



Floristic diversity of Al wadi Al-Akhthar, Tabuk region, Saudi Arabia

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Abstract

This study was conducted in Wadi Al-Akhthar in the north-western region of Saudi Arabia. The main objective is to determine the floristic composition of the area, including a breakdown of its different life forms and the chorology of the recorded species. A total of 82 species belonging to 63 genera and 25 families of the Angiospermae were recorded. About 46.34% of the recorded species in the study area are belonging to three families: Asteraceae, Brassicaceae, and Fabaceae. The data also reflect a high degree of monotypism, where 56% of the recorded families were represented by a single species, and 60.78% of the genera were monotypic. Perennial species dominated the plant cover (61%) defining the character of the vegetation, while annuals were represented by about 39%. Chamaephytes (35.4) and Therophytes (31.7) were the most frequent lifeforms. Chorological analysis of the floristic data revealed that the monoregional Saharo-Arabian chorotype is the most dominant chorotype in Wadi Al-Akhthar (39%), followed by the monoregional Sudanian chorotype (11%). The results also showed the predominance of mono-regional taxa (63.4%) over the other phytogeographical elements followed by the bi-regional (30.5%). Information from the current study may provide a valuable reference for appropriate conservation and management of the study area.

Keywords: flora, life-form, chorology, valley

Introduction

Saudi Arabia is an arid desert covers the majority of the Arabian Peninsula. The flora of Saudi Arabia is one of the richest bio diversities in the Arabian Peninsula and comprises very important genetic resources of crops and medicinal plants (Atiqur Rahman *et al.*, 2004) [8]. The distribution of life form is closely related to topography and landform (Zohary, 1973, Fakhireh *et al.*, 2012) [22, 12]. According to Collenete (Collenette, 1999) [11], Flora of Saudi Arabia contains 2250 species belonging to 835 genera and 142 families. The north-western and south-western territories of Saudi Arabia harbor a rich flora and contain the highest number of species, about 80% of the total flora of the country (Thomas, 2011) [19]. Components of the flora of Saudi Arabia are diverse, having affinities with the floras of North and East Africa, the Mediterranean, and Irano-Turanian countries (AlNafie, 2008, Alfarhan, 1999) [6, 5]. Many studies on the flora of Saudi Arabia have been conducted either on a general scale or limited to specific regions or ecosystems, which over the years have helped to strengthen the foundations of desert environmental studies in Saudi Arabia. The diversity of geophysical features is associated with the diversity of climatic differences, which in turn leads to a diversity of vegetation. The ecosystems of the valleys are one of the main centers of plant diversity in the Saudi Arabia. Valleys are important habitats that embrace many plant communities, encompasses many perennial and annual species, and because of their paramount importance in the conservation of biodiversity, many ecological studies have been conducted on the valleys of Saudi Arabia but none of the research and environmental studies have been carried out on the Green Valley (Wadi Al-Akhthar), which is characterized by the abundance of natural vegetative covering, so it is considered a good area for future agricultural investment. The present study

includes a survey and identification of the wild plant species growing in Wadi Al-Akhthar in Tabuk region, Northwestern of Saudi Arabia, with the objective of determining the floristic composition, with analysis of life forms and chorology of the recorded species. Floristic analysis of the status of vegetation is very important as prerequisites for the conservation of plant species, to provide appropriate strategies for developing an effective system of management and conservation. Results from the present study may provide a valuable reference for appropriate conservation and management of the study area.

Materials and Methods

1. Study Area

Tabuk is located in northwestern Saudi Arabia. The region falls within the Mediterranean deserted continental climate. The area is dry zone, characterized by hot, arid, desert climate. Climate data have been collected from the General Authority for Meteorology and Environmental Protection in Tabuk Governorate for the mean rate during the years 2010-2021. The records of Tabuk climatic stations showed that the highest average rate of rainfall is recorded in winter, up to 8.1 mm in January. Air temperatures are high in summer. The mean monthly temperature ranges from 6 in January to 38 in July. The average relative humidity in the study area is low ranging from 24.3 in spring to 41 in winter. Al-Atawi (2014) [4] explained that Wadi Al-Akhthar is one of the large valleys in the Tabuk region and the valley feeds a number of tributaries, it is a place to collect rainwater. It is a long valley whose tributaries originate from the south of Tabuk, and the course of the valley goes to the northeast in a rugged groove. The valley is 150 km long from its source of Harrat Al-Raha until it flows into the bottom of Sharuri to the north (Saudi Geological Survey, 2017) [17].

2. Plant Collection and Species Identification

The first author Hanan Anazi carried out the field collections through intensive field surveys of the wild plant communities in the study area for three years (2020 – 2022). Fifty sites were selected along Wadi Al-Akhtar. In each site, sampling stands were located randomly by using the Relève method (Muller & Ellenberg, 1974) [15]. When selecting each site and stand, habitat uniformity and a reasonable degree of plant cover homogeneity was insured. The plant species were identified according to existing literatures (Collentte,1999; Chaudhary, 2001; Boulos, 2009) [10, 9]. Plant life-forms and duration have been defined. Phytogeographical affinities of the recorded species were determined (Zohary, 1966; Zohary, 1972) [20, 21]. Herbarium specimens were prepared and deposited in herbarium of the College of Science, King Saud University, Saudi Arabia.

Results

1. Floristic Composition

A total of 82 species belonging to 25 families of Angiospermae were recorded in the study area and

presented in Figure 1. Three of these families dominate the flora of the study area as they were the most species-rich families: Asteraceae (17 species = 20.73%), Brassicaceae (11 species = 13.41%), and Fabaceae (10 species = 12.20%). Chenopodiaceae and Zygophyllaceae were represented by 7 species each (8.54%), Poaceae was represented by 4 species (4.88%), Boraginaceae and Lamiaceae were represented by 3 species each (3.66%). While Asclepiadaceae, Cistaceae, and Polygonaceae were represented by 2 species each (2.44%). Meanwhile, 14 families were represented by only one species for each (1.22%). This may reflect the high taxonomic diversity in the study area. The low ratios of species/genera and genera/families estimated for total species (1.30 and 2.52 respectively) indicate high taxonomic diversity in the study area. It is noteworthy to mention that *Fagonia* was the largest genus, represented by five species, followed by *Launaea*, represented by four species. Other genera with greater number of species (three species each) were *Artemisia*, *Heliotropium*, and *Astragalus*.

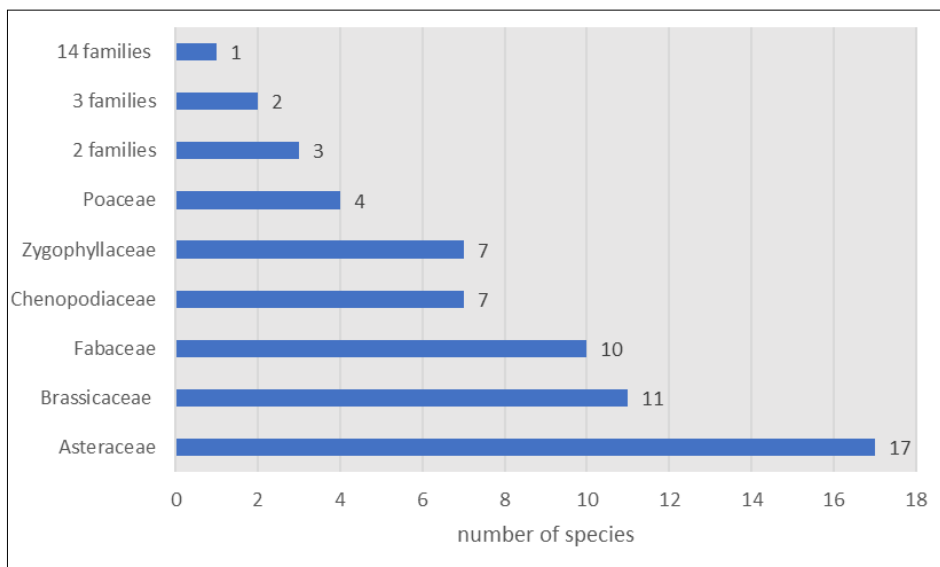


Fig 1: Histogram of the floristic structure of 31 families recorded in Wadi Al-Akhtar

Most of the species recorded during this study were perennials with 50 species (62.50%) of the total surveyed

species, while annual plants were represented by 32 species (39.02%) (Table 1, Table 2).

Table 1: List of plant species surveyed in Wadi Al-Akhtar and their families, duration, life form, and chorology. Life form: Ch: Chamaephyte, G: Geophyte, H: Hemicyptophyte, Ph: Phanerophyte, Th: Therophyte - Chorology (Floristic categories): SA: Saharo-Arabian; ME: Mediterranean; IT: Irano-Turanian; SU: Sudanian; SZ: Sudano-Zambeian; ES: Euro Siberian, SS: Saharo Sindian and COSM: Cosmopolitan.

Family	Species	Life-form	Duration	Chorology
Amaranthaceae	<i>Aerva javanica</i> (Burm.f.) Juss. ex Schult.	Ch	perennial	SA+SZ
Apocynaceae	<i>Leptadenia pyrotechnica</i> (Forssk.) Decne.	Ph	perennial	SA+SU
Asclepiadaceae	<i>Calotropis procera</i> (Aiton) Aiton f.	Ph	perennial	SU
	<i>Glossonema boveanum</i> (Decne.) Decne.	H	perennial	SU
Asphodelaceae	<i>Asphodelus tenuifolius</i> Cav.	Th	annual	SA+SU
Asteraceae	<i>Achillea fragrantissima</i> (Forssk.) Sch.Bip.	H	perennial	SA+IT
	<i>Aaronsohnia factorovskyi</i> Warb. & Eig	Th	annual	SA
	<i>Anvillea garcinii</i> (Burm.f.) DC.	Ch	perennial	SA
	<i>Artemisia judaica</i> L.	Ch	perennial	SA
	<i>Artemisia monosperma</i> Delile	Ch	perennial	SA
	<i>Artemisia sieberi</i> Besser	Ch	perennial	IT
	<i>Asteriscus graveolens</i> (Forssk.) Less.	Ch	perennial	SA

	<i>Centaurea mesopotamica</i> Bornm.	Th	annual	SA
	<i>Centaurea sinaica</i> DC.	Th	annual	SA
	<i>Echinops spinosissimus</i> Turra	H	perennial	ME
	<i>Ifloga spicata</i> (Forssk.) Sch.Bip.	Th	annual	SA
	<i>Launaea procumbens</i> (Roxb.) Amin	H	annual	SA
	<i>Launaea capitata</i> (Spreng.) Dandy	H	perennial	SA
	<i>Launaea nudicaulis</i> (L.) Hook.f.	H	perennial	SA
	<i>Launaea resedifolia</i> (L.) Kuntze	H	perennial	ME
	<i>Picris babylonica</i> Hand.- Mazz.	Th	annual	ME+SS
	<i>Pulicaria undulata</i> (Forssk.) C.A.Mey.	Ch	perennial	SA+SU
Boraginaceae	<i>Heliotropium bacciferum</i> Forssk.	Ch	perennial	SA+SU
	<i>Heliotropium digynum</i> (Forssk.) C.Chr.	Ch	perennial	SA
	<i>Heliotropium ramosissimum</i> Sieber ex DC.	H	perennial	IT
Brassicaceae	<i>Brassica tournefortii</i> Gouan	Th	annual	ME+SA
	<i>Lepidium aucheri</i> Boiss.	Th	annual	IT
	<i>Eremobium aegyptiacum</i> Asch. & Schweinf.ex Boiss.	H	annual	SA
	<i>Eruca sativa</i> Mill.	Th	annual	SA+ME+IT+ES
	<i>Matthiola longipetala</i> (Vent.) DC	Th	annual	ME+IT
	<i>Morettia parviflora</i> Boiss.	Ch	perennial	SU
	<i>Moricandia sinaica</i> (Boiss.) Boiss.	Ch	perennial	SA
	<i>Schimpera arabica</i> Hochst. & Steud. ex Steud.	Th	annual	SA
	<i>Schouwia purpurea</i> (Forssk.) Schweinf.	Th	annual	SA
	<i>Sisymbrium orientale</i> L	Th	annual	ME+IT
	<i>Zilla spinosa</i> (L.) Prantl	Ch	perennial	SA
Capparaceae	<i>Cleome amblyocarpa</i> Barratte & Murb.	Th	annual	SA+SU
Caryophyllaceae	<i>Polycarpaea repens</i> (Forssk.) Asch. & Schweinf.	H	perennial	SU
Chenopodiaceae	<i>Atriplex leuoclada</i> Boiss.	Ch	perennial	SA+IT
	<i>Bassia eriophora</i> (Schrad.) Asch.	Th	annual	SA+SU
	<i>Bassia muricata</i> (L.) Asch.	Th	annual	SA+IT
	<i>Haloxylon salicornicum</i> (Moq.) Bunge ex Boiss.	Ch	perennial	SU
	<i>Haloxylon persicum</i> Bunge	Ph	perennial	IT
	<i>Salsola tetrandra</i> Forssk.	Ch	perennial	SA
	<i>Suaeda vermiculata</i> J.F.Gmelin	Ch	perennial	SA+IT
Cistaceae	<i>Helianthemum lippii</i> (L.) Dum.Cours.	Ch	perennial	SA+SU
	<i>Helianthemum aegyptiacum</i> (L.) Mill.	Th	annual	ME+IT
Cucurbitaceae	<i>Citrullus colocynthis</i> (L.) Schrad.	H	perennial	SA+ME+IT+SZ
Cynomoriaceae	<i>Cynomorium coccineum</i> L.	parasite	annual	SA+ME+IT
Euphorbiaceae	<i>Euphorbia retusa</i> Forssk.	Th	annual	SA
Fabaceae	<i>Acacia gerrardii</i> var. <i>najdensis</i> Chaudhary	Ph	perennial	SU
	<i>Acacia tortilis</i> (Forssk.) Hayne	Ph	perennial	SU
	<i>Alhagi maurorum</i> Medik.	H	perennial	ME+IT
	<i>Astragalus hauarensis</i> Boiss.	Th	annual	SA
	<i>Astragalus sieberi</i> DC.	Ch	perennial	SA
	<i>Astragalus spinosus</i> (Forssk.) Muschl.	Ch	perennial	IT
	<i>Crotalaria aegyptiaca</i> Benth.	Ch	perennial	SU
	<i>Retama raetam</i> (Forssk.) Webb	Ph	perennial	SA
	<i>Tetragonolobus purpureus</i> Moench	Th	annual	ME
	<i>Trigonella stellata</i> Forssk.	Th	annual	SA
Lamiaceae	<i>Salvia aegyptiaca</i> L.	Ch	perennial	SA
	<i>Salvia spinosa</i> L.	H	annual	IT
	<i>Teucrium oliverianum</i> Ging. ex Benth.	Ch	perennial	SA+IT
Malvaceae	<i>Malva parviflora</i> L.	Th	annual	ME+IT
Orobanchaceae	<i>Cistanche tubulosa</i> (Schenk) Hook.f.	parasite	annual	SA+IT
Poaceae	<i>Avena barbata</i> Pott ex Link	Th	annual	ME
	<i>Cynodon dactylon</i> (L.) Pers.	G	perennial	COSM
	<i>Lasiurus scindicus</i> Henrard	H	annual	SA+SU
	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	G	perennial	SA+ME+ IT
Polygonaceae	<i>Emex spinosa</i> (L.) Campd.	Th	annual	ME
	<i>Rumex vesicarius</i> L.	Th	annual	SA
Ranunculaceae	<i>Ranunculus muricatus</i> L.	Th	annual	ME+IT
Rhamnaceae	<i>Ziziphus nummularia</i> (Burm.f.) Wight & Arn.	Ph	perennial	SU
Solanaceae	<i>Hyoscyamus muticus</i> L.	Ch	perennial	SA

Tamaricaceae	<i>Tamarix aphylla</i> H.Karst.	Ph	perennial	SA+SZ
Zygophyllaceae	<i>Fagonia bruguieri</i> DC.	Ch	perennial	SA
	<i>Fagonia indica</i> Burm.fil.	Ch	perennial	SA
	<i>Fagonia ovalifolia</i> Hadidi	Ch	perennial	SA
	<i>Fagonia glutinosa</i> Delile	Ch	perennial	SA
	<i>Fagonia tristis</i> Sickenb.	Ch	perennial	SA
	<i>Peganum harmala</i> L.	H	perennial	SA+IT
	<i>Zygophyllum coccineum</i> L.	Ch	perennial	SA

Table 2: Tabular summary showing the total number of families, genera and species, growth types and life forms of recorded plants.

Total Number of		Growth type			Life forms		
Genera	Species	Type	Number of species	Percentage (%)	Form	Number of species	Percentage (%)
63	82	Perennial	50	60.98	Ph	8	9.76
					Ch	29	35.36
		Annual	32	39.02	H	15	18.29
					G	2	2.44
		Total	-	-	-	Th	26
				parasite	2	2.44	
				Total	82	100	

2. Life-form

Six different life forms have been recorded in the present study. Classes of the plant life-forms along the study area indicated that Chamaephytes were the most frequent life form (29 species = 35.36%), followed up with Therophytes (26 species = 31.71%), Hemicryptophytes (15 species = 18.29%), Phanerophytes (8 species = 9.76%), and Geophytes and parasites were represented by 2 species each (2.44%). (Table 2).

3. Chorology

Chronological analysis of the 82 plant species surveyed in the present study categorized them into eight phytogeographical groups: SA: Saharo-Arabian; ME: Mediterranean; IT: Irano-Turanian; SU: Sudanian; SZ: Sudano-Zambeian; ES: Euro Siberian, SS: Saharo Sindian and COSM: Cosmopolitan (Table 3). A total of 52 species representing 63.41% of the total number of surveyed species were monoregional taxa of various affinities. The recorded monoregional elements fall under four main chorotypes of which Saharo-Arabian taxa have the highest share (32 species forming 61.54% of monoregional species). Nine Sudanian and Six Irano-Turanian taxa were recorded in the study area, representing 17.31% and 11.54% of the monoregional flora respectively. The Mediterranean chorotype was rarely represented in the study area with just five species, forming 9.61% of the total number of the recorded monoregional plant species. The biregional elements were less represented (25 species = 30.49%) among the recorded species in the study area with various affinities. The recorded biregional elements include six major chorotypes: the Saharo-Arabian/Sudanian chorotype has the highest share of species (8 species), representing 32% of the biregional surveyed flora, followed by the Saharo-Arabian/Irano-Turanian and Mediterranean/Irano-Turanian regions, represented by 7 and 6 species (28% and 24%) respectively. While the lowest share of species was recorded for the Mediterranean/Saharo-Arabian and Mediterranean/Saharo-Sindian with only one species for each (4%). The pluriregional elements were represented by a total of 4 species (4.88%) of various affinities. These pluriregional species include three major chorotypes: Two species belonging to Saharo-Arabian/ Mediterranean/Irano-

Turanian chorotype. While the two chorotypes Saharo-Arabian/ Mediterranean/Irano-Turanian/Sudano-Zambeian and Saharo-Arabian/ Mediterranean/Irano-Turanian/ Euro-Siberian were represented by one species for each. Only one species is Cosmopolitan representing 1.22% of the of the total number of surveyed species in the study area (Table 3).

Table 3. The number of recorded species belonging to the main floristic categories and their relevant percent. Chorotype's abbreviations: SU: Sudanian, SA: Saharo-Arabian, ME: Mediterranean, IT: Irano-Turanian, SZ: Sudano-Zambian, SS: Saharo-Sindian, and COSM: Cosmopolitan.

Phytochoria	Number of species	Percentage (%)
Monoregional		
SA	32	39.02
SU	9	10.98
IT	6	7.32
ME	5	6.09
Total	52	63.41
Biregional		
SA+SU	8	9.76
SA+IT	7	8.53
ME+IT	6	7.32
SA+SZ	2	2.44
ME+SS	1	1.22
ME+SA	1	1.22
Total	25	30.49
Pleuriregional		
SA+ME+IT	2	2.44
SA+ME+IT+SZ	1	1.22
SA+ME+IT+ES	1	1.22
Total	4	4.88
Cosmopolitan (COSM)	1	1.22

Discussion

The flora of Wadi Al-Akthar, including many valuable plant species. In the present study, a floristic survey of vascular plant species from the study area comprises 82 species belonging to 63 genera and 25 families. The floristic

analysis of Wadi Al-Akhthar showed that Asteraceae (17 species), Brassicaceae (11 species), and Fabaceae (10 species), were the most rich families, constituting most plant species (46.34%). Similar results were obtained in different regions of Saudi Arabia such as Moawed (2016) [14] worked on a comprehensive survey of plant species in the Alaqa area of Tabuk, where the majority of the species found to be belonging to Fabaceae family (16 species), followed by Astraceae family (10 species) and Brassicaceae (8 species). Also similar results were recorded in Wadi Al-Jufair (Alatar *et al.*, 2012) [3], in Wadi Al Dissah area (Fakhry & Anazi, 2017) [13], in Wadi Ar'ar (Osman *et al.*, 2014) [16]. Results of the present study are also confirmed to those of AlNafie (2008) and Collenette (1999) [11] for the flora of Saudi Arabia, where Poaceae, Fabaceae, and Asteraceae have been reported to represent the main bulk of plant species in Saudi Arabia. Abbas *et al.* (2020) [1], attributed the presence of few floristically rich plant families in Saudi Arabia, to the efficient seed dispersal capabilities, migration efficiency, in addition to their wide ecological amplitude of tolerance.

The results of the present study also showed high degree of monotypism in the floristic composition of Wadi Al-Akhthar, where 14 families (56%) out of 25 were represented by only one species. These findings are confirmed with the results of (Thomas, 2011) [19], who have reported the presence of 33 monotypic families (25.19%) of the total number of families recorded in the whole flora of Saudi Arabia. The low ratios of species/genera and genera/families estimated for total species (1.30 and 2.52 respectively) indicate high taxonomic diversity in the study area. Fakhry & Anazi (2017) [13] also reported similar results for Wadi Al-Dissah area in Tabuk region, where species/genera and genera/families were 1.03 and 2.03, respectively. A ratio less than 2.68 which was documented by AlNafie (2008) in the total area of Saudi Arabia.

The present study shows that perennial species dominated the plant cover defining the character of the vegetation. About 61% of the recorded flora is represented by perennial species, while annuals were represented by about 39%. This trend is consistent with the finding of many studies in regions of Saudi Arabia especially those which were carried on in wadis such as Abdel Khalik *et al.* (2013), Osman *et al.* (2014) [16], and Fakhry & Anazi (2017) [13].

Chorological analysis of the floristic data showed that mono-regional Saharo-Arabian chorotype (39%) constitutes the major component of the floristic structure in Wadi Al-Akhthar, followed by the Sudanian chorotype (about 11%). The results also showed the predominance of mono-regional taxa (63.41%) over the other phytogeographical elements followed by the bi-regional (30.49%). The dominance of Saharo-Arabian and Sudanian elements have also been reported in Al Soada region southwestern Saudi Arabia (Seraj, 2014), and in Khulais region, west Saudi Arabia (Alsherif *et al.*, 2013) [7].

The present study has not surveyed all the area of Wadi Al-Akhthar, however, the results of the local flora of the valley indicates that Wadi Al-Akhthar region needs further thorough botanical studies and documentation of floristic diversity.

Conclusions

The ecosystems of the valleys are one of the main centers of plant diversity in the Saudi Arabia, and because of their paramount importance in the conservation of biodiversity,

the present study includes a survey and identification of the wild plant species growing in Wadi Al-Akhthar in Tabuk region, Northwestern of Saudi Arabia, with the objective of determining the floristic composition, with analysis of life forms and chorology of the recorded species. A total of 82 species belonging 25 families of the Angiospermae were recorded. A high degree of monotypism was recorded, where 56% of the recorded families were represented by a single species. Perennial species dominated the plant cover (61%) defining the character of the vegetation, while annuals were represented by about 39%. Chamaephytes (35.4) and Therophytes (31.7) were the most frequent lifeforms. The data revealed that the Saharo-Arabian chorotype is the most dominant chorotype in Wadi Al-Akhthar (39%), followed by the Sudanian chorotype (11%). The results also showed the predominance of mono-regional taxa (63.4%) over the other phytogeographical elements.

References

1. Abbas AM, Al-Kahtani MA, Alfaifi MY, Elbehairi SI, Badry MO. Floristic Diversity and Phytogeography of JABAL Fayfa: A Subtropical Dry Zone, South-West Saudi Arabia. *diversity*,2020;12(9):345.
2. Abdel Khalik K, El-Sheikh M, El-Aidarous A. Floristic diversity and vegetation analysis of Wadi Al-Noman, Mecca, Saudi Arabia. *Turk. J. Bot.*,2013; 37: 894-907.
3. Alatar A, El-Sheikh MA, Thomas J. Vegetation analysis of Wadi Al-Jufair, a hyper-arid region in Najd, Saudi Arabia. *Saudi J. Biol. Sci.*,2012;19(3):357-368.
4. Al-Atawi NMS. *Tabuk Dictionary*, Tabuk, 2014, (2).
5. Alfarhan AH. A phytogeographical analysis of the floristic elements in Saudi Arabia. *Pakistan J. Biol. Sci.*,1999;2:702-711.
6. AlNafie AH. Phytogeography of Saudi Arabia. *Saudi J. Biol. Sci.*,2008;15:159-176.
7. Alsherif EA, Ayesh AM, Rawi SM. Floristic composition, life form, and chorology of plant life at Khulais region, western Saudi Arabia. *Pak. J. Bot.*,2013;45:29-38.
8. Atiqur Rahman M, Mossa JS, Al-Said MS, Al-Yahya MA. Medicinal plant diversity in the flora of Saudi Arabia. 1: a report on seven plant families. *Fitoterapia*,2004;75(2):149-161.
9. Boulos L. *Flora of Egypt Checklist-Revised Annotated Edition*; Al Hadara Publishing: Cairo, Egypt, 2009, 410.
10. Chaudhary SA. *Flora of The Kingdom of Saudi Arabia*. Minist. Agric. Water Natl. Agric. Water Res. Cent,2001;2:342-354.
11. Collenette S. *Wildflowers of Saudi Arabia*; National Commission for Wildlife Conservation and Development (NCWCD): Riyadh, Saudi Arabia, 1999, 799.
12. Fakhireh A, Ajourlo M, Shahryari A, Mansouri S, Nouri S, Pahlavanrabi A. The autecological characteristics of *Desmostachya bipinnata* in hyper-arid regions. *Turk. Jour. Bot.*,2012;36:690-696.
13. Fakhry AM, Anazi HK. Floristic diversity and vegetation structure of Al-Dissah area northwestern Saudi Arabia. *Egypt. J. Exp. Biol. (Bot.)*,2017;13(2):447-457.
14. Moawed MM. Plant flora of Alaqa region, Tabuk Province, Saudi Arabia. *Egypt. J. Exp. Biol. (Bot.)*,2016;12(1):107-113.

15. Muller-Dombois D, Ellenberg H. Aims and Methods of Vegetation Ecology; John Wiley and Sons: New York, NY, USA, 1974, 547.
16. Osman AK, Al-Ghamdi F, Bawadekji A. 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;21:554-565.
17. Saudi Geological Survey, Kingdom of Saudi Arabia Facts and Figures, King Fahd National Library Riyadh, 2017.
18. Seraj SS, Jrais RN, Ayyad SK. Floristic composition, life form, and chorology of plant life at Al-Saoda, Asir Region, South-Western Saudi Arabia. J. Biol. Agr. Health,2014;4(26):60-65.
19. Thomas J. Plant Diversity of Saudi Arabia, King Saud University, 2011. Available online: <http://www.plantdiversityofsaudiArabia.info/> (accessed on 15 June 2020).
20. Zohary M. Flora Palaestina: Equisetaceae to Moringaceae; The Israel Academy of Science and Humanities: Jerusalem, Israel,1966:1:364.
21. Zohary M. Flora Palaestina: Platanaceae to Umbelliferae; Israel Academy of Science and Humanities: Jerusalem, Israel,1972:2:489.
22. Zohary M. Geobotanical Foundations of the Middle East; Gustav Fischer Verlag Press: Stuttgart, Germany; Swets & Zeitlinger: Amsterdam, The Netherlands, 1973, 1-2.