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Ethiopia's Food Treasures: Revitalizing Ethiopia's underutilized fruits and vegetables for inclusion in the Food-Based Dietary Guidelines for improved diet diversity, nutrition and health of the population



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1. Introduction

One in three people worldwide are affected by one or more forms of malnutrition: 800 million are undernourished, 1.9 billion adults are overweight or obese, and about two billion people worldwide suffer from micronutrient deficiencies [1, 2]. Poor quality diets are now the leading causes of morbidity and mortality putting people at a greater risk than unsafe sex, tobacco, drug and alcohol use combined [3]. Although what constitutes a healthy diet is context-dependent, there is consolidated evidence that diverse diets that include nutrient-dense foods like whole grains, fruits, vegetables, legumes and nuts, along with moderate consumption of animal source foods, are associated with better health outcomes [4-6].

Ethiopian diets have been characterized as monotonous and predominantly cereal-based, with very low or no consumption of fruits and vegetables [7]. The recent World Health Organization (WHO) STEPwise approach to Surveillance (STEPS) survey revealed that in 2015, 85% of the Ethiopian population had zero servings of fruits and vegetables [8]. Less than 2% of the population met the more conservative recommendation of 3-4 daily servings [9] of fruits and vegetables and only 1.5% met WHO recommendation of five or more servings a day. This is an alarmingly low level of fruit and vegetable consumption, which can predispose the Ethiopian population to poor health and was identified as the primary cause for the increased incidence of and death from non-communicable diseases (NCDs) [10, 11]. The same study indicates that a diet low in fruits was responsible for 86 deaths per 100,000 or 11.0% of NCD deaths and accounted for 1632 disability-adjusted life year (DALYs) per 100,000 between 1990 and 2013 [11]. Low consumption of fruits and vegetables were also found to be associated with a higher risk of adverse pregnancy outcomes [12].

Choice of diet is determined by various factors, including consumer behaviour driven by traditions, beliefs and nutrition awareness or lack of it, the food environment and the food supply system, which include agricultural production, storage and transportation, marketing and processing – all together referred to as the ‘food system’. Evaluating the agricultural production system at the national level, Baye et al., [13] showed that fruits and vegetables each provided less than 1% of the Ethiopian population’s energy supply. This limited supply contributed to the considerable increases in price for fruits and vegetables that were above the general inflation rate [14]. Therefore, promoting fruit and vegetable production to increase their availability, access, and particularly affordability in Ethiopia is critical and urgent.

While a great deal is known about the amount of fruits and vegetables cultivated, little is known about the supply and consumption of wild edible fruits and vegetables. Attention to availability, access and acceptability of wild edible fruits and vegetables can be used as an entry point to broaden the resource base of locally-available fruits and vegetables and ultimately bring down prices and increase choice for consumers. Anecdotal and localized studies indicate the use of wild edible plants (WEPs) throughout Ethiopia [15, 16] but, to our knowledge, little effort was made to review the evidence in a way that can support the development of the Ethiopian food-based dietary guidelines (FBDG), due to be released in 2020. Many African countries like Ethiopia do not have FBDGs [59]. In Ethiopia, researchers are working to develop food-based dietary guidelines that will be used to help promote healthier diets and fight the multiple burdens of malnutrition, by providing country-specific guidance. Drafting of the guidelines is underway with the following objectives: (1) To develop FBDGs for Ethiopia informed by systematic reviews and data analyses from global and national data sets; (2) To translate the general guideline messages into daily practical food choices using linear mathematical programming and evaluating the FBDGs developed for cultural appropriateness, consumer understanding, acceptability and practicality; (3) To develop an EHEI for the general population based on the developed FBDGs, and to evaluate this index among WRA in urban and rural settings; (4) To develop and evaluate a brief food quality screener to assess adherence to Ethiopian FBDGs; and (5) To assess whether the national food supply can support adherence to FBDGs for Ethiopia [60].

This research paper aims to provide evidence on which wild edible fruits and vegetables are available, where they can be found and how they are sourced, consumed and perceived by the local population. Whenever available, we present the nutrient composition of the wild fruits and vegetables identified and evaluate their implications for improving diets and nutritional wellbeing.

2. Literature search and description of studies

We performed a literature search using the search terms ‘underutilized’ + ‘Ethiopia’ + ‘fruits’ or ‘vegetables’ or ‘wild edible plants’. We used search engines such as Google Scholar, Public Library of Science (PLOS), PUBMED, BioMed Central (BMC), as well as university thesis repositories. Grey literature, including theses and project reports, was also searched and, using a snowball method, we also identified additional reports and articles. A total of 102 studies were reviewed, and our study retained 47 studies¹ on indigenous foods grown

¹ It should be noted that in some cases (e.g. articles by Fentahun and Hager, 2008, 2009 and 2010) articles are based on the same study site in the Amhara region. One PowerPoint and one unpublished study also included.

and consumed in Ethiopia. The information provided by the studies was categorized into four thematic categories and each study was coded based on relevance to these selected thematic areas: (i) availability, (ii) consumer perceptions, (iii) culinary use, and (iv) nutrient composition. In most cases, ‘availability’ referred to which wild edible plant is available and where they are found; ‘consumer perceptions’ were often assessed using qualitative methods including key informant interviews, focus group discussions and food ranking. Thirty-four studies included information on availability of species, 23 studies included information on consumer perceptions, 16 provided information on the culinary use of the plant (e.g. plant part consumed or how it is prepared) and 12 papers included information on nutritional or anti-nutritional content of the species (Table 1). Given the limited number of papers on the topic, we did not apply a stringent quality control and inclusion criteria.

Table 1 - Thematic areas covered in the papers reviewed (n=40)

Thematic areas	Number of studies	References
Availability	34	[15-48]
Consumer perceptions	23	[15,16,18,26-33,35-37,39-42,46,48-50]
Culinary use	16	[16,17,19,20,23,28,35,39-45,48,49]
Nutrient composition	14	[17, 20, 27, 28, 34, 35, 38, 43, 51-54]

3. Geographical availability of wild edible fruits and vegetables

In total, 365 plant species bearing fruits or categorized as vegetables were identified. Ethiopia is a Federal Democratic Republic composed of nine National Regional states: namely Tigray, Afar, Amhara, Oromia, Somali, Benishangul-Gumuz, Southern Nations Nationalities and People Region (SNNPR), Gambella and Harari, and two Administrative states (Addis Ababa City administration and Dire Dawa city council). The studies covered six of the nine regional states of Ethiopia, namely: Afar, Amhara, Benishangul-Gumuz, Oromia, Southern Nations Nationalities and People Region (SNNPR) and Tigray.

No studies were found for three states, while Afar and Tigray regions had one study identified for each. The Oromia region was the most researched state with ten studies in ten districts. Therefore, the results presented in this paper may not completely reflect the abundance or lack of species by region in Ethiopia. Table 2 shows the distribution of the species and studies by region.

Of the 365 plant species identified, 342 species were fully identified by their scientific names while 23 (6.3%) were only identified by their local names. The species identified belonged to 86 plant families, with Fabaceae (n=18) and Moraceae (n= 17) being the most abundant, followed by the Cucurbitaceae and Rubiaceae with 15 species each.

Among the species, four – Christ’s thorn jujube (*Ziziphus spina-christi* (L.) Desf.), Abyssinian rose (*Rosa abyssinica* R.Br.), red milkwood (*Mimusops kummel* Bruce ex A. DC.) and desert date (*Balanites aegyptiaca* (L.) Delile) – were reported in six regional states of Ethiopia. Eleven species were reported in five of the six regional states and ten species in four regional states under study.

In terms of use, the majority (220 species, 60.3%) of these plants were listed as fruits, 118 (32.4%) as vegetables and 4 of the plants were listed as both fruits and vegetables.

Table 2 - Distribution of plant species by regions

Region	Districts	Number of Species	Number of Families	Number of articles
Afar	Yalo	16	13	1
Amhara	Adiarkay, Chilga, Delanta, Simada, Yilmanadenssa, Dejen, Debark & Ebinat	101 (+13 unidentified)	48	7
Benishangul-Gumuz	Bullen	69	36	2
Oromia	Benna Tsemay, Burji, Cheha, Hamar, Hula, Kara, Konso, Maale, Kwegu, Debub Ari	226	70	10
SNNPR	Dheera, Fantalle, Goma, Guna, Yayu, Ziway, Sivo, Chora, Boosat, Hurumu, Tiyo, Doreni	121 (+6 unidentified)	57	6
Tigray	Alamata	29 (+3 unidentified)	20	1

4. Seasonal availability of wild edible fruits and vegetables

Seasonality is an important aspect in relation to availability of and access to fruits and vegetables, including wild edible ones. As illustrated in Figure 1, at least four fruit species are available in any given season (by month of the year). There are also many more options available in the months of February and March. Both seasonal and local availability should be considered when formulating FBDGs for the Ethiopian population.

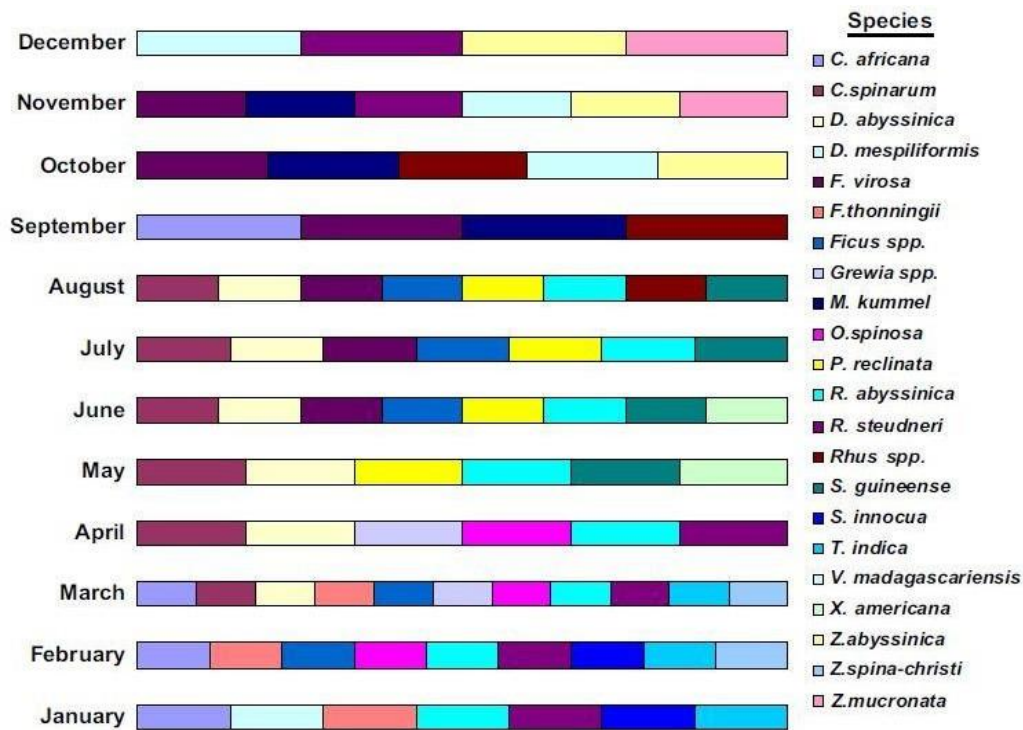


Figure 1 - Seasonal availability of commonly consumed wild edible fruits and vegetables in Ethiopia - reproduced with permission from reference 30

5. Consumer perceptions

Of the 47 research papers we reviewed, 23 papers studied consumer beliefs or behaviours. In the papers, various methods were used to document knowledge of wild food plants. Methods used included observation, oral history and from elders, in addition to consumer preferences. Figure 2 shows the most common motivations for consumers' use of indigenous or wild fruits and vegetables. The most common reason is to supplement the diet – normally sourced from both own-farm production and market purchases – during normal times and during periods of food shortage [15, 37, 39, 41, 48]. Other papers reported that these foods are believed to be foods that can be habitually consumed and are nutritious or medicinal, while other studies reported them to be perceived as foods for the poor or food to be consumed during emergencies, such as times of famine and prolonged food shortage. This demonstrates a wide range of perceptions, including the fact that these foods are considered equally as medicinal as they are harmful, and both useful for habitual consumption, as well as important buffer foods for coping during periods of stress.

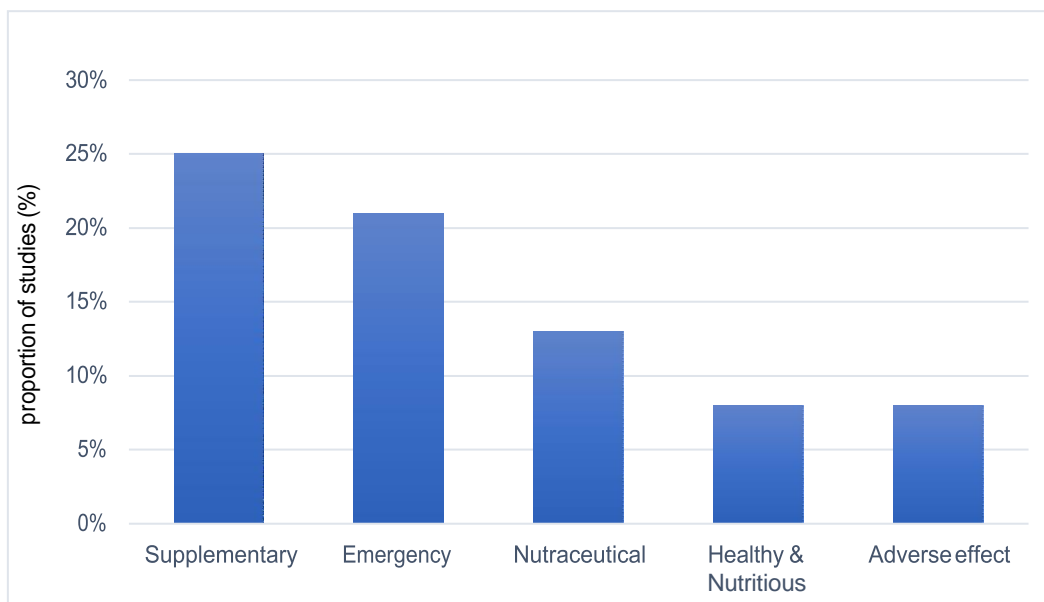


Figure 2 - Consumer perception of and use of Indigenous fruits & vegetables in Ethiopia (n= 45 studies)

Specific studies offer the following additional insights on consumer perceptions. A large proportion of rural households, irrespective of socio-economic status, consume WEPs [18]. WEPs, especially fruits, are appreciated by children throughout the year, but are consumed by adults and children alike in times of food scarcity [20, 31, 45].

In the Amhara region, red milkwood (*Mimusops kummel* Bruce ex A. DC.), jackal berry (*Diospyros mespiliformis* Hochst. ex A.DC.), tamarind (*Tamarindus indica* L.) and Christ's thorn jujube (*Ziziphus spina-christi*) were indicated as the four most highly-valued species [30]. However, there are within-region variations in preference. For example, Adiarkay, Debark and Dejen districts in the Amhara region, each have very locally-specific fruit preferences. For example, Christ's thorn jujube was the most preferred followed by bush plum (*Carissa spinarum* L.) and jackal berry in Adiarkay, while at Debark, Abyssinian rose (*R. abyssinica*) and woodland water berry (*Syzygium guineense*) are the most valued, even though the latter is not listed as one of the 15 priority species for Ethiopia due to unavailability in other regions. In Dejen district, tamarind and tallow wood (*Ximenia americana* L.) were the most preferred species [31]. This indicates that a wide range of wild edible plants are culturally acceptable, and further highlights the need to study the value chain potential in locally-contextual settings, as consumer preference and desirability may orient towards marketing

opportunities based on locally-specific preferences. According to focus group discussions in four regions, motivations for including these foods in diets included:

- to add dietary variety because of their good taste
- as a snack during hungry periods of the day, as well as during lean/hungry seasons of the year
- to moisten the mouth in the absence of drinking water
- as a colouring and flavouring agent
- as chewing gum
- to make 'ergo' (a curdled dairy product)
- as a substitute for coffee
- to avert emaciation in children [19].

6. Culinary uses

Regarding the culinary uses of the wild edible species, the major edible parts and the methods of consumption were documented for 15 of the 47 reviewed papers. Depending on the plant, the fruits, leaves, seeds, flowers, stems, tubers and roots are consumed. Parts of the plant can be consumed raw (mostly the fruits) or cooked (boiled, roasted or baked) as vegetables, as well as powdered or juiced (the roots and tubers). Given the limited availability, accessibility and affordability of cultivated fruits and vegetables, but also considering the existing habit of consuming wild edible fruits and vegetables in various parts of the country, it is important to include some of the WEPs in the Ethiopian FBDGs. Due to their agronomical traits (e.g. drought resistance), their seasonal availability, their nutrient density and their familiar taste that evokes memories of childhood for many Ethiopians, these foods should be considered treasures.

7. Nutrient composition

Nutrient composition of 84 WEP species was provided in 14 of the 47 papers. Considerable work is needed to document the nutrient composition of these Ethiopian food treasures. The analysis of the nutrient composition presented several challenges, which included mixed reporting of the nutrient content, based sometimes on fresh weight and other times on dry matter basis (with no moisture reported in some cases), and different units of measurement for nutrient values. We were therefore not able to convert data in a reliable way to provide a comparable summary of results from the 12 papers. We present the nutrient composition values, for which there is high confidence in data quality and comparability, in section eight.

8. Ethiopia's food treasure species for promotion in the FBDGs

This section provides information on 15 of Ethiopia's most available treasured foods for inclusion in the Ethiopian Food-Based Dietary Guidelines as 'Future-Smart Food for Ethiopians'. These fruit and vegetable species are agronomically adapted to Ethiopia's climate and environmental conditions and are also known and used by the population, therefore, the potential for increasing their consumption as part of a healthy diet is high. Table 3 presents a list of the 15 priority species available in many of the regions.

Table 3 - Fifteen wild and edible priority species in Ethiopia

	Species name	Number of regions mentioned in papers reviewed	Regions of availability	References (see Annex 2)
1	<i>Balanites aegyptiaca</i> (L.) Delile	6	Afar; Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[15-19, 23, 26, 32, 34-37, 41, 43, 44, 46, 48, 55]
2	<i>Mimusops kummel</i> Bruce ex A.DC.	6	Afar; Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[16, 18-20, 30, 31, 36, 37, 41, 46-48]
3	<i>Rosa abyssinica</i> R.Br.	6	Afar; Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[19, 20, 25, 29-31, 41, 42, 44, 47, 48, 55]
4	<i>Ziziphus spina-christi</i> (L.) Desf.	6	Afar; Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[16, 18, 19, 29-32, 35, 37, 41-44, 46, 47, 54]
5	<i>Carissa spinarum</i> L.	5	Afar; Amhara; Benishangul-Gumuz; Oromia; SNNPR	[15, 16, 18, 20, 23, 30-32, 36, 37, 41, 42, 44, 46-48]
6	<i>Cordia Africana</i> Lam.	5	Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[15, 16, 18-20, 25, 29-32, 36, 37, 41, 42, 46-48, 54, 55]
7	<i>Dovyalis abyssinica</i> (A.Rich.) Warb.	5	Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[15, 19, 20, 25, 29-31, 41-43, 46-48, 51, 55]
8	<i>Ficus sur</i> Forssk.	5	Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[15, 16, 18-20, 23, 25, 30, 31, 36, 37, 41, 42, 46, 47, 55]
9	<i>Ficus sycomorus</i> L.	5	Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[16, 18-20, 30-32, 36, 37, 41, 45-48, 54, 55]
10	<i>Ficus vasta</i> Forssk.	5	Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[16, 18, 19, 23, 25, 30-32, 36, 37, 41, 42, 46, 47]
11	<i>Grewia damine</i> Gaertn.	5	Afar; Amhara; Benishangul-Gumuz; Oromia; SNNPR	[16, 19, 30-32, 36, 44-46]
12	<i>Opuntia ficus-indica</i> (L.) Mill.	5	Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[15, 18, 19, 23, 29-32, 36, 46-48, 55]

13	<i>Solanum americanum</i> Mill.	5	Amhara; Benishangul-Gumuz; Oromia; SNNPR; Tigray	[15, 16, 19, 25, 37, 42, 45]
14	<i>Tamarindus indica</i> L.	5	Afar; Amhara; Benishangul-Gumuz; Oromia; SNNPR	[16, 18, 23, 29-32, 36, 37, 44, 45]
15	<i>Ximenia americana</i> L.	5	Afar; Amhara; Benishangul-Gumuz; Oromia; SNNPR	[15, 16, 18, 19, 23, 29-32, 37, 41, 44-48, 55]

Source: Data extracted and compiled from the 45 papers reviewed for this study.

9. Profiles of the 15 priority species

This section presents profiles for each of the 15 selected plants and their culinary uses.

***Balanites aegyptiaca* (L.) Delile**



Photograph1-Bekele-Tesemma,2007

Family: Zygophyllaceae

Genus: *Balanites*

Species: *aegyptiaca*

English name: desert date

Vernacular names: Bedana/ Kudekuda

(Amharic); Bedana/Meki (Tigrigna); Domoko

(Hamar); Hankalta/Hangalta (Afa – Konso);

Qota (Shinashegna); Baddanno(Oromia);

Donkey (Malló mucchi);

Edible parts: fruits and leaves

Balanites aegyptiaca (L.) Delile is a small evergreen tree that grows to a height of about 10 metres. The species is widely distributed in Ethiopia. It produces fragrant, yellow-green clustered flowers and oblong fruits of about 5cm in length, of a bright yellow when ripe. The fruit is ellipsoid, with a hard-pointed seed within, surrounded by yellow-brown bittersweet flesh, from which the seeds are easily separated [56].

Fruits are abundant during the dry season and are also available during the short rainy seasons. Geographical availability of the species was reported in all six regions covered by 15 articles that described the available indigenous plant species (Table 3). Harvesting of the species for its fruits and leaves is almost year-round across the regions, from December to May in four districts of Ethiopia: Alamata, Cheha, Goma, and Yilmana Densa districts of Tigray, Southern Peoples, Oromiya, and Amhara regional states, respectively [19] and September to May in Oromia [32].

Uses

The importance of the species to the community was assessed using the fidelity level of consumption and pairwise ranking of the fruits and leaves based on edibility, taste and income-earning properties. Results demonstrated that the species is among the most commonly used and preferred wild plant because of its availability during the dry seasons [15, 18, 36, 46]. Fruits are harvested when ripe and pulp/exocarp, excluding the peel and discarding the seeds, are eaten raw by all age groups and sexes. The fruits can be eaten fresh or dried. Young leaves and shoots are harvested and cooked, then consumed with other foods as vegetables.

***Mimusops kummel* Bruce ex A.DC.**



Photograph 2 - World Agroforestry Centre

Family: Sapotaceae

Genus: *Mimusops*

Species: *kummel*

English name: mimusops, red milkwood

Vernacular names: Ishe/ Eshe (Amharic);

Tulukanta/Tuleta (Afa Konso): Shemiya

(Shinashegna); Kolati (Afan Oromo); gosho (Malló mucci); Olati (Oromia/Amharic)

Edible parts: fruits

Mimusops kummel is an evergreen tree that can reach a height of 30 metres. It grows in East Africa and Eritrea, the Sudan and West Africa. In Ethiopia, it occurs in drier montane forest and humid highland forest. The fruit is a hard drupe of about 2cm; it is a bright orange yellow colour and has a single seed.

Uses

Availability of the species was described in six regions by 12 of the articles reviewed. Seasonal availability of the fruit occurs between October and March. The fruits are collected by all genders and age groups when ripe and eaten. Unripe fruit is collected and buried in the soil, until it ripens and becomes red. Unripe fruit is not edible and assumed to be poisonous [44]. The authors assessed the relative importance of the species by different methods. Pairwise ranking based on taste of the fruit [18, 36], fidelity level for consumption over 48 hours [36] and Smith's saliency scores [31] showed that the species is amongst the most preferred because of its edibility and marketability [30, 41].

***Rosa abyssinica* R.Br.**



Photograph 3 - Bekele-Tesemma, 2007

Family: Rosaceae

Genus: *Rosa*

Species: *abyssinica*

English name: Abyssinian rose

Vernacular names: Qega/ Kega/gora (Amharic); Qaqa (Tigrigna); Inkoche (Guragigna); Qaqawi, Enqoto, Goro (Afan Oromo); Otila (Sidama); Atim Afar

Edible parts: fruits

Rosa abyssinica can be a prickly evergreen shrub, creeper or climber, or a small tree that grows up to 7 metres in height. Flowers are fragrant and white-pale yellow, numbering between 3 and 20 in dense heads, each stalked. The sepals are long, narrow and hairy, soon fall, have five petals of about 2cm in length, and rounded to square tips, with many stamens. The fruits are green at first, but later ripen to orange-red. They are about 2cm long, fleshy and edible with inner seed [56].

Uses

The species' geographical and seasonal availability was documented in all six regions in 12 of the articles reviewed. It is widely harvested in the period between June and March. The fruits are collected and eaten by children and sometimes by adults. The fruits are eaten whole when ripe, while the seeds are spat out. Consumer preferences for this species were assessed and reported differently by the various authors of the reports we reviewed. Fentahun and Hager [29] reported an average Smith's salience index scores of between 0.3 – 0.98 describing it as the most preferred among the wild edible species by 40% of the respondents in Debark district, Amhara region.

***Ziziphus spina-christi* (L.) Desf.**



Photograph 4 – Wikimedia commons

Family: Rhamnaceae

Genus: *Ziziphus*

Species: *spina-Christi*

English name: Christ's Thorn Jujube

Vernacular names: Qurqura/Arka/Gava (Amharic);

Qurqura/Giba (Tigrigna); Sirah (Gumuzegna);

Qurqura Mi'o (Oromo); gaudii (Malló mucci)

Edible parts: fruits

Ziziphus spina-christi (L.) Desf. is a spiny shrub that can grow into a tree of about 10 metres in height. It is a drought-resistant and hardy species that can be found in very dry areas throughout the tropical and subtropical regions of the world. The bark is grey-brown; when cut at the edge it is reddish; matured bark is grooved and cracking. Flowers are small, 10-25 in number besides leaves that are yellow-green in colour, stalks and calyx are hairy and white. Fruits are yellow and ~2cm in diameter; when dried the colour turns reddish [56].

Uses

The species was documented in 13 of the articles reviewed in all six regions covered by the articles. The plant starts flowering and producing fruits from September to April, thus covering all the months of the short, dry seasons [32]. It is an important fruit as rated in the different articles. Fentahun and Hager [29] reported an average Smith's salience index scores of between 0.21 – 0.71. The fruit is important for income generation, selling at 2.50 Birr per Kg [32]. The ripe fruits are edible and sweet; they are collected by all sexes and age groups. The exocarp is consumed raw.

***Carissa spinarum* L.**



Photograph 5 - Wikimedia commons

Family: Apocynaceae

Genus: *Carrisa*

Species: *spinarum*

English name: bush plum, carisse

Vernacular name: Wanza (Amharic); Bugitsi

(Agewgna);

Urogu (Agnuakgna); Abanga (Bertagna),

Otayita (Konsogna); Waddessa (Oromiffa)

Edible parts: fruits

Carissa spinarum L. is an evergreen shrub or small tree that is abundantly found in Africa, but also present in some parts of Asia (India) and the Middle East (Yemen). Parts of the plants are used for food and medicinal purposes.

Uses

Carissa spinarum L. fruits are very sweet and can be consumed raw or cooked. The fruits can also be fermented to make vinegar. The roots can be left to soak in water jars to impart a good flavour to the water and can also be added to soups and stews to enhance their flavour. Both the fruits and the roots have several medicinal uses, including as an anthelmintic, an anti-inflammatory or as a tonic.

Cordia Africana Lam.



Photograph 6 - <http://www.mi-aime-a-ou.com>

Family: Boraginaceae

Genus: *Cordia*

Species: *Africana*

English name: large-leaved cordia

Vernacular name: Wanza (Amharic), Bugitsi (Agewgna), Urogu (Agnuakgna), Abanga (Bertagna) Otayita (Konsogna), Waddessa (Oromiffa)

Edible parts: fruits

Cordia Africana Lam. is a tree found in most parts of Africa in Polyscias and Podocarpus forests. It grows well in dry, moist and wet midland agroclimatic conditions. It is often found in altitudes ranging between 900 and 2500m above sea level.

Uses

C. Africana has yellowish fruits embedded in hairy cups, which are edible. The fruit flesh is sticky, and each fruit contains up to six seeds. The fruits are often eaten by children in rural areas, but also by adults during periods of famine. Juices from the bark and roots also have medicinal applications to cure diseases such as coughs, toothache, fever and influenza, stomach ache, wounds and skin [63].

***Dovyalis abyssinica* (A.Rich.) Warb.**



Photograph 7 - International Institute of Tropical Agriculture

Family: Flacourtiaceae

Genus: *Dovyalis*

Species: *abyssinica*

English name: Abyssinian gooseberry,
tropical apricot

Vernacular name: Koshim (Amharic), Ankakute
(Oromiffa), Ongolatz (Somalga),
Aihada (Tigrigna)

Edible parts: fruits

Dovyalis abyssinica (A.Rich.) Warb. is a spiny shrub or tree found mostly in Ethiopia and Malawi. It is often found in the upland rain forests, dry evergreen forests, on riverbanks and sometimes in more open woodlands

Uses

Dovyalis abyssinica fruits are collected and eaten raw, mostly by children who enjoy the pleasant sweet-sour flavour of the fruits. Adults also consume them, but mostly in periods of food shortage. The fruits are about 25mm in diameter [64]. They have a thin, tender skin and a juicy melting flesh with an aroma and flavour faintly suggestive of apricots [65]. When fully ripe they can be cooked to make a pleasant tasting jelly [65]. The roots and stems are used for medicinal purposes, as a tonic, cooked and eaten as a soup [65].

***Ficus sur* Forssk.**



Photograph 8 - Wikimedia commons

Family: Moraceae

Genus: *Ficus*

Species: *sur*

English name: bush fig

Vernacular name: Cape fig,
broom cluster fig

Edible parts: fruits and young leaves

Ficus sur Forssk. is a deciduous tree that can grow to a height of 30 metres. In drier areas it grows to around 10 metres. Common in tropical Africa, it can be found in areas where abundant rains fall, such as riverbanks, upland forest, woodland and wooded grasslands.

Uses

Ficus sur fruits are eaten raw or cooked. Young leaves can be consumed as vegetables. *Ficus sur* has many applications in traditional medicine, for which the latex, roots, bark, leaves and sap are used for different purposes.

***Ficus sycomorus* L.**



Photograph 9 – Wikimedia commons

Family: Moraceae

Genus: *Ficus*

Species: *sycomorus*

English name: wild fig, bush fig, sycamore fig

Vernacular name: Shola/Bamba/Banba

(Amharic); Shamfa, Wushanfa (Tigrigna)

Wushanfa (Tigirgna)

Edible parts: fruits and leaves

Ficus sycomorus L. is native to Africa south of the Sahel and north of the Tropic of Capricorn, excluding the central-west rainforest areas. In Ethiopia it grows in Amhara region, Adiarkay, Chilga and Simada woredas. In its native habitat, the tree is usually found in rich soils along rivers and in mixed woodlands. The fruit is a large edible fig, up to 10cm long and 2-3cm in diameter, ripening from buff-green to yellow or red. It is eaten both fresh and dried. Flowering and fruiting occur year-round, peaking from July to December.

Uses

F. sycomorus L. is a plant of many uses, mainly consumed for its sweet and aromatic fruits, which can be consumed raw, cooked or dried. Fermented fruits are distilled to make an alcoholic beverage, similar to gin. The leaves can be used in soups.

***Ficus vasta* Forssk.**



Photograph 10 – Bahir Dar University, 2016

Family: Moraceae

Genus: *Ficus*

Species: *vasta*

English name: fig plant

Vernacular name: Warka (Amharic); Daiero (Tigrigna)

Edible parts: fruits

Ficus vasta Forssk. is a fig plant that is primarily endemic to Ethiopia and Yemen, but can also be found in the Sudan, Somalia and Saudi Arabia, and in the African Great Lakes region such as Uganda and Tanzania. It reaches a height of 25m and presents a massive trunk. The tree grows along rivers forming stands or thickets; however, the tree is not cultivated under domestication and is disappearing due to human pressure, mainly for its use as firewood.

Uses

Ficus vasta figs are edible and often collected by children. They are also eaten by sheep, goats, monkeys (including baboons) and birds. The figs can be eaten right off the tree, half or fully dried. Dried figs can be stored and eaten throughout the year, as needed.

***Grewia damine* Gaertn.**



Photograph 11 - <http://pza.sanbi.org/grewia-bicolor>

Family: Tiliaceae

Genus: *Grewia*

Species: *damine*

English name: white raisin

Vernacular name: Harorecha/ Haaroressa
(Oromifa) Daiyta, Dahita, Dawaita (Afa Konso)

Edible parts: fruits

Grewia damine Gaertn. is a many-stemmed shrub. The leaves are alternate, elliptic to lanceolate, broad and typically bi-coloured. The fruit is a two-lobed drupe, sometimes hairy, orange to purple black in colour and with a hard-woody endocarp.

Uses

Grewia damine Gaertn. is a multipurpose shrub. The wood is valuable for construction, utensils, fuel and charcoal. The bark can be used for ropes and the sticks are used for basketry. Bark and roots have many ethno-medicinal properties due to their high content in triterpenes and alkaloids. The berries are edible and used to make drinks.

***Opuntia ficus-indica* (L.) Mill.**



Photograph 12 - <https://pixabay.com/en/cactus-fruits-fruit-plant-1943019/>

Family: Cactaceae

Genus: *Opuntia*

Species: *ficus-indica*

English name: prickly pear, Indian fig
opuntia, barbary fig and spineless
cactus

Vernacular name: Gambora (Burji);
Kelekella (Guragigna); Qulqualita,
Papaldotta (Afa Konso)

Edible parts: fruit and pads

Opuntia ficus-indica (L.) Mill. is an evergreen, large, bushy cactus plant that can sometimes develop a strong, woody trunk and can grow up to 5 metres in height. It has shallow fleshy roots. It is typical of the cool, semiarid tropics and subtropics. *O. ficus-indica* was domesticated in ancient times and is the most widespread and most commercially important cactus, and it likely originated in Mexico

Opuntia ficus-indica is found in many parts of northern Ethiopia (Tigray), Benishangul Gumuz region and in Debre-Zait (Oromia region). In Tigray, uncultivated cacti cover about 32,000 ha. Farmers plant and maintain backyard and edge rows cacti, though most of the harvested fruit comes from wild-growing cactus plants. Prickly pear is an integral part of the culture and economy of Tigray's inhabitants. The fruits are up to 10cm long and 9cm wide and are eaten fresh in months of July to September. [61]

Uses

This plant has long been cultivated for its edible fruits: sweet and refreshing, they can be eaten raw, cooked or dried in a variety of manners, and are very nutritious. In Northern Ethiopia the pads are cooked and consumed as a vegetable, once the thorns have been removed from the pads.

***Solanum americanum* Mill.**



Photograph 13 - <https://pixabay.com/photos/black-nightshade-plant-vegetable-2352800/>

Family: Solanaceae

Genus: *Solanum*

Species: *S. americanum*

English name: American black nightshade

Vernacular name: Awit, Tikur awit, Tinishu

awit, Awtign, Awichign, Yechaka gomen

(Am); Ammalo (T), Func'a

Edible parts: fruits and leaves

Solanum americanum Mill., or American black nightshade, is a common short-lived perennial shrub, found in many wooded areas, as well as undisturbed habitats. This species was mentioned in seven papers in our review and was found in five Ethiopian regions (Amhara; Benishangul Gumuz; Oromia; SNNPR; and Tigray). Local names include Awit, Tikur awit, Tinishu awit, Awtign, Awichign, Yechaka gomen (Am); Ammalo (T), Func'a [16, 19, 42].

Uses

Both the fruit and the leaves of this plant are edible and in Ethiopia are consumed by adults and children alike. The peak harvesting season is June to September. *Solanum americanum* can sometimes be confused with the more toxic nightshade *Atropa belladonna* L., from a different Solanaceae genus. A comparison of the fruit shows that the American black nightshade berries grow in bunches, whereas the deadly *Atropa* nightshade berries grow individually. During focus group discussions, no undesired side effects from consuming the fruits were reported [19].

Leaves of *S. americanum* ranked third in a pairwise ranking based on taste of seven green leafy vegetables in study area. The leaves are also considered medicinal and effective for abdominal pain and malaria [16].

Tamarindus indica L.



Family: Fabaceae

Genus: *Tamarindus*

Species: *indica*

English name: tamarind

Vernacular name: *Hura, Dogha [16]*

Edible parts: fleshy fruit

Photograph 14 - Girma Yinebeb., 2014

Tamarindus indica L. is indigenous to Africa and has achieved a modest commercial potential in Senegal, Gambia, Kenya, Tanzania and Zambia [57]. It is also common in Asia and Latin America. It is considered a multi-purpose plant with uses for most parts of the tree. This species was mentioned in seven papers in our review (see Table 3) and was found in five regions (Afar, Amhara, Benishangul-Gumuz, Oromia, and SNNPR).

Uses

Tamarind is widely consumed due to its central role in Asian and Latin American cuisines. In Ethiopia, the fruit is soaked in cold water for 12 or more hours to make juice [62]. The pod containing a pulpy fruit is light brown in colour and not edible. The edible inner flesh is described as having a mild taste between sour and bitter [44], however, other literature describes the fruit as both sweet and sour in taste. Tamarind is high in B vitamins, sugar and calcium. The edible fruit is mature when the flesh is brown or reddish brown. The tamarind fruit ranked third out of a pairwise ranking of seven wild edible fruits in the Bullen district of Ethiopia [16].

***Ximenia americana* L.**



Photograph 15 -
<https://www.flickr.com/photos/pondapple/5963679978>

Family: Olacaceae

Genus: *Ximenia*

Species: *americana*

English name: hog plum, wild plum, yellow plum

Vernacular name: *Helena, Inkoy, Meyo (Berhanu 2017)*

Edible parts: fruits

Ximenia americana L. is a small, sprawling tree native to the tropics. This species was mentioned in 16 papers in our review and was found in five regions (Afar; Amhara; Benishangul-Gumuz; Oromia; SNNPR).

Uses

This species ranked among those wild fruits widely sold at a local level [47]. At Kurar site of Dejen district, in Amhara, *Tamarindus indica* (80%) and *Ximenia americana* (20%) were the species of utmost preference [31]. The fruits have a pleasant, plum-like flavour. In Asia, the young leaves are cooked and consumed as a vegetable. However, the leaves need to be thoroughly washed and cooked as they contain cyanide and should not be eaten in large amounts.

8. Nutritional contribution of WEPs

Wild edible fruits and vegetables are rich in vitamins (e.g. vitamin C) and selected minerals. WEPs are often reported to be rich in phytochemicals like polyphenols, and most have documented medicinal properties. The nutritional content of WEPs was reported in only 12 of the 47 papers, and only for selected macro- or micro-nutrients. The composition data was of inferior quality, with only a few of the studies supplying adequate descriptions of (i) the sampling procedures followed for obtaining a representative sample of WEPs, and (ii) the analytical methods and quality control procedures applied during analyses. **Table 4** presents the energy and nutrient content of selected species to illustrate the potential of WEPs, but also to highlight the critical gaps in food composition data for these species.

Table 4 - energy and nutrient content of selected species to illustrate the potential of WEPs

Species	Moisture	Energy (Kcal)	Protein (g)	Fat (g)	CHO (g)	Ca (mg)	Fe (mg)	Zn (mg)	VitC (mg)	Reference
<i>Balanites aegyptiaca</i>	63.5	59	10.5	0.9	14.9	908	4.90	0.4		[17]
<i>Mimusops kummel</i>	13.1		2.2	1.6	80.5		2.95			[30]
<i>Ziziphus spina-christi</i>	7.6	79	3.2-4.8	0.9-1.2	80.7	140	-	-	30.0-35.2	[30] Saied et al., 2008 Nour et al. 1987 Abdelmuti 1991 Duke 1985 Berry-Koch et al. 1990
<i>Carissa spinarum</i>	84.2	62	0.5	1.3	13.6	11	1.31	-	38.0	[58]
<i>Tamarindus indica</i>	41.3	-	2.4	1.1	53.0	-	2.08	-	11.3	[30]

Source: Data extracted and compiled from the 45 papers reviewed for this study.

Table 4 illustrates that species such as desert date (*Balanites aegyptiaca*) are relatively rich in protein and calcium, whereas Christ's thorn jujube (*Ziziphus spina-christi*) and bush plum (*Carissa spinarum*) are rich sources of vitamin C. Given that most of the nutrient composition data was documented by non-nutritionists/food scientists, and that the information is presented in the context of highlighting the

importance of these species as famine foods, many of the studies focused on reporting only the macronutrient composition. This is unfortunate, given that these species are likely to contribute more to micronutrient intake than to energy intake. Moreover, despite the consumption of WEPs in some parts of the country, the lack of information on their food composition hindered the estimation of WEPs' contribution to nutrient intakes. Therefore, every effort should be made in the future to update the Ethiopian Food Composition Table with information on the nutrient composition of WEPs as and when it becomes available. Nevertheless, given the documented evidence of fruits and vegetables as the cornerstone of a healthy diet, the consumption of wild edible fruits and vegetables should be promoted in the Ethiopian food-based dietary guidelines that are under development.

9. Ways forward: gaps in and opportunities for the promotion and use of indigenous foods

Generally, diets in Ethiopia are low in diversity and are lacking the critical components of a healthy diet such as fruits and vegetables. The low production of fruits and vegetables, their seasonality and unaffordability constrain Ethiopians from reaping the health benefits provided by regular consumption of fruits and vegetables. This, added to the ever-increasing morbidity and mortality from NCDs on top of the already high burden of undernutrition, is stretching Ethiopia's health system to the extreme.

Wild edible fruits and vegetables have the potential to greatly improve diets by providing alternative sources of more affordable, nutritionally-rich fruits and vegetables, with the added advantage of being available all year round, and the ability to grow in drought-prone, water-stressed areas. Unlike cultivated fruits, some of the wild edible fruits exhibit good shelf life, hence they are better adapted to settings where a cold chain is not available. However, integrating wild edible fruits and vegetables into markets, and designing a functional and efficient value-chain, is key to ensuring increased availability and consumption.

In Ethiopia, children and the sick are often prioritized when it comes to consumption of fruits. This illustrates that Ethiopians are perhaps aware of the benefits of these foods, but because of poor access and unaffordability they are forced to ensure that only the weaker members of society, such as the children and the sick, to reap the benefits of these nutritionally-rich food groups. More specifically, consumption of wild edible fruits is often observed in rural areas, mostly by children (herders), but also by adults during times of food scarcity. This has perhaps unintentionally led to the general perception that wild edible plants are famine foods or foods for children and the poor. These misconceptions need to be targeted by behavioural change communication interventions, if diets are to include these precious foods. With urbanization, shifts

in dietary patterns and agricultural policies focusing mainly on cereal yields, there is a decline in knowledge and habits of consuming WEPs [27]. The limited research attention given to WEPs to date, reflected in the gap in information about the nutrient composition of wild edible plants, has also not helped to bring Ethiopia's hidden treasures to the forefront due to. Consequently, although WEPs are consumed abundantly in regions like Benshangul-Gumuz, it was not possible to accurately account for their contribution to nutrient intake in the Ethiopian Food Consumption Survey.

However, opportunities exist to revitalize Ethiopian interest in and use of wild edible fruits and vegetables to improve diet quality and promote health. Nutrition and health policies of the country now recognize the consequences of all forms of malnutrition and identify poor diets as the most important cause. Several agricultural policy documents like the Second Agricultural Growth Programme (AGP2) and the Nutrition-Sensitive Agriculture Strategy Ethiopia, one of the cross-cutting issues in AGP2, call for the promotion of locally-available, underutilized and nutrient-dense foods. Besides, the year-round availability of wild edible fruits, their consumer acceptability and their potential to supplement diets during fasting seasons, droughts and food scarcity, makes them essential ingredients in the fight against food and nutrition insecurity in Ethiopia. The year-round availability of fruits of different species within and across the study areas also presents an opportunity for trade, which brings powerful motives for local people to conserve wild fruit species and encourage their domestication.

10. Conclusion and recommendations

Although indigenous foods have the potential to contribute positively to food and nutrition security in Ethiopia, little emphasis has been placed on promoting their use. We have found very few recent studies that confirm the cultural wisdom of the nutritional value of indigenous foods. The studies conducted on Ethiopia's WEPs only cover about 5% of the country's districts. Thus, the nutrient profiles of indigenous foods and their potential contribution to nutrient intake in the regions of Ethiopia need to be further documented.

Emphasis must be placed on increasing public awareness on the importance of indigenous foods. Ethiopia urgently needs to introduce and implement policies and interventions that will promote agricultural biodiversity and support the consumption and conservation of WEPs in order to improve diet quality. We also recommend further documentation of the indigenous knowledge, culinary practices and nutritional composition of the semi-wild and wild edibles, to integrate and update the Ethiopian food composition

tables. The Ethiopian Food-based Dietary Guidelines provide an unprecedented opportunity to promote the consumption of healthy diets that are rich fruits and vegetables; not only domesticated fruits and vegetables, but also semi-wild and wild fruits and vegetables that can be considered Ethiopian treasures to be widely promoted to provide a wide range of options for consumers.

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