International Journal of Plant Science and Ecology
Vol. 6, No. 2, 2020, pp. 31-38
http://www.aiscience.org/journal/ijpse
ISSN: 2381-6996 (Print); ISSN: 2381-7003 (Online)

Floristic Diversity and Perennial Vegetation Analysis of Al-Wadi Al-akhder, Tabuk Region, Saudi Arabia

Suliman Mohammed Alghanem*, Hussein Qasim Al-Atwi, Mohammed Omar Al-Saiari, Abdul Karim Mohammed Al-Balawi, Saleh Ahmed Al-Zahrani, Ali Musa Al-Sayed

Biology Department, Science Collage, Tabuk University, Tabuk City, Saudi Arabia

Abstract

The present study was aimed to investigate the floristic diversity for Perennial species and phytogeographical distribution of plant species of Al-Wadi Al-akhder from Tabuk region, Saudi Arabia. A total of 30 species belonging to 23 genera and 15 families were recorded. Chenopodiacea had the highest contribution (20% of the total species) followed by Asteraceae and Fabaceae (16.76%), Lamiaceae (10%), Cistaceae and Asclepiedaceae (6.76%). The life form spectrum of the recorded species showed the prevalence of chamaephytes (56.67%) followed by Therophytes (20%), Phanerophytes (16.67%) and Hemicryptophyte (6.76%). The chorological analysis of the recorded species indicated the predominance of monoregional taxa over the other elements. In the same context, the flora of Tabuk region, as reflected by the present study findings, showed that most perennial species belonged to Saharo-Arabian (70%), Sudano-Zambezian and Mediterranean (26.67%) and Cosmopolitan (3.33%) elements, and that constitute almost 60% of the total number of plant species. It was concluded that Tabuk region had remarkable floristic diversity, however, this natural biodiversity hot spot is probably affected by several human activities including woodcutting and development. The associations and speciation of these Al-Wadi Al-akhder plants demonstrate significant variation in pH, electrical conductivity, soil mineral contents, and human impact. Therefore, a conservation program should be launched to protect the natural diversity in such important plant area.

Keywords

Floristic Diversity, Tabuk, Suadi Arabia, Life Forms, Phytogeography

Received: May 27, 2020 / Accepted: June 17, 2020 / Published online: July 7, 2020

1. Introduction

Saudi Arabia is a country with vast area occupying about 80% of the area of Arabian Peninsula. However, most of this area is barren deserts except southwestern highlands with ample rainfall and mild climate that supports plant life Therefore, xerophytic vegetation is a prominent feature of the plant life in this country. (Masrahi, 2012).

The geological history of this region indicates that this region shares with the flora of the west Africa, the southeast & northeast Asia and the north & northwest Mediterranean. The vegetation of Saudi Arabia belongs to Saharo-Sindian phytogeographical region (Zohary, 1973).

The topography of Saudi Arabia, as well as that of Arabian Peninsula, is an ancient massif in which geologic structure developed concurrently with the Alps. Climate change is an important factor for sustainable water resource management in the arid and semi-arid countries. In this study, future trends of temperature and rainfall were assessed for several regions

* Corresponding author
E-mail address: s-alghanem@ut.edu.sa (S. M. Alghanem)

in Saudi Arabia. The linear and Mann–Kendall analyses showed an increase of temperature in all regions and decrease of rainfall in many regions. The diversity of plant life is an essential underpinning of most of our terrestrial ecosystems. Humans and most other animals are almost dependent on plants, directly or indirectly. Another important role of plant life is the provision of ecosystem services, the protection of water sheds, stabilization of slopes, improvement of soils, moderation of climate and the the provision of a habitat for much of our wild fauna (Yavari, A. and S. M. Shahgolzari, 2010).

Moreover, floristic studies are not only important to know the variety of plants present in an area, but also socio-economically significant. They provide shelter, food, medicine and everything for the human being and other species of that area (Shehata and Galal, 2014).

Wadis represent one of the most prominent desert landforms, exhibiting physiographic irregularities that lead to parallel variation in species distribution. Life-form distribution is closely related to topography and landform (Fakhireh et al., 2012).

The role of the society in combination with long-term programmes for the study of plant species richness, functional diversity and patterns of species assemblages over time are necessary for the effective management and protection of protected areas (Alexandros Papanikolaou and Maria Panitsa, 2020).

It was found that over utilization, over collection, over exploitation, habitat degradation, overharvesting, deforestation, population explosion and over grazing are the conspicuous biotic stresses which severely threatened the flora in the area which affect the population sustainability on earth crust. (Muhammad Ibrahim et al, 2017).

Life-form composition is typical of desert flora; the majority of species are therophytes and chamaephytes. Wadi vegetation in general is not constant. It varies from year to year depending upon moisture levels (Siddiqui & Al-Harbi, 1995). Establishment, growth, regeneration, and distribution of the plant communities in the wadis are controlled by many factors such as geographical position, physiographic features, and human impact (Kürschner & Neef, 2011; Alatar et al., 2012; Korkmaz & Özçelik, 2013).

Despite the large number of floristic published studies (see Migahid 1996, Collenette 1999; Chaudhary 1999; Chaudhary 2001) and more recent studies such as Al- Turki (1997), Al-Turki and Al-□lyan (2003) and El-Ghanim et al. (2010) and Al-Mutairi et al. (2016), there is still scarcity in the information about the diversity and distribution of plants in Saudi Arabia. This is due the fact that Saudi Arabia is large (~2.25 million km^2). In addition to this, the climate varies significantly from the north to the South and from the East to the West and this creates diverse habitats and environments, which results in diversity in plant communities (Al- Nafie, 2008; El-Sheikh et al. 2013). The plant communities in Arabian Peninsula especially in Saudi Arabia are threatened by anthropogenic activities and urbanization (Khalik et al. 2013; Al-Mutairi et al., 2015). Although there is a quite high number of studies aimed to investigate the plant communities in several parts of Saudi Arabia, the plant biology and ecology in Saudi Arabia is incompletely understood. The present study aims to describe the floristic diversity in Al-Wadi Al-akhder in Saudi Arabia.

2. Materials and Methods

The present study was carried out in Al-Wadi Al-akhder is suitated about 120km from the Tabuk "Figure 1". Al-Wadi Al-akhder is characterised with unique plant species communities due its location in North part of Arabian Peninsula. Similar to the most regions of Saudi Arabia, Al-Wadi Al-akhder characterised with low annual precipitation which is always less than 200mm/year. The temperature varies significantly between summer and winter seasons. The temperature vary from 43C in summer to less than 7C during winter time. Sampling of plant species The plant species were surveyed in this region using the 10x10 m stands following the standard procedures as described in several studies (see Al-Mutairi et al., 2016). The vascular plant species occurred inside the stand were counted and identified following the available keys of Chaudhary (2001) and Collenette (1999). The phytogeographical classification was conducted using the keys of Zohary (1973) and Al-Nafie (2008) as well as previously described in Al-Mutairi et al. (2016). The life forms identification was performed following the reference of White and Liéonard (1991) which has been proven to be adequate guide for plant species in Arabian Peninsula.

Soil analysis

Soil samples were collected at 5 random points from each site as a profile (composite samples) at a depth of 0–50 cm. The electrical conductivity (EC) and pH for each sample were determined as a 1:5 dilution in deionised water (Wilde et al., 1979). Soil analyses including total dissolved salts (TDS; g L–1) and total carbonates (C□$_3$), bicarbonate (HC□$_3$), and chlorides (Cl; g 100 g–1 DW) were analysed by precipitation by AgCl and titration according to Jackson (1967); sulphates (S□$_4$; g 100 g–1 DW) were precipitated gravimetrically and estimated according to Wilde et al. (1979). Major cations such as sodium (Na), potassium (K), calcium (Ca), and magnesium (Mg; g 100 g–1 DW) were

determined in the 1:5 soil extract by flame photometer (Jenway, PFP-7), according to the methods of Williams and Twine (1960). The minor cations iron (Fe), copper (Cu), and zinc (Zn) were determined using a GBC model 1100B atomic absorption spectrophotometer, and their concentrations were expressed in mg kg–1 dry soil.

3. Results

Floristic diversity a total of 30 Perennial species belonging to 23 genera and 15 families were recorded from various sample plots and attached areas "table 3" and "Figure 4". The most highly represented families were Chenopodiacea, Asteraceae and Fabaceae (Leguminosae). Chamaephytes constituted 16 species, or 53.33% of the total species, followed by 6 species of Therophytes (20%), 5 species of Phanerophytes (16.67%) and species of Hemicryptophyte (10%) (Table 1; Figures 2 and 3). Chronological analysis of the species in the study area revealed that biregional elements that belong to the Saharo-Arabian representing 22 species, followed by the Mediterranean representing 10 species, The Tropical representing 6 species and the Cosmopolitan representing 2 species. The associations and speciation of these Al-Wadi Al-akhder plants demonstrate significant variation in pH, electrical conductivity, soil mineral contents, and human impact "Table 2".

Table 1. Floristic diversity and Perennial vegetation analysis of Al-Wadi Al-akhder, Tabuk Region, Saudi Arabia. Life forms are Ch= chamaephytes; Ph= phanerophytes; He = hemicryptophyte; Th= therophytes. Chorotypes are: SA= Saharo-Arabian; SZ= Sudano-Zambezian; ME= Mediterranean; TR= Tropical; COSM, cosmopolitan.

	Family	Species name		Life form	Chorotype
1	Amaranthaceae	Aerva javanica	القطيفة	Ch	SA+SZ
2	Asclepiedaceae	Leptadenia pyrotechnica	المرخ	Ph	SA+SZ
3	Asclepiadaceae	calotropis procera	العشار	Ph	SA+SZ
4	Asteraceae	Rhanterium Epapposum	العرفج	Ch	SZ
5	Asteraceae	Artemisia judaica	البعيثران	Th	SA
6	Asteraceae	Artemisia monosperma	العاذر	Ch	ME+SA
7	Asteraceae	Artemisia Sieberi	الشيح	Ch	ME+SA
8	Asteraceae	Pulicaria undulate	الجثجاث	Ch	SA+SZ
9	Boraginaceae	Heliotropium bacciferum	رمرام	Ch	SA+SZ
10	Chenopodiacea	Salsola Tetrandra	فراس او رمد	Ch	SA
11	Chenopodiacea	Suaeda Vermiculata	السويدا	Ch	SA
12	Chenopodiaceae	Haloxylon salicornicum	الرمث	Ch	SZ
13	Chenopodiaceae	Atriplex leucoclada	رغل	Ch	ME+SA
14	Chenopodiaceae	Salsola villosa	الروه او الحمض	Ch	ME+SA+TR
15	Chenopodiaceae	Salsola volkensii	الخذراف	Ch	COSM
16	Cistaceae	Helianthemum lippii	الرقروق ، القصيص ، الهشمة	Ch	SA+SZ
17	Cistaceae	Helianthemum Aegyptiacum	الرقروق	Th	SA
18	Cucurbitaceae	Citrullus colocynthis	الحنظل	He	ME+SA+TR+SZ
19	Fabaceae	Acacia nilotica	القرض	Ph	SA + SZ
20	Fabaceae	Retama Raetam	الرتم	He	SZ
21	Fabaceae	Astragalus spinosus	القتد	Th	SA
22	Fabaceae	Acacia Ehrenbergiana	السلم	Ph	SZ
23	Fabaceae	Alhagi maurorum	العاقول	Ch	ME+SA+TR+SZ
24	Lamiaceae	Salvia Spinosa	لسان الثور	He	ME+TR
25	Lamiaceae	salvia aegyptiaca	غبيشة او فن الضب او شجيرة الغزال	Ch	SA+SZ
26	Lamiaceae	Teucrium oliverianum	العهن ، العيهن ، العهيل ، القيسبة	Ch	COSM
27	Scrophulariaceae	Zilla spinosa	الشبرم	Ch	ME+SA+TR+SA
28	Tamaricaceae	Tamarix nilotica	طرفا او ل	Ph	SA
29	Umbelliferae	Ducrosia Anethifolia	الحزا	Th	TR
30	Zygophyllum	Zygophyllum Coccineum	هرم	Th	SZ

Table 2. Soil analysis of environmental variables in Al-Wadi Al-akhdar.

Performed Test	Soils Samples					General Guide Levels
	1	2	3	4	5	
Silt%	0.5	1.75	1.75	1.75	0.5	
Clay%	0.5	0.5	0.5	0.5	0.5	
Sand%	99	97.75	97.75	97.75	99	
Soil Texture	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	
pH (0 – 14)	7.85	8.03	7.92	8.01	7.92	6.0 – 7.5
EC (Ms/cm)	0.47	0.3	0.36	0.41	0.31	Not < 105

Performed Test	Soils Samples					General Guide Levels
	1	2	3	4	5	
Ca (ppm)	3048	3930	6273	3383	4762	1000 – 4000
Mg (ppm)	82.64	90.64	193	89.68	91.68	100 – 250
K (ppm)	56	53	123	54	47.5	120 – 250
Na (ppm)	80.64	87	112	51	55	<200
HCO_3 (ppm)	76.25	76.25	76.25	76.25	76.25	<152
Cl (ppm)	133	44.31	88.62	133	44.31	<176
P (ppm)	5.5	5.4	12.2	5.5	3.2	20 --- 30
SO_4 (ppm)	0	0	0	0	0	<100
$CaCO_3$%	4.16	4.16	3.56	4.16	8.2	

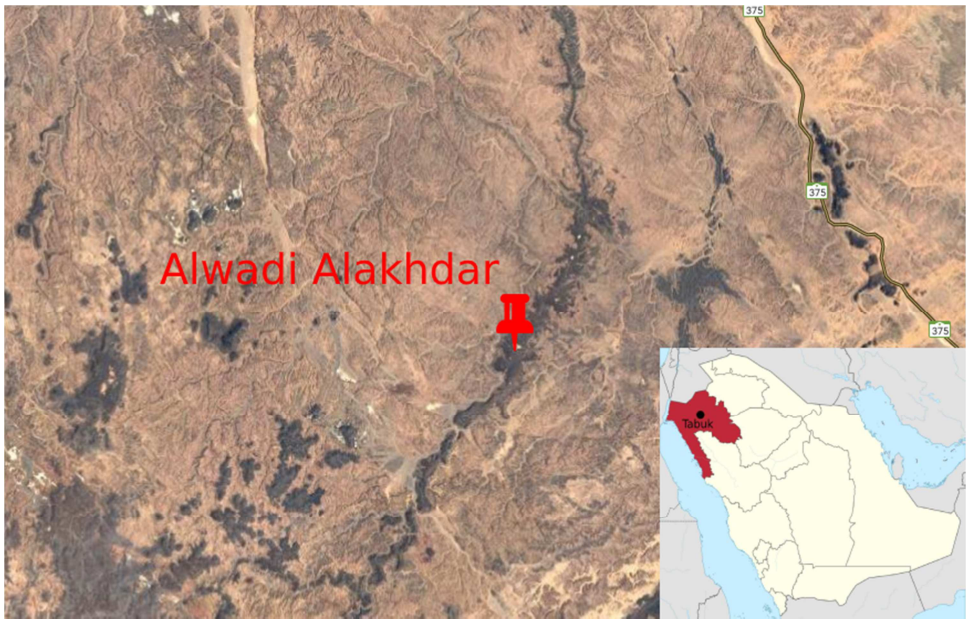


Figure 1. Location map of the studied area showing Al-Wadi Al-akhder tributaries and topography.

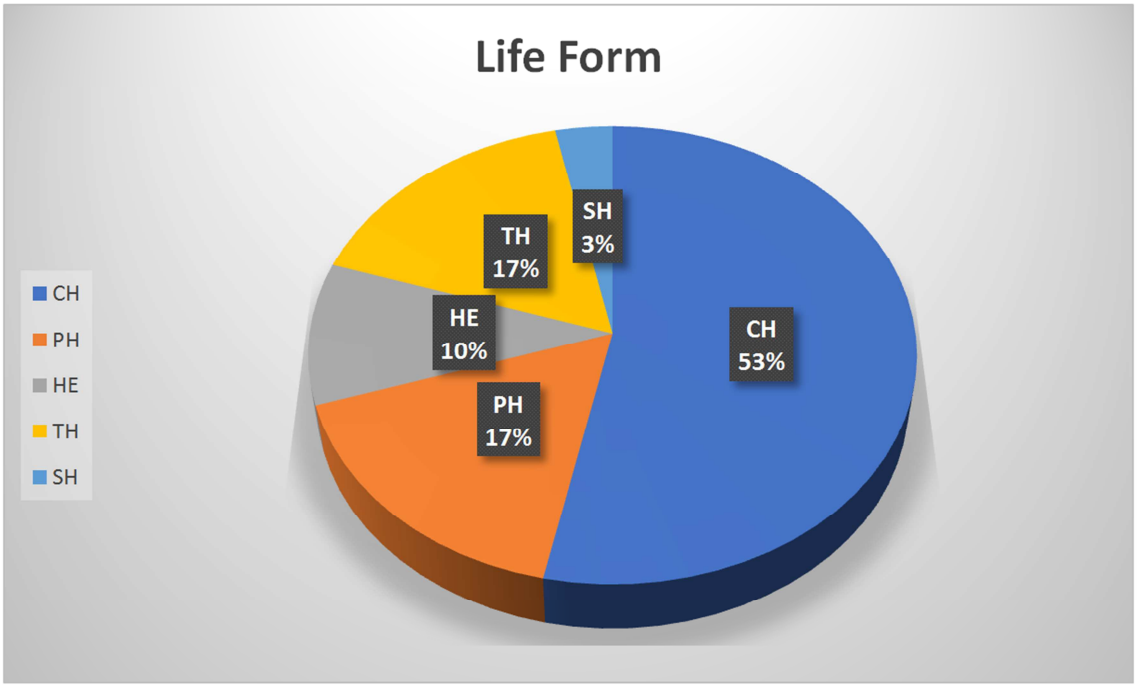
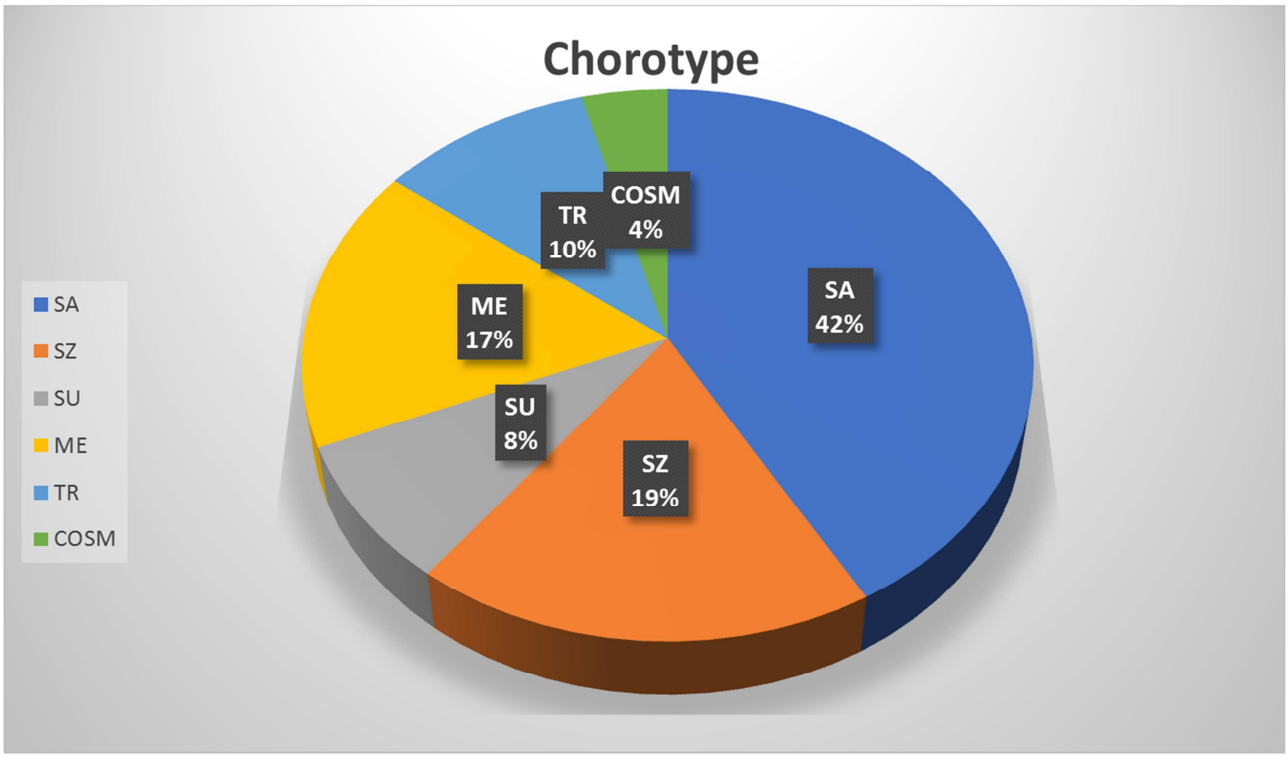


Figure 2. Life form spectrum of the recorded species in Al-Wadi Al-akhdar, Saudi Arabia. PH: Phanerophytes, CH: Chamaephytes, HE: Hemicryptophytes, GE: Geophytes, TH: Therophytes.

Table 3. Comparison of floristic diversity in Al-Wadi Al-akhder (present study) to the plant diversity in the entire Saudi Arabia.

	Family	Genus	Species
alwadi alakhdar in tabuk	15	23	30
Flora of Saudi Arabia from 1998 to 2001	131	855	2282
Percentages	10.80%	2.80%	1.34%



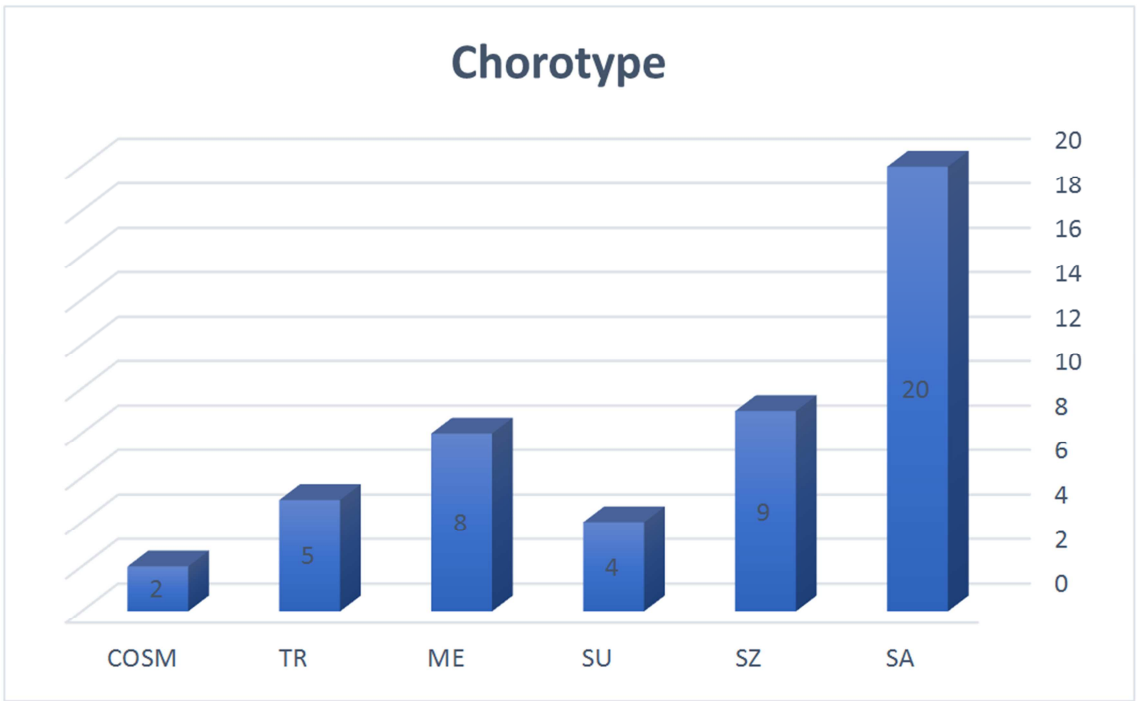


Figure 3. Chorotype analysis of the rcorded species in Al-Wadi Al-akhder, Saudi Arabia. SU =Sudanean, SA = Saharo- Arabian, IT = Irano-Turanian, ME = Mediterranean. COSM = Cosmopolitan. Others include Saharo- Arabian- Mediterranean-Euro-Siberian and Saharo-Arabian-Tropical-Sudanean.

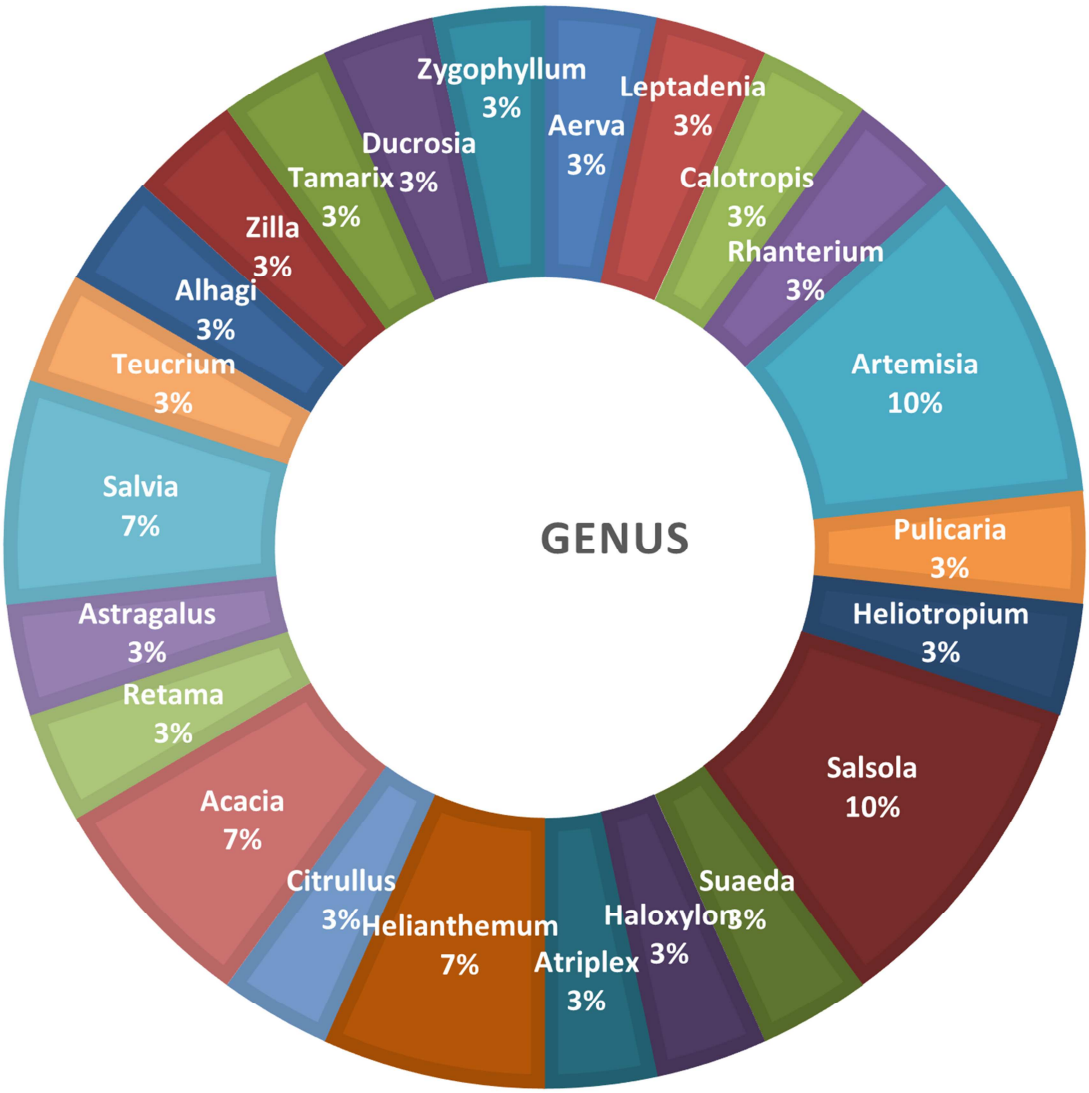


Figure 4. Proportional percentage of Genus for the study area.

4. Discussion

The number of Perennial plant species reported in this study was lower than what has been recorded in the Northern part of Saudi Arabia such as Tabuk (Al-Mutairi et al., 2016) Hail and other northern parts (El-Ghanim et al., 2010; Al-Turki T and Al-Olyan, 2003, Osman et al., 2014). Chenopodiacea was reported to be the dominant family with total number of species of 11. This is in general with coincidence of previous reports such as (Seraj et al. 2014) and (Al-Mutairi et al. 2016) in various parts of Saudi Arabia.

The life form analysis is known for its importance in providing supplementary information which facilitates understanding the complex interaction of plant species with abiotic and biotic factors in the surrounding environment (Ayyad and El-Ghareeb, 1982). "Figure 1" presented the life forms of plant species in Al-Wadi Al-akhder. It is clearly shown that chamaephytes and therophytes are the dominant life forms, while, hemicryptophyte comprised the lowest percentage of life form types. The present findings are in the line with other related studies such as (Osman et al. 2014) and (Seraj et al. 2014). This is can be explained by the prevalence of the Mediterranean climate (Mobayen, 1996). Moreover, therophytes are known for their high adaptability to arid environment (Asri, 2003) which is the main feature of Al-Wadi Al-akhder.

As indicated by several studies that the diversity of natural habitats in Saudi Arabia is the good driver of the high floristic diversity in this region (Alfarhan, 1999). However, compared to other areas, species diversity is low figure from that recorded in Hail region (El-Ghanim et al., 2010; Al-Turki and Al-Olyan, 2003) and that recorded in Northern Saudi Arabia (Osman et al., 2014). This may be attributed to the high aridity prevailing in the study area. According to (Danin, 1976), low diversities of vascular plants are expected in extreme deserts, high Arctic and high alpine habitats, salt marshes and mangrove swamps.

5. Conclusion

The present study studied the Floristic diversity and Perennial vegetation analysis of Al-Wadi Al-akhder, Tabuk Region. The present study reported 30 plant perennial species in this region which can be considered as one of the moderately diverse areas of Saudi Arabia. Further ecological studies should be carried out in the future to better understand the ecological interaction between plant species and physical and chemical variables in Al-Wadi Al-akhder. Moreover, the conservation programs should be designed and implemented in order to protect the natural biodiversity of this region.

References

[1] Alatar A, El-Sheikh MA & 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.

[2] Alexandros Papanikolaou, Maria Panitsa. 2020. Plant species richness and composition of a habitat island within Lake Kastoria and comparison with those of a true island within the protected Pamvotis lake (NW Greece). Biodiversity Data Journal.

[3] Alfarhan A. (1999). A phytogeographical analysis of the floristic elements in Saudi Arabia. Pakistan J. Biol. Sci. 2 (3): 702-711.

[4] Al-Mutairi KA, Al-Atawi A, Alajlan A, Al- Shami SA (2015) Woodcutting Activities in Tabuk Region (Saudi Arabia): assessment of conservation knowledge. Aceh International Journal of Science and Technology 4 (2).

[5] Al-Mutairi K, Al-Shami S, Khorshid Z, Moawed M (2016) Floristic diversity of Tabuk Province, North Saudi Arabia. JAPS: Journal of Animal and Plant Sciences 26 (4): 1019-1025.

[6] Al-Nafie AH (2008) Phytogeography of Saudi Arabia. Saudi Journal of Biological Science 15 (1): 159-176.

[7] Al-Turki T (1997) A preliminary checklist of the flora of Qassim, Saudi Arabia. Feddes Repertorium 108 (3-4): 259-280.

[8] Al-Turki T, Al-Olayan H (2003) Contribution to the flora of Saudi Arabia: Hail region. Saudi journal of biological sciences 10: 190-222.

[9] Asri Y. (2003). Plant diversity in Touran Biosphere Reserve. Research Institute of Forest and Rangelands, Tehran, Iran, pp 306.

[10] Ayyad M. and R. El-Ghareeb (1982). Salt marsh vegetation of the western Mediterranean desert of Egypt. Vegetatio 49 (1): 3-19.

[11] Chaudhary SA (1999–2001). Flora of the Kingdom of Saudi Arabia, Vols. 1–3, Riyadh: Ministry of Agriculture and Water Press.

[12] Collenette S (1999). Wild Flowers of Saudi Arabia. Riyadh: National Commission for Wild Life Conservation and Development.

[13] Danin A. (1976). Plant species diversity under desert conditions. Oecologia 22 (3): 251-259.

[14] El-Ghanim WM, Hassan LM, Galal TM, Badr A (2010) Floristic composition and vegetation analysis in Hail region north of central Saudi Arabia. Saudi journal of biological sciences 17 (2): 119-128.

[15] El-Sheikh MA, Thomas J, Alatar AA, Hegazy AK, Abbady GA, Alfarhan AH, Okla MI (2013) Vegetation of Thumamah Nature Park: a managed arid land site in Saudi Arabia. Rendiconti Lincei 24 (4): 349- 367.

[16] Fakhireh A, Ajorlo M, Shahryari A, Mansouri S, Nouri S & Pahlavanravi A (2012). The autecological characteristics of Desmostachya bipinnata in hyper-arid regions. Turkish Journal of Botany 36: 690–696.

[17] Jackson ML (1967). Soil Chemical Analysis. New Delhi: Prentice Hall of India.

[18] Khalik KA, El-Sheikh M, El-Aidarous A (2013) Floristic diversity and vegetation analysis of wadi Al-Noman, Mecca, Saudi Arabia. Turkish Journal of Botany 37 (5): 894-907.

[19] Korkmaz M & Özçelik H (2013). Soil-plant relations in the annual Gypsophila (Caryopyhllaceae) taxa of Turkey. Turkish Journal of Botany 37: 85–98.

[20] Kürschner H & Neef R (2011). A first synthesis of the flora and vegetation of the Tayma oasis and surroundings (Saudi Arabia). Plant Diversity Evolution 129: 27–58.

[21] Masrahi, Y. S. Masrahi (2012). The Illustrated Guide to Wild Plants of Jazan Region Al Sarawat Publisher, Jeddah.

[22] Migahid AM (1996). Flora of Saudi Arabia, Vols. I–III. Jeddah: King Abdul Aziz University Press.

[23] Mobayen S. (1996). Flora of Iran 1980-1996. Vol. 1-4, Tehran University Press, Tehran, Iran.

[24] Muhammad Ibrahim, Muhammad Nauman Khan, Sajjad Ali, Abdul Razzaq, Akhtar Zaman, Majid Iqbal and Farmanullah Jan. 2017. Floristic Composition and Species Diversity of Plant Resources of rural area "Takht Bhai" District Mardan, Khyber Pakhtunkhwa, Pakista. Medicinal & Aromatic Plants.

[25] Osman AK, Al-Ghamdi F, Bawadekji A. (2014). Floristic diversity and vegetation analysis of Wadi Arar: A typical desert Wadi of the Northern Border region of Saudi Arabia. Saudi journal of biological sciences. Vol (21), pp 554-565.

[26] Seraj, S. S., Jrais, R. N., & Ayyad, S. K. (2014). Floristic Composition, Life Form and Chorology of Plant Life at Al-Saoda, Asir Region, South-Western Saudi Arabia. Journal of Biology, Agriculture and Healthcare, 4 (26), 60-65.

[27] Shehata H. S. and T. M. Galal (2014). Factors affecting the distribution and associated species of Malva parviflora in the Nile Delta, Egypt. Weed Biol. Manag. 15: 42-52.

[28] Siddiqui AQ & Al-Harbi AH (1995). A preliminary study of the ecology of Wadi Hanifah stream with reference to animal communities. Arab Gulf Journal Science Research 13: 695–717.

[29] White, F. and J. Leonard. 1991. Phytogeographical links between Africa and Southwest Asia. Fl. Veg. Mundi., 9: 229-246.

[30] Wilde SA, Corey RB, Lyer JG & Voigt GK (1979). Soil and Plant Analysis for Tree Culture. New Delhi: Oxford & IBH Publication Co.

[31] Williams V & Twine S (1960). Flame photometric method for sodium, potassium and calcium. In: Peach K & Tracey MV (eds.) Modern Methods of Plant Analysis, Vol. 5, pp. 3–5. Berlin: Springer Verlag.

[32] Yavari, A. and S. M. Shahgolzari, 2010. Floristic study of Khan-Gormaz protected area in hamadan province, Iran. Int. J. Agric. Biol., 12: 271-275

[33] Zohary M (1973). Geobotanical Foundations of the Middle East. Stuttgart: Gustav Fischer Verlag.