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INACCESSIBLE ZONES OF JABAL SALMA, HA'IL REGION IN SAUDI ARABIA: A RESERVOIR FOR NATIVE SEED SPECIES

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KEYWORDS

Jabal Salma

Endemic

Native

Invasive

Refuge

ABSTRACT

A reservoir in the current study describes where endemic plants are most likely to thrive and provide natural gene bank for native seed species. Twelve sites representing different altitudinal zones of Jabal Salma in Ha'il region, Saudi Arabia were regularly visited for two consecutive years. From each site 2–5 locations were investigated for floristic composition and types of vegetation. During the study, the presence of total 150 species representing 39 families was recorded. Among the reported species, the highest number of species (25 species) were belong to the family Asteraceae which was followed by the family Brassicaceae, (17 species), Fabaceae (14 species), Boraginaceae (11 species), Caryophyllaceae (10 species) and finally Poaceae (9 species). However, 15 other families including Acanthaceae, Convolvulaceae, Moraceae, Nyctaginaceae and Primulaceae, were monospecific which represented by only a single species. In addition, the effect of elevation on plant species distribution along altitudinal gradient of Jabal Salma has been noticed clearly in this study.

According to the current findings, Jabal Salma can be strongly considered as a reservoir for native seed species as it provides refuge for 21 endangered species, 43 medicinal species, 45 ornamental species, 48 forage species and 13 edible species. However, despite accessibility difficulties, Jabal Salma “unfortunately” is not well protected against invasive species where 27 exotic species where recorded.

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1 Introduction

Worldwide, natural rangelands and grasslands have been severely degraded in the last few decades (Conant et al., 2017). Overgrazing and growth of human population (83% growth between 1990–2015) which exacerbate the issue of climatic change, have been reported as the main factors causing the loss of biological diversity of natural grasslands (Aukema et al., 2017).

Rangelands of Saudi Arabia suffer strongly from harsh climate where long periods of drought and high temperatures take place along with intensive grazing (Baig et al., 2017). The Saudi Ministry of Environment, Water and Agriculture has previously declared many rangelands in Ha'il region, north of Saudi Arabia, as severely degraded zones in terms of plant biodiversity (Alghamdi, 2017). It has also raised an alarm about the invasion by external and dangerous exotic species. In addition, Mseddi et al., (2017) reported that many invasive plant species have been introduced to Ha'il's natural landscapes from neighboring wheat and alfalfa fields of the surrounding regions.

Recently, the Saudi Ministry of Environment and Water and Agriculture have set new ambitious plans in order to fight desertification and save the country's natural landscapes including rangelands, grasslands, forests and wild areas. The aforementioned ministry has launched a restoration program for natural landscapes by planting four million trees by the end of year 2020. This program is designed to revive the Saudi flora by re-planting native species including trees and shrubs (Heneidy et al., 2017). Therefore, the Saudi government needs to look carefully for original resources of local seed species that can be planted in millions by 2020. Such native seed species can be collected from natural enclosure habitats that are difficult to be accessed by humans and grazing animals. Mseddi et al. (2016) reported that enclosure rangelands for a period of 15 years can restore a large part of local seed species.

We argued that native seed species can be exploited in restoration programs and to afford species with economic value (such as; forage, ornamental and medicinal species) which currently are completely disappeared in the natural regions. Collecting native seed species in Saudi Arabia particularly in Ha'il region has been proved by Alghamdi (2017) who has successfully collected 40 species from protected rangeland zone compared to neighboring open area where only 15 species were collected.

We also argued that plant biodiversity measures such as species diversity and richness should provide important indicators of the assessment of human impacts on the ecosystems, and therefore such measures can serve as a basis for conservation and restoration programs.

Therefore, the objective of the current work was to assess the floristic composition and plant species diversity in Jabal Salma at the east of Ha'il region. Jabal Salma was chosen because it is a special topographic area consisting of a chain of mountains which is difficult to be accessed by humans and their livestock. To the best of our knowledge the current study will be the first of its kind. Hoping that these difficulty accessed mountains will provide unique source of information about native seeds of a diverse species to be reported in this paper.

2 Materials and methods

2.1 The study area

Jabal Salma is a chain of mountains located about 60 km far from the city of Ha'il and extends from the north-east to the south-west about 13 km (Figure 1). Ha'il region located in northern central of Saudi Arabia and extends between 25° 29'N and 38° 42'E. The altitude varies from 992 (plateau) to 1300 meters (the highest peak).

Belonging to Saudi Arabia, Jabal Salma in Hail region, has a desert climate characterized by elevated heat during the day and a drop in night temperatures, with a very low annual precipitations. Due to the influence of the sub-tropical high pressure system, there is a significant difference in humidity and temperature .

Such as in other parts of Saudi Arabia, the sun-rays are intense and rarely diffused by clouds. Minimum temperature can reached about 5°C in January while in summer temperature raised up to 50 ° C during August, with a daytime variation of 25°C. Precipitation is erratic and irregular with an average of 150 mm/year. The main source of precipitation comes from the winter cyclones of the Mediterranean Sea and the Eastern Atlantic Ocean. Jabal Salma is far from the sea, but it rains in the rainy season. The driest months extend from September to mid-October (Schultz & Whitney 1986). The relative humidity recorded in summer was very low and not exceed 15% in July, whereas, it was about 53 % in January with an annual average of 31%



Figure 1 Map showing the study area of Salma Mountains (Map created using QGIS v.2.18.14).

2.2 Floristic composition and plant species diversity

Flora investigation in Jabal Salma was conducted in 12 site locations in which numerous quadrats of 5 X 5 m were randomly allocated. Number of plants was counted and their frequencies were obtained following Pielou, (1959). Randomly placed quadrats have been aligned to cover 3 altitudinal zones of Jabal Salma from down to the top (Valley, Foothill and Top). The potentiality of the economic value of plant species was assessed according to the literature and information collected from local inhabitants.

Plant specimens were studied and identified using a Leica stereoscope. The taxonomic classification of the species was identified following Colletete (1999) and Chaudhary (2001).

3 Results and Discussion

The floristic composition and vegetation features in Jabal Salma were studied during two consecutive years (2015-2016). The study showed very high plant diversity with richness index of 150 species belonging to 39 families (Table 1). This number of species in Jabal Salma represent 6.9% of the total plant species recorded in Saudi Arabia (2172 species reported by AlZubaide et al., 2017). Low biological diversity percentage of Jabal Salma in comparison to Saudi Arabia's diversity could be attributed to the harsh environment conditions particularly low rainfall and high temperature which resemble the Sahara climate that covers most of the country (El-Ghanim et al., 2010).

The floristic analysis in Jabal Salma showed that the Asteraceae was the most abundant family with the highest number of species (25 species). Previously the Asteraceae family has been reported as the dominant family in Hail area (El-Ghanim et al., 2010). The second largest family in the study area is the Brassicaceae which is represented by 17 species followed by Fabaceae (14 species), Boraginaceae (11 species), Caryophyllaceae (10 species) and finally Poaceae (9 species) (Figure 2). These families were reported as the most dominant flora in Jabal Salma. These families were followed by 15 families represented by 2-6 species and 19 families represented only by single species. The floristic analysis showed that annuals plants were the most abundant plants whereas trees are represented only by three spaced trees.

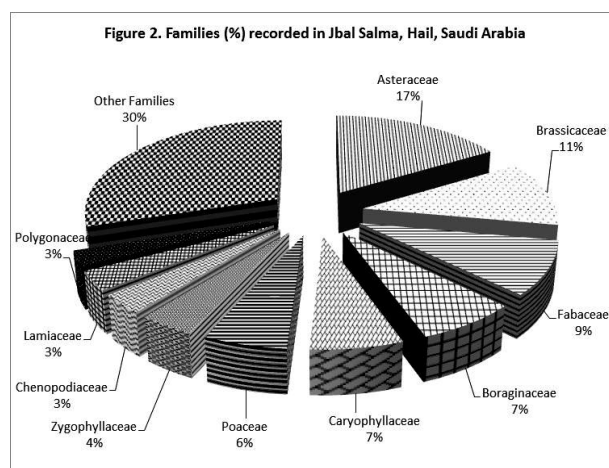


Figure 2 Percentage of plant families recorded in Salma Mountains of Hail, Saudi Arabia

Table 1 Flora of Jbal Salma: proprieties of different species

	Species	Families	Proprieties			
1	<i>Acacia raddiana</i> Savi	Fabaceae	F	M	O	
2	<i>Acacia tortilis</i> (Forssk.) Hayne	Fabaceae	F	M		
3	<i>Achillea fragrantissima</i> Forssk.	Asteraceae		E	M	O R
4	<i>Aerva javanica</i> (Burn.f.) Spreng.	Amaranthaceae		M	O	R
5	<i>Aizoon canariense</i> L.	Aizoaceae			O	W
6	<i>Alkanna orientalis</i> (L.) Boiss.	Boraginaceae			O	
7	<i>Alyssum homalocarpum</i> (Fisch. & Mey.) Boiss.	Brassicaceae		M		R
8	<i>Amaranthus graecizans</i> L.	Amaranthaceae			O	W E
9	<i>Anagallis arvensis</i> L.	Primulaceae			O	W
10	<i>Anastatica hierochuntica</i> L.	Brassicaceae		M		
11	<i>Anchusa aegyptiaca</i> (L.) DC.	Boraginaceae			O	R
12	<i>Anchusa hispida</i> Forssk.	Boraginaceae			O	
13	<i>Anthemis deserti</i> Boiss.	Asteraceae	F	M	O	E
14	<i>Anvilleagarcini</i> (Burm. F.) DC.	Asteraceae		M		W R
15	<i>Arnebiadecumbens</i> (Vent.) Coss. & Kral.	Boraginaceae		M		
16	<i>Arnebia hispidissima</i> (Lehm.) DC.	Boraginaceae				W
17	<i>Arnebiate trastigma</i> Forssk.	Boraginaceae				
18	<i>Asphodelus fistulosus</i> L.	Liliaceae			O	W
19	<i>Asteriscus graveolens</i> Less.	Asteraceae				
20	<i>Astragalus asterias</i> Stev. Ex. Ledeb.	Fabaceae	F			
21	<i>Astragalus bombycinus</i> Boiss.	Fabaceae	F			
22	<i>Astragalus corrugatus</i> Bert.	Fabaceae	F			
23	<i>Astragalus hamosus</i> L.	Fabaceae	F			W
24	<i>Astragalus schimperi</i> Boiss.	Fabaceae	F			
25	<i>Astragalus sieberi</i> DC.	Fabaceae				
26	<i>Astragalus spinosus</i> Forssk.	Fabaceae				
27	<i>Astragalus tribuloides</i> Del.	Fabaceae				
28	<i>Atractylis cancellata</i> L.	Asteraceae				W
29	<i>Atriplex leucoclada</i> Boiss.	Chenopodiaceae	F			R
30	<i>Avena fatua</i> L.	Poaceae	F	E		
31	<i>Ballota undulata</i> (Fres.) Benth.	Lamiaceae		M	O	E
32	<i>Bassia eriophora</i> (Schrad.) Asch. ap. Schweinf.	Chenopodiaceae				
33	<i>Bassia muricata</i> (L.) Murr.	Chenopodiaceae				
34	<i>Blepharis ciliaris</i> (L.) B. L. Burt.	Acanthaceae				
35	<i>Brassica rapa</i> L.	Brassicaceae				
36	<i>Brassica tournefortii</i> Gouan.	Brassicaceae		M		W
37	<i>Bromus rubens</i> Jusl. ap. L.	Poaceae	F			
38	<i>Calendula micrantha</i> Tineo et Guss.	Asteraceae		M	O	R
39	<i>Calligonum comosum</i> L'Her	Polygonaceae	F	M		R

Species		Families	Proprieties				
40	<i>Capparis decidua</i> (Forssk.) Edgew.	Capparaceae	F	E	O	E	
41	<i>Cenchrus ciliaris</i> L.	Poaceae	F		O	W R	
42	<i>Centaureas coparia</i> Sieb.	Asteraceae			O		
43	<i>Centaurea sinaica</i> DC.	Asteraceae	F		O	R	
44	<i>Chenopodium murale</i> L.	Chenopodiaceae		E		W	
45	<i>Chrozophora plicata</i> (Vahl.) A. Juss. Ex Spreng.	Euphorbiaceae			M		
46	<i>Cistanche phelypaea</i> (L.) Cout.	Orobanchaceae					
47	<i>Citrullus colocynthis</i> (L.) Schrad.	Cucurbitaceae		E	M		
48	<i>Cleome africana</i> Botsch.	Capparidaceae					
49	<i>Conyza dioscoridis</i> (L.) Desf.	Asteraceae			M	W	
50	<i>Cuscuta planiflora</i> Ten.	Convolvulaceae					
51	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	F			W	
52	<i>Diplotaxis acris</i> (Forssk.) Boiss.	Brassicaceae	F		M		
53	<i>Diplotaxis harra</i> (Forssk.) Boiss.	Brassicaceae	F	E	M	O W	
54	<i>Echinops spinosissimus</i> Turra.	Asteraceae					
55	<i>Echinosciadium arabicum</i> Zohary.	Apiaceae				R	
56	<i>Echium longifolium</i> Del.	Boraginaceae					
57	<i>Emex spinosus</i> (L.) Campd.	Polygonaceae			M		
58	<i>Eragrostis aegyptiaca</i> (Willd.) Del.	Poaceae					
59	<i>Erodium glaucophyllum</i> (L.) Aiton.	Geraniaceae	F		M	O	
60	<i>Erodium laciniatum</i> (Cav.) Willd.	Geraniaceae				O	
61	<i>Erucaria hispanica</i> (L.) Druce.	Brassicaceae					
62	<i>Euphorbia granulata</i> Forssk.	Euphorbiaceae			M		
63	<i>Euphorbia retusa</i> Forssk.	Euphorbiaceae			M		
64	<i>Fagoniacretica</i> L.	Zygophyllaceae					
65	<i>Fagoniaglutinoso</i> Del.	Zygophyllaceae				W	
66	<i>Fagonia indica</i> Burm.	Zygophyllaceae					
67	<i>Farsetia aegyptia</i> Turra.	Brassicaceae	F			O W R	
68	<i>Ferula sinaica</i> Boiss.	Apiaceae					
69	<i>Filago desertorum</i> Pomel.	Asteraceae					
70	<i>Forskoalea tenacissima</i> L.	Urticaceae				E	
71	<i>Francoeuria crispa</i> Forssk.	Asteraceae					
72	<i>Fumaria parviflora</i> L.	Fumariaceae	F		M	O W	
73	<i>Gymnarrhenamicrantha</i> Desf.	Asteraceae				R	
74	<i>Gymnocarpos decandrum</i> Forssk.	Caryophyllaceae	F				
75	<i>Gypsophila capillaris</i> (Forssk.) C. Chr.	Caryophyllaceae				O	
76	<i>Haloxylonsalicornicum</i> Bunge.	Chenopodiaceae					
77	<i>Haplophyllum tuberculatum</i> (Forssk.) A. Juss.	Rutaceae					
78	<i>Helianthemum lippii</i> (L.) Pers.	Cistaceae					
79	<i>Helianthemum salicifolium</i> (L.) Mill.	Cistaceae					

	Species	Families	Proprieties			
80	<i>Heliotropium bacciferum</i> Forssk.	Boraginaceae				R
81	<i>Heliotropium longiflorum</i> (A.DC.) Steud. Et Hochst. Ex Bunge.	Boraginaceae				
82	<i>Herniaria hirsuta</i> L.	Caryophyllaceae				W
83	<i>Hibiscus micranthus</i> L.F.	Malvaceae	F	M	O	
84	<i>Hippocrepis areolata</i>	Fabaceae	F			
85	<i>Hyoscyamus muticus</i> L.	Solanaceae				
86	<i>Iflagospicata</i> (Forssk.) Sch. Bip.	Asteraceae				
87	<i>Iphiona scabra</i> DC.	Asteraceae				R
88	<i>Isatis lusitanica</i> L.	Brassicaceae				R
89	<i>Juncus rigidus</i> C.A. Mey.	Juncaceae			O	
90	<i>Koelpinialinear</i> is Pall.	Asteraceae				W
91	<i>Lactuca serriola</i> L.	Asteraceae		E	M	W
92	<i>Launaea resedifolia</i>	Asteraceae	F		O	
93	<i>Lavandula stricta</i> Del.	Lamiaceae		M	O	R
94	<i>Leyseraleysseroides</i> Desf.	Asteraceae				
95	<i>Limonium thouini</i> (Viv.) Ktze.	Plumbaginaceae				
96	<i>Linaria simplex</i> (Willd.) DC. in Lam. et DC.	Scrophulariaceae				
97	<i>Lolium rigidum</i> Goudin	Poaceae	F			W
98	<i>Lycium shawii</i> Roem. Et Sch.	Solanaceae	F	M		
99	<i>Lygos raetam</i> (Forssk.) Heywood	Fabaceae				
100	<i>Malva parviflora</i> L.	Malvaceae	F	E	M	W
101	<i>Matthiola longipetala</i> (Vent.) DC.	Brassicaceae	F		O	
102	<i>Medicago laciniata</i> (L.) Mill.	Fabaceae				W
103	<i>Moltkiopsis ciliate</i> (Forssk.) Johnst.	Boraginaceae	F			
104	<i>Morettia canescens</i> Boiss.	Brassicaceae				
105	<i>Neuradaprocumbens</i> L.	Neuradaceae				R
106	<i>Notocerasbicorne</i> (Ait.) Amo.	Brassicaceae				
107	<i>Ochradenus baccatus</i> Del.	Resedaceae				
108	<i>Orobanche ramosa</i> L.	Orobanchaceae				
109	<i>Paronychia arabica</i> (L.) DC.	Caryophyllaceae			M	
110	<i>Paronychia argentea</i> Lam.	Caryophyllaceae				
111	<i>Pergularia tomentosa</i> L.	Apocynaceae				
112	<i>Periploca aphylla</i> Decne.	Apocynaceae	F	M	O	E
113	<i>Phoenix dactylifera</i> L.	Arecaceae		M	O	
114	<i>Picris abyssinica</i> Sch. Bip.	Asteraceae				
115	<i>Pituranthos tortuosus</i> (Desf.) Benth. & Hook.	Apiaceae	F	M	O	E
116	<i>Plantago amplexicaulis</i> Cav.	Plantaginaceae	F			
117	<i>Plantago cylindrica</i> Forssk.	Plantaginaceae	F			
118	<i>Plantago ovate</i> Forssk.	Plantaginaceae	F			
119	<i>Polygonumbellardii</i> All.	Polygonaceae			M	

Species	Families	Proprieties						
120	<i>Pteranthus dichotomus</i> Forssk.	Caryophyllaceae						M
121	<i>Pulicaria orientalis</i> Jaub.	Asteraceae						M
122	<i>Reseda decursiva</i> Forssk.	Resedaceae						
123	<i>Reseda muricata</i> Presl.	Resedaceae						
124	<i>Rhanterium epapposum</i> Oliv.	Asteraceae	F		M		O	
125	<i>Rhus tripartite</i> (Ucria) Grande.	Anacardiaceae	F				O	E
126	<i>Rumex vesicarius</i> L.	Polygonaceae			E	M	O	W
127	<i>Salvia deserti</i> Decne	Lamiaceae	F	E	M		O	E
128	<i>Salvia spinosa</i> L.	Lamiaceae		E	M		O	E
129	<i>Savignya parviflora</i> Del.	Brassicaceae	F		M		O	E
130	<i>Scabiosa olivieri</i> Coult.	Dipsacaceae					O	W
131	<i>Schimpera Arabica</i> Hochst. & Steud.	Brassicaceae						
132	<i>Schismus barbatus</i> (Hojerejud. L.) Thell.	Poaceae	F					
133	<i>Scorzonera Intricata</i> Boiss.	Asteraceae			E		O	
134	<i>Senecio flavus</i> (Decne.) Sch. Bip.	Asteraceae	F				O	
135	<i>Silene arabica</i> Boiss.	Caryophyllaceae						
136	<i>Sisymbrium irio</i> L.	Brassicaceae	F	E				W
137	<i>Spergula fallax</i> (Lowe) E.H.L. Krause.	Caryophyllaceae						W
138	<i>Spergularia diandra</i> (Guss.) Boiss.	Caryophyllaceae						
139	<i>Spergularia rubra</i> L.	Caryophyllaceae					M	
140	<i>Stipa capensis</i> Thunb.	Poaceae	F					
141	<i>Stipagrostis Plumosa</i> (L.) Munro ex T. Anders.	Poaceae	F				O	
142	<i>Tamarix aphylla</i> (L.) Karst.	Tamaricaceae						
143	<i>Teucrium polium</i> L.	Lamiaceae			M		O	R
144	<i>Tribulus longipetalus</i> Viv.	Zygophyllaceae	F					
145	<i>Tribulus terrestris</i> L.	Zygophyllaceae	F					
146	<i>Trichodesma africanum</i> (L.) R.Br.	Boraginaceae	F				O	
147	<i>Trigonella stellate</i> Forssk.	Fabaceae			M		O	R
148	<i>Urospermum picroides</i> (L.) Scop. Ex F.W. Schmidt.	Asteraceae						
149	<i>Zillaspinosa</i> (Turr.) Prantl.	Brassicaceae	F				O	
150	<i>Zygophyllumdecumbens</i> Del.	Zygophyllaceae						
Total			48	13	43	45	27	20

F: forage; E: Edible; M: Medicinal; O: ornamental; W: Weeds; R: Rare; E: Endemic

In addition, the current study found that about 21 plants in Jabal Salma were considered to be threatened species or have already become extinct according to Al-Turki & Al-Olayan (2003) including: *Anthemis sheilae*, *Arabidopsis erysimoides*, *Astragalus collenetiae*, *Trisetaria chautharyana*, *Aerva javanica*, *Alyssum homalocarpum*, *Anchusa aegyptiaca*, *Anvillea garcini*, *Calendula micrantha* and *Cenchrus ciliaris*. These species were

also considered as threatened or have already become extinct according to Alghamdi, (2017) who compared the floristic composition of other protected and accessible areas in Hail. Also, a number of species from the current study area have been identified in a previous study to be endemic only in Jabal Salma and have been classified as endemic-endangered, such as *Anthemis sheilae*, *Arabidopsis erysimoides*, *Astragalus*

colnettiae and *Trisetaria chautharyana*. Meanwhile other species which were encountered rarely in the current survey, such as; *Echinops glaberrimus*, *Ochradenus arabicus* and *Zygophyllum propinquum* were classified as endemic to Jabal Salma and all over Saudi Arabia (Al-Turki & Al-Olayan, 2003).

According to the results of present study, Jabal Salma is holding many species of economic values where 43 of them classified as medicinal, 45 ornamental and 13 edibles species can be used for human consumption. The most frequent medicinal species include; *Salvia deserti*, *Salvia spinosa*, *Savignya parviflora*, *Polygonumbellardii*, *Pteranthus dichotomus*, *Pulicariaori entalis*, *Periploca aphylla*, *Teucrium polium* and *Trigonella stellate*. Also these mountains were considered as a safe refuge for many ornamental species such as *Cenchrus ciliaris*, *Centaurea scoparia*, *Centaurea sinaica*, *Trichodesma africanum*, *Trigonella stellate*, *Salvia spinosa*, *Savignya parviflora*, *Scabios aolivieri*, *Gypsophila capillaris* and *Hibiscus micranthus*. These results would confirm the biological diversity of mountains as special habitats in Saudi Arabia.

In accordance with Zhang et al (2016) elevation along the altitudinal gradient plays major role in plant distribution in mountains due to many variables including; slope degree and position, soil pH, organic matter, total nitrogen and available nitrogen. In agreement with this statement, the current study clearly showed that the plants were distributed in different patterns according to altitudinal gradient. Some species like *Asphodelus fistulosus*, *Euphorbia retusa*, *Haloxylonsali cornicum*, *Acacia tortilis*, *Plantago ovate*, *Aizon canariense*, *Anastatica hierochuntica*, *Schismus barbatus* and *Trigonella stellate* were dominated the non-pastoral zones on the low and flat areas surrounding the mountains.

Further, in the foothill several pastoral species have been reported including; *Cenchrus ciliaris*, *Cynodon dactylon*, *Lolium rigidum*, *Schismus barbatus*, *Stipa capensis*, *Stipagrostis Plumosa*, *Plantago amplexicaulis*, *Plantago cylindrica*, *Plantago ovate*, *Medicago laciniata* and *Astragalus corrugatus*. The availability of such number of pastoral species could be easily attributed to topographic difficulties which prevent grazing animal including camels, sheep and goats from reaching Jabal Salma foothill.

At high altitudes (top of Jabal Salma) and within its ridges and small valleys there were many medicinal and aromatic plants which have been considered as threatened to extinct species in other open habitats. Such species include *Ballota undulata*, *Lavandula stricta*, *Salvia deserti*, *Salvia spinosa*, *Teucrium*

polium, *Asphodelus fistulosus*, *Calendula micrantha* and *Tribulus terrestris*.

The invasion of exotic species is considered to be the main destructor of diversity and ecological equilibrium in natural landscapes (Dogra et al., 2010). In this study and despite accessibility difficulties of Jabal Salma, 27 species were identified as weeds for example, *Sisymbrium irio*, *Spergula fallax*, *Rumex vesicarius*, *Medicago laciniata*, *Lolium rigidum*, *Lactuca serriola*, *Cynodon dactylon* and *Conyza discoridis*. These species were also reported previously as weeds in Ha'il by (Mseddi et al., 2017).

Historically, Hail region was considered as an excellent area for forage and pasture throughout the year (Al-Rowaily et al., 2016). However, due to human disturbances which took place in the last few decades such as; intensive grazing, over cutting and urban sprawl, many rangelands of Ha'il were degraded into a less productive pasture with a few shrubs and trees (mainly Acacias) which in turn seek refuge in wadis and foothills. However, we believe that Ha'il region's mountains still hold a number of economic, endemic and rare species, some of which are endemic only in Jabal Salma the current study area.

In the current study, the floristic composition analysis showed that the family Asteraceae followed by Brassicaceae, Fabaceae, Boraginaceae, Caryophyllaceae, and Poaceae were the most dominant families. The dominance of Asteraceae, Brassicaceae and Poaceae families has been also reported by Al-Turki & Al-Olayan (2003) and El-Ghanim et al. (2010) who worked on some accessible areas in Hail region. They found the most common genera was *Astragalus* (Asteraceae) which was represented by 8 species, followed by *Arnebia* (Boraginaceae) and *Fagonia* (Zygophyllaceae) with three species for each family (El-Ghanim et al., 2010) reported that *Euphorbia* (Euphorbia), *Heliotropium* (Boraginaceae) and *Plantago* (Plantaginaceae) were the most common genera. Each of these genera was represented by three species. In addition, Al-Turki & Al-Olayan (2003) found that *Plantago* and *Astragalus* were the most common genera in the whole region of Hail.

According to the current findings, Jabal Salma holds many species of economic values those where classified as medicinal, ornamental and edibles species used for human consumption. These results would confirm the biological diversity of mountains as a special habitat in Saudi Arabia. In accordance with this a similar recent study was conducted by AlZubaide et al. (2017) to assess the floristic composition of Shada Mountain in the south of Saudi Arabia and found there many species of economic value including; medicinal, grazing, fuel and edible.

As reported by Dogra et al. (2010), the invasion by exotic species was considered to be the main disturbing factor of wild ecosystems. The presence of some noxious and invasive weeds such as *Lolium rigidum* and *Lactuca serriola* have been reported in the current study and this should raise the alarm to the local authority to take rapid action in order to prevent these noxious species from destructing the natural vegetation of Jabal Salma. This warning must be taken seriously as it is well documented now that invasive alien species is the second greatest threat to biodiversity after habitat loss (Thapa & Maharajan, 2014).

Conclusion

Although there is a huge loss of plant biodiversity in Saudi Arabia, the outcomes of the current study provide strong evidence that inaccessible zones such as Jabal Salma still hold a number of endemic and rare species of economic value. Therefore, Jabal Salma could be described as a reservoir for native seed species which could be exploited by the Saudi government in order to provide native plants to fight desertification and to stop the loss of biodiversity.

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Conflict of Interest Statement

There is no conflict of interest

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