Jimma University

College of Natural Sciences

Department of Biology

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Ethnobotanical Study of Wild Edible Plants in Dedo District, Jimma Zone, Oromia National Regional State, Southwest Ethiopia

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Abstract

*The people of the world and most rural communities in our country rely on wild edible plants (WEPs) through food shortage and traditional medicine. An ethnobotanical study of WEPs was conducted in Dedo district, Jimma Zone, Oromia Regional State, Southwest Ethiopia. The objective of the study was to assess WEPs and related indigenous knowledge of the local people. Three Ganda (the smallest administrative unit) were purposively selected for the data collection from the study area and 344 informants were selected randomly from 2474 households by using simple random sampling. The size of the sample population for each Ganda was decided using the sample size determination of Yamane's (1967) formula. Ethnobotanical data were collected using a semi-structured interview, guided field walk, focus group discussion, and market survey. The data was analyzed using a Microsoft Excel spreadsheet, preference ranking, direct matrix ranking, paired comparison. In total, 30 WEP species belonging to 26 genera and 21 families were identified and recorded from the study area. Moraceae and Myrtaceae families were relatively the most frequent in terms of the number of WEPs species represented by four and three species each followed by Boraginaceae, Rutaceae, Solanaceae, Sapotaceae, and Oleaceae which contributed two species each. The collections of this WEP species were dominated mainly by children. Regarding their mode of consumption, the majority (*96.67%*) of WEP species were consumed as raw by the local communities.* Trees were the highest growth forms (53.33%) *and fruits were mostly edible plant parts of the WEPs in the study area. The study showed that agricultural expansion was identified as a major threat to WEPs followed by timber making, construction, firewood, and fence in the study area. Hence, the conservation of WEPs species as well as protecting indigenous knowledge were the basic critical issues.*

***Keywords**: Dedo district, Ethnobotany, Ganda, Indigenous knowledge, WEPs*

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List of Acronyms

DAO	Dedo Agriculture Office
DHO	Dedo Health Office
IBC	Institute of Biodiversity Conservation
IK	Indigenous Knowledge
NMA	National Metrological Agency
SNNPRS	Southern, Nations, Nationalities, and Peoples Regional State
TK	Traditional Knowledge
WEPs	Wild Edible Plants

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1. Introduction

1.1. Background of the Study

Different people of the world feed upon several categories of food depending on their culture. All cultures have always depended on plants for their primary requirements; food, shelter, medicines, and have indigenously learned diverse applications of plants (Pharmacotherapy Group, 2009). Plants are the basis of life on earth, central to people's livelihood, and have been the source of food materials from the dawn of human civilization (Khanal, 2006). The interaction between humans and plants is studied in the field of Ethnobotany (Amenu Endalew, 2007). Ethnobotany is one of the distinct branches in natural science which combines several disciplines including anthropology, archaeology, agroforestry, botany, ecology, systematics, religious studies, forestry, economics and medicine, culture, and several other aspects (Martin, 1995).

Wild edible plants (WEPs) refer to plant species that are collected from their wild natural habitats and used as food for human consumption (Ermias Lulekal *et al*., 2011). WEPs are usually considered to constitute all plant resources that are neither cultivated nor domesticated but utilized as dietary supplements by the local people (Cunningham, 2001). On the other hand, wild edible plants are plants with consumable parts, which develop normally on farmland and fallow or uncultivated land (Ruffo *et al*., 2002).

Wild edible plants play a critical role in ensuring food and livelihood security for countless families (Ermias Lulekal *et al*., 2011). Many of them showed that wild plants are essential components of many African diets, especially in periods of seasonal deficiency of foods, and are nutritionally rich, particularly vitamins, and micronutrients (Kebu Balemie and Fassil Kebebew, 2006). Hence, in many cases, the nutrient qualities are richer in the wild edibles than the cultivated and commercial varieties (Ogle *et al*., 2001). High species of wild fruits, leaves, seeds, roots, and tubers are consumed as food plant parts. The majority of women in Vietnam consume large quantities of wild vegetables and many other wild edible species (Julia *et al*., 2014). A study made in Zimbabwe showed that some poor households rely on wild fruits as an opportunity to cultivated food for a quarter of all dry season's meals (Tabuti *et al*., 2004). According to different scholars, wild plants in Ethiopia are serving as a source of food in a time of food problem and consumed by rural communities (Getachew Addis *et al*., 2005). Guinand,

Y. and Dechassa Lemessa (2000) reported that people in southern Ethiopia, Konso, Derashe, and Burji districts use a diversity of WEPs.

The local people prefer WEPs not only for their normal food value but also to fill a variety of food gaps and for their multiple uses and contribution to the well-being of people, livestock, and environments (Debela Hunde *et al*., 2011). The tradition of collecting and consuming wild food plants still continues (Harris and Mohammed, 2003). Hence, ethnobotanical investigations made on WEPs showed that more than 7,000 species have been documented for food in human history (Grivetti and Ogle, 2000). About 1,000 species were identified in America, 800 species in Asia, 326 species in Tanzania (Ruffo *et al*., 2002), and 413 species were specifically identified in Ethiopia (Ermias Lulekal *et al*., 2011). Zemede Asfaw and Mesfin Tadesse (2001) reported that almost 5% of the whole plant species of Ethiopian plants serve as food for human beings and about 8% of the higher plants are edible. This shows still many wild plant species are accepted to be edible and undocumented yet.

In other way, people have different indigenous management strategies to conserve plant resources; for instance, many wild edible plants are left to widely grow in farmlands, farm boundaries, watershed areas, homesteads as a live fence, shade, along roadsides, and degraded areas (Getu Alemayehu *et al*., 2015). Conservation procedures of wild edible plants are within the natural forest, within the agroforestry system, close to the home garden, and living fences (Baressa Anbessa, 2016).

Wild edible plants in Ethiopia however challenged a number of anthropogenic and environmental threats. Agricultural land expansion, human settlement, burning forests, charcoal production, timber production, fencing materials, deforestation, construction and building, environmental degradation, and global climatic change have a direct impact on wild edible plants (Tinsae Bahru, 2009). As a result, the diversity of wild edible plants is diminishing from time to time and the socio-economic, cultural, traditional, and nutritional aspects of wild edible plants are not well studied and reported (Guinand, Y. and Dechassa Lemessa, 2000). In addition, most of the ethnobotanical studies conducted in Ethiopia have focused on medicinal plants as compared to WEPs and very little attention has been given to the inventory and conservation of the species (Getachew Addis *et al*., 2005). Moreover, there is a lack of information concerning their taxonomy, genetic diversity, and uses, among other aspects (IBC, 2005). This calls for

further assessment of wild edible plants in the whole country including the present study area in order to sustainably use the resources in food security (Ermias Lulekal *et al*., 2011).

1.2. Statement of the Problem

For many years, the importance of wild edible plants in developing countries, as a means of survival during drought and famine has been ignored. However, many wild edible plants are used by the majority of the rural population, but they are still not as valued as they should (Demel Teketay *et al*., 2010). WEPs and the traditional knowledge associated with various plant resources are disappearing very fast due to a lack of proper conservation strategy and scientific documentation (Getachew Addis *et al.*, 2005). WEPs are largely overlooked in land use planning and implementation, economic development, and biodiversity preservation (Uprety *et al*., 2012).

The loss of valuable wild edible plants due to population pressure, agricultural expansion, overexploitation, charcoal production, timber production, illegal settlement, population growth, and deforestation is extensively reported in the country (Mekuanent Tebkew *et al.*, 2018). In the present study area (Dilbi, Walla, and Omoyella) wild edible plants are affected due to continued agricultural expansion, illegal settlement, timber production, and mining. As in any part of the country, there has not been any study on wild edible plants in Dedo District. Therefore, there is a need to conduct an ethnobotanical study to document wild edible plants and associated indigenous knowledge, threats, and conservation status in the District.

1.3. Objectives of the Study

1.3.1. General Objective

The general objective of the study was to assess wild edible plants and associated indigenous knowledge of the people in Dedo District, Jimma Zone, Oromia Regional State, Southwest Ethiopia.

1.3.2. Specific Objectives

The specific objectives of the study were to:

1. Identify the wild edible plant species in Dedo District.
2. Assess the multiple uses of wild edible plants in the study area.
3. Assess the existing threats and conservation practices of wild edible plants.

1.4. Research Questions

The present research is aimed to answer the following research questions.

1. What are the wild edible plant species in the study area?
2. What are the multiple uses of wild edible plants in the study area?
3. What are the threats and conservation practices of wild edible plants in the study area?

1.5. Significance of the Study

Wild plants in Ethiopia are in threat of being lost, as habits, value systems, and the natural environment change, and there is a widespread decline in knowledge about wild food plants, particularly among young generations. Also, Traditional knowledge (TK) on wild edible plants is being eroded through acculturation and the loss of plant biodiversity along with indigenous people and their cultural background, promoting research on wild edible plants is crucial to maintain this information for future societies. Therefore, this study is expected to contribute towards bridging the existing information gap concerning the diversity of wild edible plants resources available, it is present use, management, and indigenous knowledge (IK) as well as help people of the study area to be aware of problems associated with wild edible plants and give attention for the threatened wild edible plants. The findings also help as an input for research development institutions and policymakers in their planning relevant interventions and can be part of the information source for those who want to conduct further research.

1.6. Scope of the Study

Due to time and budget limitations, the study was constrained to an ethnobotanical study of wild edible plants in three *Ganda* (the smallest administration unit in Oromia) of Dedo District, Jimma Zone, Oromia Regional State, Southwest Ethiopia.

1.7. Limitation of the Study

This study was confronted with several challenges. Some of the challenges were the COVID 19 pandemic, shortage of time, financial limitations, scarcity of transportation, lack of enough information on the edibility of wild edible plants from respondents during interviews, focal group discussion, and market survey.

2. Literature Review

2.1. The concept of Ethnobotany

It is difficult to tell exactly when the term ethnobotany became part of modern science. However, it can be traced back to the time when humans started making aware of interactions with plants and animals (Amenu Endalew, 2007). The term ethnobotany was first introduced by the American botanist, John Harshberger, in 1896 as "the study of plant use by humans" (Cotton, 1997). Later, the science of ethnobotany was broadened and redefined by many ethnobotanists like Martin (1995). Nevertheless, Martin conceptualized ethnobotany as the study of how local people classify, manage, and use plants available in their surroundings. Also, others defined ethnobotany as a multidisciplinary science that is used to investigate interactions between plants and people (Getnet Chekole, 2011). According to Cotton (1996), ethnobotany encompasses all studies that concern the mutual relationships between plants and traditional people.

Ethnobotany encompasses studies concerning plants that describe the uses plant resource, the interaction of local peoples with their natural environment and other relations which exist between humans and plants (Mathewos Agize *et al*., 2013). The focus of ethnobotany is on how plants have been used, managed, and perceived in human societies, and includes plants used for food, medicinal, rituals, social life, and others. The relationship between plants and human cultures is not limited to the use of plants for food, clothing, and shelter but also includes their use for religious ceremonies, ornamentation, and health care (Khanal, 2006).

The historical dimensions of ethnobotany that were largely listings of plant names and uses play a role in contemporary approaches to traditional plant knowledge **(**Hinnawi, 2010). Most past researchers did not regard what the people thought about plants as important. Nowadays ethnobotany has been developed into the new scientific field with the appropriate methodology of documenting and studying IK on plants which then brought quantitative methods rather than a simple listing of plants (Fikiru Ayana, 2017). Ethnobotany tries to find out how people have traditionally used plants, for whatever purposes, and how they are still doing so. Thus, ethnobotany tries to preserve valuable TK for both future generations and other communities.

The results of ethnobotanical research are used as a lead in development, sustainable utilization of plant resources, and IK in particular, and conservation of biodiversity in general (Debela Hunde, 2001). Ethnobotanical studies have played a key role in revealing and promoting traditional practices that have been found useful in enhancing biodiversity and sustainable use of biological resources (Zemede Asfaw, 2004). Thus, saving plant species and documenting and preserving indigenous knowledge are the major issues to be accomplished in ethnobotany studies (Cunningham, 2001). Ethnobotany helps us in identifying conservation issues such as cases where a rate of harvest exceeds the rates of re-growth. There is an urgent need of conserving wild food plants that are over-harvested so that in the future the coming generations could benefit from the precious plants that are a real gift of nature for humankind (Qureshi *et al*., 2009). Being related with almost all branches of natural sciences, it tries to find the secret knowledge of people on plant resources, which can be the foundation of multipurpose development of the society (Aryal *et al*., 2009).

Ethnobotany not only discovers the IK of plant resources but also tries to deal with all aspects of plant conservation. However, Ethnobotanical knowledge can tell which species are most significant to people's livelihood needs and useful to planners and extension workers in management planning. Hence, with such interdisciplinary and multidisciplinary approaches, ethnobotany is aimed at gathering and documenting indigenous botanical knowledge, cultural practice, use and management of botanical resources and discovers benefits from plants (Getu Alemayehu, 2017). Generally, documenting TK based on the ethnobotany of WEPs will help in identifying species for domestication, complex production systems for its sustainable development, utilization through commercialization, and conservation (Biswakarma *et al*., 2015).

2.2. Wild food plant resources

Wild edible plants are with one or more parts that can be used for food if gathered at the appropriate stage of growth and properly prepared. Wild edible plants refer to species that are neither cultivated nor domesticated, but that are available from their wild natural habitat and used as sources of food and they provide staple food for indigenous people (Ermias Lulekal *et al.*, 2011). Wild edible plants could be weeds growing in urban areas to native plants growing in the deep wilderness (Hinnawi, 2010).

Different people in many developing countries do not have enough food to fulfill their daily requirements and many of them are deficient in one or more micronutrients. Thus, in most cases, rural communities rely on wild resources including wild edible plants to satisfy their food needs in periods of food shortage (Kebu Balemie and Fassil Kebebew, 2006). For instance, about 40,000 to 100,000 plant species have been frequently used for food, shelter, and medicines in the world. However, only a small number of plants are widely used and the remaining plant diversity is underutilized (Magbagbeola *et al*, 2010). Wild edible plants have an important role to play in poverty eradication, security of food availability, diversification of agriculture, generation of income resources, and alleviation of malnutrition (Thakur *et al*., 2017).

Wild and semi-WEPs highly promote family food security and are used as a means of survival during the season of drought, famine, and risks (Mekuanent Tebkew, 2015). Consumption of WEPs is an important local survival strategy, made necessary by climatic fluctuations that hamper agricultural efforts (Gemedo Dalle *et al.,* 2005). Despite agricultural the fact that societies primarily rely on crop plants, the tradition of eating wild plants has not completely disappeared, their nutritional role and health benefits being reported in many surveys worldwide (Pardo *et al*., 2007). More than 70% of the WEPs were consumed during times of food scarcity and starvation from where the stored cultivated food crops are declining progressively (Tilahun Teklehaymanot and Mirutse Giday, 2010). On the other hand, Getachew Addis *et al*. (2005) stated that wild plants in Ethiopia are used as a source of food.

For many peoples, including indigenous groups, the contribution of WEPs goes beyond nourishment (Pilgrim and Pretty, 2010). In countries such as China, India, Thailand, and Bangladesh, hundreds of WEPs are still consumed along with non-cultivated species (Termote *et al.*, 2011). In addition to their contribution to food security, many WEPs such as *Adansonia digitata, Balanites aegyptiaca, Cordia africana, Ximenia americana, Ficus spp, Carissa spinarum,* and *Rosa abyssinica* are acknowledged for their medicinal, cultural, forage, and economic values (Demel Teketay and Abeje Eshete, 2004). Ethnobotanical studies conducted in Ethiopia have indicated that over 300 species of wild food plants are gathered and consumed by the people (Gemedo Dalle *et al.,* 2005). The available information on the WEPs and their contribution to climate change adaptation were poorly documented in Ethiopia (Debela Hunde *et al*., 2011).

2.2.1. Features of wild edible plants

The main features of wild edible plants are as follows: They are locally accessible and their utilization is based on traditional ecological knowledge (Arenas and Scarpa, 2007); they are low-input, low-cost option for increasing nutrition and reducing the need to spend limited cash resources (Jama *et al.,* 2008); they provide greater benefits to easily affected populations; for instance, poorer households, women, and children, who are frequently excessively affected by climate events (Eriksen and Brien, 2007); they contribute to livelihoods and available during times of conflict-driven famine (Strauch *et al*., 2008); they tolerate water stress better than their domesticated relatives (Getachew Addis *et al*., 2005) and possessing an "innate resilience to rapid climate change, which is often lacking in exotic species" (Fentahun Mengistu and Hager Herber, 2009).

2.2.2. Diversity and habitat distribution of wild edible plants

From different plants that can be used as a source of food, some are grown in the forest and others are cultivated (Bharucha and Pretty, 2010). However, wild edible plants with high diversity are widely distributed in forests, mountain slopes forest, wooded grasslands, riverine environments, and farmland or abandoned fields and they are adapted to the local surroundings (Kebu Balemie and Fassil Kebebew, 2006). These enabled them to grow easily with few inputs and can be integrated into sustainable farming systems (Abraham Demekristos, 2016). The habitat distribution of the surveyed wild edible plants was found diverse ranging from low to high land (1250 to 2300 m.a.s.l.). The majority of wild edible plants are available from forest habitat as well as they are distributed within the altitude range of 1500 to 2400 m.a.s.l. (Demel Teketay and Abeje Eshete, 2004).

2.2.3. Role of wild edible plants in fighting food security

Food security refers to the availability of food one`s access to it and it exists when all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for active and healthy life (FAO, 2011). The world is depending on plant source foods which are not enough in balancing food security. The food situation is a major problem in most developing countries due to the rapid growth of population, shortage of land for cultivation, high prices of available staples, and restrictions on the importation of food. However, this has resulted in a high occurrence of starvation and peoples

are suffering from malnutrition. Therefore, poor people regularly collect WEPs for food and other plants from natural habitats to meet their survival needs (Tapan and Kausik, 2016). In West African countries, WEPs play a fundamental role in the survival of populations and fight against hunger during war and droughts (Gauze, 2016). WEPs are relevant to household food security and dietary diversification in some rural areas, particularly in the drylands, to supplement the staple food, to fill the gap of seasonal food scarcities, and an emergency food during the famine, prolonged drought, or social unrest (Guinand, Y. and Dechassa Lemessa, 2000).

WEPs are important for achieving nutritional balance in the diet and are particularly important for ensuring food security for women, children, and the poor, who heavily depend on them (Demel Teketay *et al*., 2010). Among others, underutilized WEPs are considered a potential alternative for achieving nutritional security (Chivandi *et al*., 2015). Moreover, utilization of WEPs as a food source is an integral part of the culture of indigenous people that dwell in the rain forests of Africa and South America who gather and consume as snacks and at times of food-scarcity (Getachew Addis, 2009; Tilahun Teklehaymanot and Mirutse Giday, 2010; Assegid Assefa and Tesfaye Abebe, 2011; Ermias Lulekal *et al*., 2011). More than 35% of Ethiopian people are food insecure and the country's ever-increasing population along with recurrent drought, war, and poor agricultural practices with low productivity, have pulled the country into a vicious circle of food insecurity (FAO, 2010). Over-dependence on a limited number of food sources and poor efforts to diversify dietary sources aggravate the country's food insecurity problem.

In most parts of Ethiopia, wild edibles form integral parts of the feeding habits of many communities (Kebu Balemie and Fassil Kebebew, 2006). However, consumption of wild edibles is more common in food insecure areas than in other areas in the country (Tilahun Teklehaymanot and Mirutse Giday, 2010). On the other hand, many WEPs were reported as an emergency, supplementary, or seasonal food sources to prevent food-insecurity in rural communities (Getachew Addis, 2005); for instance, the invasive *Opuntia ficus-indica* (L.) *Miller* (Cactaceae) was found to be widely exploited for its fruit in many parts of the countries and playing a significant role in food source diversification. Belem *et al*. (2017) showed that one of the ways to combat food insecurity could be the use of forest food plants that may contribute to food self-sufficiency. The increase and diversification of livelihood outcomes contribute a great

role in maintaining food security. Generally, diversifying food sources through the use of ecologically adapted crops, including selected recruits from among the WEPs, would contribute to the fight against food insecurity and malnutrition.

2.2.4. Nutritional value of wild edible plants

Leaves, stems, fruits, flowers, tubers, barks, seeds, roots, and lots of WEPs are still consumed for their nutritional value in many communities around the globe and some of these WEPs are used as primary food sources while others are used as secondary condiments in freshly prepared from domesticated cultivars (Lockeett *et al*., 2000). Multiple compositional and nutritional WEPs indicate that in many cases, the nutritional quality of WEPs is comparable and, in some cases, even higher than domesticated varieties (Ermias Lulekal *et al.,* 2011). WEPs can play an important role in establishing better livelihoods by providing an improved diet in terms of nutritional value and in supplementing staple foods with micronutrients and represent nutrition quality for both the rural and urban population in sub-Saharan Africa (Archarya and Archarya, 2009).

The information available from the nutritional analysis of WEPs shows its potential contribution to nutritional diversity and food security. On the other hand, it has been reported that WEPs are the cheapest source of vitamin A, C, minerals, and fiber; still, people fail to consume enough to meet their nutrient requirement due to a lack of knowledge in the nutritional value and production of those vegetables in the easiest way (Dandena Gelmesa, 2010). But, sometimes the nutritional value of traditional wild plants is higher than several known common vegetables and fruits (Orech *et al.,* 2007). The nutritional value of wild edible plants is comparatively less explored but considered as a potential contribution to nutritional diversity and food security of rural communities all over the world (Ogle *et al*., 2003).

In Ethiopia reported to have nutritional and commercial properties that are valued in other countries; for example, (*Adansonia digitata* L., *Tamarindus indica* L., and *Ziziphus mauritiana* Lam.) are found to be underutilized in the country. WEPs are found contributing useful amounts of essential nutrients, including amino acids, fatty acids, and trace minerals to human diets. According to many sources, the amounts of vitamins, minerals, and other nutrients in wild food is on the average greater in wild foods (Hinnawi, 2010). Research supports that some of these foods, as part of an overall healthful diet, have the potential to delay the onset of many age-

related diseases (Khanal, 2006). The present studies noted that about 8% of the nearly 7000 higher plants of Ethiopia serve as a food supplement and of these, 203 wild and semi-wild plant species are documented (Kebu Balemie and Fassil Kebebew, 2006).

2.2.5. Multipurpose values of wild edible plants

Wild edible plants have several indirect benefits such as sources of genetic diversity; encourages agroforestry practice in dryland areas; habitat for different organisms; rehabilitation of degraded lands; soil and water conservation as well as mitigation and adaptation to climate change (Demel Teketay *et al*., 2010). As stated by Samant and Dhar (2018) there are several species of WEPs, which provide multiple benefits and have traditional usage in the region of India, and such species of WEPs are termed as multipurpose plants. Among multipurpose species, some species are used as fodder, medicinal, timber, firewood, construction, farm tools, fences, cash income, furniture (Misganaw Meragiaw *et al*., 2016).

WEPs provide staple and supplement foods, as well as cash income to local communities, thus favoring food security (Sansanelli and Tassoni, 2014). Tena Regassa *et al*. (2014) and Kassa (2017) observed that multipurpose WEPs species for medicinal, food, drink, firewood, charcoal, shade, construction and tools, commercial value, animal feed/fodder, bee forage, culture and rituals, ornamental, life fence construction materials, household furniture, farm implements, and fuelwood purposes were found in Chelia District and Sheka zone. Even though there are no global estimates of the economic value of wild foods, there is no doubt that their use and trade become important during economic hardship (Bharucha and Pretty, 2010).

2.2.6. Documentation of indigenous knowledge of wild edible plants

Documenting indigenous knowledge through an ethnobiological approach is important for species conservation and sustainable resource use (Uprety *et al*., 2012). Indigenous knowledge refers to the accumulation of knowledge, rules, standards, skills, and mental sets, which are possessed by local people in a particular area and it is the result of many generations' long years' experiences, careful observations, and trial and error experiments (Martin, 1995). Knowledge about wild plants is important to enhance the utilization and conservation of diversity.

People in rural areas of Ethiopia, particularly elders and other knowledgeable community members have a deep and time-tested indigenous knowledge concerning the availability,

management, and use of wild edible plants (IBC, 2005). Kebu Balemie and Fassil Kebebew (2006) reported that elder community members are the reservoirs of wild plants use in southern Ethiopia by songs, riddles, and indirect ways of conveying knowledge. Shrestha and Dhillion (2006) found a greater knowledge about food plants in women than men where elder women were the most knowledgeable compared to young men in describing WEPs use. Local knowledge, known variously as folk is people's main form of knowledge that for most of human history has been adapted to the local environment and based on experience and empirical testing (Reyes *et al.,* 2005). The gathering and use of wild plants are part of the cultural history of a community; hence they form part of the people's local identity and traditions (Kayode and Akinluyi, 2016).

The use of wild edible plants in the life of rural and indigenous people is not only in terms of food, income, or farm inputs but also in terms of social, cultural, and religious purposes as in sacred groves (Pala *et al*., 2013). Ethnobiological knowledge and practice within any culture vary by geographical origin, residence, ethnicity, religion, occupation, educational background, social status and relations, income class, age, and gender (Pfeiffer and Butz, 2005). In spite of some hints to their current contribution to the food security of rural people, wild edible plant resources, culture, traditions, and indigenous knowledge associated with the plants, still lacks adequate attention by development policies in Ethiopia (Gemedo Dalle *et al*., 2005).

2.2.7. Factors threatening wild edible plants

People use many wild species of plants for food, medicine, clothing, shelter, fuel, fiber, income generation, and for fulfilling cultural and spiritual needs throughout the world (Zemede Asfaw and Mesfin Tadesse, 2001). These practices adversely affect wild edible plants in the country and lead to the reduction of biodiversity conservation. The main sources of threats to plants are manmade and nature cause factors; for example, natural causes include recurrent drought, bush fire, disease, and pest outbreaks that affect these plants (Kebu Balemie and Fassil Kebebew, 2006).

A rapid increase in population, the need for fuel, and construction of roads, urbanization, timber production, over-harvesting, destructive harvesting, illegal settlement, invasive species, commercialization, degradation, forest clearance for agricultural activities, and habitat devastation are human-caused threats to wild edible plants (Haile Tesfaye, 2020). Also, in

Nigeria, deforestation has caused a severe reduction in the population of wild plant species (Kayode and Akinluyi, 2016). The continuity of knowledge on the utilization of wild edible plant species has also faced problems because of changes in the feeding culture of the people (Tilahun Teklehaymanot and Mirutse Giday, 2010). Therefore, several combined factors mentioned earlier have resulted in the loss of wild edible plant species which calls for urgent measures to be taken to rehabilitate and conserve the remaining vegetation in general and wild plants in particular with their associated indigenous knowledge.

2.2.8. Conservations of wild edible plants

Conservation of wild edible plants are in the natural forest, in agroforestry system, along roadsides and degraded areas, near the home garden as living fences, trees around homesteads, schools, in- situ (in original/natural habitat/park) or field gene banks, botanic gardens/ex-situ conservation methods and protected pasture land in different worship areas (churches, mosques) and in their farm field/farm margins and protection from fire and regulation of cutting (Debela Hunde *et al*., 2012). Effective sustainable management of the 58 National Forest Priority Areas of the country will play a major role in conserving a great number of wild edible plants that cannot be economically cultivated, require very specific habitats, and are exceptionally difficult to reproduce in nurseries and the bulk of plant matter used for wild food purposes is collected from natural vegetation (Melakeselam Dagnachew, 2001).

As time goes by, the widely occurring wild edible plant species and the associated traditional knowledge are being eroded. Also, many wild edible species are endangered due to genetic erosion (IBC, 2005). These phenomena are more pronounced in countries like Ethiopia where a high rate of human population growth is compounded by insufficient documentation and conservation of biota, which can safeguard promising plant taxa (Zemede Asfaw and Mesfin Tadesse, 2001). In general, the reported research outputs on the WEPs of the country indicate the need for conservation as well as documentation (Getachew Addis, 2009).

2.2.9. Status of wild edible plants in Ethiopia

Concerning the studies and documented ethnobotanical information on wild edible plants of Ethiopia is very limited and fragmentary. Accordingly, Getachew Addis *et al*. (2005) identified 138 wild edible plants used by indigenous people in Alamata, Cheha, Goma, Yilmana, Densa

Districts of Tigray. Kebu Balemie and Fassil Kebebew (2006) documented 66 wild edible plants from Derashe and Kucha districts. Getachew Addis (2009) identified 137 WEPs in Hamar and Konso Districts. Fentahun Mengistu and Hager Herber (2008) documented 46 species of wild edible plants in Addi Arkay, Debark, and Dejen Districts. Tilahun Teklehaymanot and Mirutse Giday (2010) identified 38 wild edible plants as a food source from Kara and Kewego people of the South Omo zone in Kuraz and Hamar Districts. Debela Hunde *et al*. (2011) documented 37 wild edible plants for food and other multipurpose uses in Fantalle and Boosat Districts, East Shewa Zone of Oromia Regional State. Tariku Berihun and Eyayu Molla (2017) identified a total of 77 wild edible plants belonging to 61 genera and 39 families in Bullen District, Northwest Ethiopia. Assegid Assefa and Tesfaye Abebe (2011) documented a total of 30 wild edible trees and shrubs, belonging to 25 genera and 19 families in the semi-arid lowlands of Southern Ethiopia. Fekere Fugaro and Melese Maryo (2018) identified 41 wild edible plants in Kedida Gamella Woreda, Kembata Tembaro Zone of Southern Nations, Nationalities, and Peoples Regional State. Zewdie Kassa (2017) identified 35 wild edible plants belonging to 32 genera and 24 families in Sheka Zone, Southern Nations, Nationalities, and Peoples Regional State. An Ethnobotanical study by Tena Regassa (2016) documented 71 wild edible plants in Jibat, Chelia, and Dendi Districts, West Shewa Zone of Oromia Regional State. Zemede Asfaw and Mesfin Tadesse (2001) identified 203 WEPs in Ethiopia. Abraham Demekristos (2016) documented a total of 23 wild edible plants in the Amhara Regional State of Ethiopia. Tena Regassa *et al.* (2014) documented 58 wild and semi-wild edible plant species classified into 48 genera and 30 botanical families in Chelia District, West-Central Ethiopia. Ermias Lulekal *et al*. (2011) compiled 413 wild edible plants in the country belonging to 224 genera and 77 families. Getu Alemayehu (2017) documented a total of 80 wild edible plants in Amaro District of Southern Nations, Nationalities, and Peoples Regional State and Gelana District of Oromia Region, Southern Ethiopia, and these plants were distributed in 52 genera and 32 families. Tigist *et al*. (2006) documented 41 wild edible plant species in Dheera town, Arsi Zone of Oromia region. Getu *et al.* (2015) identified 53 wild edible plants belonging to 38 genera and 30 families in Berehet District, North Shewa Zone of Amhara Region. Atinafu Kebede *et al*. (2017) reported 22 wild edible plants in Kefira Market, Dire Dawa City, Eastern Ethiopia. Getnet Chekole (2011) collected a total of 33 wild edible plant species distributed in 30 genera and 25 families in Libo Kemkem Wereda, South Gonder Zone, Amhara Region, Ethiopia. Fekere and Melese (2018)

documented 41 wild edible plant species belong to 27 genera and 35 families in Kedida Gamella Woreda, Kambata Tembaro Zone, Southern Nations, Nationalities and Peoples of Regional State, Ethiopia. Dessalegn Ayele (2017) collected a total of 60 wild edible plant species belonging to 35 families and 49 genera in Kamash Woreda, Benishangul Gumuz Regional State, Ethiopia. Baressa Anbessa (2016) recorded 29 wild edible plant species belong to 27 genera and 22 families in Bule Hora Woreda, Southern Ethiopia. Getu Alemayehu *et al*. (2015) documented 143 wild edible plant species belonging to 113 genera and 60 families in Berehet District, North Shewa Zone of Amhara Region, Ethiopia. Mersha Ashagre *et al*. (2016) documented a total of 46 wild edible plant species belonging to 37 genera and 29 families in Burji District, Segan Area Zone of Southern Nations, Nationalities and Peoples Region, Ethiopia. Mekuanent Tebkew *et al*. (2018) identified a total of 36 wild edible plants in Quara District, Northwest Ethiopia. Demel Teketay *et al*. (2010) documented a total of 378 wild edible plants of Ethiopia which only 262 species under specific locality information and 116 species with no locality information. However, the investigation seems to emphasize only commonly known and widely accessible plants most of which occur in the central and highland regions of Ethiopia. Guinand and Dechassa (2000) and in Afar Region by Dandena Gelmesa (2010) presented that strong traditions, beliefs, and religious taboos still limit people's psychological and mental willingness to domesticate and cultivate wild food plants. Information on WEPs of Ethiopia is scattered in botanical monographs, glossaries, and informal notes as well as in the rich oral tradition of different communities (Zemede Asfaw and Mesfin Tadesse, 2001). As a result, the indigenous knowledge practice, and skill-related to wild edible plants is highly developed, but it is poorly investigated and documented.

3. Materials and Methods

3.1. Description of the study area

The study was conducted in Dedo District, Jimma Zone, Oromia Regional State, Southwest Ethiopia from October 2019 to June 2020. The geographic location of the district is between 7º13'N to 7º39'N latitude and 36º43'E to 37º12'E longitude (Figure 1). The capital of the district is Sheki town and 360km Southwest of Finfinne/Addis Ababa and 20km South of Jimma town on the way to Dawuro-Chida District of Southern Nations, Nationalities and Peoples Region (SNNPR). Dedo District shares boundaries to the East by Mancho District, to the West by Seqa Chokorsa District, to the North by Qarsa District, and the South by SNNPRS (DAO, 2019).

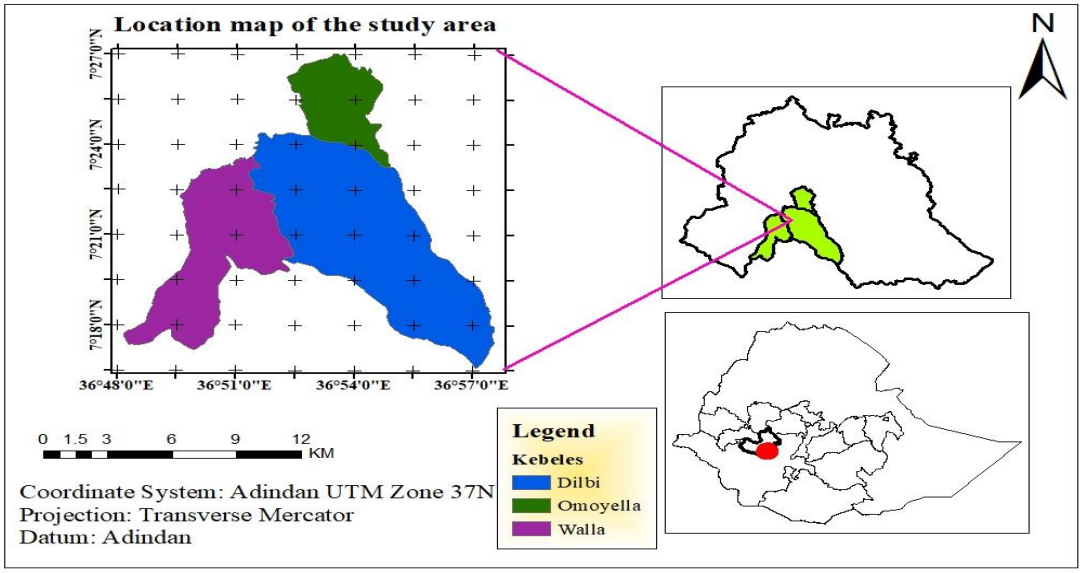

Figure 1: Map of the study area showing Ethiopian Regions, Jimma Zone, and Dedo District

3.1.1. Population of the study area

According to the Dedo Health Office (DHO, 2019), the population of the study area was 23,343. Of these, 11,648 were male-headed and 11,695 were female-headed households. The study area is also the densely populated areas with 1,571 people per square kilometer. Based on the DHO (2019) information, there are different ethnic groups living in the study area. These are Oromo (81.40%), Dawuro (11.07%), Amhara (4.07%), and Kafficho (3.46%). The major ethnic group is Oromo followed by Dawuro, who are the main indigenous people, and the working language is Afan Oromo.

3.1.2. Rainfall and temperature distribution

The climate data of the study area was obtained from the National Metrological Agency (NMA) Jimma station. The maximum mean annual temperature over ten years (2010-2019) was 25.4°C, while the minimum temperature was 12.4°C respectively (Figure. 2). The maximum and minimum mean annual precipitation of the study area during the last ten years (2010-2019) was 4.44 and 0.7mm recorded in June and January respectively. The study area receives unimodal rainfall, where the dry season is in months from October to February, whereas the wet season rainfall is in months from May to September. The study area is locally characterized by three agro-climatic zones; 40% Woina Dega (highlands), 55% Dega (midlands), and 5% Kola (lowlands).

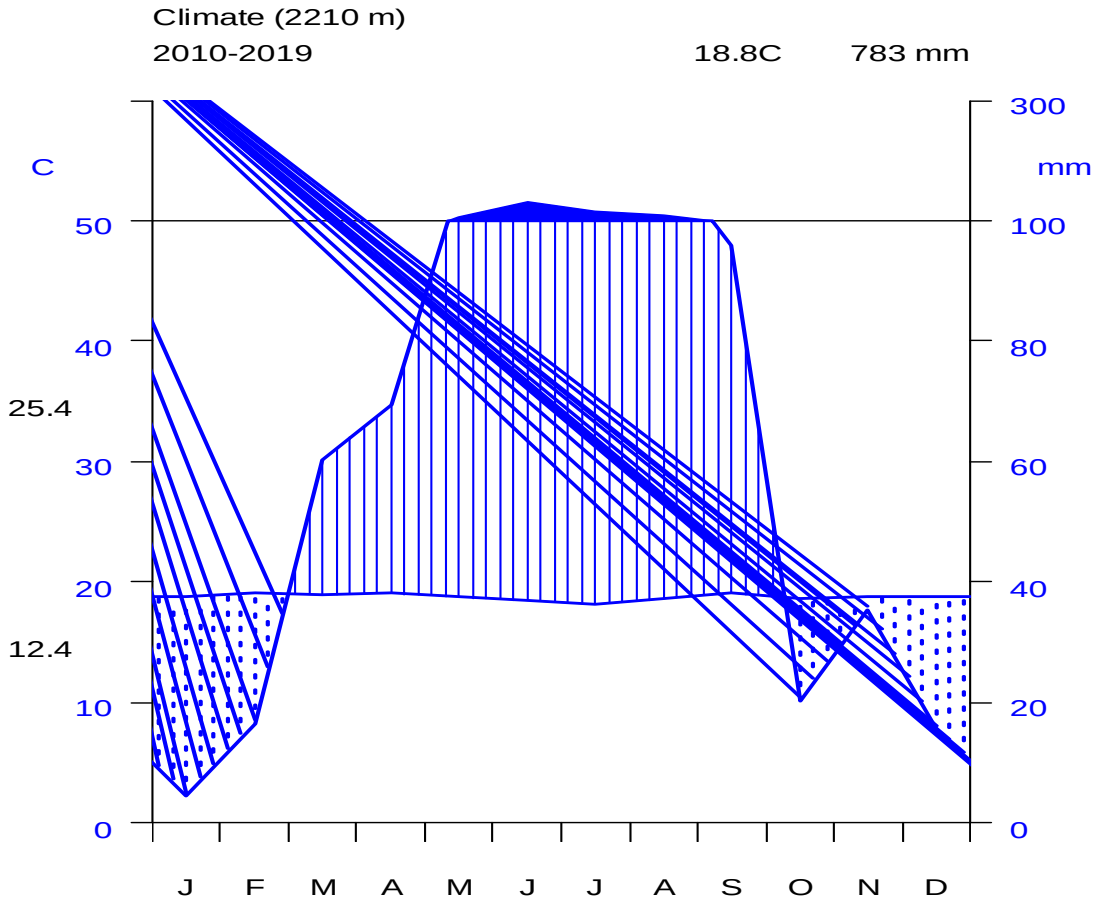

Figure 2: Diagram showing rainfall distribution and temperature variation in the study area 2010-2019. Source: NMA (2019)

3.1.3. Livelihood of the people

The study area has 6666 cattle, 4056 sheep, 2954 goats, 2433 poultry, 903 mules, 937 horses, and 2643 donkeys (DAO, 2019). Animals are kept as a source of milk, meat, and cash as well as cow dung is an important source of fuel in the study site. Farming practices are characterized by the crop-livestock mixed system, where cereal grains take the major food crops cultivated followed by khat and coffee as major cash crops of the study area. Also, teff (*Eragrostis tef*, maize (*Zea mays*), and vegetables are important cash crops in the study site (DAO, 2019).

3.1.4. Land use system

According to DAO (2019), 43.98% of the land in the study area is arable while 38.81% is otherwise unusable lands (Table 1).

Table 1: Land use pattern of Dedo District

S/N	Land use type	Area in hectare	Percentage (%)
1	Arable	36366	43.98
2	Pasture	6276	7.59
3	Forest	3500	4.23
4	Swampy	234	0.28
5	Coffee plantation	4218	5.10
6	Others	32086	38.81
	Total	82680	100

Source: DAO (2019)

3.1.5. Vegetation of the study area

Vegetation types of the study areas lie in moist evergreen Afromontane forests in Southwest Ethiopia. The common plant species in the study area are *Cordia africana* Lam., *Calpurnia aurea* (Alti) Benth., *Acacia spp., Ocimum spp., Ficus spp., Carissa spinarum* L., and *Podocarpus falcatus* (Thunb.) R.B. ex Mirb. The vegetation of the area is extremely influenced by expanded overexploitation for charcoal production and clearing forests for settlement and agricultural land expansion. Some of the woody and grass species such as *Acacia nilotica* (L.) Willd. ex Del., *Acacia senegal* (L.) Willd., *Acacia tortilis* (Forssk.) Hayne and *Cordia sinensis*

Lam. are the most influenced and young seedlings were not usually recorded from the study area (DAO, 2019).

3.2. Materials used

Plastic bags, scissors, permanent markers, plant press, straps, cardboards, blotters, newspapers, and field notebooks as well as pre-printed collection formants such as printed checklists of semi-structured questions for interviews and the photographic camera.

3.3. Reconnaissance survey and site selection

A reconnaissance survey was conducted from February 12 - 20, 2020 to have a general overview of the district vegetation and to select representative *Ganda*. Dedo District has a total of thirty-six *Ganda;* where three *Ganda* are urban and thirty-three are rural G*anda* (DAO, 2019). Based on the vegetation coverage of the study area and information obtained from the elders, local authorities, and District Agricultural Development Office as well as observation made during the reconnaissance survey, three study sites were selected purposely by considering the availability of more vegetation in the area. These study sites were; Omoyella, Walla, and Dilbi *Ganda.*

3.4. Sample size determination and sampling techniques

A purposive sampling method was conducted to select three *Ganda* from the District, based on the existing vegetation, but also informants were chosen stratified. The sample size was determined using Yamane's Taro (1967) formula (considering a confidence level of 95% and accepting the margin error of 5%). The total number of households of the three *Ganda* was 2474. Applying the formula (Yamane's Taro, 1967), the sample size for the three *Ganda* was 344 respondents (180 males and 164 females). The sample size population of each *Ganda* was determined proportionally based on the total number of their households (Table 2). Ten key informants (7 males and 3 females) were selected stratified from the sample population.

$$n = \frac{N}{1 + N\left(e^2\right)}$$

Where: **n** = sample size; **N** = Population; **e** = Margin error (5%).

The sample size at each *Ganda* levels was calculated by using the following formula:

$$ni = \frac{Ni \times n}{N}$$

Where: **ni** = sample size to be determined; **Ni** = number of households in a community; **n** = sample size and; **N** = total number of households selected.

Table 2: Name of selected *Ganda* with the number of households each *Ganda*

District	Name of *Ganda*	Households	Sample size
	Walla	650	79
Dedo	Dilbi	1274	175
	Omoyella	567	90
	Total	2474	344

3.5. Methods of data collection

Ethnobotanical data were collected from March -April 2020, based on the standard data collection methods (Martin, 1995; Cotton, 1996) to obtain IK of the local community on wild edible plant uses, threats, and conservations. The tools employed for ethnobotanical data collection were semi-structured interviews, guided field walk, focus group discussions, and market surveys. Informants and key informants were interviewed based on a checklist of questionnaires and a semi-structured interview related to the use of wild edible plants in the study area (Appendix 1). Semi-structured interview questions were prepared in English and translated into the Afan Oromo language. Interviews were conducted with informants in their local language (Afan Oromo). Different age, sex, religion, occupation, educational level of the respondents, and knowledgeable elders were interviewed (Appendix 2).

Focus group discussions were made at each *Gandas* (Omoyella, Dilbi, and Walla) once time with informants and key informants. The groups containing of five to six local people in three selected *Ganda*. The key participants were elders and youngsters. The focus group discussions were conducted on threats to wild edible plants, conservation of the wild edible plants, and how the knowledge of wild edible plants use is transferred from elders to the next generations in the study area. Field walk observations were performed with the help of local guides and the status, local names, habit, and habitat characteristics of the wild edible plants were recorded on the study

sites. Based on the ethnobotanical information obtained from respondents, sample specimens were collected during a guided field walk with their local names, parts used, mode of consumption, growth habits, habitat, and numbered, pressed, and dried for identification. The identification was done mainly referring to Flora of Ethiopia and Eritrea and comparison with the already identified specimen used in the Jimma University Herbarium. Finally, a voucher for the identified wild edible plant specimens was stored in the Jimma University Herbarium.

3.6. Data analysis

The collected Ethnobotanical data were entered into Microsoft Excel spreadsheets 2010 and analyzed using preference ranking, direct matrix ranking, and paired comparison ranking. It was employed to estimate frequencies of wild edible plant use, percentage of growth forms, parts used, habit, and habitat.

3.6.1. Preference ranking

Preference ranking was conducted following Martin (1995) and five important wild edible plants used by local communities. Eight randomly selected informants were participated, to identify the best preferred wild edible plants. The informants were given five wild edible plants and asked to arrange them based on their preference by assigning the highest value (5) for plant species most preferred and the lowest value (1) for the least preferred plant. Finally, the values were summed and the overall ranking of each wild edible plants were done.

3.6.2. Direct matrix ranking

Direct matrix ranking was employed following Martin`s (1995) and Cotton (1996) suggestions. Five multipurpose wild edible plants that have the highest use-value were selected based on data collected from the society and five use attributes of wild edible plants were identified which include food, medicinal, construction, firewood, and timber. Also, five key informants were selected by a random sampling method and told to give values to each wild edible plant based on the listed attribute. Each chosen key informants were asked to assign use values (5 = best, 4 = very good, 3 = good, 2 = less used, 1 = least used and 0 = not used). Finally, the values of each species were added and ranked.

3.6.3. Paired comparison ranking

In paired comparison, eight informants and five wild edible plants were selected and asked to choose the best wild edible plants from every pair. The total number of possible pairs (10) was obtained by applying the formula **n (n-1)/2**, where **n** is the number of wild edible plants being compared. A list of the pairs of selected wild edible plants with all possible combinations was made, sequenced and the order within each pair was randomized before every pair is presented to selected informants and their responses recorded as well as total value summarized and the rank was made based on the report of the informants.

3.7. Ethical considerations

Permission was first obtained from Dedo District and *Ganda* administrative offices to carry out the study by showing official letter support written from Jimma University, Department of Biology, and presenting the objectives of the study. During data gathering, an effort was orally made to inspire the respondents in such a way that their teamwork is a great advantage to the country. Moreover, informed consent was obtained from the informants to confirm their willingness.

4. Results

4.1. Taxonomy diversity of wild edible plants

A total of 30 wild edible plant species belonging to 26 genera and 21 families were identified and recorded in the present study area (Appendix 3). Of these, (19 species, 63.33%) were used as wild food plants and the rest (11 species, 36.67%) were nutraceutical wild plant species in the study area. The families Moraceae and Myrtaceae were relatively the most frequent species with four and three species in each followed by Boraginaceae, Rutaceae, Solanaceae, Sapotaceae, and Oleaceae were represented by two species each. The remaining families were however represented only by one species each.

4.2. Indigenous knowledge transfer and practices

The indigenous knowledge associated with edibility and practices on WEPs species were transferred directly and indirectly to the next generation (Getachew Addis, 2009). The majority (73.8%) of respondents showed that the knowledge of wild food plants was acquired through observation, oral history, imitation, free flow of information among community members, storytelling, and myths. This result agrees with the report of Mulugeta Kebebew and Gemechu Leta (2016) on Nech Sar National Park.

4.3. Main collectors and consumers of wild edible plants

WEPs are collected by children, women, or men in the study area. On the other hand, wild edible plants are consumed by all household members regardless of age and gender (Table 3).

Table 3: Main collectors and consumers of WEPs in the study area

Respondents	Collector		Consumer	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Women	106	30.81	71	20.64
Men	104	30.23	73	21.22
Children	134	38.95	99	28.78
All household members	-	-	101	29.36
Total	344	100	344	100

4.4. Habitat of wild edible plants

Of the total collected and recorded wild edible plants (15 species, 50%) were in the forest, and (1 species, 3.33%) was collected from the farmland (Figure 3).

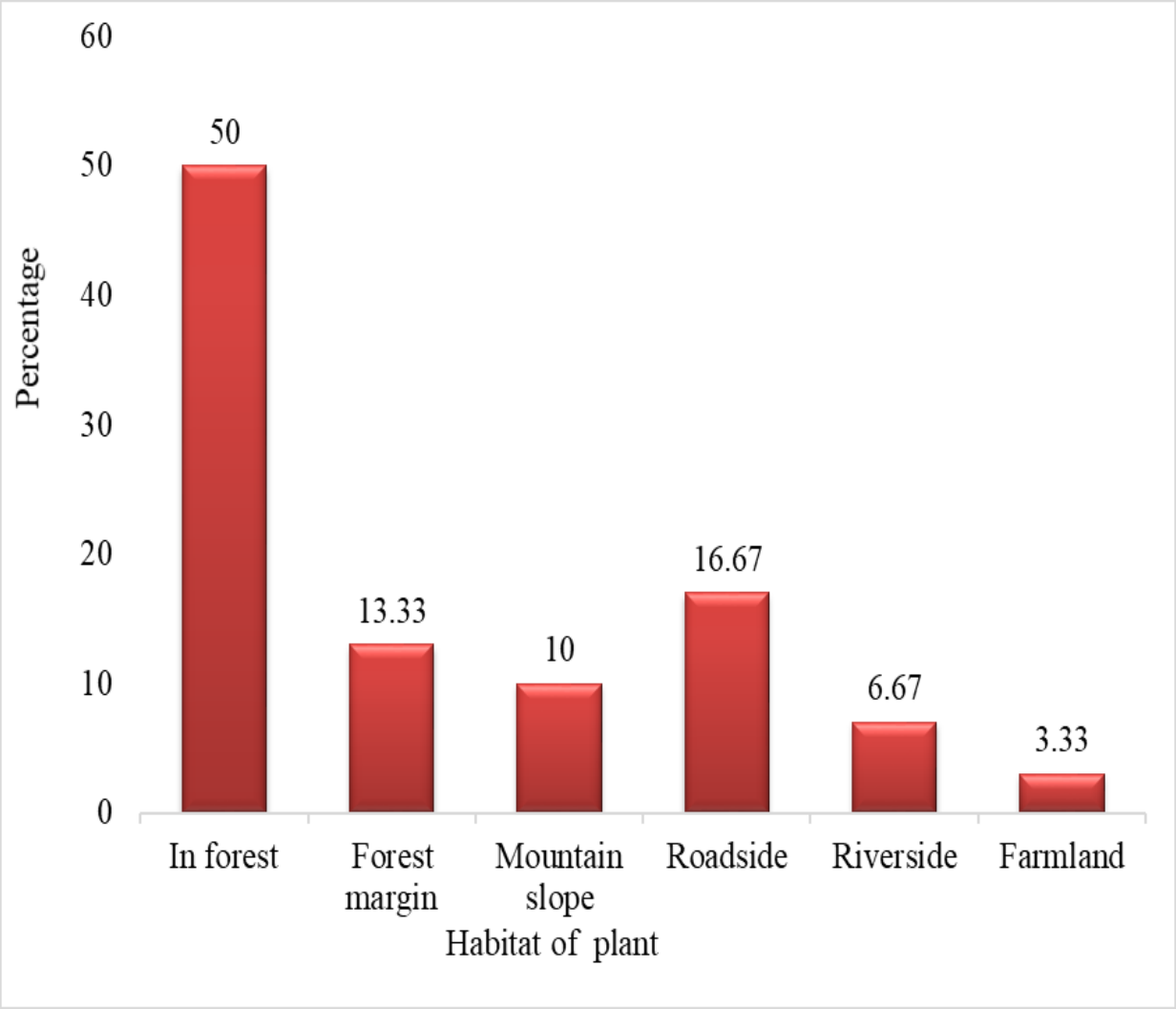

Figure 3: Habitat of wild edible plant species in the study area

4.5. Habit of wild edible plants

Trees were the highest growth forms (16 species, 53.33%), while (1 species, 3.33%) lianas/climber was the least in bearing the WEPs in the study area (Figure 4).

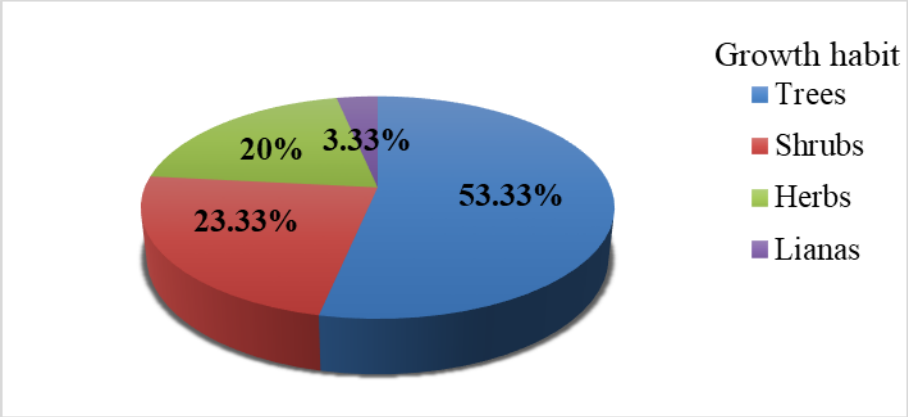

Figure 4: Growth forms of wild edible plants in the study area

4.6. Mode of consumption of wild edible plants

Most of the WEPs species (29 species, 96.67%) were consumed raw, while (1 species, 3.33%) were cooked before consumption by the local communities.

4.7. Edible plant parts

The most widely used plant parts as food sources belong to fruits (24 species, 80%), whereas the least used parts were represented by (1 species, 3.33%) each (Figure 5).

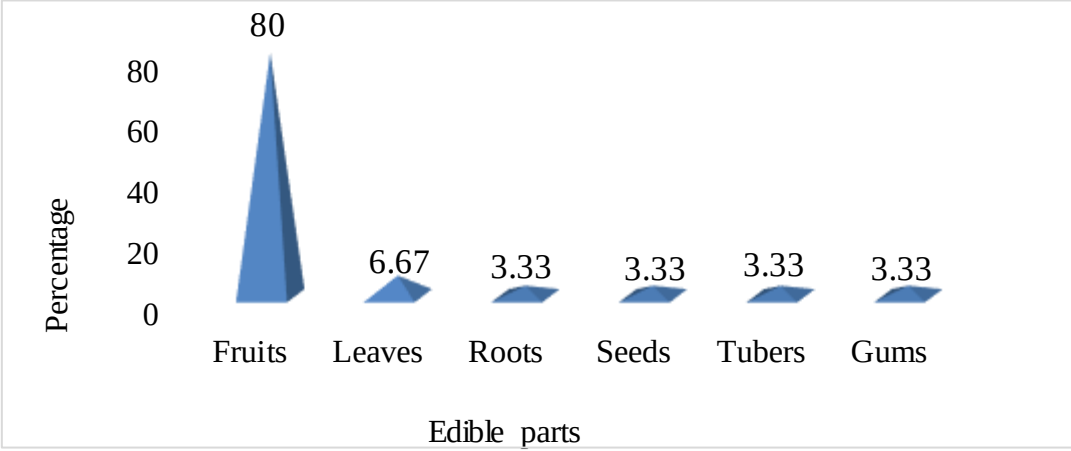

Figure 5: Edible parts of wild edible plants used as food in the study area

4.8. Wild edible plants contribution to food security

Most of the indigenous people of the area consume the wild edible plants as famine foods or foods in the condition of starvation and to fill the gap of seasonal food shortage. According to respondents, 49% of the WEPs species are used during the famine, 20% of the species during the shortage of food, and 31% of the species during climate fluctuations.

4.9. Wild edible plants used as traditional medicine

Out of the total wild edible plants collected (11 species, 36.67%) were reported as sources of food and traditional medicine (Table 4). *Aframomum corrorima, Myrica salicifolia, Piper capensis,* and *Vepris dainellii* were the most commonly used nutraceutical plants as abdominal pain as well as wild edible plants reported by local people.

Table 4: Traditional use of WEPs as medicinal plants in the study area (H = herb, Sh = Shrub, T=Tree)

S. N	Wild edible plants	Habit	Part used	Disease treated
1	*Aframomum corrorima* (Braun). Jansen	H	Fruit	Abdominal pain
2	*Carissa spinarum* L.	Sh	Fruit	Evil eye
3	*Clausena anisata* (Willd.) Benth.	Sh	Leaf	Fibril illness
4	*Flacourtia indica* (Burm.f.) Merr.	Sh	Root	Gland pain
5	*Lepidotrichilia volkensii* (Giirke) Leroy	T	Fruit	Asthma
6	*Myrica salicifolia* A. Rich.	T	Leaf	Abdominal pain
7	*Piper capensis* L.F.	H	Fruit	Abdominal pain
8	*Rhamnus staddo* A. Rich	Sh	Root	Gland pain
9	*Rubus steudneri* Schweinf.	Sh	Fruit	Doziness
10	*Syzygium guineense* (Willd.) DC. subsp. *afromontanum* F. White	T	Leaf	Toothache
11	*Vepris dainellii* (Pichi-Serm.) Kokwaro	T	Fruit	Abdominal pain

4.10. Importance of WEPs used by the local people

4.10.1. Preference ranking of WEPs by respondents

The five most popular WEPs were selected and ranked, based on their taste quality and utilization by the indigenous peoples of the area. The most preferred species was *Manilkara butugi*, while the least was *Vepris dainellii* (Table 5).

Table 5: Preference ranking of wild edible plant species based on their taste quality (5 = most preferred, 1 = least preferred)

WEPs	Respondents (A-H)									
	A	B	*C*	D	E	F	G	H	Total	Rank
Syzygium guineense (Willd.) DC. *subsp. Guineense*	5	5	5	5	2	4	4	4	34	2nd
Manilkara butugi	4	4	4	5	5	5	5	5	37	1st
Syzygium guineense (Willd.) DC. subsp. *afromontanum*	3	2	3	4	3	1	2	2	20	3rd
Vepris dainellii	2	3	1	1	2	2	1	1	13	5th
Rubus steudneri	1	1	2	2	1	3	3	3	16	4th

4.10.2. Multipurpose use of wild edible plants

Among the five WEPs mentioned by the informants, *Syzygium guineense* (Willd.) DC. *subsp. afromontanum* and *Cordia africana* were ranked 1st and 2nd in terms of their multipurpose use value (Table 6).

Table 6: Direct matrix ranking of wild edible plant species by five informants based on five use criteria (5 = best; 4 = Very good; 3 = good; 2 = less used; 1 = least used and 0 = no value, Cons = construction, Med = medicinal, Fo = food, Fw = firewood, Ti = timber)

WEPs	Use categories of respondents						
	Cons.	Med.	Fo.	Fw.	Ti.	Total	Rank
Ficus sur	3	0	2	4	2	11	4th
Manilkara butugi	4	0	5	3	1	13	3rd
Syzygium guineense	5	3	3	2	5	18	1st
Cordia africana	5	0	3	2	5	15	2nd
Aframomum corrorima	0	5	1	1	0	7	5th

4.10.3. Threats to wild edible plants

To understand the local people's perception of threats to wild edible plant species, a paired comparison ranking of five factors (agricultural land expansion, timber making, construction building, firewood, and fence) were conducted. As indicated by the results of paired comparison factors affecting wild edible plant species in the study area, eight key respondents reported that agricultural land expansion was ranked first, followed by timber making in the context of the local people (Appendix 1).

4.10. 4. Marketability of wild edible plants

Market surveys were made to get general information on the marketability of WEPs in the study area. However, the result of an assessment on the marketability of WEPs species showed that most of the edible plants reported in this study are not sold in the local market.

4.11. Conservation and management practices of wild edible plants

Local people in the study area have some indigenous management practices of wild edible plants. For instance; planting around the home garden, pruning, pollarding, fencing, avoiding tree cutting on Wednesday and Friday (due to socially accepted taboo), and growing of some wild edible plants in farms, homesteads, and protecting from livestock.

4.12. Availability status of wild edible plants

The degree of abundance of wild edible plant species considering their current status was reported as common (10 species, 33.33%), intermediate (8 species, 26.27%), and rare (12 species, 40%) based on informants' perception and direct field observation in the wild (Appendix 3).

5. Discussions

The current study has revealed that the study area is generally gifted with many and rich sources of wild edible plants which serve the local people as food sources and for other purposes. The number of species documented in this study (30 species) is similar to the result reported by Assegid Assefa and Tesfaye Abebe (2011), who documented a total of 30 wild edible trees and shrubs, belonging to 25 genera and 19 families in the semi-arid lowlands of Southern Ethiopia. It was, however; lower than some reports from other parts of Ethiopia (Tatek Dejene *et al*., 2020). For instance, Getachew Addis (2009) reported 137 WEPs species used by the Konso people in Southern Ethiopia. Similarly, Tariku and Eyayu (2017) identified a total of 77 WEPs belonging to 61 genera and 39 families in Bullen District. The number of WEPs in the present study is however slightly higher than the report of Abraham Demekristos (2016) and Atinafu Kebede *et al*. (2017), who documented 23 and 22 WEPs from the Amhara National Regional State and in Kefira Market, Dire Dawa City, Eastern Ethiopia. This could be associated with differences in local traditions and customs relating to the use of WEPs in different parts of the country (Tatek *et al*., 2020). Also, the difference in species diversity was mainly due to differences in altitude, which in turn depends on the soil, temperature, and rainfall, which are determining factors for the survival and growth of species (Mersha Ashagre *et al*., 2016).

The local community of the study area collects wild edible plants from natural vegetation when they are matured at a different time of the seasons. The seasons preferred for the collection were during the dry seasons and the majority were collected and consumed from March to May and from September to December. However, the main collectors of wild edible plants were dominated by children. The result agrees with the finding of Vainio (2000); Agea *et al*. (2011); Tena Regassa *et al*. (2014) and Tena Regassa (2016). Children have more interaction with wild edible plants during cattle keeping, fetching water, collecting wood, and sale of wild edible plants (Mersha Ashagre *et al*., 2016). Zemede Asfaw (2009) also stressed the importance of children in handling the issue of wild edible plants with special reference to southern Ethiopia. The study also shown that WEPs is largely consumed by all household members. This practice could indicate the importance of these edible plants in the household diet. Similar results were reported by Tena Regassa *et al*. (2014); Mulugeta Kebebew and Gemechu Leta (2016) and Tena Regassa (2016).

Wild edible plant species in the study area were collected from the forests, roadsides, forest margins, mountain slopes, riversides, and farmlands habitats. This is mostly due to habitat modification. More species were documented from forest and forest margins, which accounted for (19 species, 63.33%) of wild edible plants. This result agrees with Getu Alemayehu *et al*. (2015); Mekuanent Tebkew (2015); Tena Regassa (2016); Fekere Fugaro and Melese Maryo (2018) in different parts of the country.

Trees, shrubs, herbs and lianas/climbers were found to be the sources of wild edible plant species in the study area. The result of the study revealed that WEPs largely belong to the tree habit group. This is attributed to the composition of the dominant species in the respective localities and diverse utilization in relation to the agroforestry system in the study area (Fentahun Mengistu and Hager Herber, 2008). Similar results were reported by Tigist Wondimu *et al*. (2006); Kebu Balemie and Fassil Kebebew (2006); Tilahun Teklehaymanot and Mirutse Giday (2010); Assegid Assefa and Tesfaye Abebe (2011); Mekuanent Tebkew (2015); Atinafu Kebede *et al*. (2017). It was, however; in contrast with the findings of Demel Teketay *et al*. (2010); Ermias Lulekal *et al*. (2011); Getu Alemayehu *et al.* (2015), who reported WEPs belonging to shrubs. This difference may be due to the ecological variation and vegetation type of the study sites (Dessalegn Ayele, 2017).

With regards to mode of consumption, most plant species were consumed without processing, because they were required no sophisticated means of preparation during normal times and periods of food scarcity (Tatek Dejene *et al*., 2020). This finding agrees with the report of Guinand, Y. and Dechassa Lemessa (2000); Getachew Addis *et al*. (2005); Kebu Balemie and Fassil Kebebew (2006); Tigist Wondimu *et al*. (2006); Getu Alemayehu *et al*. (2015) and Mersha Ashagre *et al*. (2016). However, it disagrees with the finding of Redzic (2006), which showed boiled meals as the dominant mode of consumption in Bosnia and Herzegovina. The variation due to the trends and cultures of the traditional knowledge communities use to plant species in different areas (Azene Bekele, 2007).

Fruits, leaves, roots, stems, tubers and gums were the most reported edible plant parts consumed by the households in the study area. The preference of fruits to other plant parts could be attributed to ease of preparation and consumption pattern (Tena Regassa *et al.,* 2014). Different cultural groups make use of diverse WEP parts as food sources and the most preferred by the

local people (Ermias Lulekal *et al*., 2011). The dominance of fruits as edible parts has been reported elsewhere in Ethiopia (Zemede and Mesfin, 2001; Getachew *et al*., 2005; Kebu and Fassil, 2006; Tigist *et al*., 2006; Tilahun and Mirutse, 2010; Getnet, 2011; Ermias *et al*., 2011; Tena *et al*., 2014; Getu, 2017; Fekere and Melese, 2018), who reported fruits as the oldest forms of food which provide essential nutrients for human health. However, it disagrees with Mohammed *et al*. (2008), who reported leaves as the most widely used parts of wild edible plants in Palestine. This is due to the variation in the available species and culture of the communities concerning food preference and preparation (Misganaw Meragiaw *et al*., 2016

The general public consumes most of the WEPs as snacks, supplement or refreshments. So, most of the indigenous people of the area occasionally consider the WEPs as famine foods or foods in condition of starvation. As stated by Dandena Gelmesa (2010) the use of wild foods increased from 10% in a normal year to up to 40% in the famine period. Zemede Asfaw and Mesfin Tadesse (2001) also reported that about 15% of the wild edible plants are considered as famine foods for the sustainable use and development of wild food plants in Ethiopia. As reported by Tilahun Teklehaymanot and Mirutse Giday (2010), 70% of the wild edible plants are consumed during a period of food crisis and starvation, when the saved cultivated food crops decrease. This indicates the wider use of wild edible plants in the district to fight against food scarcity especially during the famine season (Baressa, 2016). Wild edible plants help to prevent starvation and sustain life during drought season and social unrest (Cunningham, 2001). Also, similar studies were reported from different parts of the world including Ethiopia (Guinand, Y. and Dechassa Lemessa, 2000; Zemede Asfaw and Mesfin Tadesse, 2001; Getachew Addis *et al*., 2005; Getachew Addis *et al*., 2005; Kebu Balemie and Fassil Kebebew, 2006; Fentahun Mengistu and Hager Herber, 2008; Getachew *et al*., 2009; Demel Teketay *et al*., 2010; Assegid Assefa and Tesfaye Abebe, 2011; Debela Hunde *et al*., 2011; Mekuanent Tebkew, 2015; Chakravarty *et al*., 2016; Mersha Ashagre, 2017; Dessalegn Ayele, 2017; Mekuanent Tebkew *et al*., 2018), who reported WEPs as relevant to household food security, particularly to supplement the staple food, to fill the gap of seasonal food scarcities, during the famine, drought, and hardships.

People of the study area use wild edible plants for food and spices, household tools, toothbrush, firewood, fence, charcoal, and medicine (for the treatment of both human and livestock

ailments). Regarding the frequency of plant parts used as a nutraceutical, the study reveals that the most frequently used plant parts were fruits (6 species, 54.55%), followed by roots (2 species, 18.18%) and leaves (3 species, 27.27%) to treat human health problems and livestock ailments. The majority of nutraceutical plants used by the local people in the study area were obtained from shrubs (5 species, 45.45%). This is due to the ease of access to these species in the study area compared to other growth forms. This finding agrees with Getu Alemayehu *et al*. (2015) and Tena Regassa (2016). However, it disagrees with Tariku Berihun and Eyayu Molla (2017) in Bullen District, Northwest of Ethiopia, who reported herbs as the most dominant WEPs used as a source of traditional medicine.

Species preference ranking of WEPs was conducted based on the taste quality of WEP species in the study area used by local communities. So, the result showed that *Manilkara butugi* is the most preferred species used as wild food and tastier. Also, key informants said that Abba Jifar used to eat fruits of *Manilkara butugi* and his palace was also constructed from *Manilkara butugi*. The preference for this plant species was due to taste quality compared to other species and its easy accessibility and familiarity to the local people. This finding similar to other studies elsewhere in Ethiopia (Tariku Berihun and Eyayu Molla, 2017; Desalegn Ayele, 2017).

Direct matrix ranking was conducted to evaluate the multipurpose use of wild edible plant species and their relative importance to the local people. The majority of wild edible plants in the study area, apart from their food and medicinal values, also used for fodder, firewood, charcoal, construction, farm tools, furniture, fences, and other uses as frequently mentioned by the informants. Direct matrix ranking exercise showed *Syzygium guineense* (Willd.) DC. *subsp. afromontanum* was exploited more in the study area because of its multidimensional function followed by *Cordia africana*. This is due to overharvesting of multipurpose wild edible plant species for making construction, medicine, food, firewood, timber making purposes were the factors responsible for aggravating depletion of the species in the area. This finding agrees with Tariku Berihun and Eyayu Molla (2017) in Bullen District, Northwest Ethiopia, and Getachew Addis *et al*. (2013) also reported the same pattern of highest exploitation of wild edible plant in South Ethiopia. *Syzygium guineense* (Willd.) DC. *subsp. afromontanum* and *Cordia africana* were found to be the most important trees with multiple utility values among wild edible plants in the study area.

Since the local community has an intimate relationship with their natural environment, they are familiar with the threats to wild edible plants (Mulugeta Kebebew and Gemechu Leta, 2016). Hence, during the focus group discussion, respondents were identified as the major threats to wild edible plants. This is mainly due to human activities and factors associated with them. This is mainly due to the increasing demand for arable land and due to the increasing human population. A similar result was reported by Kebu Balemie and Fassil Kebebew (2006); Assegid Assefa and Tesfaye Abebe (2011); Debela Hunde *et al*. (2011); Getachew Addis *et al*. (2013); Tena Regassa *et al*. (2014); Getu Alemayehu (2017). As a result, *Syzygium guineense* (Willd.) DC. subsp. *afromontanum* and *Cordia africana* Lam. were identified as highly threatened wild edible plants in the study area. This is due to over-harvesting not only for food but also for other uses (Getu Alemayehu, 2017).

As information obtained from the local community showed, only Syzygium *guineense* (Willd.) DC. *subsp*. *Guineense* and *Syzygium guineense* (Willd.) DC. *subsp. afromontanum*, had been sold in the past during the shortage of food. Currently, these wild edible plants are not sold in the study area. This was also verified from the observation during a market survey and discussions made with the local people. There is also a cultural influence on the marketability of the wild edible plants. According to the respondents in the study area, it is a shame for someone to collect and sell WEPs in the market. These results agree with Getu Alemayehu *et al*. (2015) in Berehet District, North Shewa Zone of Amhara Region, and Baressa Anbessa (2016) in Bule Hora district, Southern Ethiopia, but disagrees with Kebu Balemie and Fassil Kebebew (2006); Tinsae Bahru *et al*. (2013). The variation in the marketability of WEPs could mainly due to a lack of trends in the location, types of WEPs, and culture of the society (Haile Tesfaye, 2020).

The local communities reported some conservation strategies of WEPs in the natural forest, in agro-forestry system and near the home garden. Similar results were reported in the indigenous communities in the buffer area of Awash National Park (Tinsae Bahru *et al*., 2013; Mekuanent Tebkew *et al.,* 2018). Mulugeta Kebebew and Gemechu Leta (2016) reported that conservation of wild edible plants can also be possible in-home gardens, as the home garden is a deliberate and perfect farming system for the conservation, production, and enhancement of edible plants. Also, NGOs and the Dedo District administration are conserving the forest by

employing a guard to protect the forest from exploitation by man and other factors which threatened the forest as well as wild edible plants. This shows that there were insufficient conservation activities in place to safeguard the wild edible plants.

The wild edible plant species in the study area are rare and distributed in the forest, forest margin, roadside, riverside, mountain slope and around farmland. This result agrees with Getnet Chekole (2011); Atinafu Kebede *et al*. (2017) around Tara Gedam and Amba remnant forests in Libo Kemkem District, South Gonder Zone, and in Kefira Market, Dire Dawa City, Eastern Ethiopia respectively. In their study, they reported that the majorities (38.3%) and (54.5%) of wild edible plants were rare in the study area. Also, Tigist Wondimu *et al*. (2006); Debela Hunde *et al*. (2011) reported that the majority of wild edible plants are rare in their respective study areas, due to continued destruction of their habitats and overharvesting. Likewise, Kebu and Fassil (2006) reported that the availability of wild edible plants varies depending on ecological and climatic conditions. This is due to the influence of seasonal variation most of them are rare during the dry season. However, it disagrees with the study of Misganaw Meragiaw *et al*. (2016) in Delanta district, Northern, Ethiopia, who reported that the majorities (40%) of wild edible plants were common in the study area.

6. Conclusion and Recommendations

6.1. Conclusion

In the present study 30, wild edible plants including nutraceutical species were identified and recorded. These plants belong to different genera and family showing that the study area is rich in wild edible plants. Moreover, the local community uses different wild edible plants such as fruits, seeds, leaves, stems, roots, tubers, and gums as a source of food for all age groups mainly during drought or famine season. They also use wild edible plants for medicinal value to treat human and livestock ailments in the study area. *Manilkara butugi* Chiov. is the most known wild edible plant species in the district and it was also preferred by King Abba Jifar for its tasty fruits. Most wild edible plants also provide multiple uses for the local people, for instance, *Syzygium guineense* (Willd.) DC. *subsp*. *afromontanum* was reported as the main multipurpose plant species as foods, medicines, fuels, timbers, constructions, fences, and farm implements. However, multipurpose plants that give valuable services are presently getting rare in wild vegetation due to natural and human impacts like agricultural land expansion, illegal settlement, and timber making. Some of the local people have attempted to cultivate the most commonly used plants in home gardens as live fences, shade trees, and at the edges of farmlands upon noticing they are being threatened in the wild vegetation. The results overall showed that wild edible plants are playing a significant role to improve food insecurity problems in the study area and the activities associated with their home garden practices are playing a major role in biodiversity conservation.

6.2. Recommendations

Based on the results of the study, the following recommendations are forwarded:

1. Encourage the local communities to use wild edible plants as a portion of food is highly recommended to ensure food security in the district;
2. Concerned bodies should be encouraged the local communities to protect, conserve, and wisely use the wild edible plants in their natural forests;
3. Encourage the local communities including youngsters to engage in the marketability of the wild edible plants products to popularize and get an incentive from the plants is very imperative;
4. Furthermore, in-situ and ex-situ conservation of edible trees, shrubs, herbs, and lianas used as wild edible plants should be enhanced through the participation of the local community;
5. Finally, further investigation is recommended on nutritional, medicinal quality, and side effects of the wild edible plant species in the future.

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Appendices

Appendix 1. Checklist of the questionnaires and semi-structured interviews for collecting ethnobotanical data of wild edible plants.

Personal information

Date	Ganda	Name	Age	Sex	Religion	Job	Marital status	Level of education	Ethnic group

I. Information related to wild edible plants
   1. Who collect WEPs?
   2. Who eat WEPs in your locality or ganda?
   3. At what time do people eat WEPs in your area?

II. Information related to indigenous knowledge
   4. Which WEPs species are commonly threatened in the study area?
   5. What are the WEPs species parts to be edible, mode of consumption, habitat, and habit?
   6. What is the traditional use of WEPs as medicinal plants in the study area?

III. Information related to focus group discussion
   7. Is WEPs marketable locally?
   8. What are the other uses of WEPs in addition to their food value?
   9. What are the threatening factors and conservation methods of WEPs?
   10. How the knowledge of WEPs use is transferred from elders to the next generations in the study area?

Thank you in advance!

Appendix 2. Socio-demographic characteristics of the respondents.

Characters	Male	Female	Total Number	Percentage (%)
Age				
20-34	87	83	170	49.4
≥35	93	81	174	50.6
Total	180	164	344	100
Marital status				
Single	71	80	152	44.2
Married	109	84	192	55.8
Total	180	164	344	100
Religion				
Orthodox	45	43	88	25.6
Protestant	47	45	92	26.7
Muslim	88	76	164	47.7
Total	180	164	344	100
Ethnicity				
Amhara	68	63	131	38.1
Oromo	112	101	213	61.9
Total	180	164	344	100

Appendix 3. List of wild edible plants and their characterization in the study area (Parts used = PU, Mode of consumption = Mode cons, Habitat = Hab, Habit = Ha, Herb = H, Shrub = Sh, Tree = T, Lianas = L).

S/N	List of Wild edible plants (WEPs)		Local name (A/Oromo)	PU	Mode cons	Hab	Ha	Availability status
	Scientific name	Family						
1	*Aframomum corrorima* (Braun). Jansen	Zingiberaceae	Ogiyoo	Fruit	Raw	Forest	H	Common
2	*Amaranthus sparganium* Cephalus	Amaranthaceae	Liimaa	Leaf	Cooked	Road margin	H	Intermediate
3	*Carissa spinarum* L.	Apocynaceae	Hagamsa	Fruit	Raw	Forest	Sh	Common
4	*Clausena anisata* (Willd.) Benth.	Rutaceae	Ulumaayii	Fruit	Raw	Mountain slope	Sh	Common
5	*Cordia africana* Lam.	Boraginaceae	Waddeessa	Fruit	Raw	Forest	T	Rare
6	*Dioscorea schimperiana* Kunth	Dioscoreaceae	Kotte harree	Root	Raw	Forest margin	L	Intermediate
7	*Ficus sur* Forssk.	Moraceae	Harbuu	Fruit	Raw	Riverside	T	Rare
8	*Ficus thonningii* Blume	Moraceae	Danbii	Fruit	Raw	Forest	T	Rare
9	*Ficus sycomorus* L.	Moraceae	Odaa	Fruit	Raw	Forest margin	T	Rare
10	*Ficus vasta* Forssk.	Moraceae	Qilxuu	Fruit	Raw	Riverside	T	Rare
11	*Flacourtia indica* (Burm.f.) Merr.	Flacourtiaceae	Hudhaa	Fruit	Raw	Forest	Sh	Rare

S/N	List of Wild edible plants (WEPs)		Local name (A/Oromo)	PU	Mode cons	Hab	Ha	Availability status
	Scientific name	Family						
12	*Ehretia cymosa* Thonn.	Boraginaceae	Ulaagaa	Fruit	Raw	Forest	T	common
13	*Hibiscus macranthus* Hochst. ex A. Rich.	Malvaceae	Ajaa gaarii	Fruit	Raw	Forest margin	H	Intermediate
14	*Lepidotrichilia volkensii* (Giirke) Leroy	Meliaceae	Sigiluu	Fruit	Raw	Forest	T	common
15	*Manilkara butugi* Chiov.	Sapotaceae	Gawoo aannanii	Fruit	Raw	Forest	T	Common
16	*Maytenus senegalensis* (Lam.) Exell.	Celastraceae	Jimaa dawwee	Leaf	Raw	Roadside	Sh	Intermediate
17	*Mimusops kummel* Bruce ex A.DC.	Sapotaceae	Qolaatii	Fruit	Raw	Forest	T	Common
18	*Myrica salicifolia* A. Rich.	Myricaceae	barooddoo	Fruit	Raw	Forest	T	Rare
19	*Olea welwitschii (*Knobl.) Gilg & Schellenb.	Oleaceae	Bahaa	Gum	Raw	Forest	T	Common
20	*Piper capensis* L.F.	Piperaceae	Tunjoo	Fruit	Raw	Forest margin	H	Common
21	*Phoenix reclinata* Jacq.	Arecaceae	Meexxii	Fruit	Raw	Forest	T	Intermediate

S/N	List of Wild edible plants (WEPs)	Local name	PU	Mode	Hab	Ha	Availability

	Scientific name	Family	(A/Oromo)		cons			status
22	*Physalis peruviana* L.	Solanaceae	Tinii	Seed	Raw	Farmland	H	Intermediate
23	*Psidium guava* L.	Myrtaceae	Zayituunaa	Fruits	Raw	Roadside	Sh	Intermediate
24	*Rhamnus staddo* A. Rich	Rhamnaceae	Qadiidaa	Tubers	Raw	Forest margin	Sh	Rare
25	*Rubus steudneri* Schweinf.	Rosaceae	Goraa	Fruits	Raw	Forest	Sh	Rare
26	*Schrebera alata* (Hochst.) Welw.	Oleaceae	suurrursaa	Fruits	Raw	Mountain slope	T	Rare
27	*Solanum nigrum* L.	Solanaceae	Achoo	Fruits	Raw	Roadside	H	Intermediate
28	*Syzygium guineense* (Willd.) DC. subsp. *afromontanum* F. White	Myrtaceae	Baddeessaa	Fruits	Raw	Roadside	T	Rare
29	*Syzygium guineense* (Willd.) DC. subsp. *Guineense*	Myrtaceae	Goosuu	Fruits	Raw	Mountain slope	T	Rare
30	*Vepris dainellii* (Pichi-Serm.) Kokwaro	Rutaceae	Hadheessaa	Fruits	Raw	Forest	T	Common

Appendix 4. Paired wise ranking factors as threats to wild edible plants.

	R1			
Factors	Agricultural expansion (AE)	Construction (C)	Timber making (T)	Firewood (FR)	Fence (F)
Agricultural expansion (AE)	-	AE	AE	AE	F
Construction (C)		-	C	FR	C
Timber making (T)			-	T	F
Firewood (FR)				-	FR
Fence (F)					-

	R1				
Factors	AE	C	T	FR	F
Frequency	3	2	1	2	2

Factors	R2				
	Agricultural expansion (AE)	Construction (C)	Timber making (T)	Firewood (FR)	Fence (F)
Agricultural expansion (AE)	-	C	T	AE	F
Construction (C)		-	T	FR	F
Timber making (T)			-	T	F
Firewood (FR)				-	FR
Fence (F)					-

	R2				
Factors	AE	C	T	FR	F
Frequency	1	1	3	2	3

Appendix 4. Continued

R3					
Factors	Agricultural expansion (AE)	Construction (C)	Timber making (T)	Firewood (FR)	Fence (F)
Agricultural expansion (AE)	-	AE	AE	AE	AE
Construction (C)		-	T	FR	C
Timber making (T)			-	T	F
Firewood (FR)				-	FR
Fence (F)					-

R3					
Factors	AE	C	T	FR	F
Frequency	4	1	2	2	1

R4					
Factors	Agricultural expansion (AE)	Construction (C)	Timber making (T)	Firewood (FR)	Fence (F)
Agricultural expansion (AE)	-	C	T	AE	AE
Construction (C)		-	T	FR	C
Timber making (T)			-	T	F
Firewood (FR)				-	FR
Fence (F)					-

R4					
Factors	AE	C	T	FR	F
Frequency	2	2	3	2	1

Appendix 4. Continued

R5					
Factors	Agricultural expansion (AE)	Construction (C)	Timber making (T)	Firewood (FR)	Fence (F)
Agricultural expansion (AE)	-	AE	AE	AE	AE
Construction (C)		-	C	FR	C
Timber making (T)			-	T	F
Firewood (FR)				-	FR
Fence (F)					-

R5					
Factors	AE	C	T	FR	F
Frequency	4	2	1	2	1

R6					
Factors	Agricultural expansion (AE)	Construction (C)	Timber making (T)	Firewood (FR)	Fence (F)
Agricultural expansion (AE)	-	AE	T	FR	AE
Construction (C)		-	C	FR	C
Timber making (T)			-	T	T
Firewood (FR)				-	F
Fence (F)					-

R6					
Factors	AE	C	T	FR	F
Frequency	2	2	3	2	1

Appendix 4. Continued

Factors	R7				
	Agricultural expansion (AE)	Construction (C)	Timber making (T)	Firewood (FR)	Fence (F)
Agricultural expansion (AE)	-	C	T	AE	AE
Construction (C)		-	C	T	C
Timber making (T)			-	T	F
Firewood (FR)				-	FR
Fence (F)					-

	R7				
Factors	AE	C	T	FR	F
Frequency	2	3	3	1	1

Factors	R8				
	Agricultural expansion (AE)	Construction (C)	Timber making (T)	Firewood (FR)	Fence (F)
Agricultural expansion (AE)	-	C	AE	AE	AE
Construction (C)		-	T	C	F
Timber making (T)			-	T	T
Firewood (FR)				-	FR
Fence (F)					-

	R8				
Factors	AE	C	T	FR	F
Frequency	3	2	3	1	1

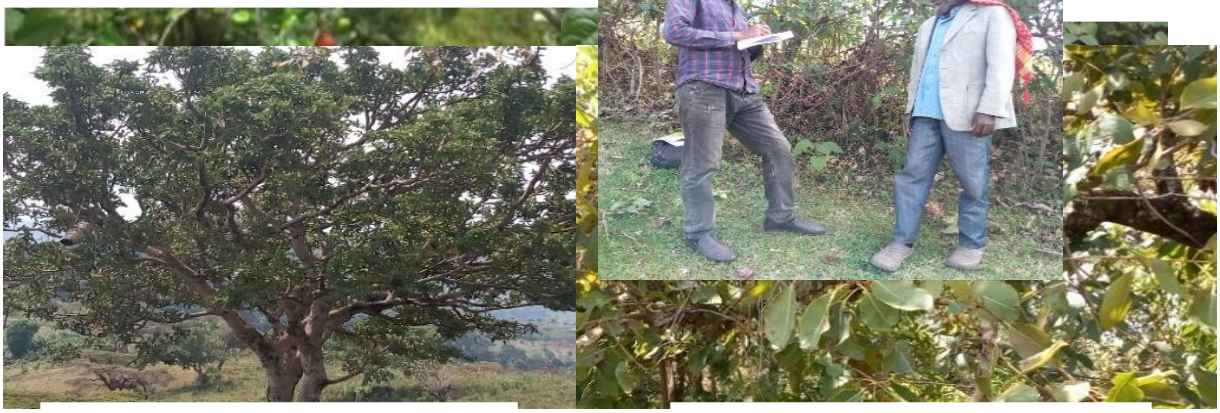
Appendix 4. Continued

Summary of paired comparison ranking factors threatening wild edible plants in the study area by eight respondents (R_1-R_8)

Factors	Respondents (R_1-R_8)									
	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	Total	Rank
Agricultural expansion	3	1	4	2	4	2	2	3	21	1st
Construction /building	2	1	1	2	2	2	3	2	15	3rd
Timber making	1	3	2	3	1	3	3	3	19	2nd
Firewood	2	2	2	2	2	2	1	1	14	4th
Fence	2	3	1	1	1	1	1	1	11	5th

Appendix 5. Some photographs illustrating ethnobotanical field data collection.

Carissa spinarum



Ficus sur *Syzygium guineense* (Willd.) DC.

Some plants of study area