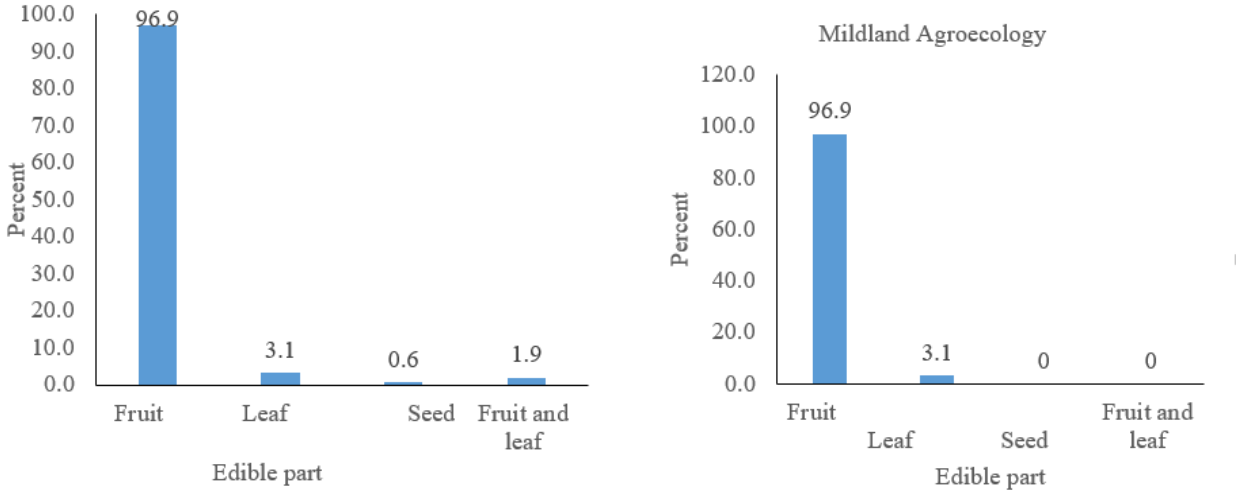

Figure 3: WSWE parts used for food consumption

The results on consumption modes showed that communities consumed WSWE fruits in various forms, including fresh ripe fruits, fruit juice, cooked/roasted fruits, cooked leaves, and raw seeds. Approximately 74.53% of the fruits in lowland areas and 96.75% in midland areas were consumed raw, without processing (Table 8). In addition to being eaten raw, *Tamarindus indica* was also consumed in cooked form, often combined with other ingredients, and as juice. *Mimusops kummel Bruce ex A.DC.* was typically consumed in roasted form, while *Moringa oleifera Lam* leaves were cooked, and *Cordia africana Lam.*

seeds were eaten for medicinal purposes. Similar to the present findings, previous studies have also reported that a higher proportion of fruits were consumed raw (Anbessa et al., 2024; Demise, 2020; Dejene et al., 2020; Girmay et al., 2022; Musa et al., 2023; Tariku and Eyayu, 2017).

Table 8: Consumption mode of the WSWE fruits

Consumption mode	Lowland Agroecology		Consumption mode	Midland Agroecology	
	Frequency	Relative Frequency		Frequency	Relative Frequency
Fresh ripe fruit /Raw	88	74.53	Raw	119	96.75
Juice	19	16.15	Cooked/roasted	1	0.81
Dried	1	0.62	Dried	1	0.81
Raw and cooked	1	1.24	Raw and dried	2	1.63
Raw and dried	1	0.62		0	0.00
Cooked and juice	7	5.59		0	0.00
Raw, cooked and juice	1	0.62		0	0.00
Seed	1	0.62	Seed	0	0.00
Total	118	100		123	100

3.7. Yield and market assessment of the commonly used WSWE

The seasonal yield of WSWE fruits per stem varied from plant to plant. The average yield ranged from 3 to 97.9 kilograms per stem, with the highest yield coming from *Syzygium guineense (Willd.)DC.* and the lowest from *Verbascum sinaiticum Benth.* (Table 9). The market assessment revealed that, except for *Tamarindus indica, Balanites aegyptica (L.) Del., Ziziphus spina-christi (L.) Desf., Syzygium guineense (Willd.)DC., Vangueria edulis Vahl, Diospyros mespiliformis Hochst. ex A.DC., Cordia africana Lam., Ximenia americana L.*, and *Mimusops kummel Bruce ex A.DC.*, 75% of the WSWE fruits were not available for sale in the local markets (Table 8). Among these, *Tamarindus indica*, *Balanites aegyptica (L.) Del.*, *Vangueria edulis Vahl*, *Hyphaene thebaica (L.) Mart*, and *Adansonia digitata L.* were sold individually by count, while *Diospyros mespiliformis Hochst. ex A.DC., Ziziphus spina-christi (L.) Desf., Cordia africana Lam., Ximenia americana L.*, and *Mimusops kummel Bruce ex A.DC.* were typically sold using traditional local measuring units, such as "Tanika" (where 2 Tanika equal 1 kilogram). Similar to this finding, previous studies conducted in other regions have shown that a higher number of WSWE fruit trees are not sold in markets as a food source (Alemayehu et al., 2015; Anbessa, 2016; Emire et al., 2022; Kidane et al., 2014). In contrast, research carried out in the neighboring country of Sudan revealed that WSWE fruits contribute 50-60% and 75-100% of the total annual family income in lowland and midland areas, respectively (Salih and Ali, 2014).

Table 9: Seasonal fruit yield of the WSWE/stem

Scientific name	Local name	Annual Yield (Kg)	Price/Kg or per fruit
Ziziphus abyssinica	Abetere	29.9	0

Hochst. ex A.Rich.			
Carissa edulis Vahl	Agam	33.6	0
Diospyros mespiliformis Hochst. ex A.DC.	Aye	67.6	20-30 birr/Kg
Cordia africana Lam.	Awhi	77.7	20-35 Kg
Ficus vasta Forssk.	Daero	66	0
Ziziphus spina-christi (L.) Desf. (L.) Desf.	Gaba	59.8	25-40 Kg
Euclea schimperi (A. DC.) Dandy	Kiliow	22.1	0
Mimusops kummel Bruce ex A.DC. Bruce ex A.DC.	Kumel	35.2	15-30 Kg
Syzygium guineense (Willd.)DC. (Willd.)DC.	Liham	97.9	20-30 Kg
Ximenia americana L. L.	Milio	29.9	15-30 Kg
Ficus sycomorus L. L.	Sagla	68.5	0
Phoenix reclinata Jacq.	Siye	11.3	0
Rhus natalensis Bernh.	Tetaelo	12.08	0
Grewia ferruginea Hochst. ex A.Rich.	Tsinkuya	24.5	0
Hyphaene thebaica (L.) Mart (L.) Mart	Arkokobay	72.5	The price for one fruit is 5 birr
Dovyalis abyssinica (A. Rich.) Warb.	Ayahada	10.8	0
Adansonia digitata L.	Dima	64.9	0
Vangueria edulis Vahl Vahl	Guramayl	15	The price for five fruit is 2 birr
Grewia villosa Willd.	Haben	5	0
Securinega virosa (Roxb. ex Willd.) Baill.	Harmazo	20.9	0
Tamarinudus indica L.	Humer	66.6	The price for five fruit is 1 birr
Ficus sur Forssk.	Kodo	55	0
Balanites aegyptica (L.) Del.	Mekie	47.5	The price for five fruit is 2 birr
Verbascum sinaiticum Benth. Benth.	Tinkako	3	0
Ficus ingens/glutinosa Miq.	Tsekente	5.75	0
Moringa oleifera Lam Lam	Moringa		
Grewia bicolor Juss.	Mesoka	0	0

3.8. Other multi-purpose values of WSWE Plants

In addition to supplementing the regular food supply and filling the food gap during times of famine or drought, WSWE plants in the study area serve multiple purposes. These include providing forage/fodder, medicine, fuel wood, and materials for agricultural tools, furniture, construction, and rope. WSWE plants are also used for shade, erosion control, fencing, and saddle making. Furthermore, they play a role in agroforestry, income generation, and are integral to religious and cultural ceremonies.

3.9. Side Effects of the WSWE

The results indicate that the majority of WSWE plants, specifically 96.61% in lowland areas and 91 % in midland areas, do not have disease-causing effects on human health (Table 10). However, some WSWE plants can have negative effects when consumed in excessive amounts. For example, overconsumption of *Balanites aegyptica (L.) Del.* may lead to diarrhea, *Diospyros mespiliformis Hochst. ex A.DC.* can cause constipation, urinary incontinence, and abdominal bloating, *Ximenia americana L.* may result in dehydration, heart disease, and itchy teeth, *Tamarindus indica* can cause itchy teeth and constipation, *Ziziphus spina-christi (L.) Desf.* may lead to abdominal bloating, and *Cordia africana Lam.* can cause nausea. Excessive intake or overdose of WSWE fruits can lead to side effects on human health (Anbessa, 2016).Table 9: Overconsumption side effects of WSWE plants.

Table 10: Side effects of The WSWE plants

Side effect	Lowland Agroecology		Side effect	Midland Agroecology	
	Frequency	Relative Frequency		Frequency	Relative Frequency
No side effect	114	96.61	No side effect	112	91
Abdominal bloating	1	0.85	Abdominal bloating	1	0.92
Itchy teeth	1	0.85	Itchy teeth	1	0.69
Diarrhea	2	1.69	Urinary incontinence	0	0.23
Constipation	1	0.85	Constipation	5	4.00
			Heart disease	0	0.23
			Abdomen pain	4	2.99
			Nausea	0	0.23
Total		100			100

3.9. Major threating factors and management practices of the WSWE

3.9.1. Major threating factors

In the study area, people utilize a variety of WSWE plants from natural forests, homesteads, riverine areas, exclosures, and cultivated land for purposes such as medicinal use, income generation, and food. However, despite their importance, the abundance and diversity of

WSWE plants are decreasing due to anthropogenic and environmental threats. Respondents in the study area identified the main threats as agricultural expansion, charcoal production, and overgrazing. Specifically, in the lowland agroecology, 79.63% of respondents highlighted agricultural expansion and charcoal production, while 20.37% cited grazing as a major threat. In the midland agroecology, 76.32% pointed to agricultural expansion and charcoal production, and 23.68% identified grazing as a significant threat. These and other factors may contribute to the decline in the number of WSWE plants in the study area. Similar to these findings, many studies in other regions have identified agricultural expansion, overgrazing, and fuelwood production as the primary threats to WSWE plants (Kebebew and Mohamed, 2017; Girmay et al., 2022; Musa et al., 2023; Regassa et al., 2015; Tariku and Eyayu, 2017; Emire et al., 2022).

3.9.2. Management and Conservation Practices

Effective management of WSWE plants includes various strategies, such as in situ conservation, selective thinning and pruning, habitat restoration through plantations and exclosures, community-driven harvesting guidelines and integration with agricultural systems. Despite the numerous roles of WSWE plants in enhancing food security through consumption and income generation, providing stable ecological services, creating job opportunities and supporting religious and cultural practices in the study area, these economically important species have received little attention. Fifty and more than fifty percent of the respondents stated that there is improper WSWE plants utilization and no effective management practices have been implemented to conserve and restore these plants (Figure 4). Consequently, it becomes low diverse in the study area. Similar to the present result, previous studies conducted in other region also showed that little attention plus misuse causes to reduction of the WSWE plants (Anbessa, 2016; Guzo et al.,2023; Woldemedhin et al., 2021).

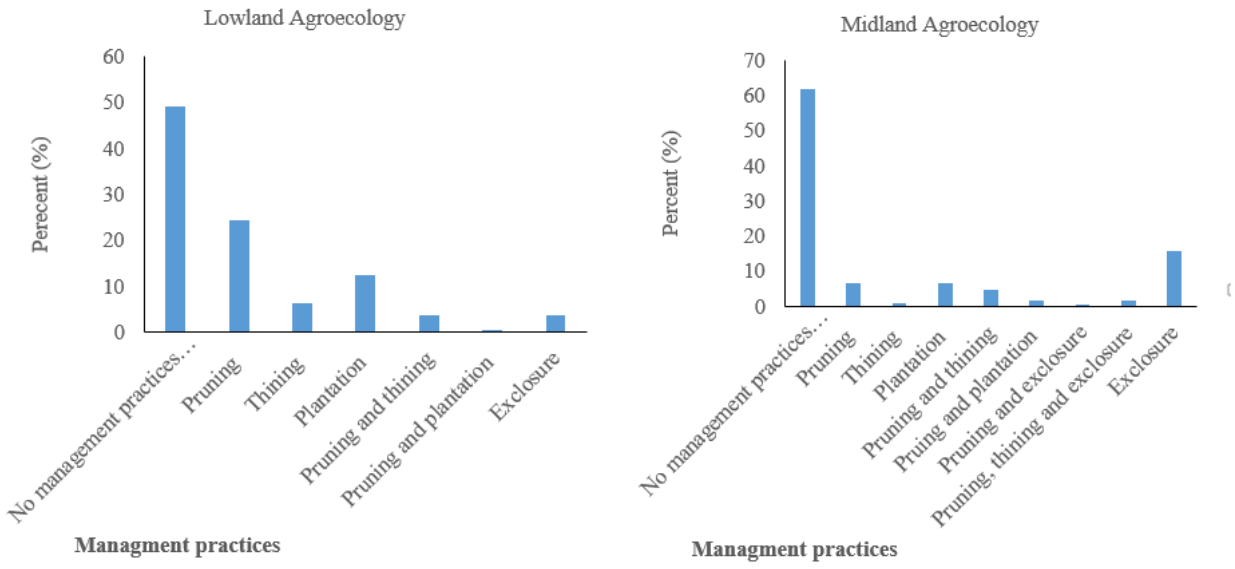

Figure 4: Management practices of the WSWE plants in the study area

4. Conclusion

The study revealed that the northwestern Tigray region is endowed with a diverse range of WSWE plants, with a total of 32 species documented across both lowland and midland areas. The majority (96.88%) of these WSWE plants are native, with only a small proportion of

exotic species (3.12%). Despite the abundance of WSWE plants, only a few are marketed as food sources. The primary edible parts consumed are fruits, which serve to supplement the local diet. However, excessive consumption of WSWE fruits has been linked to various health issues, including abdominal pain, bloating, heart disease, nausea, urinary discomfort, constipation, and itchy teeth. Furthermore, local perceptions of WSWE plants are generally low, particularly in terms of management practices, parts consumed, sustainable utilization, and conservation strategies. Currently, the diversity and population of WSWE plants face threats from both anthropogenic and natural factors, such as agricultural expansion, illegal cutting for firewood and charcoal production, overgrazing, urbanization, and climate change. These factors are contributing to the declining availability of WSWE plants, potentially leading to their disappearance. Therefore, this study emphasizes the need to raise awareness among local communities about the sustainable and wise use of WSWE plants. It also calls for urgent restoration and conservation efforts to preserve these valuable resources for future generations.

Acknowledgements

The authors express their gratitude to the staff of the Forestry and Agroforestry Research Unit, the Soil and Water Conservation Research Team, and the Shire Maytsebri Agricultural Research Center for their support during data collection. We also acknowledge the financial support from the Tigray Agricultural Research Institute. Special thanks to the Woreda experts and development agents for their assistance in study site selection and facilitating respondent participation. Finally, we extend our sincere thanks to the respondents for their time and willingness to share valuable insights.

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