

Wild Edible Plants Traditionally Collected and Used in Southern Yemen

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Research Article

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Abstract

Background: The local wild edible plants (WFPs) are still used traditionally in the rural communities in Yemen but this traditional knowledge is still undocumented and has been never reported before. Therefore, this study is the first ethnobotanical survey on WFPs conducted in Yemen.

Methods: This study is based on two field surveys made between 1988 and 1992 and between 2014 and 2016 to document the wild plants used as edible by local indigenous peoples in 15 districts belongs to six governorates, in southern Yemen. Information data were collected by oral face-to-face interviews from 250 informants. Percentage of citation were calculate for each species.

Results: A total of 58 plant species belong to 37 genera and 21 families are reported as wild edible plants consumed in southern Yemen. Apocynaceae was the dominant plant family with 18 species followed by Asteraceae (6), and Malvaceae (5). The most widely used edible parts are stem, leaf and fruit with more than 17 species for each. Herbs were reported as the most important sources (31 species), followed by shrubs (16) and trees (9). Most of reported wild edibles (48 species parts) are consumed in raw form; only 12 of them are cooked. Seven wild edible plants were collected in dry season, 16 species throughout the year, and 38 in rainy season. In this study, 58 wild plants were reported for the first time as food in Yemen. Comparing the southern Yemeni findings to those from other world countries, 12 of them are eaten only in southern Yemen, while 46 are consumed in different world countries practically in East Africa.

Conclusions: The results data reflects the strong relationship between the local peoples and the wild plants and the valuable knowledge of the uses of wild species as potential sources for traditional food. The use of these wild plants is attributed to food shortage, nutritional values, and local cultural tradition. This study preserves the oral traditional knowledge of the local wild plants used as food and/or nutraceutical sources for human in the future instead their losing at risk of time, immigration and wars.

Introduction

Collection of wild plants was the first source of food for human besides hunting; however, this wild source has been continued also after the emergence of agriculture and animal husbandry. Ethnic peoples have kept in their memory the traditional knowledge of wild food plants as heritage and transmitted it orally through generations. The relationship between human and plant is considered an ecological balance system since ancient times to preserve living organisms in the earth. Therefore, the “ethnobotany” studies the relationship between humans and plants. It aims to survey and to document the different local wild plants using by ethnic groups for therapy, nutrition, and economic proposes [1]. In developed countries, in Europe, wild edible plant is considered to be an iconic ecosystem factor [2]. Many ethnobotanical researches have resulted the importance of the wild edible in saving people during famine, drought, and war in different developing and developed world countries [3, 4].

Even there is now modern agriculture technology; the local people in Yemen still have strong relationship to the wild edible plants. Many conditions that have made an attention by local people to the wild plants as an important food including the economic crises, the unlimited war, and the continues political and tribal conflicts. Moreover, the aridity and drought are general climatic characters of the Yemeni tropical southern rural regions, due to the lack of rains during one or more years, therefore the agriculture did not provide sufficient crops for food. In this situation, local people were dependent on consumption of local agricultural crops until the 18th century. Southern Yemen including the study area has a large geographical region and wide diversity in mountains, deserts, plains, and islands [5, 6, 7]. It has a rich diversity of plants, especially in some of the islands and the inner depth of the country [7].

On other hand, along with its importance as edible, modern science is proving to be important sources for disease resistance [5]. In ancient Arab-Islam medicine, *Al-Razi* (865-910 C.E.) identified for the first time the relationship between food and medicine. He wrote a famous book about the “benefits of the foods and avoid their undesired effect”; that has the fact that “your medicine is in your food”. Therefore, we can indicated that, *Al-Razi* was the father of the health nutrition or nutraceutical science.

The phytochemical contents of many wild edible plants have been previously investigated focused on their nutritional and antioxidant constituents, which effect human nutrition and health [8]. Generally, wild edible plants contain two metabolites groups: a) the primary metabolites, which are essential agents for organism life: carbohydrates, fats, protein, and mineral elements and b) the secondary metabolites as antioxidant agents mostly polyphenols and vitamins that protect plants. Compared to the cultivated food plants, the wild plants are the ideal and richer natural sources for the inorganic metabolites (minerals) for balance of human and animal health. The high content of the mineral elements gives the important differences between the wild and cultivated food plants.

The available published studies on the wild edible plants are rare to Arab countries except to neighboring Oman where numerous wild edible plants have been reported [9]. In contrast, there are high interest in the regional African countries such as Ethiopia [4, 10, 11] focusing on studies of the local wild edible plants.

Moreover, there are no reports about the traditional knowledge on wild edible plants neither in southern Yemen nor in Yemen except for Soqatra Island, which were reported previously by [6]. The present study presents for the first time the wild edible plants of southern Yemen as well as for Yemen in general. It should be establishing the basis for data of the traditional knowledge of the edible wild plants for Yemen and Arabian Peninsula.

The aims of the current study are: (1) documentation of the wild plants using as food for human in southern Yemen, and (2) identification of the new species used as food through the comparison the reported wild edible plants with data of other traditional systems in neighboring, regional and world countries.

Materials And Methods

Study area, ethnobotanical and demographical data

This study is based on two field surveys made between 1988 and 1992 and between 2014 and 2016 to document the wild plants used as edible by local indigenous peoples in 15 districts belongs to six governorates, in southern Yemen (Table 1).

Information data were collected by oral face-to-face interviews from 250 informants; most of them were adult and elderly. No significant difference between the number proportion of men (48%) and women (42%) who were interviewed in Arabic language. The informants were housewives, villager, farmer and shepherds besides student in schools. Ethnobotanical data that were primarily aimed to document are: local names of the plants, growth form of plants, edible parts, time of collection (season) and consumed modes. Some care was taken to document the local names of each species in the different localities and the local names of the used parts or products obtained from the wild plants.

The taxonomic identifications were carried out in Pharmacognosy Department, Aden University. Most of the collected plants specimens were identified using references of botanical data on Yemeni flora [5]. Voucher specimen were deposited at Al-Fatima's Herbarium. Acceptance taxonomic names of species were done using "The Plant List" (www.theplantlist.org) and for Apocynaceae species were done based on Meve and Liede [12]

Organoleptic properties of used parts

The taste is an important organoleptic property used to determinate a crude drug or food. Therefore, each reported wild food part were examined to document the taste types.

Data analysis

For each wild plant species, a percentage of citation (C%) was calculated. The C% index expresses the number of informants who cited a specific wild edible plant divided by the total number of informants and multiplied by 100.

Comparative studies on literature review

A Comparative study based on literature review was conducted. The obtained local data were compared with data from studied conducted in neighboring and regional countries. This aims to identify the new local wild plants that reported as food for the first time.

Results

Local names of plants

The indigenous people of southern Yemen are capable for naming and classifying the plants, which they have been using as food (Table 1). They can instantly differentiate between plants with similar morphology and give them different names. They give local names not only for the wild plant species but

also for the edible parts and exudates of plants. Instance, the name of the plant species *Acacia nilotica* (L.) Delile is *qaradh*, while the name of its edible gum is *samaa* (Table 1). Moreover, the different edible parts of single plant have different local names: example, the species *Ziziphus spina-chisti* (L.) Desf.; the tree is named *elb*, its edible fruit is named *daom*, and the seed endosperm is named *fersoos* or *ferquoos* (Table 1). On the other hand, the different species of one genus or the different subspecies of a species, of which different parts are used, were differentiated using different local names. Example, *arnaq* is the name of the edible stem of *Cynanchum viminalis* (L.) L. and *alab* is the name of inedible and toxic stem of *Cynanchum viminalis* subsp. *undefined*. These different local names help to avoid the confusion of the products, which is essential due to the toxicity of stems of the species.

The local names for each plants in different localities (urban and villages) in southern Yemen are shown in (Table 1, Fig.1,2)

Ethnobotanical data

Fifty-eight wild plant species were reported to be used as food sources in southern Yemen, belonging to 21 plant families and 37 genera. These traditional knowledge data obtained from field surveys are summarized in (Table 1) for use as food.

Botanical data about species, general and families of the WFPs in southern Yemen are represented in (Table 1, Table 2). Most of species belong to the Apocynaceae family (18 species), followed by Asteraceae (6 species), Malvaceae (5 species), Moraceae and Fabaceae (4 species for each), Rhamnaceae and Amaranthaceae (3 species for each) and Portulacaceae (2 species). The remained 13 families presented by one species for each. The genera presented highest species are *Cynanchum* and *Ficus* (4 species for each), *Acacia*, *Amaranthus*, *Desmidorchis*, *Grewia*, and *Monolluma* (3 species for each) followed by *Corchorus*, *Launaea*, *Portulaca*, *Rhytidocaulon*, and *Ziziphus* (2 species, for each). The remained twenty-five genera represented by one species for each (Table 2). This indicates the high diversity of the flora of southern regions of Yemen.

Life forms

Local people used wild edible plants with different life forms: herbs, shrubs, trees and climber. Of them 31 species are herbs that presented (53.45%) of the total species; followed by shrubs, with 16 species (27.59%) trees with 9 species (15.52%) (Fig. 3).=

Edible parts and collection time

Sixty-three edible parts and five plant exudates are reported to obtain from 58 wild plant species. Stem and leaf were the most used parts (18 species for each), followed by fruits (17), and flowers (5) (Table 3). Moreover, products from plant parts such as exudates: flower nectar and gum were reported to use in by local people (Table 3).

The wild edible parts were gathered at different time of the year. Most wild edible parts (38 parts) are collected in the rainy season. While sixteen wild edible parts were collected throughout the year, 16 species parts were collected in the dry season, and only seven plant parts are collected in the dry season. *Cissus rotundifolia* Vahl leaves and *Ziziphus spina-christi* fruits are the important and most cited wild edible plants, which are available in whole year (Fig. 1, 2). The leaves of *Cissus rotundifolia* are still green during the year even in time of rainfall lack; therefore, these leaves were gathered and consumed during times of food shortage. Some wild food plants are found only after heavy rain, which grow quickly after rains with high-disturbed abundance on either ground such as *Amaranthus graecizans* L., *Cynanchum viminale* (L.) L. and *Monolluma quadrangular* (Forssk.) Plowes, or underground such as *Hydnora abyssinica* A.Br. Others wild species collected in the rainy seasons are rare and found seldom which are *Ceropegia bulbosa* Roxb., *Rhytidocaulon macrolobum* Lavr., *Rhytidocaulon tortum* (N.E. Br.) M.G. Gilbert, and *Cynanchum viminale* subsp. *suberosum* (Meve & Liede) Goyder (Table 1).

Modes of consumptions

All of the edible parts wild edible plants are eaten fresh and immediately after collection and are not stored except the fruits of *Ziziphus spina-christi*, which can be dried and stored that were thus of critical importance in times of edible scarcity. Even gum of the *Acacia* species, the local people like to eat it fresh semiliquid. Nineteen of total 61 reported wild edible parts are cited to eat as tender young parts. Most reported wild plants parts (46 species) are eaten fresh raw and uncooked, while only twelve edible parts are cooked include, *Amaranthus graecizans*, *Cissus rotundifolia*, *Cleome gynandra* L., and *Corchorus tridens* L. Of them, three edible parts can be eaten either raw or cooked *Hydnora abyssinica* flower, *Portulaca oleracea* L. and *Portulaca quadrifida* L. herb (Table 1).

Traditional knowledge and citation values

Most local wild plants were reported with highest frequency to be used as edible (Table 1, Fig. 1,2). Thirty-four species of total 43 plants, were reported by all informants (100%) in southern Yemen, which included *Amaranthus graecizans*, *Cleome gynandra*, *Corchorus trilocularis* L., *Desmidorchis awdelianus* (Deflers) Meve & Liede, *Ficus palmata* Forssk., *Hydnora abyssinica*, *Monolluma quadrangular*, *Portulaca oleracea*, and *Ziziphus spina-christi* (Table 1, Table 4, Fig. 1,2). More than 90 % informants reported seven wild plants to use frequently as edible sources. Thirteen species were reported by more than 50% of the informants. Only 11 species were reported as wild edibles by less than 50% of the informants (Table 1).

Organoleptic characters of edible parts

The taste character of each wild edible part was tested or cited by informants and results are shown in (Table 1). Twenty-four wild edible parts are described with bitter taste, followed by twenty-three parts with sweet taste, eleven have sour taste and three products have mucilaginous taste. The most taste of the edible parts is a palatable bitter taste. Elder local people in studied regions say, "What bitter (*murr*) is, it is a medicine (*dawa*)". The specific delicate and taste of most local wild edible parts were an important

factor to remain this traditional knowledge still live among local people. The taste is an important organoleptic property to determinate the quality of a crude drug.

Discussion

Study area

The studied area was selected due to its important biodiversity and ethnobotany [5, 7] and lack of the documentation for the traditional knowledge of wild edible plants neither in the study area nor in Yemen. Therefore, this study can establish the first and essential step in the traditional knowledge of local wild plants using as wild food and wild nutraceuticals in Yemen and nearby Arab countries. We observed in the study area that there is a strong relationship between local people and the environment and therefore they have a high traditional knowledge among indigenous communities to identify food from the wild plants instinctively. It is observed that the local people have traditional behavior to the rational use of the roots of the wild plants [5]. Moreover, most of these studied wild edible plants are widely distributed across the southern Yemen.

Botanical data and life form

Local people can accurately determine the local wild plant species with different local names, according to their morphological characteristics. They can differentiate between species belongs to one genus to know which of them is edible and which is toxic. Instance, they the species of *Aloe* and *Cynanchum*.

Apocynaceae has the highest number of wild edible species due to the abundance and diversity of this family species in the flora of southern Yemen [5, 7]; which was previously not reported in other countries as most source for edible species.

Herb was rarely reported as most life form for wild plants foods such in this study area. In contrast, shrub or trees were reported as usually most sources for wild food in different world localities such in Uganda [26] and Ethiopia [33].

Used parts and collection time

Fruits were the most frequently used parts in many world countries [17, 26, 34]; while fruit, leaf, and stem were reported as the most used parts in the study area. The high frequently use of the fresh wild edible parts indicted that the fresh parts contain highest nutritional values than dried parts; which may be loss their nutritional metabolites by heating.

The collection time of the wild food plants are dependent on the availability of the used parts that most found only after rainfalls. The growth of the wild edible plants in the semiarid region of southern Yemen is effected by the rain (*madtar*) and draught (*gadb, gafaf*) during the year.

These findings confirm that local wild plants are still required as an important traditional food sources for local people in studied regions, similar to other many semiarid countries [11, 17].

Traditional knowledge, citation level and modes of consumptions

Most reported edible plants were cited to use by all the informants, they knew most of the reported wild edible plants and still eat these wild plants foods. This high citations level indicates two important specific data of the local traditional knowledge: 1) the high and wide share of traditional knowledge among all informants types, women, men, children, young, and adult. This traditional knowledge distributes among the local people as a local traditional in southern Yemen; and 2) the high and close connection and strong relationship between the local people and nature; this indicated through their high appreciation for the environment, plants, and animals. Therefore, this traditional knowledge of wild plants as a food has always been used and demanded by the local people even the economic, political, and environmental events and the factors of time that have affected the different life sides in the country. There are 15 top most important wild edible plants cited by all informants and recommended for sustainable use (Table 4).

It was observed that the wild edible plants still use in southern Yemen for their importance as food security and as nutritional sources. Therefore, local wild edible plants can be classified into four groups according to their uses benefits by local peoples in the study are:

- *Wild edible plants are using during time of food shortage: Ziziphus spina-christi* (fruit), *Cissus rotundifolia* (leaf), and *Monolluma quadrangular* (stem).

In this ongoing war in Yemen, the use of *Cissus rotundifolia* leaves has spread as food for many poor people in many Yemen regions. This plant has wide distribution throughout the year in all the country regions. The fresh leaves are boiled in water with salt, where the cooked leaves are eaten. In some area of southern Yemen, the leaves of *C. rotundifolia* can be cooked with *Cleome gynandra* leaves. In other case, the crushed leaves are mixed in water with flour in the boiling water to make flour dough. The plant leaves added to the flour, when the stock of wheat is not in sufficient quantity due to economic crises or war. The leaves have a sour taste similar to vinegar; if not cooked, therefore, it was as natural vinegar in the Arab old manuscripts of traditional food and medicine [].

Ziziphus spina-christi distributed vey wide in southern Yemen mostly on the edges of agricultural areas. Its fruits are important food for the local people. They can eat the fruit fresh or dried. Dried fruits are sweeter than fresh fruits, they can be stored for some weeks. This plant is considered as an important botanical and ecological manifestation of the region. Not only as a source of food, but for many popular uses, the most important of which are for shade, grazing and household appliances and for many medicinal properties [5]. *Z. spina-christi* is one of the most popular wild plants food that local people eat, especially children. Immature fruit has a sweet sour taste and fully ripened fruit has a sweet taste with some sourness. When dried, it changes into orange-red and becomes a very sweet taste. This is evidence that it contains a high percentage of sugars that help to store it for a long time.

Many wild plants belong to the Apocynaceae. Local people like to eat their moist, fleshy stems growing after the rains; specially the upper branches newly growing in the stems of the plant. The stem has a sticky taste and a sweet bitterness.

- *Wild edible plants are using for home consumption by family:*

These plants grow with sufficient water in rainy time. Therefore, they used as supplements to households due to their luxury and delicate nutritional values and have been cited by all informants are leaves of *Amaranthus graecizans*, *Amaranthus blitum* L., *Corchorus trilocularis*, *Cleome gynandra*, *Portulaca oleracea* and *Lactuca serriola* L.

Local people like to eat these edible leaves for their sweet tastes and nutritional benefits. The leaves of these wild plants are cooked in boiling water and a pinch of salt is added. Some of these plants may be cooked in mixture such as leaves of *Portulaca oleracea* and *Corchorus trilocularis*. These two plants appear in the rainy time, mostly near farmland. *P. oleracea* leaves have salty taste and can be eaten fresh. Mostly the leaves cooked with other vegetables. *C. trilocularis* leaves have mucilage taste, and eaten only cooked with salt.

The fruits of *Ficus palmata* are one of the most important wild fruits that people like to eat for their delicious tastes and as home consumption. They often grow in high places in the region but their presence is seasonal and limited.

- *Wild edible parts are using regular by children:* as delicate wild foods, including *Ziziphus spina-christi* (fruit), *Hydnora abyssinica* (flower), *Anisotes trisulcus* (Forssk.) Nees (flower nectar), and *Opuntia ficus-indica* (fruit). The traditional knowledge of wild edible plants by children and young over 12 years was high and accurate. They can collect the fruits of *Ziziphus spina-christi* in big mass. They know the growth places in the underground and the growth time of the flowers of *Hydnora abyssinica*, especially after the rainy period. The flower of this parasite plant is fleshy and soft part, it has aromatic smell because it contains volatile compounds that we reported in previous study [28]. The flower can be eaten fresh with aromatic and astringent taste. The local people mostly like to eat it cooked, and usually the flower are roasted over coals, thus eliminating the volatile components; therefore, it tastes mild sour and delicious with a distinctive plant flavor. Children like to pick the red flowers of *trisulcus* and suck their very sweet-tasting nectar to give them energy.

O. ficus-indica grows on the high plateaus of the southern region. Its fruits can be sold in popular markets as delicious sweet fruits.

Wild edible plants in folk markets

The wild edible plants with highest citations frequency have also commercial values; some of them were found in the local markets, including the fresh herbs of *Amaranthus graecizans* and *Portulaca oleracea*, fresh or dried fruits of *Ziziphus spina-christi*, fresh fruit of *Ficus palmata*, and *Opuntia ficus-indica* (L.) Mill., fresh stems of *Monolluma quadrangular*, *Desmidorchis awdelianus*, and *Orbea wissmannii* Bruyns,

fresh flowers of *Hydnora abyssinica*, and fresh or dried gum of *Acacia nilotica* (Table 1, 4). Storable wild foods are only two plant products: *Acacia nilotica* (gum) and *Ziziphus spina-christi* (fruits).

Different collected wild edible parts were found in the folk markets as entire fresh, dried parts and dried exudates. In addition, some of these wild plants have faced the risk of extinction, due to increased collecting and marketing and due to over exploitation in the last ten years such as *Hydnora abyssinica* and *Monolluma quadrangular*.

The cultural tradition is an important factor that made people still use these wild edible plants in southern Yemen. They still keep their cultural tradition and still gather wild edible plants as a preferred food to imported industrial food. Besides the characteristic delicious tastes of the WEPs, the local peoples called this wild edible plants as “*vitamin baldi*” means “local rural vitamins” which are also strongly required in the cities of the country. In addition, the local people faith that the WEPs consumption give a natural powerful immunity force “*quwah*” against infectious diseases. Therefore, indigenous people described a wild edible plant as “*dawa*” means “*health food*” which can give “*quwah*” means immunity with strong general health. Compared to our previous study, many of the local wild edible plants (30 species) were reported in our previous study to have local traditional medicinal uses [5].

Therefore, the local people still keep their cultural tradition and still gather wild edible plants as a preferred food to imported industrial food.

Comparative study

The local traditional knowledge on wild edible plants in southern Yemen has specific characters compared to the traditional knowledge of selected world localities. A total of 58 wild edible plants are reported for the first time for Yemen except *Cissus rotundifolia* and *Hydnora abyssinica* which was reported previously also in our studies [21, 28] and three other species reported by Miller and Morris [6] to use as food in Soqatra island. To know if people in neighboring and regional courtiers use similar wild species as food, we have made comparison per ethnobotanical literature review. Compared to the literature review, 25 wild plants reported in our study were found to be used also as wild foods with same edible parts in different East Africa countries [Table 1]. Where fifteen of them have similar uses reported previously in Ethiopia (Table 1). Sixteen wild plants reported in our study showed similar uses as food in nearby Oman include *Caralluma subulata* (Forssk.) stem, *Senna italic* Mill. fruit, *Crepis rueppellii* Sch. Bip. root, *Cynanchum viminale* subsp. *suberosum* root, *Gladiolus candidus* (Rendle) Goldblatt corm, and *Salvadora persica* fruit (Table 1) [9]. While in other Asian countries, only 11 wild species were found to use as edible parts (Table 1). The similarity in the traditional uses of wild plants in Oman and Southern Yemen is due to the existence of a common relationship between the two countries and the two peoples in terms of similar geographical characteristics, as well as a kind of similarity in ethnic characteristics, heritage, inherited customs, language and history. *Ziziphus spina-christi*, *Hydnora abyssinica*, *Amaranthus graecizans*, and *Monolluma quadrangular* were the most frequently reported to eat in many different countries (Table 1).

For the best of our knowledge, the 58 wild edible plants have never been reported before from Yemen except three species from Soqatra Island [6]. Even all local wild species reported in our study for first time for inland Yemen, most of them were found to have similar use as food in the traditional knowledge of other countries based on the literature, with some different in edible parts or consumption modes (Table 1). However, twelve edible plants recorded in this study were not found to have been used as food before in any other country, according to the literature; they are marked with bold in (Table 1) and summarized in (Table 5).

Conclusions

This is the first and sole ethnobotanical study on the wild edible plants from Yemen. The study reports for the first time the traditional knowledge on 58 wild edible plants consumed by local people in southern Yemen. Moreover, the literature comparison indicated that 12 plants or parts of them are unknown as edibles and have not been reported previously anywhere in the world, as wild foods. These including such as the flower of *Aloe lanata* and *Anisotes trisulcus*, stem of *Desmidorchis awdelianus*, *Monolluma hexagona*, *M. solenophora* and *Orbea wissmannii*. This clears evidence for the strong relationship between the indigenous people and the nature. Nowadays most local people in southern Yemen still consume wild edible plants as food security in the war and as local traditional culture. They faith that these local WEPs contain high and specific nutritional values compared to the industrial food and have high potential power to increase the human immunity against diseases. Therefore, many local wild edible species become to have commercial values and use frequently including *Amaranthus graecizans*, *Corchorus tridens*, *Hydnora abyssinica*, *Monolluma quadrangular*, *Rhytidocaulon macrolobum*, and *Cynanchum viminalis*. This study preserves the traditional knowledge of the wild edible plants in a region ravaged by wars, conflicts and economic crises that threaten to lose of this local traditional knowledge.

Declarations

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Authors' contributions

The author designed the research, analyzed data, wrote, and revised the manuscript. The author read and approved the final manuscript.

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Availability of data and materials

All analyzed data and materials have been presented in research article.

Ethics approval and consent to participate

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Consent for publication

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Competing interests

The author declares that he has no competing interests.

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Tables

Table 1 Wild edible plant species used by local people in southern Yemen

Botanical Data: Plant species name (Plant family), Voucher numbers	Local name of species (Locality number)	Life form/ season	Edible part: Consumed modes; taste; (Citation %)	Similar use in other countries [References]*
<i>Acacia gerrardii</i> Benth (Fabaceae), SA 83	Tree: Taleh ((1e), Gum: Samaq (1e)	Tree/ dry	Gum: chewed and eaten fresh; mucilage; (80)	Uganda [13]
<i>Acacia nilotica</i> (L.) Delile (Fabaceae), SA 89	Tree: Qaradh (1a-1e,2a-2c,3), Gum: Samaq (1a, 3), Samaa, Sumaa (1b,1c,1d)	Tree/ dry	Gum: chewed and eaten fresh; mucilage; (100)	Sudan [14]
<i>Acacia senegal</i> (L.) Willd. (Fabaceae), SA 85	Qutad (1b,1c,1d), Gum: Samaa (1b,1c,1d)	Tree/ dry	Gum: chewed and eaten fresh; mucilage; (80)	Africa [10]
<i>Aloe lanata</i> T.A.McCoy & Lavranos (Xanthorrhoeaceae), SA 64	Shrub: Anded (2), Flow er: Alhab (2)	Shrub/ dry	Flower: fresh cooked with reis; Sweet; (60)	-
<i>Amaranthus blitum</i> L. (Amaranthaceae) SA 70	Ladah (1b-1d), Annass (1c,1d), Gana (1e, 3a), Dhadah (1e,4)	Herb/ rainy	Leaf: fresh cooked boiled; mild sweet (100)	Ethiopia [15] Himalaya [16] Pakistan [3]

<i>Amaranthus graecizans</i> L. (Amaranthaceae) SA 71	Dhadah (1a,1e,4), Ladah (1b), Annass (1b,1c), Gana (1e,3a)	Herb/ rainy	Leaf: fresh, cooked boiled; mild sweet; (100)	Oman [9]
<i>Amaranthus spinosus</i> L. (Amaranthaceae) SA 72	Dhadah (1a,4)	Herb/ rainy	Leaf: fresh, cooked boiled; mild sweet (50)	Himalaya [16] Angola [17]
<i>Anisotes trisulcus</i> (Forssk.) Nees (Acanthaceae) SA 51	Mudhadh (1,3), Sheri (2a), Masis (2b)	Shrub/ rainy	Flower nectar: squeeze and drink the nectar; sweet (100)	-
<i>Apteranthes tuberculata</i> (N.E. Br.) Meve & Liede (Apocynaceae) SA 40	Khusmaa (1a,2b)	Herb/ rainy	Young stem: eaten fresh; bitter (90)	Pakistan [18]
<i>Boerhavia elegans</i> Choisy (Nyctaginaceae) SA 30	Hidwan (4)	Herb/ rainy	Leaf: eaten fresh; Bitter; (50)	Iran [19]
<i>Caralluma subulata</i> (Forssk.) Decne. (Apocynaceae) SA 42	Shawrer (2a,2c)	Herb/ rainy	Young stem: eaten fresh; Bitter; (90)	Namibia [20]
<i>Ceropegia bulbosa</i> Roxb. (Apocynaceae), SA 95	Alat-khalah (1b,1c,1d), Roob (5)	Herb/ rainy	Young stem: eaten fresh; mild sour (100)	Oman [9]
			Root (tuber); eaten fresh; Sweet	

			(50)	
<i>Cissus rotundifolia</i> Vahl (Vitaceae), SA 21	Alfaq (1a,1b,1c), Alfaq (2a), Hadel (2a,ab), Alfaq (3b, c)	Climber/ all year	Young leaf: fresh boiled cooked; mild sour; (100)	Yemen [21]
<i>Cleome gynandra</i> L. (Cleomaceae), SA 22	Raab (1b,1c)	Shrub/ rainy	Leaf: cooked by boiling with salts and/or with <i>Cissus rotundifolia</i> leaf; Bitter; (95)	Ethiopia [4]
<i>Coccinia grandis</i> (L.) Voigt (Cucurbitaceae), SA 25	Maqd, (1a,1e,2c), Mad (1b,1c,1d)	Climber/rainy	Fruit: eaten fresh ripe; mild sweet (100)	Himalaya [16] Ethiopia [4]
<i>Corchorus tridens</i> L. (Malvaceae), SA 26	Weakeh (1b), Legen (1b,1c), Quddah (2b)	Herb/ rainy	Leaf: fresh cooked; mild bitter (100)	South Africa [22]
<i>Corchorus trilocularis</i> L. (Malvaceae), SA 27	Legen, Weakeh (1)	Herb/ rainy	Leaf: fresh cooked; mild bitter (100)	Ethiopia [23]
<i>Crepis rueppellii</i> Sch. Bip. (Asteraceae), SA 12	Kaanan (1c,1d,3), Hamham (5)	Herb/ rainy	Root excluding coat: eaten fresh; sweet 100	Oman [9]
<i>Cynanchum viminale</i> (L.) L. (Apocynaceae),	Arnaq (1b,1c,1d),	Shrub/ rainy	Young stem: eaten fresh;	Oman [9] South

SA 41	Khal (1c), Radhaa (2a,2c), Bidar (3)		mild sour (100)	Africa [24]
<i>Cynanchum viminale</i> subsp. <i>stipitaceum</i> (Forssk.) Meve & Liede (Apocynaceae), SA 60	Radhaa (2a,2c), Milab (3)	Shrub/ rainy	Young stem: eaten fresh; Sour (80)	-
<i>Cynanchum viminale</i> subsp. <i>suberosum</i> (Meve & Liede) Goyder (Apocynaceae), SA 43	Zab-lmbaer (1b,1c,1d,1e)	Shrub/ rainy	Young stem: eaten fresh; sour (100)	Oman [9]
<i>Cynanchum vanlessenii</i> (Lavranos) Goyder (Apocynaceae), SA 44	Qalab (1a)	Shrub/ rainy	Flower: eaten fresh; mild sweet; (5)	-
<i>Desmidorchis awdelianus</i> (Deflers) Meve & Liede (Apocynaceae), SA 45	Uruz (1b,1c), Kuaaur, (1b,1c,1d,1e,3d), Muqrer, (2a,2b), Kuaath (3f)	Herb/ rainy	Young stem: eaten fresh; mild bitter; (100)	-
<i>Desmidorchis flavus</i> (N. E. Br.) Meve & Liede (Apocynaceae), SA 46	Uruz (1b,1c,1d), Dhaba, Dhagohom (5)	Herb/ rainy	Young stem: eaten fresh; mild bitter; (95)	Oman [25]
<i>Desmidorchis lavrani</i> (Rauh & Wertel) Meve & Liede (Apocynaceae), SA 47	Uruz (1b,1c,1d), Obar (1b,1c,1d,2a,3e)	Herb/ rainy	Young stem: eaten fresh; mild bitter; (100)	-
<i>Ficus ingens</i> (Mig.) Mig. (Moraceae),	Dharef (3)	Tree/ all	Fruit: eaten fresh ripe; mild sour;	Uganda [26]

SA 09		year	(100)	
<i>Ficus palmata</i> Forssk. (Moraceae), SA 10	Tree: Areen (1a), Fruit: Balas (1a,2a,b)	Tree/ all year	Fruit: eaten fresh ripe; mild sour (100)	Ethiopia [4] Pakistan [3]
<i>Ficus sycomorus</i> L. (Moraceae), SA 11	Saqam (1,2), Suqmi (2a,2b), Saqum (3)	Tree/ all year	Fruit excocarp: eaten fresh ripe; sweet; (20)	Ethiopia [4]
<i>Ficus vasta</i> Forssk. (Moraceae), SA 13	Tauluq (1,2), Tauluq (3) Tiq (5)	Tree/ all year	Fruit excocarp: eaten fresh ripe; sour; (15)	Ethiopia [4]
<i>Gladiolus candidus</i> (Rendle) Goldblatt (Iridaceae), SA 14	Bedhah (5)	Herb/ dry	Corm: stir-fried cooked; sweet (100)	Oman [9]
<i>Glossonema varians</i> (Stocks) Benth. ex Hook.f. (Apocynaceae), SA 15	Qumredh (1c), Kobash (1d)	Herb/ rainy	Fruit: Fresh unripe eaten; very sweet; (30)	Oman [9]
<i>Grewia erythraea</i> Schweinf. (Malvaceae), SA 80	Shrub: Schohudt (1b,1c,1d,1e), Fruit:	Shrub/ all year	Fruit(ripe, red): eaten fresh; sweet (100)	Soqotra [6] Oman [9] Angola [17] Ethiopia [15]

	Hungass (1b,1c,1d,1e)			
<i>Grewia mollis</i> Juss. (Malvaceae), SA 81	Nashem (2a)	Shrub/ all year	Young fruit: eaten fresh; Sweet; (50)	Ethiopia [27]
<i>Grewia tenax</i> (Forssk.) Fiori. (Malvaceae), SA 59	Schohudt (1a,1b,1c,1d,1e), Khedar (2a)	Shrub/ all year	Young fruit: eaten fresh; sweet; (100)	Ethiopia [15]
<i>Hydnora abyssinica</i> A.Br. (Aristolochiaceae), SA 03	Nabeekh (1b), Trateef (1c,1e), Fateekh (1c,3a,3b), Twacheen, Kuaarer, Twhoot (2b), Ftookh (3c), Imlokh (5)	Herb/ rainy	Flower: eaten fresh or stir-fried cooked; fresh: astringent; mild sour, aroma; cooked: mild sweet; (100)	Yemen [28] Uganda [26]
<i>Lactuca serriola</i> L. (Asteraceae), SA 04	Lessan- imthawr (1b,1c,1e)	Herb/ rainy	Leaf: eaten fresh without or with bread; mild bitter; (90)	Turkey [29]
<i>Launaea intybacea</i> (Jacq.) Beauverd (Asteraceae), SA 05	Hawa (1a), Lessan- imthawr (1b,1c,1e), Hawa (2a), Lessan- albaqarah (4)	Herb/ rainy	Leaf: eaten fresh without or with bread; mild bitter (100)	Ethiopia [11]

<i>Launaea procumbens</i> (Roxb.) Ramayya & Rajagopal (Asteraceae), SA 06	Hawa (1a,2a)	Herb/ rainy	Leaf: eaten fresh without or with bread; mild bitter; (90)	Ethiopia [4]
<i>Lavandula pubescens</i> Decne. (Lamiaceae), SA 07	Feheh (2b)	Shrub/ dry	Leaf: eaten fresh with bread; mild bitter, aromatic; (50)	-
<i>Monolluma hexagona</i> (Lavranos) Meve & Liede (Apocynaceae) SA 52	Mequrezh (1a, 1e), Uruz (1b,1c)	Herb/ rainy	Young stem: eaten fresh; mild bitter; (100)	-
<i>Monolluma quadrangular</i> (Forssk.) Plowes (Apocynaceae), SA 48	Mequrezh (1a, 1e), Uruz (urzh) (1b,1c,1d,2b), Mulaauzah (2a), Qarnat-adhabia (3a), Hwimadhah (3c), Dhaba, Dhagohom (5)	Herb/ rainy	Young stem: eaten fresh; mild bitter; (100)	Oman [9]
<i>Monolluma solenophora</i> (Lavranos) Meve & Liede (Apocynaceae), SA 49	Khusmaa (1a,2b) , Uruz (1b,1c)	Herb/ rainy	Young stem: eaten fresh; mild bitter; (100)	-
<i>Opuntia ficus-indica</i> (L.) Mill. (Cactaceae), SA 53	Tarung (1a), Rangah, Teen (2b)	Shrub/ all year	Fruit: eaten fresh peeled; sweet;	Ethiopia [29]

			(100)	
<i>Orbea wissmannii</i> (O. Schwartz) Bruyns var. <i>wissmannii</i> (Apocynaceae), SA 50	Khusmaa (1a), Uruz (1b,1c,1d)	Herb/ rainy	Young stem: eaten fresh; mild bitter; (100)	-
<i>Plantago major</i> L. (Plantaginaceae), SA 54	Lessan-imthaur (1b,1c,1d,1e)	Herb/ rainy	Leaf: eaten fresh; Bitter; (25)	Spain [30]
<i>Portulaca oleracea</i> L. (Portulacaceae), SA 55	Dhuras (1a,1b,1c,1d), Sungulah (2a), Qalqalah (2b), Rubidta (4), Hamdhieh (5)	Herb/ rainy	Leaf, stem: eaten fresh as salad with bread or without; cooked with <i>Corchorus tridens</i> ; mild sour; (100)	Oman [9] Turkey [31]
<i>Portulaca quadrifida</i> L. (Portulacaceae), SA 56	Dhuras (1d)	Herb/ rainy	Leaf, stem: eaten fresh or cooked; mild sour; [100]	Ethiopia [11]
<i>Reichardia tingitana</i> (L.) Roth (Asteraceae), SA 85	Khasoor (2b,2c), Hawa (2b)	Herb/ rainy	Leaf, stem: eaten fresh with bread; mild bitter; (100)	-
<i>Raphionacme velutina</i> Schltr. (Apocynaceae), SA 86	Qurs-bathilan (1b,1c)	Herb/ rainy	Root (tuber); eaten fresh; Sweet;	South Africa [24]

			(60)	
<i>Rhytidocaulon macrolobum</i> Lavr. subsp. <i>macrolobum</i> (Apocynaceae), SA 87	Quarran (1b,1c,1d)	Herb/ rainy	Young stem: chewed and eaten fresh; mild bitter; (100)	Tropical Africa [32]
<i>Rhytidocaulon tortum</i> (N.E. Br.) M.G. Gilbert (Apocynaceae), SA 88	Quarran (1b,1c,1d)	Herb/ rainy	Young stem: chewed and eaten fresh; mild bitter; (100)	Tropical Africa [32]
<i>Rumex nervosus</i> Vahl (Polygonaceae), SA 16	Uthrub (1b)	Shrub/ all year	Flower nectar: fresh sucked; mild sweet; (10)	-
	Uthrub (1a,1e)		Leaf: chewed and eaten fresh; mild bitter; (50)	-
<i>Sageretia thea</i> (Osbeck) M.C. Johnst. (Rhamnaceae), SA 89	Niem (1a)	Shrub/ all year	Fruit: ripe fruit, eaten fresh; sweet; (20)	Oman [25]
<i>Salvadora persica</i> L. (Salvadoraceae), SA 90	Shub: Rak (1c), Fruit: Mard (1c)	Shrub/ all year	Fruit: ripe fruit, eaten fresh; sweet; (60)	Oman [9]
<i>Senna italica</i> Mill. (Fabaceae),	Ushruq (2a,3)	Shrub/	Fruit: eaten fresh;	Oman [9]

SA 91		dry	bitter; (50)	
<i>Sonchus oleraceus</i> (L.) L. (Asteraceae), SA 92	Lessan- imthawr (1b,1c), Lessan Albuqri (2b), Lessan- athawr (3), Lessan al- baqarah (4)	Herb/ rainy	Leaf: eaten fresh without or with bread; mild bitter; (90)	Turkey [31]
<i>Ziziphus spina-christi</i> (L.) Desf. (Rhamnaceae), SA 93	Tree: Elb (1,2,3,4), Dhaood (5), Fruit: Daoom (1,2,3,4), Girem (5)	Tree/ all year	Ripe fruit excluding kern: eaten fresh or dried; Sweet; (100)	Soqotra [6] Oman [9] Angola [17] Ethiopia [23]
	Seed: Agarah (1a,1b,1c,1d), Seed excluding coat: Fersoos, Ferquoos, (1a,1b,1c,1d)		Seeds excluding coat: eaten fresh; Oily; (50)	Ethiopia [29]
<i>Ziziphus leucodermis</i> (Baker) O. Schwartz (Rhamnaceae), SA 94	Elb (3), Labdhi, Habedh (4), Dhood (5)	Tree/ all year	Fruit: eaten fresh or dried; sweet; (50)	Oman [9]

Species names with bold font recorded as new wild edible species which not reported before in literature; while all species reported for the first time for Yemen

Local geographical origins of the species:

1-5 The names of the governorates

1 Abyan governorate, 1a Mukeiras, 1b Lawdar, 1c Modyah, 1d Al-Wadhee, 1e Gischan

2 Lahj and Al-Dhalee governorates, *2a* Radfan, *2b* Yafee, *2c* Al-Dhalee

3 Shabwa governorate, *3a* Gardan, *3b* Ataq, *3b* Alrowdhah, *3c* Haban, *3d* Saaeed, *3d* Nasab, *3e* Maifaah, *3e* Alrwadha, *3f* Arma.

4 Hadhramout governorate (Syoon, Dawaan, Mukalaa, Sheher).

5 Mahrah governorate (Qeedhah, Haoof).

Table 2 Botanical data for plants families, genera and species

Family name	No. of genera	No. of species
Apocynaceae	10	18
Asteraceae	5	6
Malvaceae	2	5
Moraceae	1	4
Fabaceae	2	4
Rhamnaceae	2	3
Amaranthaceae	1	3
Portulacaceae	1	2
Xanthorrhoeaceae	1	1
Acanthaceae	1	1
Nyctaginaceae	1	1
Vitaceae	1	1
Cleomaceae	1	1
Cucurbitaceae	1	1
Iridaceae	1	1
Aristolochiaceae	1	1
Lamiaceae	1	1
Cactaceae	1	1
Plantaginaceae	1	1
Polygonaceae	1	1
Salvadoraceae	1	1
Total 21 families	37 genera	58 species

Table 3 The wild edible plants parts used in southern Yemen

Edible parts/ exudates	Number	Percentage %
leaf	18	26.5
stem	18	26.5
Fruit	17	25
Flower	5	7.4
Root and corn	4	5.9
Seed	1	1.5
Gum	3	4.4
Flower nectar	2	2.9

Table 4 The 15 top most important wild edible plants cited by all informants and recommended for sustainable use

Scientific name (edible part)
<i>Acacia nilotica</i> (gum)
<i>Amaranthus blitum</i> (leaf)
<i>Amaranthus graecizans</i> (leaf)
<i>Anisotes trisulcus</i> (flower nectar)
<i>Cissus rotundifolia</i> (leaf)
<i>Coccinia grandis</i> (fruit)
<i>Cynanchum viminale</i> (stem)
<i>Ficus palmata</i> (fruit)
<i>Hydnora abyssinica</i> (flower)
<i>Lactuca serriola</i> (leaf)
<i>Monolluma quadrangular</i> (stem)
<i>Opuntia ficus-indica</i> (fruit)
<i>Orbea wissmannii wissmannii</i> (stem)
<i>Portulaca oleracea</i> (leaf)
<i>Ziziphus spina-christi</i> (fruit)

Table 5 The 12 new wild species are eaten only in southern Yemen based on literature

Plant species	Edible part
<i>Aloe lanata</i>	Flower
<i>Anisotes trisulcus</i>	Flower
<i>Cynanchum vanlessenii</i>	Flower
<i>Rumex nervosus</i>	Flower
<i>Cynanchum viminale</i> subsp. <i>stipitaceum</i>	stem
<i>Desmidorchis awdelianus</i>	stem
<i>Desmidorchis lavrani</i>	stem
<i>Monolluma hexagona</i>	stem
<i>Monolluma solenophora</i>	stem
<i>Orbea wissmannii</i>	stem
<i>Reichardia tingitana</i>	Leaf
<i>Lavandula pubescens</i>	Leaf

Figures



Figure 1

please see the manuscript file for the full caption



Figure 2

please see the manuscript file for the full caption

■ Herb ■ Shrub ■ Tree ■ Climber

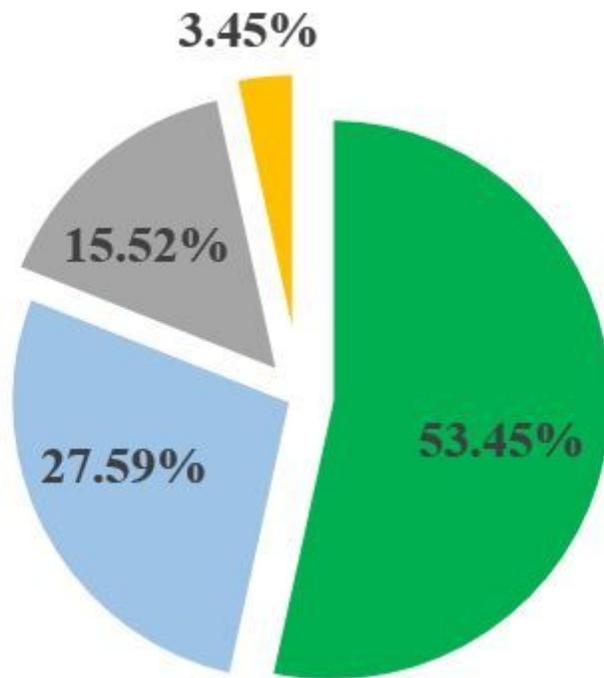


Figure 3

Life forms of edible plants in southern Yemen