An International, Peer-Reviewed, Open Access Journal

www.ethnoenvironjournal.com

Journal of
Ethnobiology and Environmental Research

Volume 1, Issue 1
January-June, 2026

e-ISSN: 3139-7883

RESEARCH ARTICLE

A comprehensive survey of flora in Dubai, UAE: composition, ecological adaptations and ethnobotanical significance.

O.P Sharma (IFS)[1], Bhekam Pal Singh[2], Kewal Kumar[3]*

[1] Retd. PCCF, Member Biodiversity Council, Jammu & Kashmir & Ladakh.
[2]Department of Botany, Government Gandhi Memorial Science College, Jammu, a constituent college of the Cluster University of Jammu-180016, J&K, India.

[3]Department of Botany, Govt. Degree College, Ramnagar-182122, J&K, India*
**Corresponding Author: kewalkumar0@gmail.com*
DOI: https://doi.org/10.67893/jeer.v1.i2.46

Received: 20-05-2026 | Revised: 30-05-2026 | Published: 02-06-2026

Abstract: The present study was conducted to document the floristic composition, ecological adaptations and ethnobotanical significance of plant species occurring in Dubai, United Arab Emirates (UAE). Field surveys were carried out during January-February 2025 across diverse habitats including desert reserves, coastal ecosystems, wildlife sanctuaries, urban parks and landscaped areas. A total of 54 plant species belonging to 48 genera and 28 families were recorded. Apocynaceae and Boraginaceae were the dominant families, while shrubs constituted the most abundant life form. Native species (31 spp.) predominated over introduced species (23 spp.), reflecting the characteristic vegetation of the Arabian desert ecosystem. Most recorded plants exhibited xerophytic adaptations such as deep root systems, reduced leaf surfaces, succulent tissues, thick cuticles and water-storage mechanisms, enabling survival under extreme arid conditions. Nine species were identified as true halophytes adapted to saline coastal habitats. Ethnobotanical analysis revealed that 22 species possessed documented medicinal or traditional uses, primarily for treating wounds, skin diseases, digestive disorders, fever, diabetes, rheumatism and other ailments. Leaves were the most frequently utilized plant part. Biological spectrum analysis indicated the dominance of phanerophytes (53.7%) and chamaephytes (24.0%), suggesting a Phanero-Chamaeophytic phytoclimate typical of arid environments. The study highlights the remarkable ecological resilience and ethnobotanical value of Dubai's flora and emphasizes the importance of conserving native plant diversity in rapidly urbanizing desert landscapes.
Keywords: Floristic composition, ecological adaptations, ethnobotany, xerophytes, desert vegetation, United Arab Emirates.

Introduction

Floristic composition refers to the identity, diversity and distribution of plant species within a defined geographical area or ecosystem (Mueller-Dombois and Ellenberg, 1974). It includes species richness, abundance and spatial arrangement, which are influenced by environmental factors such as climate, soil, topography and disturbance regimes (Kent, 2012). Floristic composition plays a vital role in assessing biodiversity patterns across different spatial scales and contributes to vegetation classification

and ecological monitoring (Simpson, 1949). Floristic inventories enable the identification of rare, endemic and threatened species, thereby supporting conservation planning and biodiversity management (Curtis and McIntosh, 1950). Furthermore, it is equally important in evaluating ecosystem services such as carbon sequestration, soil stabilization and habitat provision for wildlife, making it indispensable for sustainable resource management and ecological restoration (Kent, 2012).

Ecological adaptations refer to the structural, physiological and behavioral traits that enable organisms to survive, reproduce and thrive in their specific environments (Odum and Barrett, 2005). These adaptations arise through the process of natural selection, allowing species to respond to environmental pressures such as climate, resource availability, predation and competition (Darwin, 1859). Ecological adaptations are therefore central to understanding species distribution, community structure and ecosystem dynamics (Begon and Townsend, 2020). The study of ecological adaptations is highly significant in assessing how organisms respond to environmental changes, including climate change and habitat degradation (Odum and Barrett, 2005). It provides insights into evolutionary processes and helps predict species resilience or vulnerability under changing conditions (Smith and Smith, 2015). Moreover, understanding ecological adaptations is essential for biodiversity conservation, ecosystem management and restoration efforts, as it highlights the mechanisms that sustain life in diverse habitats (Larcher, 2003).

Since ancient times, plants have served as a primary source of food, fodder, shelter, clothes and healthcare for humans (World Health Organization, 2023; Ralte *et al.*, 2024). Ethnobotanical studies explore the complex relationships between human societies and plants, particularly focusing on the traditional knowledge associated with the use of plants for medicine, food and cultural practices (Heinrich *et al.*, 1998; Aremu *et al.*, 2024). The study of medicinal plant wealth in a given area provides valuable insights into the diversity, distribution and utilization of plant species. Also, the ethnobotanical research is of immense importance in biodiversity conservation and drug discovery. Documentation of medicinal plants not only helps preserve rapidly eroding traditional knowledge but also provides a scientific foundation for phytochemical and pharmacological investigations (Heinrich *et al.*, 2009; Silveira and Boylan, 2023). Furthermore, such studies contribute to sustainable resource management and conservation planning by identifying threatened and overexploited species (Albuquerque *et al.*, 2019; Kunwar *et al.*, 2018).

Dubai, located in the United Arab Emirates, is one of the most rapidly developing urban centers in the Middle East. The natural landscape of Dubai is dominated by sandy deserts, gravel plains and coastal ecosystems including mangroves and salt flats (sabkhas). Despite harsh environmental conditions, the area supports a range of xerophytic and halophytic vegetation adapted to extreme heat, drought and salinity (Brown and Boer, 2004). Dubai's strategic location, diverse habitats and ongoing environmental changes make it a suitable study area for research in ecology, biodiversity and ethnobotany. The region also reflects a blend of traditional knowledge and modern development, offering opportunities to examine plant utilization patterns and conservation challenges in an arid ecosystem context. Although several studies on floristic diversity and ethnobotany have been conducted independently in Dubai, research focusing on the ecological adaptations of plant species in the region remains limited. Moreover, an integrated approach encompassing floristic composition, distribution patterns, adaptive mechanisms and ethnobotanical significance has not been adequately addressed in the study area.

In light of these gaps, the present study aims to provide a comprehensive and systematic account of the plant diversity of the region, with particular emphasis on floristic composition, ecological adaptations and ethnobotanical importance of the plant species occurring in the study area. It is pertinent to mention here that the ethnobotanical importance of the plant species recorded during the present study has been derived from available literature and previously conducted studies.

Materials and Methods

Study Area

Dubai is one of the seven emirates of the United Arab Emirates (UAE) located in the eastern part of the Arabian Peninsula (Fig 1.). It is characterized by coastal habitats, arid desert landscape, rapidly urbanizing area, international tourism, skyscrapers and business opportunities. It receives very low annual rainfall, typically below 100 mm and is characterized by an arid desert climate. The temperature remains very high during summers, often exceeding 45°C, and its soils are predominantly sandy and saline. Although arid regions are considered to be poor in biodiversity, Dubai harbours a diverse assemblage of highly resilient xerophytic plants adapted to extreme climatic conditions. Vegetation is mainly xerophytic, consisting of desert shrubs, halophytic species and grasses along coastal areas and scattered trees in urban green zones and wadis. The present study was carried out on a variety of habitats within Dubai, including sand dunes, coastal zone, wadis and urban green spaces to document the diversity of plant species, their ethnobotany and ecological adaptations across both natural and manmade landscapes.

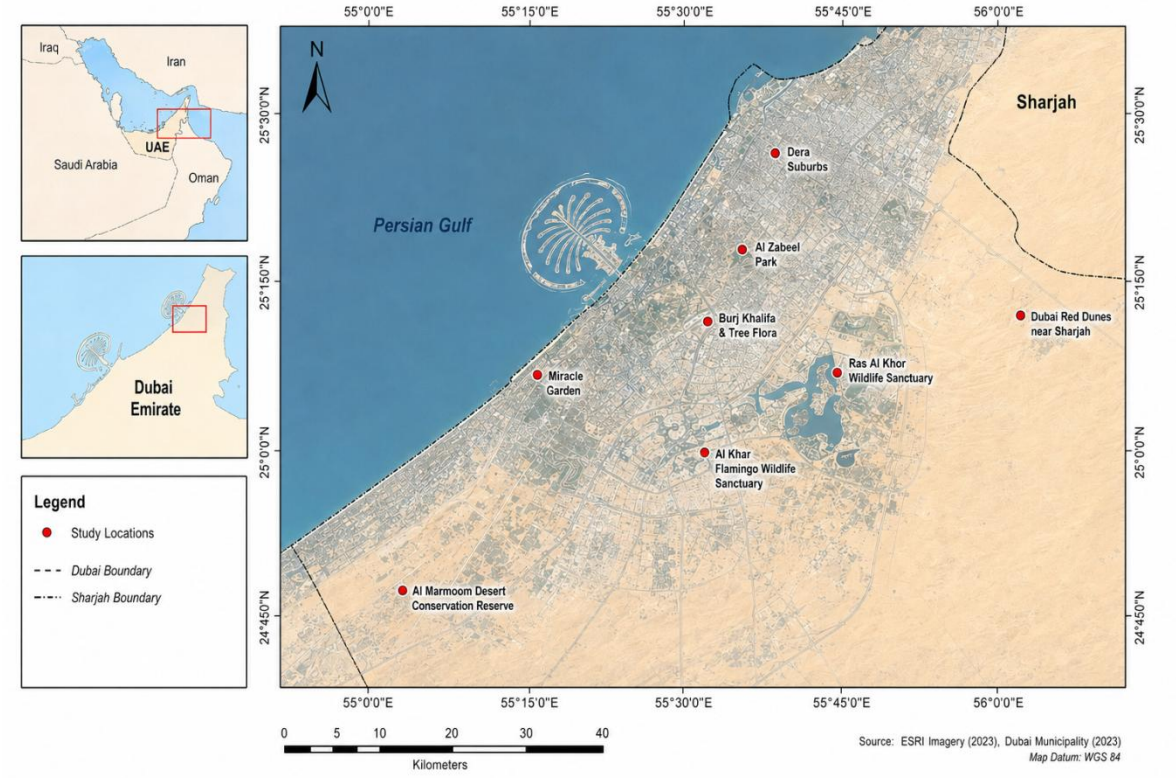


Figure 1. Geographical map of the study area.

Survey and data collection

The field survey was carried out during the months of January and February 2025 in different areas of Dubai like Al Marmoom desert conservation reserve, Miracle garden, Al khar Flamingo wildlife sanctuary, Dera suburbs, Al Zabeel park, Burz Khalifa tree flora, Ras Al Khor Wildlife sanctuary, Dubai Red dunes near Sharjah. The data were collected and recorded in the field book. The pictures of the plants were captured through photography and videography. Plant species were scientifically identified using standard literature including regional floras (Western, 1989; Jongbloed *et al.* 2003; Brown, G., Feulner, G.R. 2024) and through online platforms like UAE Flora (https://www.uaeflora.ae/), Flora And Fauna (https://www.ddcr.org/flora-and-fauna/). Besides helps was also taken from taxonomic experts for identification and further verification of identified species. The International Plant Names Index

(http://www.ipni.org) and Plants of the World online (http://www.plantsoftheworldonline.org/) was followed for the correct botanical nomenclature of plant species.

Results and Discussions

Floristic Composition

A total of 54 plant species belonging to 48 genera represented by 28 families were documented in the present study (Table 1). The most represented genera were *Calotropis, Ipomoea, Salvodora, Tamarix, Tribulus* and *Vachellia,* each represented by two species. The most dominating families were Apocynaceae and Boraginaceae, represented by 10 and 6 species respectively, followed by Fabaceae, Poaceae and Zygophyllaceae, each represented by 3 species. The dominance of these families is a reflection of their strong adaptability to arid desert ecosystems of the Arabian Peninsula, though the degree and type of adaptation can vary within each family. Shrubs (19 spp.) were the most dominating life forms followed by trees (18 spp.), herbs (15 spp.) and woody climbers (2 spp.). The dominance of shrubs in the study area reflects adaptation of plants to arid conditions of Dubai. The floristic composition recorded in the present study reflects the characteristic vegetation structure of hyper-arid ecosystems in the Arabian Peninsula. Similar floristic richness has been reported from desert habitats of the UAE, Qatar, Oman and Saudi Arabia, where vegetation is generally sparse but dominated by highly drought-adapted perennial taxa (Mandaville, 1986; Ghazanfar, 2004). The dominance of the families Apocynaceae and Boraginaceae in the study area indicates their ecological success under extreme desert conditions. Members of Apocynaceae such as *Calotropis procera* possess xerophytic adaptations including thick cuticles, succulent tissues, deep root systems and latex production, enabling them to tolerate prolonged drought and high salinity (Zahran *et al.*, 1985). Likewise, many Boraginaceae species are characterized by hairy leaves and reduced transpiration surfaces, which enhance survival in sandy and water-limited habitats. Fabaceae, Poaceae and Zygophyllaceae were also well represented, which agrees with previous studies from Arabian deserts where these families contribute significantly to desert vegetation due to their drought resistance, nitrogen-fixing ability and tolerance to nutrient-poor soils (Phondani *et al.*, 2016; Ghazanfar, 2004).

The predominance of shrubs over trees and herbs further demonstrates the adaptive response of vegetation to the harsh climatic conditions of Dubai. Shrubs are generally considered the most successful life form in arid environments because of their extensive root systems, reduced leaf area and ability to withstand water stress and grazing pressure (Mandaville, 1986). Similar dominance of shrub communities has been documented in the deserts of the UAE and other parts of the Arabian Peninsula, where perennial shrubs form the structural backbone of desert ecosystems (Gallacher and Hill, 2006; Zahran *et al.*, 1985). The comparatively lower proportion of herbs observed in the study may be attributed to irregular rainfall patterns and extreme summer temperatures, which restrict the establishment of annual species. Trees were represented by fewer species because only highly stress-tolerant woody taxa can survive in hyper-arid soils with low moisture availability. Moreover, anthropogenic disturbances and grazing pressure, particularly by camels, may also influence vegetation structure by favoring hardy shrubs over palatable herbaceous species (El-Keblawy *et al.* 2009).

The findings of the study revealed the floristic composition as a mixture of native and introduced species, with native species (31 spp.) dominating the desert and coastal vegetation. Some important species such as *Prosopis cineraria*, *Calligonum comosum*, *Vachellia tortilis* and *Ziziphus spina-christi* were prominent in sandy desert habitats where they played a pivotal role in maintaining desert stability and supporting local biodiversity. Introduced or Exotic species (23 spp.) like *Bougainvillea glabra*, *Delonix regia* and *Conocarpus lancifolius* were mainly found growing in urban green spaces, reflecting human influences on vegetation composition

Table 1. Floristic composition and ethnobotany of plant species from selected areas of Dubai, UAE.									
S. No	**Botanical name**	**Local/Arabic name**	**Family**	**Habit**	**Native/introduced**	**Ethnobotanical use**	**Reference**	**Life form**	**Conservation status**
1	*Alternanthera sessilis* (L.) DC.	Rijl al-Wazz	Amaranthaceae	H	Introduced	-		TH	LC
2	*Arnebia hispidissima* (Sieber ex Lehm.) A.DC.	Kahal	Boraginaceae	H	Native	Whole plant used for treating fevers including malarial fever., Root used Skin and hair diseases	Sakkir et al., 2012; Sajjad et al., 2017	TH	LC
3	*Azadirachta indica* A. Juss.	Al-Neem	Meliaceae	T	Introduced	-		PH	LC
4	*Bougainvillea glabra* Choisy	Jahanmiya	Nyctaginaceae	WC	Introduced	-		PH	LC
5	*Calligonum comosum* L'Hér.	Al-Arta	Polygonaceae	S	Native	Dried leaves and stems chewed to treat toothache; young shoots collected as salad, green or powdered to add to milk as tonic for flavorings.	Sakkir et al., 2012; Sajjad et al., 2017	CH	LC
6	*Calotropis gigantea* (L.) W.T.Aiton	Al-Ushr	Apocynaceae	S	Introduced	-		PH	NE
7	*Calotropis procera* (Aiton) W.T.Aiton	Ushar	Apocynaceae	S	Native	Leaves and the latex used for treating wounds, pain, and scorpion stings and for strengthening muscles affected by paralysis. Bark of the root also used medicinally.Dried leaves and stem used to fill aching hollow teeth	Sakkir et al., 2012; Sajjad et al., 2017	PH	LC
8	*Cassia fistula* L.	Khiar Shambar	Fabaceae	T	Introduced	-		PH	LC
9	*Cistanche tubulosa* (Schenk) Wight ex Hook.f.	Al-Haluk	Orobanchaceae	H	Native	The stem is used by traditional medicine practitioners for treatment of diarrhea; the fleshy stem is boiled in water and eaten to treat diarrhea.	Ghazanfar, 1994; El-Ghonemy, 1993	CR	NE
10	*Commelina benghalensis* L.	Abu-Rukba	Commelinaceae	H	Introduced	-		HCR	LC
11	*Conocarpus lancifolius* Engl.	Shajarat ad-Damas	Combretaceae	T	Introduced	-		PH	NT

12	*Cordia sebestena* L.	Al-Makhit	Boraginaceae	T	Introduced	-		PH	LC
13	*Cynodon dactylon* (L.) Pers.	Al-Najeel	Poaceae	H	Native	Infusion of roots and leaves used to treat hemorrhoids and wounds. Also used to treat cough and kidney problems.	Sakkir et al., 2012; Sajjad et al., 2017	CR	LC
14	*Delonix regia* (Bojer ex Hook.) Raf.	Shajarat al-Lahab	Fabaceae	T	Introduced	-		PH	LC
15	*Dodonaea viscosa* Jacq.	Mashdash	Sapindaceae	S	Native	Leaves are used for treating toothache.	Sakkir et al., 2012; Sajjad et al., 2017	CH	LC
16	*Helianthus annuus* L.	Abbad al-Shams	Asteraceae	H	Introduced	-		TH	LC
17	Heliotropium bacciferum Forssk.	Humayad	Boraginaceae	H	Native	leaves used in scorpion bites and snake bites	Sajjad et al., 2017	CH	NE
18	*Indigofera arabica* Jaub. & Spach	Al-Neela	Fabaceae	S	Native	-		CH	NE
19	*Ipomoea horsfalliae* Hook.	Al-Lablab al-Ahmar	Convolvulaceae	WC	Introduced	-		PH	LC
20	*Ipomoea pes-caprae* (L.) R.Br.	Rijl al-Hamama	Convolvulaceae	H	Native	Seeds used as a purgative	Sakkir et al., 2012	CH	LC
21	*Lantana camara* L.	Lantana	Verbenaceae	S	Introduced	-		PH	NE
22	*Launaea procumbens* (Roxb.) Ramayya & Rajagopal	Al-Hammad	Asteraceae	H	Native	Infusion or paste made with water applied to cool the forehead and body.	Sakkir et al., 2012	CH	LC
23	*Leptadenia pyrotechnica* (Forssk.) Decne.	Al-Markh	Apocynaceae	S	Native	Branches and stems are used as a diuretic.	Sakkir et al., 2012	PH	LC
24	*Lycium shawii* Roem. & Schult.	Awsaj	Solanaceae	S	Native	Stems used as a diuretic, laxative and tonic.Traditionally used to treat many diseases. Decoction of stem laxative and diuretic. Juice of leaves and fruits known to cure jaundice, freckles and skin problems as well as ulcers of mouth and anus, pruritus and infected ear. Fruit edible, laxative, diuretic, antispasmodic and a general tonic, used to improve vision.	Sakkir et al., 2012; El-Ghonemy, 1993	CH	LC

25	*Millingtonia hortensis* L.f.	Shajarat-al-Yasmeen al-Hindi	Bignoniaceae	T	Introduced	-		PH	NE
26	*Moringa peregrina* (Forssk.) Fiori	Al-Shou	Moringaceae	T	Native	Taken orally for constipation and stomach cramp; mixed with clove oil, cardamom oil, taken during labor.	Sakkir et al., 2012	PH	LC
27	*Nerium oleander* L.	Al-Difla	Apocynaceae	S	Native	Leaves used for the treatment of bronchitis and coughs.	Sakkir et al., 2012; Sajjad et al., 2017	PH	LC
28	*Olea europaea* L.	Shajarat-al-zaytoon	Oleaceae	T	Native	-		PH	NE
29	*Panicum turgidum* Forssk.	Ath-Thumam	Poaceae	H	Native	Above ground parts used for abortifacient and for treatment of wounds and removing eye spot	Sajjad et al., 2017	**CH**	**NE**
30	*Peganum harmala* L.	Harmal	Nitrariaceae	H	Native	-		HCR	NE
31	*Peltophorum pterocarpum* (DC.) Backer ex K.Heyne	Shajarat al-Lahab Al-Asfar	Fabaceae	T	Introduced	-		PH	LC
32	*Petunia × hybrida* (Hook.) Regel	Bituniya	Solanaceae	H	Introduced	-		TH	NE
33	*Phoenix dactylifera* L.	Nakhlat al-Tamr	Arecaceae	T	Native	The male inflorescence (spadix) and pollen used as an aphrodisiac and as a general tonic.	Sakkir et al., 2012; Sajjad et al., 2017	PH	NE
34	*Pithecellobium dulce* (Roxb.) Benth.	Ghaf al-Bahr	Fabaceae	T	Introduced			PH	LC
35	*Plumeria rubra* L.	Al-Yasmeen Al-Hindi	Apocynaceae	T	Introduced			PH	LC
36	*Pongamia pinnata* (L.) Pierre	Al-Bunjamiya	Fabaceae	S	Introduced			PH	LC
37	*Prosopis cineraria* (L.) Druce	Al-Ghaf	Fabaceae	T	Native	used as eye drops and bark used for rheumatism and applied to scorpion bites	Sajjad et al., 2017	PH	NE
38	*Rhazya stricta* Decne.	Harmal Shajari	Apocynaceae	S	Native	The whole plant including the seeds used for medicinal purposes. Also used for improving bad	Sakkir et al., 2012; Sajjad et al., 2017	CH	LC

						breath, chest pain, conjunctivitis, constipation, diabetes; used for lowering fevers, skin rash, as an anthelmintic, and to increase lactation.			
39	*Saccharum griffithii* Munro ex Boiss.	Qasab	Poaceae	H	Native	-		CR	NE
40	*Salsola drummondii* Ulbr.	Al-Rimth	Amaranthaceae	S	Native	-		CH	NE
41	*Salvadora oleoides* Decne .	Al-Arak	*Salvadoraceae*	T	Native	-		PH	DD
42	*Salvadora persica* L.	Al-Arak	Salvadoraceae	T	Native	Fresh or dried, powdered, applied on skin blisters and scorpion sting. In UAE the roots used as toothbrushes and the crushed leaves used with oil to treat joint and knee pains while the fruits also are edible.	Sakkir et al., 2012; Sajjad et al., 2017	CH	LC
43	*Senegalia senegal* (L.) Britton	Hashab	Fabaceae	S	Introduced	-		PH	LC
44	*Sesuvium portulacastrum* (L .) L.	Rijlat Al-Bahr	Aizoaceae	S	Native	-		CH	LC
45	*Tamarix aphylla* (L.) H.Karst.	Tarfa	Tamaricaceae	T	Introduced	Dried leaves applied on wounds to stop bleeding	Sakkir et al., 2012; Sajjad et al., 2017	PH	LC
46	*Tamarix nilotica* (Ehrenb.) Bunge	Athl	Tamaricaceae	T	Native	-		PH	LC
47	*Tribulus arabicus* Hosni	Zahar	Zygophyllaceae	H	Native	-		TH	NE
48	*Tribulus terrestris* L.	Al-Hasak	Zygophyllaceae	H	Introduced	In North Africa fruit used as a tonic and to treat oral inflammations and bladder disorders. fruits used for sexual function in humans and improve athletic performance	Sakkir et al., 2012; Sajjad et al., 2017	TH	LC
49	*Typha domingensis* Pers.	Bardi	Typhaceae	H	Native	Dried crushed flowers applied to burns for cooling effect	Sakkir et al., 2012	HE	LC

50	*Vachellia nilotica* (L.) P.J.H.Hurter & Mabb.	Al-Sant	Fabaceae	T	Introduced	-		PH	LC
51	*Vachellia tortilis* (Forssk.) Galasso & Banfi	Al-Samur	Fabaceae	S	Native	-		PH	LC
52	*Vitex negundo* L.	Kaf Maryam	Lamiaceae	S	Introduced	-		PH	LC
53	*Ziziphus spina-christi (*L.) Desf.	Al-Sidr	Rhamnaceae	S	Native	Crushed leaves applied to skin sores and inflamed joints; ash of wood, mixed with vinegar applied to snake bites; tea made of fruits said to be a treatment for measles; fruit and kernels eaten to treat chest pains.	Sakkir et al., 2012; Sajjad et al., 2017	PH	LC
54	*Zygophyllum qatarense* Hadidi	Hurm	Zygophyllaceae	S	Native			CH	NE

Abbreviations used in Table: T-tree, S-shrub, H-herb, WC-woody climber, TH- Therophytes, PH-Phanerophytes, CH-Chamaephytes, CR- Cryptophytes, HCR-Hemicryptophytes, LC- Least Concern, NE- Not Evaluated, DD- Data Deficient, NT-Near Threatened

Ecological adaptations

Most of the reported plants were desert xeophytes, e.g., *Arnebia hispidissima*, *Calligonum comosum*, *Calotropis procera*, *Cistanche tubulosa*, *Dodonaea viscose*, *Heliotropium kotschyi*, *Indigofera arabica*, *Ipomoea horsfalliae*, *Launaea procumbens*, *Leptadenia pyrotechnica*, *Lycium shawii*, *Moringa peregrine*, *Nerium oleander*, *Panicum turgidum*, *Peganum harmala*, *Phoenix dactylifera*, *Prosopis cineraria*, *Rhazya stricta*, *Senegalia senegal*, *Tribulus arabicus*, *Tribulus terrestris*, *Vachellia nilotica*, *Vachellia tortilis* and *Ziziphus spina-christi.* These plants exhibit adaptations like deep root systems, reduced leaf surfaces, thick cuticles, specialized water storage tissues etc., enabling them to thrive in arid conditions of desert environments of Dubai.

In addition to xerophytes, nine species were identified as true halophytes (*Ipomoea pes-caprae*, *Sesuvium portulacastrum*, *Salsola drummondii*, *Zygophyllum qatarense*, *Salvadora persica*, *Salvadora oleoides*, *Tamarix aphylla*, *T. nilotica* and *Saccharum griffithii*), while seven species can withstand moderate salinity but are not strictly halophytes (*Conocarpus lancifolius*, *Cordia sebestena*, *Cynodon dactylon*, *Typha domingensis*, *Panicum turgidum*, *Phoenix dactylifera*, *Nerium oleander*). True halophytes were found especially in coastal and saline habitats. Thus salinity plays a significant role in shaping vegetation structure along coastal zones. Some Cultivated ornamental plants were also documented in the present study e.g., *Bougainvillea glabra*, *Delonix regia*, *Petunia × hybrida etc.*

The classification of desert plants into different groups based on their adaptive features was a reflection of the diversity of survival strategies (Table 2). Deep-rooted trees and shrubs e.g., *Prosopis cineraria* and *Vachellia nilotica* has very deep root systems meant to access groundwater, whereas stem-succulent species such as *Calligonum comosum* depend on green photosynthetic stems and leaves with reduced surface areas to reduce water loss. Shrubs with leathery or waxy leaves such as *Dodonaea viscosa* and *Nerium oleander*, minimise transpiration through structural modifications, while parasitic species like *Cistanche tubulosa* rely on host plants for their nutrition.

Table 2: Vegetative and reproductive adaptations of desert plants of Dubai

Category	Vegetative Adaptations	Reproductive Adaptations	Plant Species
Category 1: Deep-rooted desert trees/shrubs	Extensive deep taproots (10–30 m) for accessing groundwater, small or compound leaves, thorny branches, drought-tolerant seeds	Drought-resistant seeds, some produce hard-coated seeds for delayed germination	*Prosopis cineraria*, *Vachellia nilotica*, *V. tortilis*, *Ziziphus spina-christi*, *Senegalia senegal*, *Lycium shawii*
Category 2: Stem-succulent or green-stem desert plants	Reduced leaves, photosynthetic green stems, deep roots, water storage in stem	Seeds adapted to arid soil, some propagate vegetatively from stems	*Calligonum comosum*, *Leptadenia pyrotechnica*, *Ipomoea horsfalliae*
Category 3: Desert shrubs with leathery or waxy leaves	Small, leathery or succulent leaves; thick cuticle, hairy surfaces, moderate-to-deep roots	Drought-tolerant seeds, some have seed dormancy mechanisms or dispersal adaptations (wind/animal)	*Calotropis procera*, *Dodonaea viscosa*, *Heliotropium kotschyi*, *Indigofera arabica*, *Moringa peregrina*, *Nerium oleander*, *Peganum harmala*, *Tribulus arabicus*, *T. terrestris*, *Arnebia hispidissima*
Category 4: Desert palms and grasses with water storage and fibrous roots	Fibrous or deep roots, water storage in trunk or fronds, thick cuticle on leaves	Fruit or seed adapted to dry conditions, date palm produces fleshy fruits aiding water storage, grass seeds can remain dormant in soil	*Phoenix dactylifera*, *Panicum turgidum*
Category 5: Parasitic desert plant	Reduced leaves; dependent on host roots for water, survives extreme drought	Produces numerous tiny seeds that attach to host roots; drought-tolerant seed dormancy	*Cistanche tubulosa*

The flora recorded in the present study exhibits remarkable ecological adaptations that enable survival under the harsh climatic conditions of the United Arab Emirates (UAE). The UAE is characterized by an arid to hyper-arid climate with extremely high summer temperatures, low and irregular rainfall, intense solar radiation, high evaporation rates, sandy soils and frequent drought conditions. To cope with the drought, tolerant plants initiate defense mechanisms against water deficit (Chaves and Oliveira, 2004). Under such environmental stress, plant species have evolved several morphological, anatomical, physiological and reproductive adaptations that help them tolerate water scarcity, salinity and heat stress. Many desert species exhibit a range of strategies to survive in arid and semi arid systems characterized by episodic precipitation and soil- moisture pulses that vary in amount and frequency (Noy-Meir, 1973).

Most of the native species documented in the study are xerophytic in nature and possess specialized features for minimizing water loss. Shrubs and trees such as *Calligonum comosum*, *Leptadenia pyrotechnica*, *Prosopis cineraria*, *Vachellia tortilis* and *Tamarix nilotica* exhibit reduced or very small leaves, which help decrease transpiration under extreme heat conditions. In several species, leaves are either modified into scales or shed during severe drought periods, while photosynthesis is largely carried out by green stems. Such stem photosynthesis is particularly evident in desert shrubs like

Leptadenia pyrotechnica and *Calligonum comosum*. The mechanisms of drought tolerance are maintenance of turgour by means of osmoregulation (a process which induces accumulation of compatible solutes in the cell), increase in elasticity of the cell and a decrease in cell size and desiccation tolerance by protoplasmic resistance (Sullivan and Ross, 1979). Roots are the key plant organs for adaptation to drought. Deep and extensive root systems represent another important adaptation among desert plants. Species such as *Prosopis cineraria*, *Calotropis procera*, and *Vachellia tortilis* develop long tap roots capable of reaching underground water reserves located deep within sandy soils. These root systems not only facilitate water absorption but also help stabilize sand dunes and reduce soil erosion in desert habitats. The presence of small diameter roots under reduced water availability is considered as a strategy aimed to maximize absorptive surfaces and nutrient uptake (Eissenstat, 1992). The roots of some desert plants are shallow but horizontally extensive in order to capture water more effectively when rain comes, while some have their roots extended deeply in the ground (Murphy, 2015). The ability of roots of common lamb's quarter *Chenopodium album* to penetrate deeply into the soil and its large fraction of fine roots enable it to survive periods of summer drought better than other species (Maganti *et al.*, 2005).

Some desert plants are adept at efficiently absorbing water during even light rainfalls, and storing the water in specialized cells in their stems, leaves or roots. This succulent, water-holding tissue provides the plants with security against extended dry spells (Clive and Bill, 1995). Many species recorded during the study also possess succulent or fleshy tissues that store water during brief rainfall events. Plants such as *Calotropis procera*, *Sesuvium portulacastrum* and *Cistanche tubulosa* exhibit water-storage adaptations that enable them to survive prolonged dry periods. In addition, thick cuticles, waxy coatings, hairy surfaces and sunken stomata are common xerophytic characters observed in many desert plants, helping reduce transpiration and protect against excessive solar radiation. Halophytic adaptations were also evident among several species growing in saline habitats and coastal regions of the UAE. Species such as *Sesuvium portulacastrum*, *Salvadora persica*, *Tamarix aphylla* and *Zygophyllum qatarense* are capable of tolerating high salt concentrations through salt-excreting glands, succulence, osmotic regulation and selective ion uptake mechanisms. These adaptations enable survival in highly saline soils where ordinary plants cannot grow.

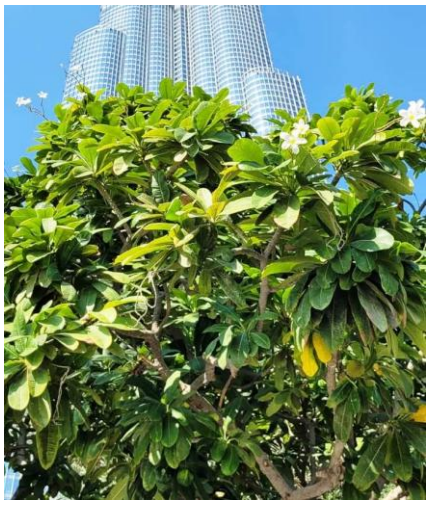
The drought escape strategy may partially explain the abundance of annual species thriving in the most arid habitats (Arnesto and Vidiella, 1993). Annual herbs and ephemeral plants recorded in the study exhibit short life cycles as an adaptation to unpredictable rainfall. These plants complete germination, flowering, seed production and dispersal rapidly following occasional rain events. Their seeds remain dormant in soil for long periods until favorable moisture conditions occur. Species belonging to Poaceae and Asteraceae commonly show such drought-escaping strategies. An ephemeral life cycle is characterized by a short life and the capacity to complete their life cycle in much less than one year. This mechanism involves rapid phenological development (early flowering and early maturity), developmental plasticity (variation in duration of growth period depending on the extent of water deficit) and remobilization of pre-anthesis assimilates (Turner, 1979). In the driest habitats (deserts) up to 90% of the plants are annuals, which effectively employ dormancy periods in order to take advantage of the very short favourable season (Travlos and Chachalis, 2008).

Several plants in the study area also display physiological adaptations such as reduced metabolic activity during drought stress, efficient water-use mechanisms and in some cases Crassulacean Acid Metabolism (CAM) or C4 photosynthetic pathways. These physiological modifications improve photosynthetic efficiency while minimizing water loss under high temperature and low moisture conditions. Plants show structural alternations that are mainly related to water saving (e.g. water storage and reduction of water losses) and mechanical reinforcement of tissues (e.g. thickening and strengthening of cell walls) (De Micco and Aronne, 2007). Drought tolerance typically requires the capacity to maintain physiological functions and growth during periods of water stress, and the ability to access soil moisture from multiple depths in the soil profile often confers an advantage to desert

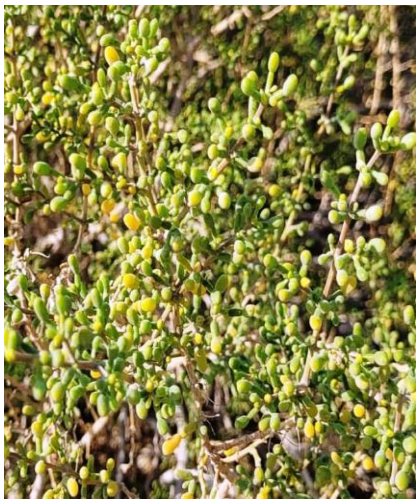
dominants (Abbott *et al.*, 2008). The desert plants have developed strategies to adjust stomatal behaviour, rate of transportation and water potential to cope with the harsh environment of the desert (Borkhari *et al.*, 1987).

The dominance of hardy shrubs, perennial grasses and drought-resistant trees in the recorded flora clearly reflects adaptation to the desert ecosystem of the UAE. Native plants not only survive under extreme climatic conditions but also contribute significantly to ecological stability by preventing desertification, stabilizing sand dunes, improving soil fertility and supporting wildlife populations.

Overall, the ecological adaptations observed among the plant species recorded in the study demonstrate the remarkable resilience of desert flora to the extreme environmental conditions prevailing in the UAE. These adaptive characteristics enable plants to survive and reproduce successfully in arid ecosystems and highlight their ecological importance in maintaining the sustainability and biodiversity of desert habitats.



(a) Plumeria rubra (on backside of Burj Khalifa)



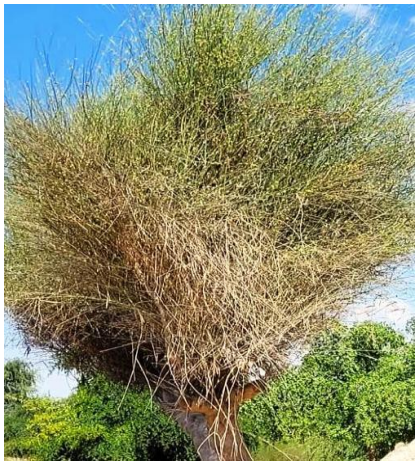
(b) Salsola drummondii



(c)Phoenix dactylifera L.



(d) Olea europaea



(e) Tamarix aphylla

Fig 2. (a-e): Some of the reported plant species.

Ethnobotany

The ethnobotanical information of the recorded plant species was compiled from available literature and previous studies conducted in the study area and surrounding regions of the UAE. It was found that out of the 54 recorded plant species, only 22 species were reported to possess documented ethnobotanical or medicinal uses, while the remaining species had no specific ethnobotanical uses mentioned in the consulted literature (Table 1). The ethnobotanically important species belonged to several plant families, among which Fabaceae, Apocynaceae, Boraginaceae, Poaceae and Zygophyllaceae were prominent. The predominance of medicinally important species belonging to Fabaceae, Apocynaceae, Boraginaceae and Poaceae observed in the present study is in agreement with earlier ethnobotanical investigations conducted in the UAE and neighboring desert regions (Kakudidi *et al.*, 2000; Bukenya – Ziraba and Kamoga, 2007; Sakkir *et al.*, 2012; Sajjad *et al.*, 2017). No single genus showed clear dominance; however, genera such as *Calotropis*, *Ipomoea*, *Salvadora*, *Tamarix*, *Tribulus*, and *Vachellia* were represented by two species each within the recorded flora. Among these, species of *Calotropis*, *Salvadora* and *Tribulus* exhibited important medicinal applications.

The results indicated that medicinal plants were mainly used for the treatment of fever, wounds, digestive disorders, skin diseases, cough, toothache, diabetes, paralysis, rheumatism, jaundice, constipation, kidney problems and scorpion or snake bites. Treatment against wounds and skin-related disorders constituted one of the most common ethnomedicinal applications reported in the study. Species such as *Calotropis procera*, *Cynodon dactylon*, *Panicum turgidum*, *Salvadora persica*, *Tamarix aphylla*, *Typha domingensis* and *Ziziphus spina-christi* were specifically used for wounds, burns, skin sores, or inflammatory conditions. Several plants were also reported for treating digestive and gastrointestinal ailments. *Cistanche tubulosa* was used for diarrhea, *Moringa peregrina* for constipation and stomach cramps, and *Lycium shawii* as a laxative and diuretic.

The study further demonstrated that different plant parts were utilized in traditional remedies. Leaves were the most frequently used plant part as reported in several other studies conducted in different regions (Addo- Fordjour *et al.*, 2008; Kamatenesi-Mugisha *et al.*, 2008; Okello and Ssegawa, 2007; Yineger *et al.*, 2008), followed by stems, roots, fruits, seeds, bark, flowers, latex and whole plants. Leaves were commonly applied in the treatment of wounds, joint pain, skin diseases and toothache, whereas roots and bark were mainly used for fever, digestive disorders and rheumatism. Fruits and seeds were utilized both medicinally and nutritionally.

Among the recorded species, *Rhazya stricta* and *Lycium shawii* showed the highest range of medicinal applications, being used for multiple ailments including diabetes, constipation, skin diseases, ulcers, jaundice, fever and chest pain. The findings highlight the rich ethnobotanical knowledge associated with the native flora of the study area and demonstrate the continued importance of medicinal plants in traditional healthcare systems of arid and semi-arid regions.

Biological spectrum

The biological spectrum of the studied area shows marked variation from Raunkiaer's Life-form Classification normal spectrum, indicating the influence of local climatic and ecological conditions on vegetation composition. The comparison of the biological spectrum of the study area with Raunkiaer s normal biological spectrum is presented in Table 3 (Fig 3). The predominance of different life forms reflects the adaptive strategies of plants in response to environmental factors such as temperature, moisture availability, grazing pressure and topography. The present study revealed Phanerophytes (53.7%) as the dominant class followed by Chamaephytes (24.0%), thus representing Phanero-Chamaeophytic phytoclimate. The over-representation of Phanerophytes (+7.7%) and Chamaephytes (+15.0%) suggests a warmer, relatively favorable, variation in rainfall, topography and landform or high-altitude/rocky environment where woody shrubs and trees thrive well (Abd El-Ghani *et al.*, 2006; Shaltout *et al.*, 2010). Similar results were also recorded in several other studies conducted in

dry, arid desert ecosystems (Abbas *et al.*, 2020; Alatar *et al.*, 2012 ; Khalik *et al.*, 2013; Barupal 2025.). The high percentage of chamaephytes may be related to their ability to resist to the drought, salinity and sand accumulation (Bana, 2002). Hemicryptophytes are severely under-represented (-22.3%), suggesting the region does not face the classic cold-temperate conditions where surface-budding perennial grasses usually dominate.

Table 3: Comparison of biological spectrum of study area with Raunkiaer's (1934) Normal Biological Spectrum

Plant Life Form	Given Spectrum (%)	Raunkiaer's Normal Spectrum (%)	Deviation (%)	Status
Phanerophytes (PH)	53.7	46.0	+7.7	Over-represented
Chamaephytes (CH)	24.0	9.0	+15.0	Significantly Over-represented
Hemicryptophytes (HC)	3.7	26.0	-22.3	Significantly Under-represented
Cryptophytes (CR)	5.6	6.0	-0.4	Almost Equal
Therophytes (TH)	13.0	13.0	0.0	Perfectly Equal

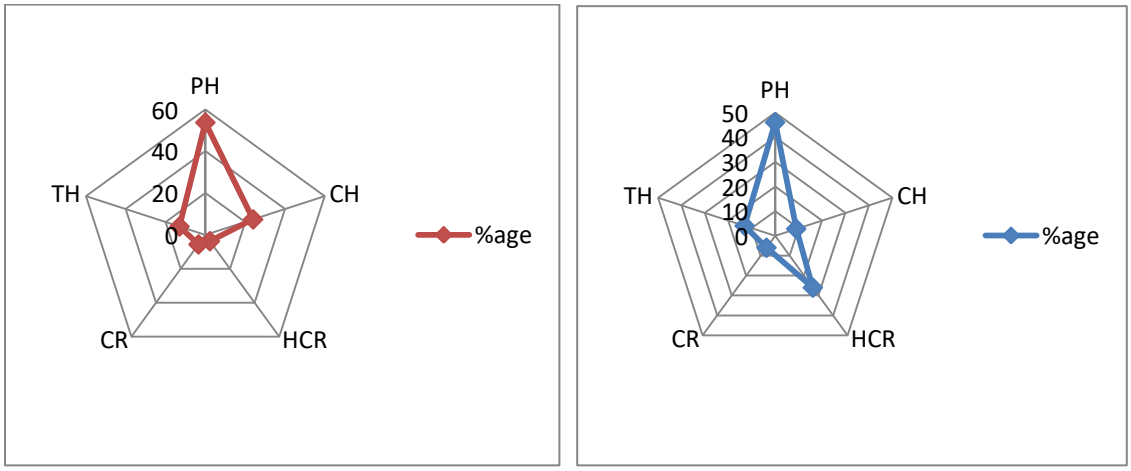


Figure 3: (a) Biological spectrum of study area, (b) Raunkiaer' s Normal Biological Spectrum

Conservation status

An analysis of the 54 target plant species against the IUCN Red List criteria revealed that the clear majority (66.6%, n=36) are classified as Least Concern (LC) Table 4 (Figure 4). This high proportion indicates a strong baseline of ecological resilience, widespread geographical distribution, or extensive human cultivation among the selected taxa. Many of these species likely exhibit tolerance to severe environmental stressors (e.g., halophytic or xerophytic traits found in desert/coastal flora), high reproductive output or high human utility (ornamental, agroforestry, medicinal), which encourages active cultivation and inadvertently protects them from extinction. e.g., Some species like *Bougainvillea glabra, Saccharum species,* or *Vachellia complexes* possess significant ornamental, agroforestry, or

economic value. Human-mediated dispersal and widespread cultivation act as a powerful buffer, safeguarding these species from drastic global population drops despite localized wilderness loss. However, a significant knowledge gap was identified, with 29.6% (n=16) of the taxa remaining Not Evaluated (NE) on a global scale. This high proportion of NE species highlights a critical bottleneck in tropical/arid land conservation biology, where lack of centralized data frequently masks localized population declines. Furthermore, the inclusion of Near Threatened (NT, n=1) and Data Deficient (DD, n=1) species emphasizes the need for localized micro-conservation strategies and regional Red List frameworks to protect fragile wild genotypes from anthropogenic pressures.

Table 4: IUCN Red list categories

IUCN Red list Category	No. of Species	%age
Least Concern (LE)	36	66.66
Not Evaluated (NE)	16	29.62
Near Threatened (NT)	1	1.85
Data Deficient (DD)	1	1.85

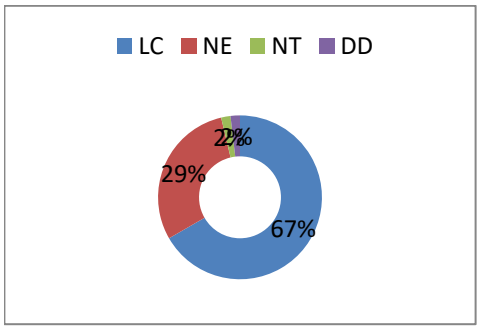


Figure 4: IUCN Red list categories

Conclusion

The present study documents the floristic composition, distribution patterns, adaptive mechanisms and ethnobotanical significance of plant species growing in the study area. The findings of the study reveal the dominance of xerophytic and halophytic plant species adapted to arid and saline environments. The dominance of families such as Apocynaceae and Boraginaceae reflects their strong ecological adaptability to extreme xerophytic desert conditions. Plants exhibited different types of vegetative and reproductive adaptations to arid conditions. These adaptations include deep root systems, reduced leaf surfaces, water-storage and succulence mechanisms which enables them to survive under extreme climatic stress. The occurrence of both native and introduced species indicates the influence of natural and anthropogenic factors on vegetation composition. Additionally, most of the documented plants were of ethnobotanical importance which emphasizes the ecological and cultural significance of the flora. The study area revealed Phanero-Chamaeophytic phytoclimate with dominance of Phanerophytes (53.7%) and Chamaephytes (24.0%).The high proportion of Least Concern (LC) category against IUCN Red List indicates a strong baseline of ecological resilience, widespread geographical distribution, or extensive human cultivation among the selected taxa. Many of these species likely exhibit tolerance to severe environmental stressors (e.g., halophytic or xerophytic traits found in desert/coastal flora), high reproductive output or high human utility (ornamental, agroforestry, medicinal), which encourages active cultivation and inadvertently protects them from extinction. Overall, the study provides valuable baseline data for understanding plant adaptation, traditional plant uses, biodiversity conservation and sustainable utilization in desert ecosystems.

Declarations

Ethical approval and consent to participate: Not applicable

Consent for Publication: Not applicable, as no identifying information of participants is included.

Competing interests: The authors have no competing interests to disclose.

Authors' contributions: OPS (OP Sharma) devised the study, framed its draft, collected the data and

wrote the manuscript. **BPS** (Bhekam Pal Singh) helped to design, draft and edit the manuscript. **KK** (Kewal Kumar) participated in, editing, compiling and interpretation of data, finalizing the draft and critical revision of the manuscript before approval for final submission.

Funding: No funding of any kind received from funding agencies.

References:

Abbas, A. M., Al-Kahtani, M. A., Alfaifi, M. Y., Elbehairi, S. E. I., & Badry, M. O. (2020). Floristic diversity and phytogeography of Jabal Fayfa: A subtropical dry zone, south-west Saudi Arabia. *Diversity, 12*(9), 345. https://doi.org/10.3390/d12090345

Abd El-Ghani, M. M., & Abdel-Khalik, K. N. (2006). Floristic diversity and phytogeography of the Gebel Elba National Park, south-east Egypt. *Turkish Journal of Botany, 30*, 121–136.

Abbott, L. B., Lepak, D., & Daniel, D. L. (2008). Vegetative and reproductive phenologies of African rue (*Peganum harmala*) in the northern Chihuahuan Desert. *Southwestern Naturalist, 52*, 209–218.

Addo-Fordjour, P., Anning, A. K., Belford, E. J. D., & Akonnor, D. (2008). Diversity and conservation of medicinal plants in the Bomaa community of the Brong Ahafo region, Ghana. *Journal of Medicinal Plants Research, 2*(9), 226–233.

Alatar, A., El-Sheikh, M. A., & Thomas, J. (2012). Vegetation analysis of Wadi Al-Jufair, a hyper-arid region in Najd, Saudi Arabia. *Saudi Journal of Biological Sciences, 19*, 357–368.

Albuquerque, U. P., De Lucena, R. F. P., da Cunha, L. V. F. C., & Alves, R. R. N. (Eds.). (2019). *Methods and techniques in ethnobiology and ethnoecology*. Springer, New York: Humana Press.

Aremu, A. O., Luo, B., & Mussarat, S. (2024). Medical ethnobotany. *BMC Complementary Medicine and Therapies, 24(1)*, 216.

Arnesto, J.J. and Vidiella, P.E. (1993). Plant life-forms and bibliographic relations of the flora of Lagunillas (30^0S) in the fog tree Pacific Coastal Desert. *Annals of the Mission Botanical Garden*, 80: 499-511

Bana, M. I. El, *et al.* (2002). Vegetation composition of a threatened hypersaline lake (Lake Bardawil), North Sinai. *Plant Ecology, 163*, 63–75.

Barupal G.K. (2025). Life Forms and Biological Spectrum of the Flora of Shekhawati Region, Rajasthan. *International Journal of Botany Studies* 10(1), 2025, 30-32.

Begon, M., & Townsend, C. R. (2020). *Ecology: from individuals to ecosystems*. John Wiley & Sons.

Borkhari, U. G., Alyaeesh, F., & Al-Nori, M. (1987). Adaptive strategies of desert grasses in Saudi Arabia. *Journal of Range Management, 40* (1), 19–22.

Brown, G., & Böer, B. (2004). *Interpretation manual of major terrestrial and semi-natural habitat types of Abu Dhabi emirate*. Research report, environmental research and wildlife development agency, Abu Dhabi.

Brown, G., & Feulner, G. R. (2024). The vascular flora of the United Arab Emirates. In J. A. Burt (Ed.), *A Natural History of the Emirates*. Springer. https://doi.org/10.1007/978-3-031-37397-8_13

Bukenya-Ziraba, R., & Kamoga, D. (2007). An inventory of medicinal plants used in treating poultry diseases in Jinja District, Eastern Uganda. *African Journal of Ecology, 45*, 31–38.

Chaves, M. M., & Oliveira, M. M. (2004). Mechanisms underlying plant resilience to water deficit: Prospects for water-saving agriculture. *Journal of Experimental Botany, 55*, 2365–2384.

Clive, I., & Bill, W. (1995). *Cacti, Succulents, and Bromeliads*. Cassell Educational.

Convention on Biological Diversity. (2022). *Global Biodiversity Framework*.

Curtis, J. T., & McIntosh, R. P. (1950). The interrelations of certain analytic and synthetic phytosociological characters. *Ecology, 31*(3), 434–455.

Darwin, C. (1859). *On the Origin of Species*. John Murray, London, U.K.

De Micco, V., & Aronne, G. (2007). Anatomical features, monomer lignin composition and accumulation of phenolics in one-year-old branches of Mediterranean trees and shrubs related to water availability. *Botanica Helvetica, 118*, 139–148.

El-Ghonemy, A. A. (1993). *Encyclopedia of Medicinal Plants of the United Arab Emirates* (1st ed.). United Arab Emirates University.

El-Keblawy, A., Ksiksi, T., & El Alqamy, H. (2009). Camel grazing affects species diversity and community structure in the deserts of the UAE. *Journal of Arid Environments*, *73*(3), 347-354.

Eissenstat, D. M. (1992). Costs and benefits of constructing roots of small diameter. *Journal of Plant Nutrition, 15*, 763–782.

Gallacher, D. J., & Hill, J. P. (2006). Effects of camel grazing on the ecology of small perennial plants in the Dubai (UAE) inland desert. *Journal of Arid Environments*, *66*(4), 738-750.

Ghazanfar, S. A. (1994). *Handbook of Arabian Medicinal Plants*. CRC Press.

Ghazanfar, S. A. (2004). Biology of the central desert of Oman. *Turkish Journal of Botany*, *28*(1), 65-71.

Heinrich, M., Ankli, A., Frei, B., Weimann, C., & Sticher, O. (1998). Medicinal plants in Mexico: Healers' consensus and cultural importance. *Social Science & Medicine, 47*(11), 1859–1871.

Heinrich, M., Edwards, S., Moerman, D. E., & Leonti, M. (2009). Ethnopharmacological field studies: a critical assessment of their conceptual basis and methods. *Journal of ethnopharmacology*, *124* (1), 1-17.

Jongbloed, M. V. D., Feulner, G. R., Böer, B., & Western, A. R. (2003). *The Comprehensive Guide to the Wild Flowers of the United Arab Emirates*. ERWDA.

Kakudidi, E. K. Z., Bukenya-Ziraba, R., & Kasenene, J. M. (2000). The medicinal plants in and around Kibale National Park in Western Uganda. *Norwegian Journal of Botany (Lidia), 5*, 109–124.

Kamatenesi-Mugisha, M., Oryem-Origa, H., Odyek, O., & Makawiti, D. W. (2008). Medicinal plants used in the treatment of fungal and bacterial infections in and around Queen Elizabeth Biosphere Reserve, Western Uganda. *African Journal of Ecology, 46*, 90–97.

Kent, M. (2012). *Vegetation Description and Data Analysis: A Practical Approach*. Wiley-Blackwell.

Khalik, K., El-Sheikh, M., & El-Aidarous, A. (2013). Floristic diversity and vegetation analysis of Wadi Al-Noman, Mecca, Saudi Arabia. *Turkish Journal of Botany, 37*, 894–907.

Kunwar, R. M., Fadiman, M., Cameron, M., Bussmann, R. W., Thapa-Magar, K. B., Rimal, B., & Sapkota, P. (2018). Cross-cultural comparison of plant use knowledge in Baitadi and Darchula districts, Nepal Himalaya. *Journal of Ethnobiology and Ethnomedicine*, *14*(1), 40.

Larcher, W. (2003). *Physiological plant ecology: ecophysiology and stress physiology of functional groups*. Springer Science & Business Media.

Mandaville, J. P. (1986). Plant life in the Rub'al-Khali (the Empty Quarter), south-central Arabia. *Proceedings of the Royal Society of Edinburgh, Section B: Biological Sciences*, *89*, 147-157.

Maganti, M., Weaver, S., & Downs, M. (2005). Response of spreading orach (*Atriplex patula*) and common lambsquarters (*Chenopodium album*) to soil compaction, drought, and waterlogging. *Weed Science, 53*, 90–96.

Mueller-Dombois, D., & Ellenberg, H. (1974). *Aims and Methods of Vegetation Ecology*. John Wiley & Sons.

Murphy, D. (2015). *How Plants Tolerate Drought*. Southwest Trees and Turf.

Noy-Meir, I. (1973). Desert ecosystems: Environment and producers. *Annual Review of Ecology and Systematics, 4*, 25–51.

Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of Ecology*. Thomson Brooks/Cole.

Okello, J., & Ssegawa, P. (2007). Medicinal plants used by communities of Ngai Sub County, Apac District, Northern Uganda. *African Journal of Ecology, 45*, 76–83.

Phondani, P. C., Bhatt, A., Elsarrag, E., & Horr, Y. A. (2016). Ethnobotanical magnitude towards sustainable utilization of wild foliage in Arabian Desert. *Journal of Traditional and Complementary Medicine*, *6*(3), 209-218.

Ralte, L., Sailo, H., & Singh, Y. T. (2024). Ethnobotanical study of medicinal plants used by indigenous communities of Mizoram, India. *Journal of Ethnobiology and Ethnomedicine, 20*, 2.

Sajjad, A., Adnan, S., Hasnain Alam, H., & Mohamed, E. A. R. (2017). Ethno botanical study of traditional native plants in Al Ain UAE. *Int. J. Adv. Res. Biol. Sci*, *4*, 165-174.

Sakkir, S., Kabshawi, M., & Mehairbi, M. (2012). Medicinal plants diversity and their conservation status in the United Arab Emirates (UAE). *J Med Plants Res*, *6*(7), 1304-1322.

Shaltout, K. H., Sheded, M. G., & Salem, A. I. (2010). Vegetation spatial heterogeneity in a hyper-arid biosphere reserve area in North Africa. *Acta Botanica Croatica, 69*, 31–46.

Silveira, D., & Boylan, F. (2023). Medicinal plants: Advances in phytochemistry and ethnobotany. *Plants, 12*(8), 1682.

Simpson, E. H. (1949). Measurement of diversity. *nature*, *163* (4148), 688-688.

Smith, T. M., & Smith, R. L. (2015). *Elements of Ecology*. Pearson.

Sullivan, C. Y., & Ross, W. W. (1979). Selecting for drought and heat resistance in grain sorghum. In H. Mussell & R. C. Staples (Eds.), *Stress Physiology in Crop Plants* (pp. 263–281). Wiley.

Travlos, I. S., & Chachalis, D. (2008). Drought adaptation strategies of weeds and other neglected plants of arid environments. *Plant Stress, 2*(1), 40–44.

Turner, N. C. (1979). Drought resistance and adaptations to water deficits in crop plants. In H. Mussell & R. C. Staples (Eds.), *Stress Physiology in Crop Plants* (pp. 343–373). Wiley-Interscience.

Western, A. R. (1989). *The Flora of the United Arab Emirates: An Introduction*. Al Ain.

World Health Organization. (2023). *Traditional Medicine Strategy*.

Yineger, H., Kelbessa, E., Bekele, T., & Lulekal, E. (2008). Plants used in traditional management of human ailments at Bale Mountains National Park, southeastern Ethiopia. *Journal of Medicinal Plants Research, 2*(6), 132–153.

Zahran, M. A., Younes, H. A., & Al-Tawil, B. A. (1985). Ecology of four community types: Red Sea coastal desert, Saudi Arabia. *Journal of Coastal Research*, 279-288.