

Contents lists available at [ScienceDirect](http://www.elsevier.com/locate/jtcm)

## Journal of Traditional and Complementary Medicine

journal homepage: <http://www.elsevier.com/locate/jtcm>

## Original article

## Ethnobotanical magnitude towards sustainable utilization of wild foliage in Arabian Desert

Prakash C. Phondani<sup>\*</sup>, Arvind Bhatt, Esam Elsarrag, Yousef A. Horr

Gulf Organization for Research and Development, Qatar Science and Technology Park, Unit 203, Doha, Qatar

## ARTICLE INFO

## Article history:

Received 15 February 2015

Accepted 5 March 2015

Available online 2 April 2015

## Keywords:

Native plants

Informants

Ethnobotanical uses

Sustainable utilization

Landscaping

Arabian Desert

## ABSTRACT

The present investigation was deals with identifying traditional uses of medicinal plants for curing a variety of ailments and degree of religious conservation for retention of ethnobotanical knowledge. The study was carried out in the State of Qatar to document the ethnobotanical uses of 58 medicinally important plant species including identification, botanical name, Arabic name, family, habit, habitat, distribution pattern, and the plant parts used for curing variety of ailments. The documented species belong to 54 plant genera and 30 botanical families. They have been used to cure more than 38 different kinds of human ailments. A majority of ethnobotanical plant species belonging to shrubs (41.38%) followed by perennial herbs (31.04%), annual herbs (18.96%) and trees (8.62%) respectively. The frequency of ethnobotanical plant species were recorded maximum in fabaceae (13.79%), followed by lamiaceae, chenopodiaceae (6.89% each), asteraceae, capparaceae, polygonaceae, boraginaceae, aizooaceae (5.17% each), brassicaceae, asclepiadaceae, convolvulaceae, zygophyllaceae, solanaceae (3.44% each) while, remaining 17 families had one (1.72%) species each. Perception of stakeholders concerning prioritization and categorization of potential native plants and 25 ethnobotanical species were prioritized and ranked on the basis of their multipurpose use value, feasibility climatic conditions and Global Sustainability Assessment System (GSAS) criteria measures i.e. drought resistant, low water requirement, growth performance, survival rate, canopy size, adaptation potential, low maintenance and use value for sustainability and landscaping. The analysis emphasized the potentials of ethnomedicinal research, sustainable utilization, conservation initiatives, and urgent need to document ethnobotanical knowledge for sustainability and scientific validation to prevent their losses.

Copyright © 2015, Center for Food and Biomolecules, National Taiwan University. Production and hosting by Elsevier Taiwan LLC. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

Millions of plants constitute the floristic treasure on the planet and are integral part of life and potential curative agents for various health related disorders both of human and animals. Medicinal preparations derived from natural sources especially from plants, have been widely used in various cultures since time immemorial.<sup>1</sup> The tradition of herbal medicine is becoming more accepted globally for conventional medicine as clinical research, analysis and quality control are capable of demonstrating the treatment value of herbal medicine.<sup>2,3</sup> Furthermore,

traditional plant based medicine is rapidly growing economic importance.<sup>4</sup> In developing countries, traditional plant based system of medicine is often the only accessible and affordable.<sup>5</sup> Herbal therapy has come of age and today, medicinal plants play a significant role in human health care globally.<sup>6</sup> About 64% of the total world population remains dependent on traditional medicine for their healthcare needs.<sup>7</sup> Plant resources provide humans with materials that have economic, medicinal and forage values.<sup>8</sup> However, habitat loss, urbanization, industrialization, migration of rural populations to urban areas for livelihood and cultural changes in indigenous communities are threatening this knowledge.<sup>9–11</sup> During the last decade, considerable attention has been focused not only on how plants are used, but also on how they are perceived and managed, as well as the mutual relationships between societies and the plants on which they depend.<sup>12</sup>

<sup>\*</sup> Corresponding author.

E-mail address: [prakashphondani@gmail.com](mailto:prakashphondani@gmail.com) (P.C. Phondani).

Peer review under responsibility of The Center for Food and Biomolecules, National Taiwan University.

Herbal medicine is widespread in the Gulf region and medicinal plants can be found in many souqs (local markets). The number of healers practicing folk or traditional medicine in the Arabian Gulf is unknown, but is probably substantial based on the number of published case studies and reports from hospitals that have treated patients with complications from improperly carried out folk medical practices. The practice is dying out (which is mostly unwritten), due to less interest or ignorance of young generation. Besides this, some plants are facing extinction from habitat loss due to impact of global warming, climate change, urbanization and overgrazing of animals. The *Quran* and *Hadith* mention a great number of wild plants that are still used in folk medicine.<sup>13</sup> Despite some undesirable side-effects, Gulf folk medical practices certainly merit further study in the framework of modern evidence based medicine and randomised controlled clinical trials. Prejudices of scientists and physicians against traditional health care practices, however, are hampering efforts to test traditional plant based medicines for efficacy and safety. The present study is an attempt to (i) document the ethnobotanical knowledge about the medicinal plants being used for traditional health care system (ii) identify and prioritization of medicinally valuable plant species for landscaping and conservation in their natural habitat.

## 2. Material and methods

### 2.1. Study area

The State of Qatar is a peninsula extending from Arabian Desert as outcrop in the Western Arabian Gulf, its land is arid or semi-arid and highly saline. It is surrounded by Saudi Arabia, Bahrain, United Arab Emirates and Iran. The country is situated midway along the western coast of the Arabian Gulf between latitudes 24.27°–26.10° North and longitudes 50.45°–51.40° East. It covers approximately 11,437 square kilometres on a low-lying limestone peninsula projecting northward about 160 km into the Gulf. The coastline is approximately 550 km long and bounds the country to the west, north and east. This region is - among the warmest parts of the world; the temperature during summer is as high as 50 °C or more. The rain is scarce and does not exceed 152 mm per year.<sup>14</sup> The vegetation of Qatar comprises herbaceous plants, grasses, dwarf shrubs and a few tree species.

### 2.2. Methodology

#### 2.2.1. Extensive literature review approach

An extensive literature review was carried out to gather information on locality, Arabic name, botanical name, family and ethnobotanical efficacy of native plants in a desert climate.<sup>1,3,15–23</sup>

#### 2.2.2. Frequent field survey approach

A preliminary survey of the diversity of the native plants in Qatar has been made and lead to the identification of the plant species which are used for medicinal purposes with the help of local and non-local informants. Regular field surveys were conducted to collect information on habit, habitat, distribution pattern, collection season, use of plant parts and status in their natural habitat.

#### 2.2.3. Interview based approach

During the surveys, attempts were made to collect all possible information regarding the traditional use of medicinal plants. A semi-structured questionnaire, personal interviews, and consultation with local and non-local informants were conducted.<sup>11</sup>

#### 2.2.4. Learning-sharing approach

Subsequent interviews were conducted with 70 different stakeholders (local and non-local people, traditional healers, shepherds, camel owners, field labourers, plant nursery owners, researchers, architecturists and academicians) having knowledge about the native plants and their uses for different purposes i.e., medicinal, economical and ecological.<sup>3</sup> Perception of different stakeholders concerning prioritization, categorization and ranking of suitable native plant species based on their use value and criteria measures of global sustainability assessment system i.e. drought resistant, low water requirement, growth performance, survival rate, canopy size, adaptation potential, low maintenance and use value for urban landscaping and also sharing our experiences with the informants.<sup>1,24</sup>

#### 2.2.5. Specimen display approach

In this approach, we showed the collected plant specimens to the informants in order to elicit information. Later, we also showed photo of these plants to the people to confirm the identity. The same plant specimens were shown to different people to confirm the accuracy of the results.<sup>25</sup>

#### 2.2.6. Interactive discussions approach

Meetings and group discussions held with different stakeholders about the different uses of plants, their conservation strategies, prioritization and categorization of reported plant species and the fate of traditional knowledge systems. Cross-checking of collected information was done during field visit and interaction with stakeholders.

## 3. Results and discussion

The results showed that herbal medicine is still playing a significant role in meeting fundamental traditional healthcare needs of inhabitants in the region of the Arabian Gulf. During the survey, the reported 58 native plants species, distributed among 54 plant genera and 30 botanical families and they were used for curing 38 different kinds of human ailments. A majority of ethnobotanical plant species belonging to shrubs (41.38%) followed by perennial herbs (31.04%), annual herbs (18.96%) and trees (8.62%) respectively (Table 1). The major plant families, which contributed the native plants in folk medicine with maximum frequency were recorded in Fabaceae (13.79%), followed by Lamiaceae, Chenopodiaceae (6.89% each), Asteraceae, Capparaceae, Polygonaceae, Boraginaceae, Aizoaceae (5.17% each), Brassicaceae, Asclepiadaceae, Convolvulaceae, Zygophyllaceae, Solanaceae (3.44% each) while, remaining 17 families had one (1.72%) species each (Fig. 1).

Initially few native plant species were tried by local people, professional plant nursery owners, researchers and experts for urban landscaping, however subsequent investigation showed that out of 58 recorded ethnobotanical plant species, 25 (*Tecomella undulata*, *Dodonaea viscosa*, *Nerium oleander*, *Capparis cartilaginea*, *Aerva javanica*, *Aeluropus lagopoides*, *Suaeda vermiculata*, *Lavandula subnuda*, *Arnebia hispidissima*, *Leptadenia pyrotechnica*, *Lycium shawii*, *Blepharis ciliaris*, *Alhagi graecorum*, *Aizoon canariense*, *Rhanterium epapposum*, *Calotropis procera*, *Calligonum comosum*, *Senna italica*, *Citrullus colocynthis* (check the spelling), *Cleome brachycarpa*, *Gisekia pharnacioides*, *Grewia erythraea*, *Haloxylon salicornicum*, *Convolvulus glomeratus* and *Zaleya pentandra*) were prioritized, categorized and ranked based on their use value, feasibility to local climatic conditions and fulfil the criteria measures of global sustainability assessment system. Based on perception of experts, their use value (ecological, economical, and medicinal) and suitability to climatic conditions *Tecomella undulata*

**Table 1**

An Inventory of ethnobotanically valuable native plant species in desert climate of Arabian Gulf.

Botanical name	Arabic name	Family	Habit	Habitat	Distribution	Medicinal uses	Other uses
<i>Abutilon pannosum</i> G. Forst.) Schltldl.	Lowaq, ja'ja'an	Malvaceae	Shrub	Occasional on roads in Qatar	Common in Qatar and also recorded in Saudi Arabia and UAE	The plant is used in the treatment of dysentery and gonorrhoea.	
<i>Aeluropus lagopoides</i> (L.) Trin. ex Thwaites	Ikrish	Poaceae	Perennial herb	Frequent to abundant in saline habitats	Common in Qatar and also recorded in Bahrain, Saudi Arabia, UAE, India, W. Asia and Northern part of Africa	The plant is used for wound healing and pain killer.	The plant species is also useful for sand binder particularly in desert areas.
<i>Aerva javanica</i> (Burm. f.) Juss. ex Schult.	Tuwaim, Tifir, ra'	Amaranthaceae	Perennial herb	Rocky substrates with shallow sand	Reported in Qatar and it has a native distribution in Arabia, Egypt, India, and Burma	In traditional medicine it is used externally to remove swelling, relieve inflammation and healing of wounds and ulcers. The flowers and roots are used to alleviate kidney problems and rheumatism and the seeds are believed to cure headaches. A gargle is made from the plant to treat toothache.	The plant species is deep rooted, and is used as soil binder in desert reclamation. It is also used for fuel and fodder.
<i>Aizoon canariense</i> L.	Jafnah, Hadaq	Aizoaceae	Perennial herb	Usually on harder substrates with shallow deposits of sand	Common in Qatar and also recorded in Bahrain, Kuwait, Saudi Arabia, UAE and Africa	Whole plant used for curing jaundice and hepatitis.	The plant species used for fodder.
<i>Alhagi graecorum</i> Boiss.	Aaqool	Fabaceae	Shrub	Usually in saline or disturbed sandy soils, including farms and coastal areas	Local in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, UAE	The whole plant is used for treating cataracts, jaundice, migraine, painful joints and as an aphrodisiac.	The plant species is used for fodder.
<i>Anastatica hierochuntica</i> L.	Kaf maryam, kaf al athra, Jumay' Fatimah, Birkan, Qufay'ah	Brassicaceae	Annual herb	Abundant in shallow sandy deposits, including runnels and small depressions	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, UAE, Sahara Desert, North Africa and regions of Egypt, Israel, Iraq, Jordan, Pakistan, and Iran.	It is used as a charm and herbal aid in childbirth is widely reported. It is sold in markets of Qatar as well as other Arabian countries. The dried plant is soaked in water and when it has unfurled the water is drunk by the expectant mother.	
<i>Arnebia hispidissima</i> (Lehm.) DC.	KaHil, Melleih, Hasheshat al 'Arneb	Boraginaceae	Annual herb	Abundant on shallow sandy deposits in all habitat types except saline areas	Common in Qatar and also recorded in Bahrain, E Saudi Arabia, and UAE	The whole plant is used for fevers including malaria.	The thick dark-red roots used as cosmetic and dye.
<i>Blepharis ciliaris</i> (L.) B.L. Burt	Shawk al-Dub, Naqi, Niqeyl	Acanthaceae	Perennial herb	Compact stony and gravelly soils	Local in Qatar and also recorded in E Saudi Arabia, and UAE	The roots are ground to make a powder (kohl) and used to treat eye inflammation and cataracts. The seeds have healing and anti-inflammatory properties.	The plant species used for fodder.
<i>Boerhavia elegans</i> Choisy	Hadimdam, shuayrqah alshams, hamra	Nyctaginaceae	Perennial herb	Moist and dry rocky areas	Rare in Qatar and also recorded in Arabia, Iran, Pakistan, India and Tropical East Africa	Used for the treatment of kidney disorders, urinary tract disorders and blood purification in baluch tribe.	
<i>Calligonum comosum</i> L. Her.	Abal, Arta	Polygonaceae	Shrub	Sand, high dunes	Rare in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, and UAE	The fruits are edible and freshen the mouth with their tart taste'. Twigs to be pounded and added to milk as a flavouring or tonic. It is used in a balm for skin ailments.	The woody base was used for firewood.
<i>Calotropis procera</i> (Aiton) W.T. Aiton	Sodom's, ushar, ashkhar	Asclepiadaceae	Small tree	Farms, roadsides and gardens	Local in Qatar and also recorded in Bahrain, Kuwait, and UAE	Leaves and latex are used for treating wounds, pain, and scorpion stings and for strengthening muscles affected by paralysis.	Wood used in preparation of the best charcoal for the manufacture of black gunpowder.
<i>Capparis cartilaginea</i> Decne.	Shafallah	Capparaceae	Shrub	Stony and rocky areas and compact silty soils in depressions and road sides	Arabian Gulf including Qatar and Israel, Iraq, South Iran North and Tropical East Africa	It is used for bruises, childbirth, earache, headache, paralysis, snakebite and swelling.	It is highly useful in landscape gardening, afforestation and reforestation. They can stop

(continued on next page)

Table 1 (continued)

Botanical name	Arabic name	Family	Habit	Habitat	Distribution	Medicinal uses	Other uses
<i>Centaurea pseudosinaica</i> Czerep.	Birkan, murrar	Asteraceae	Annual herb	Shallow sandy deposits	Common in Qatar and also recorded in Kuwait, E Saudi Arabia, and UAE	It is used to cure wounds and kidney disorders.	soil erosion and preserve agricultural land.
<i>Citrullus colocynthis</i> (L.) Schrad.	Handhal, Shary, Hadaj	Cucurbitaceae	Perennial herb	Sandy areas	Common in Qatar also recorded in Bahrain, Kuwait, E Saudi Arabia, and UAE	The plant is well known to have strong laxative properties; other medicinal uses include treatment of dog, insect and snake bites; to relieve pain in joints and as a hair dye.	The ripe fruit were used to prepare gunpowder.
<i>Cleome amblyocarpa</i> Barratte & Murb.	Mnitna, oum jlaje	Capparaceae	Annual herb	Sandy saline depressions	Local Qatar and also recorded in E Saudi Arabia, UAE	The plant used to treat abdominal and rheumatic pains	
<i>Cleome brachycarpa</i> Vahl ex DC.	Zaaf, mkhaysah	Capparaceae	Perennial herb	Sandy and saline	Rare in Qatar and also recorded in UAE	Used as a diuretic and astringent a powerful narcotic and stomach irritant.	The plant species used for fodder.
<i>Convolvulus glomeratus</i> Choisy	Ullayq	Convolvulaceae	Perennial herb	Recorded from cultivated in light or sandy soils	Rare in Qatar and also recorded in UAE	Taken as a purgative.	The plant is also used as fodder for goats and camels.
<i>Convolvulus virgatus</i> Boiss.	Adlam, hub al-risha	Convolvulaceae	Perennial herb	It grows on dry sandy and gravelly soils	Recorded in Qatar and Pakistan (Baluchistan), S. Iran, Muscat, Oman	Boiled in water and taken internally as a tonic, aphrodisiac and expectorant. Dried leaves crushed with sugar taken as a treatment for jaundice.	
<i>Cornulaca monacantha</i> Delile	Thallaj, Hadh	Chenopodiaceae	Shrub	Coastal areas and deeper saline sand	Common in Qatar and also recorded in Bahrain, E Saudi Arabia, and UAE	Leaves are used to treat jaundice.	
<i>Crotalaria persica</i> (Burm. f.) Merr.	Nzah	Fabaceae	Shrub	Low sand dunes	Recorded in Qatar and native in UAE, Oman Ethiopia, Iran, Somalia, and Pakistan	Whole plant crushed and boiled in water and given in constipation.	
<i>Dodonaea viscosa</i> Jacq.	Shahus, shatt, gashaar	Sapindaceae	Small tree	Mainly planted by roadsides	Common in Qatar and also recorded in Saudi Arabia, and UAE	The leaves are used for treating toothache.	As an ornamental and for screening; often clipped into hedges. It is also useful for control of soil erosion.
<i>Fagonia indica</i> Burm. f.	Dhuraymah, shwaikah, shka'e	Zygophyllaceae	Perennial herb	Harder substrates	Common in Qatar and also recorded in Bahrain, E Saudi Arabia, and UAE	Powdered leaves and roots boiled in water taken by mouth as a treatment for colic, or to soothe fever. Whole plant boiled in water used to wash in cases of venereal disease or mixed with thyme taken by mouth to treat kidney stones and sye problems.	
<i>Gisekia pharnacioides</i> L.	Dedman	Molluginaceae	Annual herb	Sandy, disturbed soils often in orchards	Recorded in Arabian Gulf and widespread in Africa, Florida, Iran, and Pakistan.	Traditionally the plant is used on swellings. However it is also use to cause abortion.	It is often collected as fodder for cattle, goat and sheep.
<i>Grewia erythraea</i> Schweinf.	Sherhaan, ghada	Tiliaceae	Small tree	Hillsides	Recorded in Arabian Gulf and Iran, Pakistan, India, Sri Lanka and Africa	The plant is used as tranquilizer to treat headaches.	It is important wild edible plant in the region. Its fruits are edible.
<i>Haloxylon salicornicum</i> (Moq.) Bunge ex Boiss.	Rimth	Chenopodiaceae	Shrub	Shallow to deep sands or silty soil	Local in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, and UAE	The plant traditionally used to treat hypoglycaemia.	Good fodder for camels grazing when annuals and grasses are not available. A source of firewood.
<i>Haplophyllum tuberculatum</i> (Forssk.) Juss.	Musaykah, tafr at-tais/ sinan at-tais	Rutaceae	Shrub	Sandy soils	Local in Qatar and also recorded in Bahrain, Kuwait, Saudi Arabia, and UAE	The plant is used to cure scorpion stings'. It is used to 'strengthen back muscles after childbirth, chest pains, flatulence, stomach problems and as a sedative.	

<i>Heliotropium kotschyi</i> (Bunge) Gürke	Turnsole, Heliotrope, Ramram, Dhanab al-Qqrab	Boraginaceae	Shrub	Sandy, often compacted soils, including coastal beach sand	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, and UAE	Dried powdered leaves are used as a poultice for abscesses, boils, sprains and swellings. Also used for treating ulcers, mouth blisters and snake bites.	
<i>Indigofera oblongifolia</i> Forssk.	Hasar	Fabaceae	Shrub	It is found in grassland, sandy and stoney soils, and near streams.	Rare in Qatar and also recorded in UAE	The roots are used for an analgesic and as an anti-inflammatory; leaves are used as a hair wash.	
<i>Lavandula subnuda</i> Benth.	Harq, Somr, Lavander	Lamiaceae	Perennial herb	Rocky habitats	Recorded in Arabian Gulf and widespread in North Africa	The plant known in medicine from the earliest times used to treat chest and throat problems, and epilepsy.	It is also used for Insecticide.
<i>Leptadenia pyrotechnica</i> (Forssk.) Decne.	Markh, Shajarat al Nar	Asclepiadaceae	Shrub	Sandy habitats	Local in Qatar and also recorded in Bahrain, E Saudi Arabia, and UAE	An infusion made from the stems is taken as a diuretic.	Eaten by camels. The buds are edible and dried hair is used as kindling.
<i>Leucas inflata</i> Benth.	Jeidad, rihana, rahl, qotnya	Lamiaceae	Perennial herb	Stony desert wadis	Recorded in Arabian Gulf including Egypt, Sudan, Ethiopia, Eritrea	Used in traditional medicine to cure many diseases such as cough, cold, diarrhoea and inflammatory skin disorder.	
<i>Limonium axillare</i> (Forssk.) Kuntze	Qataf	Plumbaginaceae	Shrub	Saline habitat	Common in Qatar and also recorded in Bahrain, Saudi Arabia, and UAE	The whole plant is used against diarrhoea and as an astringent.	
<i>Lycium shawii</i> Roem. & Schult.	Awsaj	Solanaceae	Shrub	Sandy and silty depressions, runnels, wadis and on rocky slopes.	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, and UAE	The plant medicinally used as a diuretic, laxative and tonic.	Grazed by animals and the berries are eaten by man; the leaves provide browsing for camels.
<i>Monsonia nivea</i> (Decne.) Webb	Qarnow, Dahmah	Geraniaceae	Annual herb	Gravel and stone plains	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, UAE	Some local people boil it to cure fevers.	
<i>Nerium oleander</i> L.	Haban	Apocynaceae	Small tree	Near running water	Recorded in Qatar, Oman and UAE	The bitter roots are used medicinally, including as a diuretic and emetic. The leaves are used for the treatment of bronchitis and coughs.	Widely planted in towns for shade and landscaping.
<i>Paronychia arabica</i> (L.) DC.	Arfaj, arfol al hamam, shadq al jamal	Caryophyllaceae	Annual herb	Shallow sandy soils	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, and UAE	The entire plant is used as a stimulant and aphrodisiac.	
<i>Pulicaria undulata</i> (L.) Kostel.	Jithjath, Shay el-jebel	Asteraceae	Perennial herb	Disturbed gravelly or silty soils	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, and UAE	It is used in traditional medicine to cure diuretic.	
<i>Reseda aucheri</i> Boiss.	Shawlah	Resedaceae	Perennial herb	Gravel plains	Rare in Qatar and also recorded in Kuwait, and UAE.	Leaves are used to remove the toxicity & sensitivity of snake bite, insect bite, and scorpions bite.	
<i>Rhanterium epapposum</i> Oliv.	Arfaj	Asteraceae	Shrub	Usually on sandy or loamy deposits; often in rocky areas.	Local in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, and UAE	Used in the treatment of digestive disorders and for its antimicrobial properties.	Widely documented as an important grazing plant. It is also used for fire wood.
<i>Rhazya stricta</i> Decne.	Harmal, Adfir	Apocynaceae	Shrub	Tropical regions, alluvial plains and sandy areas	Recorded in Arabian Gulf and India, Pakistan, Afghanistan	Important medicinal plant in desert areas of Arabian Peninsula. Dry plant more effective than fresh one, leaves bitter. The plant is a general tonic, digestive, anti-inflammatory and anti-microbial, stimulant, anticancer, and pain killer.	

(continued on next page)

Table 1 (continued)

Botanical name	Arabic name	Family	Habit	Habitat	Distribution	Medicinal uses	Other uses
<i>Rhynchosia minima</i> (L.) DC.	Baql	Fabaceae	Perennial herb	Sand and gravel	Rare in Qatar and also recorded in UAE	It used in the treatment of skin diseases.	
<i>Rumex dentatus</i> L.	Khillah	Polygonaceae	Annual herb	Damp and sandy soils	Local in Qatar and also recorded in Kuwait, E Saudi Arabia, and UAE	It is used as a cooling agent against sunstroke and that the root is astringent and applied to skin disorders.	
<i>Rumex vesicarius</i> L.	Hummayd	Polygonaceae	Annual Herb	Rocky terrain in shallow deposits of sand or silt	Local in Qatar and also recorded in Kuwait, E Saudi Arabia, and UAE	The leaves and seeds are used to treat scorpion stings.	
<i>Salsola imbricata</i> Forssk.	Khareet	Chenopodiaceae	Shrub	Coastal saline areas	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, UAE	The flowers are used as a diuretic and anti-inflammatory.	
<i>Salvia aegyptiaca</i> L.	Na'aim/na'eem, Ra'al	Lamiaceae	Shrub	Shallow silty or sandy soils in rocky areas	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, UAE	The plant is used in the treatment of diarrhoea, gonorrhoea, haemorrhoids and eye diseases.	
<i>Scrophularia deserti</i> Delile	Zeita, 'Afeena, Zafairah	Scrophulariaceae	Perennial herb	Shallow sand or sandy runnels	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, UAE	Treatment of gangrenous, disinfection of body wounds and hoof and eye infection.	
<i>Senna alexandrina</i> Mill.	Makki, Helul	Fabaceae	Shrub	A garden weed	Local in Qatar and also recorded in UAE	Leaves are used for constipation and stomach cramps.	
<i>Senna italica</i> Mill.	Ishriq, helul	Fabaceae	Shrub	Compacted soils on gravelly and rocky areas	Recorded in Arabian Gulf including Qatar, Bahrain, E Saudi Arabia, and UAE	It is used as a 'purgative and stimulant. The leaves and seeds are used to treat constipation and stomach cramps.	The plant species used for fodder.
<i>Sesuvium verrucosum</i> Raf.	Rohama, guwaifa	Aizoaceae	Shrub	Moist or dry flats, saline or alkaline habitats	Recorded in Arabian Gulf, Saudi Arabia, Bahrain, and Americas	It is important in folk medicine. It is used for the treatment of ear disorders.	
<i>Suaeda vermiculata</i> Forssk. ex J.F. Gmel.	Suweid	Chenopodiaceae	Shrub	Coastal saline habitats	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, UAE	It is used to treat asthma and other respiratory disorders	The plant is suitable for saline irrigation and a promising landscape.
<i>Tecomella undulata</i> D.Don	Farfar, ferfer	Bignoniaceae	Small tree	Drier parts	Recorded in Arabian Gulf including Qatar and Iran, Afghanistan, Pakistan and India	The bark obtained from the stem is used as a remedy for syphilis. It is also used in curing urinary disorders, enlargement of spleen, gonorrhoea, and leucoderma and liver diseases. Seeds are used against abscess. Traditionally its flower used for hepatitis.	It is mainly used as a source of timber and fodder. It is useful for soil-binding and acts as stabilizing shifting sand dunes. It is considered as the home of birds and provides shelter for wildlife.
<i>Tephrosia apollinea</i> (Delile) Link	Dhafra, omayye, nafal	Fabaceae	Shrub	Sandy desert areas	Recorded in Arabian Gulf including Qatar Pakistan, Iran, Egypt, Eritrea, Sudan, Somali Socotra, and Ethiopia	The plant is known for its medicinal properties and has significant anti-bacterial properties; the leaves and the root have been used to treat bronchitis, cough, ear ache, wounds and bone fractures.	
<i>Teucrium polium</i> L.	Ja'ad/yaad	Lamiaceae	Perennial herb	Stony runnels and silty soils	Local in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, and UAE	Many reputed medicinal uses, e.g. for fevers and cholera, malaria and insect bites.	
<i>Trigonella hamosa</i> L.	Nafal, qutifa, qirqas, darjal	Fabaceae	Annual herb	Frequent or abundant in farms and gardens	Common in Qatar and also recorded in Bahrain, Kuwait, E Saudi Arabia, UAE	It is used for Dizziness with fullness of the head (traditional medicines for brain).	
<i>Withania somnifera</i> (L.) Dunal	Babu, sumal far, hamal balbool, Morgan, simm frakh	Solanaceae	Shrub	Recorded from cultivated in garden, sunny edge; dappled shade	Introduced in Arabian Gulf including Qatar, Iraq, S. Iran, Syria, Turkey, Palestine, Pakistan and India	The berries and leaves are applied externally to tumours, tubercular glands, carbuncles, and ulcers. The roots are used to prepare the herbal remedy, which has been traditionally used to provide strength and treat sexual disorders.	

<i>Zaleya pentandra</i> (L.) C. Jeffrey	Lami	Aizoaceae	Perennial herb	A weed of waste ground	Rare in Qatar and also recorded in UAE.	It is used for stomach complaints, and snake bite.	The plant species used for fodder.
<i>Zilla spinosa</i> (L.) Prantl	Shaja, silla, shubrum	Brassicaceae	Shrub	Sandy and silty depressions	Local in Qatar and also recorded in Kuwait, E. Saudi Arabia, and UAE	A useful remedy in the treatment of ailments such as kidney stones.	
<i>Zygophyllum simplex</i> L.	Harm/hureim, da'a	Zygophyllaceae	Annual herb	Stony habitats and often saline soils	Common in Qatar and also recorded in Bahrain, E. Saudi Arabia, and UAE.	The leaves are used as an antibiotic and laxative; infusion of leaves or the seeds is applied to the eyes in ophthalmia.	

ranked first while, *Zaleya pentandra* was last in rank in terms of plantation for urban landscaping (Table 2).

A total of 58 ethnobotanically important plant species were documented, with their different parts being used in a variety of medicines such as leaves (27.58%), roots (12.06%), stems (8.62%), seeds (10.34%), bark (1.72%), fruits (3.44%), flowers (6.89%), whole plant (12.06%), and others (6.5%) was reported (Fig. 2). Further, habitat preference studies shows that 67.25% belonged to xerophytes and 29.31% belongs to halophytes and few of them were xerohalophytes (3.44%) (Fig. 3). The percentage of recorded plant species used for curing each ailment was analyzed and it showed that maximum plant species (48.29%) used for curing common ailments i.e. wounds and boils, cough and cold, fever etc. followed by 32.76% plant species used for curing moderate ailments i.e. diarrhoea, cataract, ear disorders, hair loss etc. and less percentage of reported plant species (18.95%) used for curing serious ailments i.e. jaundice, ulcer, urinary disorders, anticancer etc. Analysis of the data revealed that single species or sometimes combinations of species were used for curing individual or numerous diseases together (Fig. 4).

In Gulf Cooperation Council (GCC) countries, native plants deserve special attention to their ecological, economical and medicinal importance.<sup>26,27</sup> Large human populations in developing nations is dependent on plant resources for healthcare, because allopathic medicine can cure a wide range of diseases. However, its high prices and occasional side effects are causing many people to return to herbal medicines which tend to have fewer side effects.<sup>3</sup> It is also a matter of great concern that the transmission of traditional knowledge is decreasing, through several generations, because of no proper way of documenting this heritage except to specific individuals interested in preserving their traditions.<sup>11,28</sup> On the other hand, the native medicinal plants are under threat due to the effect of global warming, impact of climate change, overgrazing of animals, anthropogenic and developmental activities such as urbanization and growth of mega-structures. These are examples of the direct assault on nature resulting in the loss of local flora.<sup>7,29–31</sup>

The methods of using ethnobotanically valuable plants varied according to the nature of diseases. In some cases, most of the plant species were not used alone but together in specific amounts. In a majority of the cases, a decoction made of leaves, stems, barks, fruits and roots was administered or rubbed on the body for curing diseases. Most of the decoctions were prepared by crushing the plant parts with the help of mortar and pestle, but some were made by boiling plant parts in water, decanting the liquid and drinking it after cooling. Some plant decoctions were used directly on the wounds or the infected parts of the body. Paste of some plants was plastered to set dislocated or fractured bones or muscular pain. Some of the minor ailments like headache, cuts, and skin disorders were treated with external application. Some herbal medicines were taken on an empty stomach for best results and in others; there were some restrictions on food for the period of medication. The method of use of these plants varied according to the nature of different compounds present in different parts of the plants, with specific doses and nature of diseases.<sup>11</sup>

#### 4. Conclusions and future strategies

This research summarized ethnobotanical uses of native plants distributed in desert climate of Arabian Gulf. Native plants represent a part of the natural heritage for the people of the entire Gulf region. Currently, there is no commercial nursery specialized in the production of indigenous plants in the Arabian Gulf. The main reason is the lack of scientific knowledge about the native plants,

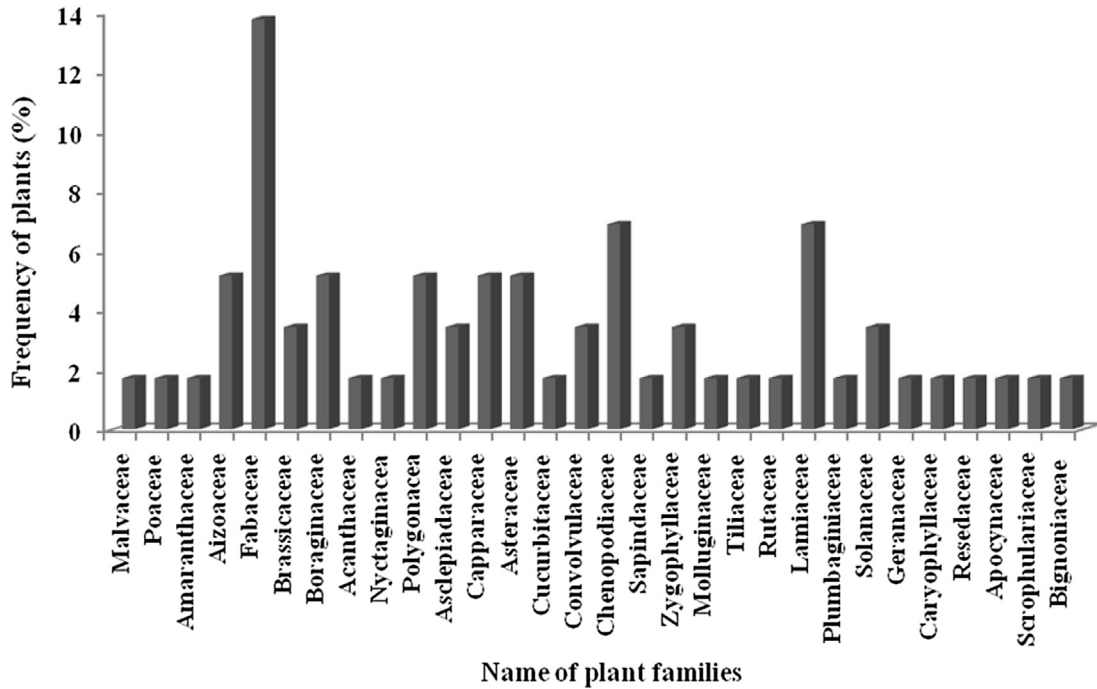


Fig. 1. Frequency (%) of medicinal plants is recorded in different plant families.

Table 2

Ethnobotanically valuable plant species ranked/prioritized for landscaping based on their multipurpose use value and criteria measures of GSAS.

Name of plants	Preference based on their use value			Total	Ranking
	Ecological	Economical	Medicinal		
<i>Tecomella undulata</i>	1	5	1	7	I
<i>Dodonaea viscosa</i>	2	6	2	10	II
<i>Nerium oleander</i>	3	7	3	13	III
<i>Capparis cartilaginea</i>	4	8	4	16	IV
<i>Aerva javanica</i>	5	9	5	19	V
<i>Aeluropus lagopoides</i>	6	10	6	22	VI
<i>Suaeda vermiculata</i>	7	11	7	25	VII
<i>Lavandula subnuda</i>	17	1	8	26	VIII
<i>Arnebia hispidissima</i>	9	2	17	28	IX
<i>Leptadenia pyrotechnica</i>	10	12	10	32	X
<i>Lycium shawii</i>	11	13	11	35	XI
<i>Blepharis ciliaris</i>	12	14	12	38	XII
<i>Alhagi graecorum</i>	13	15	13	41	XIII
<i>Aizoon canariense</i>	14	16	14	44	XIV
<i>Rhanterium epapposum</i>	15	17	15	47	XV
<i>Calotropis procera</i>	25	3	20	48	XVI
<i>Calligonum comosum</i>	8	20	21	49	XVII
<i>Senna italica</i>	22	19	9	50	XVIII
<i>Citrullus colocynthis</i>	23	4	24	51	XIX
<i>Cleome brachycarpa</i>	18	18	16	52	XX
<i>Gisekia pharnacioides</i>	16	21	18	55	XXI
<i>Grewia erythraea</i>	19	22	19	60	XXII
<i>Haloxylon salicornicum</i>	20	23	22	65	XXIII
<i>Convolvulus glomeratus</i>	21	24	23	68	XXIV
<i>Zaleya pentandra</i>	24	25	25	74	XXV

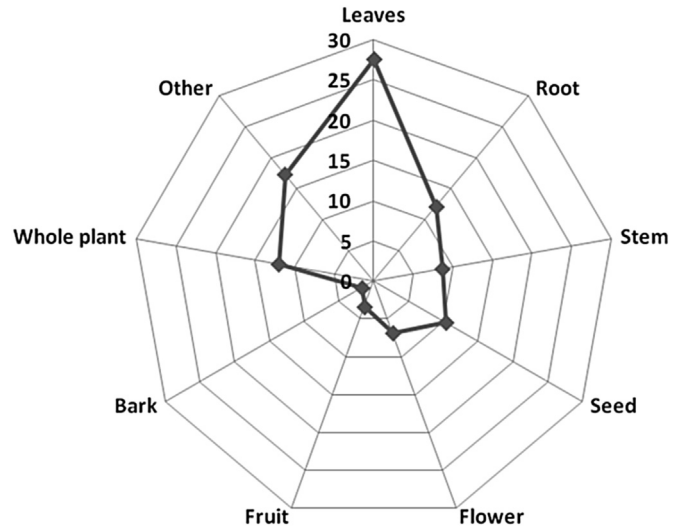


Fig. 2. Proportion (%) of medicinal plants used for curing variety of ailments.

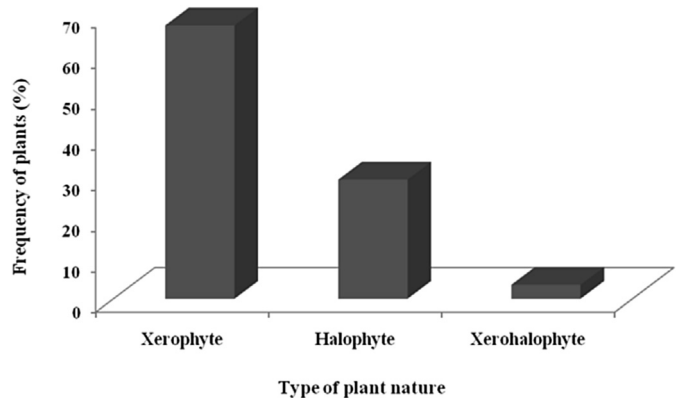


Fig. 3. Frequency (%) of medicinal plants distributed on their type of nature.

particularly proper identification, conservation status, threat assessment, propagation techniques, quality planting materials, and ethnobotanical uses. This will also increase the awareness, particularly of the new generations, about the importance of native plants in desert climate and the natural heritage of the region. The present study provided a practical example of sustainable utilization of native plants for sustaining the traditional healthcare system based on ethnobotanical knowledge and scientific validation of available knowledge before its losses. The outcomes of the present





Fig. 4. Frequency (%) of medicinal plants used for curing variety of ailments.

study would help to better understanding and appreciating the multiple values and potential of native plants and also to contribute narrowing the gap in the literature. This comprehensive information will help the local people, traditional healers, plant nursery owners, researchers, academicians, architects, landscape designers, land managers, conservation professionals and restoration specialists to identify and use the appropriate native plant species for different developmental schemes. Based on the present study, the following recommendations are suggested for future study:

- Develop and incorporate ethnobotanical knowledge/traditional health care system related curriculum in schools and universities so as to create awareness and interest among the masses.
- Support research and development activities to evaluate and standardise traditional phytomedicines in order to promote their safe, effective and affordable use.
- Establish appropriate and suitable frameworks and approaches for intellectual property rights (IPRs) and benefit sharing.
- Promote home/school herbal gardens by involving the local communities, research organizations and academic institutions.
- An urgent need to identify appropriate collection time of the plant parts used in traditional health care system and threat assessment of potential native plants in the entire Gulf region.
- Develop suitable strategy for prioritization, categorization and mass scale propagation of medicinal plants for urban landscaping through linkages with government organizations and professional plant nursery owners.
- Encourage private and governmental nurseries for the production and conservation of potential native plants.
- Create awareness for documentation of ethnobotanical knowledge and ecologically, economically, and medicinally valuable native plants used for urban landscaping through trainings, workshops, exposure visits and publications.

#### Conflicts of interest

There is no conflict of interest in this article.

#### Acknowledgements

The authors are thankful to local people, informants, field labours, traditional healers, plant nursery owners, researchers, and experts for their kind support and co-operation in this study. The partial financial support from the Qatar National Research Fund (Grant # 5-260-1-053) for this study is gratefully acknowledged.

#### References

1. Phondani PC, Maikhuri RK, Bisht NS. Endorsement of ethnomedicinal knowledge towards conservation in the context of changing socio-economic and cultural values of traditional communities around Binsar Wildlife Sanctuary in Uttarakhand, India. *J Agric Environ Ethics*. 2013;26:573–600.
2. Falsetto S. *The Practice of Plant Medicine: Herbal Medicine, Homeopathy, Naturopathy and Aromatherapy*; 2009. <http://sharonfalsetto.suite101.com>.
3. Phondani PC, Maikhuri RK, Saxena KG. The efficacy of herbal system of medicine in the context of allopathic system in Indian Central Himalaya. *J Herb Med*. 2014;4:147–158.
4. Bussmann RW, Glenn A. Medicinal plants used in northern Peru for the treatment of bacterial and fungal infections and inflammation symptoms. *J Med Plants Res*. 2011;5:1297–1304.
5. WHO. *Traditional Medicine Strategy, 2002–2005*. Geneva, Switzerland: World Health Organization; 2002.
6. Poonam K, Singh GS. Ethnobotanical study of medicinal plants used by the Taungya community in Terai Arc Landscape. *Indian J Ethnopharmacol*. 2009;123:167–176.
7. Cotton CM. *Ethnobotany: Principle and Application*. New York: John Wiley and Sons; 1996. p. 399.
8. Bayafers TA. *Floristic Analysis and Ethnobotanical Study of the Semi-wetland of Cheffa Area, South Welo, Ethiopia*. M.Sc. Thesis. Ethiopia: Addis Ababa University; 2000.
9. Zent S. The quandary of conserving ethnoecological knowledge. A Piaroa example. Pp. 90–124. In: Gragson TL, Blount B, eds. *Ethnoecology: Knowledge, Resources and Rights*. Athens, Georgia, U.S.A.: The University of Georgia Press; 1999.
10. Signorini MA, Piredda M, Bruschi P. Plants and traditional knowledge: an ethnobotanical investigation on Monte Ortobene (Nuoro, Sardinia). *J Ethnobiol Ethnomed*. 2009;5:6.
11. Phondani PC, Maikhuri RK, Rawat LS, et al. Ethnobotanical uses of plants among Bhotiya tribal communities of Niti Valley in Central Himalaya, India. *Ethnobot Res Appl*. 2010;8:233–244.
12. Cotton CM. *Ethnobotany: Principals and Applications*. New York, U.S.A: John Wiley and Sons, Inc.; 1997, 605 Third Avenue, p. 424.
13. Farooqi MH. *Medicinal Plants in the Traditions of Prophet Muhammad*. Lucknow: Sidrah Publisher; 1998.
14. Gulf Persian. <http://www.emecs.or.jp/guidebook/eng/pdf/07persian.pdf>; 2012.

15. Norton J, Sara AM, Debbie A, Mohammed AS, Benno B, Renee R. *An Illustrated Checklist of the Flora of Qatar*. 2009.
16. Ahmed KO, Faraj AG, Abdulhakim B. Floristic diversity and vegetation analysis of Wadi Arar: a typical desert Wadi of the northern border region of Saudi Arabia. *Saudi J Biol Sci*. 2014;21(6):554–565.
17. Muhammad Q, Zainul A, Muhammad YA, Raziuddin A, Bilquees G, Muhammad AK. Traditional ethno-botanical uses of medicinal plants from coastal areas of Pakistan. *J coast life Med*. 2014;2:22–30.
18. Bassam TY, Roda F, Thani A. *Ecophysiology of Wild Plants and Conservation Perspectives in the State of Qatar*. INTECH; 2013. <http://dx.doi.org/10.5772/55305>.
19. Rizk AM, El-Ghazaly GA. *Medicinal and Poisonous Plants of Qatar*. Scientific and Applied Research Centre, University of Qatar; 1995.
20. Miller AG, Cope TA, Nyberg JA. *Flora of the Arabian Peninsula and Socotra*. Edinburgh Edinburg Univ. Press; 1996.
21. Mckinney ML. Urbanization, biodiversity, and conservation. *Bioscience*. 2002;52:883–890.
22. Kermath B. Why go native? Landscaping for biodiversity and sustainability education. *Int J Sustain High Educ*. 2007;8:210–223.
23. Gairola S, Mahmoud T, Bhatt A, El-Keblawy A. Importance of seed banking and herbarium collections in biodiversity conservation and research: a new initiative in the United Arab Emirates. *Curr Sci*. 2013;105:1048–1050.
24. Phondani PC. Worth of traditional herbal system of medicine for curing ailments prevalent across the mountain region of Uttarakhand, India. *J Appl Pharm Sci*. 2011;1:81–86.
25. Tamer M, Sanjay G. Traditional knowledge and use of medicinal plants in the Eastern Desert of Egypt: a case study from Wadi El-Gemal National Park. *J Med Plants Stud*. 2013;1:10–17.
26. Saenger P. *Mangrove Ecology, Silverculture and Conservation*. Dordrecht: Kluwer Academic Publishers; 2002.
27. Easa HS, Rizk AM, Abdel-Bari EM. *Chemical Constituents and Nutritive Values of Range Plants in Qatar*. Qatar: The Scientific and Applied Research Centre, University of Qatar; 2003.
28. Tovey PA, Broom AF, Chatwin J, Ahmad S, Hafeez M. Use of traditional, complementary and allopathic medicines in Pakistan by cancer patients. *Rural Remote Health*. 2005;5:447.
29. Richer R. *Conservation in Qatar. Impacts of Increasing Industrialization. Center for International and Regional Studies (CIRS)*. Georgetown University, School of Foreign Service in Qatar; 2008.
30. Yasseen BT. Urban development threatening wild plants in Doha City-Qatar: ecophysiology is a prerequisite for ecological restoration. *J Plant Sci*. 2011;6:113–123.
31. Jones FA. Herbs-useful plants. Their role in history and today. *Eur J Gastroenterol Hepatol*. 1996;8:1227–1231.