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Phytosociological studies of *Citrullus colocyanthis* L., Growing in Different Altitudinal Sites in Saudi Arabia

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Abstract: The aim of the present study was to survey and record the plant species associated with *Citrullus colocynthis* in different altitudinal localities in the West of Saudi Arabia. Depending on the presence of *Citrullus colocynthis* L. species, seven stands on the West of Saudi Arabia; expending from 25 m up to 2220 m a.s.l. height and 330 km long were selected for this study. Soil samples were collected from the studied localities and the soil properties were investigated. Also, plant species associated with *C. colocynthis* were collected, recorded and prepared as herbarium specimens. The studied localities were represented by different ecological, geographical and edaphic sites. A list of 127 species belonging to 41 families present in all locations was recorded. *Calotropis procera* was the representative species with *C. colocynthis* in all localities. The percentage of presence of the associated species were different between species in each location and also from location to other. Three different ecological areas could be distinguished in the study area. The area near the red sea characterized by salty sandy soil and low vegetation represented the first area. The second one was the coastal plain and West slope which characterized by low rainfall and xerophytic plants. The third one was the mountainous area which characterized by high altitude, more rainfall and high density of vegetation.

Key words: Phytosociological, *Citrullus colocyanthis*, plant list, geographical areas

INTRODUCTION

Citrullus colocyanthis is a native plant to dry areas of North Africa, being common throughout the Sehara, areas of Morocco, Egypt and Sudan; eastward through Iran to India and other parts of tropical Asia. It has been reported that the extracts of *C. colocyanthis* were used for many medical purposes (Bendjeddou *et al*., 2003; Seger *et al*., 2005; Nayab *et al*., 2006; Qazan *et al*., 2007; Daradka *et al*., 2007). The plant could be used as a herbal medicine for treatment of diabetes, oedema, bacterial infection and cancer (Kumar *et al*., 2008; Huseini *et al*., 2009). On the other hand, Rahuman *et al*. (2008) isolated mosquito larvacidal material from *C. colocyanthis*.

Gross morphological features of *C. colocyanthis* L. (Cucurbitaceae) were adequately described and illustrated in the flora of Saudi Arabia by Collenette (1999), Miller and Cope (1996), Chaudhary and Al-Jowaid (1999) and in Egypt by Shaltout *et al*. (2003).

It has been reported that *Citrullus colocynthis* tolerate annual precipitation of 3.8 to 42.9 dm, annual temperature of 14.8 to 27.8°C and pH of 5.0 to 7.8. It is highly xerophytic plant, thrives when the mean of annual temperature is from 23-27°C and annual rainfall ranges from 25-37 cm. The plant thrives on sandy loam, sub-desert soils and along sandy sea coasts (Duke, 1978).

In Saudi Arabia, the plant widely distributed at some sites in different altitudinal areas ranging from 25 m to about 2220 m above sea level (a.s.l.) which representing different ecological and geographical habitats (Chaudhry, 2001).

This study was conducted to survey and record the combined species along with *C. colocynthis* in different localities, characterised with the presence of individual species as well as to give a list of the plants recorded in each locality.

MATERIALS AND METHODS

Study area: This study was carried out on a large area, starting from the low land (25 m) up to high lands (up to 2200 m above sea level) on the high mountains. Along an elevation transect on the West of Saudi Arabia of Tehama Coastal Plain and the Sarawat Mountainous, seven sites at 25, 140, 420, 770, 1400, 1900 and 2220 m a.s.l. were selected for the study (Fig. 1). These seven sites are represented in three different ecological and geographical habitats. The longitude, latitude, altitude with the

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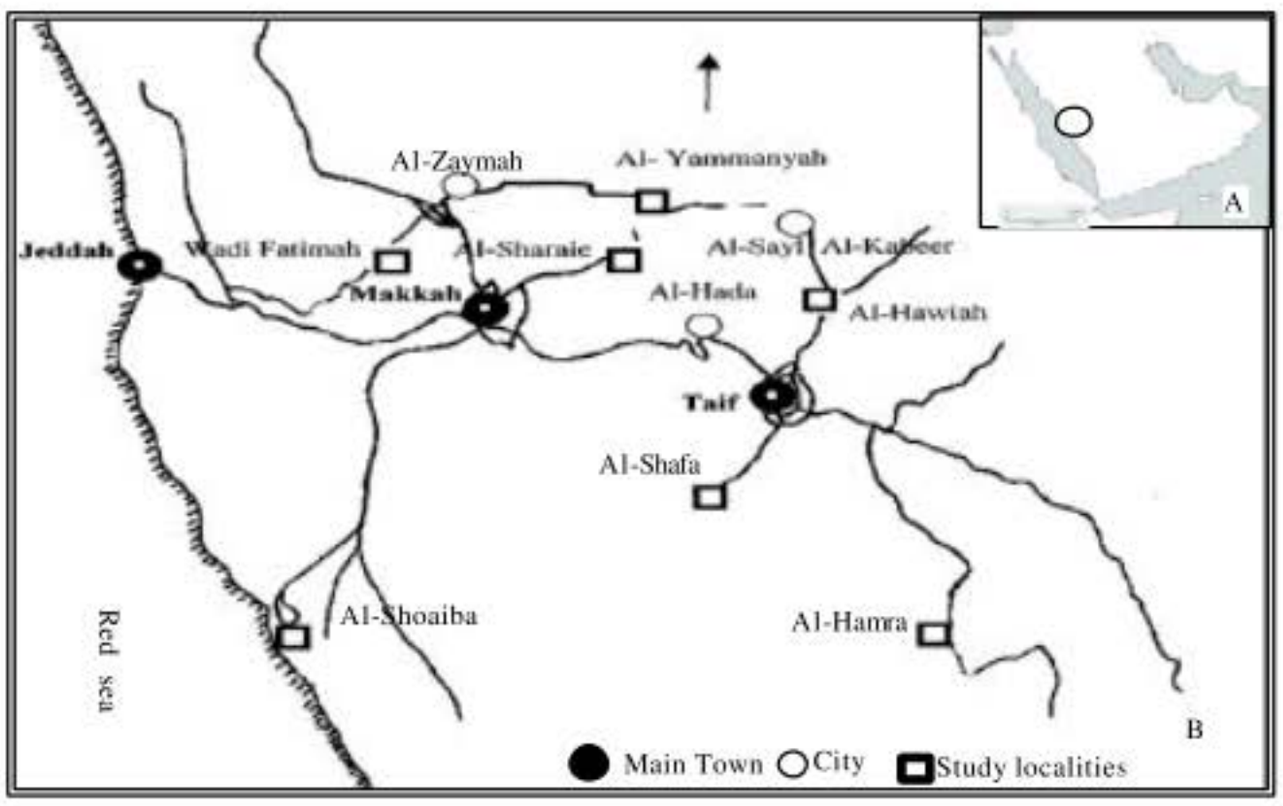

Fig. 1: (A) General map of Saudi Arabia, (B) Localities of the present study

Table 1: Ecological characters of the studied locations

Sites	Locations			Temperature(°C)	Rainfall (mm year^{-1})
	Long.	Lat.	a.s.l.		
Al-Shoaebah	20° 47'	39° 27'	25 m	23.00- 32.8 (Jan.- Aug.)	36.5
Wadi Fatimah	21° 16 '	39° 47'	140 m	23.9- 35.8 (Jan.- Aug.*)	35.5
Al-Shraie	21° 31'	40° 04'	420 m	23.9- 35.8 (Jan.- Aug.*.)	38.1
Al-Ymaniah	21° 39'	40° 05'	770 m	20.3- 32.3 (Jan.- Aug.)	38.5
Al-Hawiah	21° 26'	40° 32'	1400 m	15.3- 29.3 (Jan.- Aug.)	40.3
Al-Shafa	21° 05'	40° 21'	1900 m	15.3- 29.3 (Jan.- Aug.)	40.3
Al-Hamra	20° 53'	40° 46'	2220 m	15.3- 29.3 (Jan.- Aug.**)	40.3 40.3

*: July, **: June

minimum and maximum temperature and rainfall averages of the locations were shown in Table 1.

Soil samples treatments: Soil samples were collected from each location at depth of 10 cm from rhizosphere, air dried in the laboratory and then passed through 2 mm sieve to remove gravel and debris. Soil granules were analyzed by mechanical analysis using different sieves. Soil-water extracts (1:5, w/v) were prepared for determinations and the pH values were measured by pH meter (HI 8314), while Electrical Conductivity (EC) was measured by conductivity bridge (Metter Toledo). The ion contents and the elements were determined in the collected soil samples. Chloride content was determined by titration with silver nitrate (Jackson and Thomas, 1960), while the elements K, Ca, Mg, F and Na were measured by the atomic absorption spectrometer (3100 Perkin Elmer).

Plants samples treatments: This study was carried out during 2004. Seven stands were stated depending on the presence of the species *Citrullus colocynthis* L. The plant species associated with the *C. colocynthis* were recorded at the same localities. The collected species were prepared as herbarium specimens (Bridson and Forman, 1998) and then kept in King Abdulaziz University Herbarium (KAUH), Faculty of Science, Department of Biological Science, Jeddah. The collections were identified according to Miller and Cope (1996), Collenette (1999) and Chaudhary and Al-Jowaid (1999) and compared with identified plants in KAUH. The presence (P) of the plant species in each location was measured using the Braun-Blanquet (1964) technique.

RESULTS

Soil analysis: The elevation of the study area declines remarkably and suddenly from mountainous area in the east to the coastal plain in the West and stay almost steadily in the sandy desert. The soil analysis showed that percentages of sand in soil decreased gradually from the mountainous areas to the coastal plain areas, while percentages of silt and clay were higher in the mountainous areas than that in the coastal plain (Table 2). The pH values showed that the soil of the high mountain locations was low acidic then the pH increased to neutral in Al-Yamaniah region and to alkaline in the coastal locations. The Electrical Conductivity (EC) recorded the highest value in Al-Shoaebah location (near the red sea coast, 25 m a.s.l.) and then significant decrease was recorded with increasing altitude. The lowest amount of potassium appeared in Al-Shoaebah (25 m a.s.l.) soil and

then increased with elevation, while opposite situation was found in the case of Ca (Table 2). There was no trend appeared for Mg values. Salinity was also higher in Al-Shoaebah site (Na^+, 166.1 and Cl^-, 172.8 mg g^{-1}) and then decreased sharply to 19.8 and 20.5 mg g^{-1}, respectively, in Wadi-Fatimah (140 m a.s.l.) and then decreased with increasing elevation.

The plants species: The recorded species in each locality were arranged alphabetically in their families (Table 3). 126 species belonging to 41 families were recorded in all locations. The species associated with *C. colocynthis* varied in different localities ranging from 7 species recorded in Al-Shoaiba (25 m a.s.l.) to 71 species in Al-Hamra (2220 m a.s.l.). The dominant species in

Table 2: Soil characters of the study locations at different altitudinal areas of *C. colocynthis* plants

	Soil analysis									
						K	Mg	Ca	Na	Cl
Elevation (m)	Sand (%)	Silt (%)	Clay (%)	pH	EC (mmole cm^{-1})	($mg\ g^{-1}$dw)				
25	81.6±2.9	11.2±3.2	7.2±0.9	7.5±0.3	97.8±5.6	13.0±2.2	49.8±4.3	41.1±5.3	166.1±8.3	172.8±8.2
140	76.3±2.8	16.5±3.5	7.2±1.1	7.1±0.1	65.9±4.8	20.8±1.4	91.6±5.3	32.9±1.7	19.8±0.6	20.5±2.1
420	69.7±3.1	23.0±2.8	7.3±1.2	7.3±1.2	65.4±4.2	21.3±1.6	69.1±0.6	25.6±1.7	19.8±0.3	21.7±1.1
770	71.0±4.0	24.6±3.3	4.4±0.5	7.0±0.1	62.6±4.3	24.1±1.3	98.8±9.1	18.7±3.2	18.9±0.7	20.8±2.2
1400	69.3±2.2	28.8±2.8	11.9±0.2	6.8±0.1	61.8±5.2	26.9±1.0	93.7±6.3	18.2±2.4	18.1±0.6	20.1±3.7
1900	54.9±2.1	28.5±1.9	16.6±0.6	6.7±0.2	59.9±4.1	35.2±3.9	79.3±9.3	15.6±1.4	12.9±0.4	15.6±1.5
2220	52.5±2.0	35.1±2.1	12.4±2.2	6.5±0.2	58.4±7.6	37.1±3.3	56.0±7.8	13.1±1.6	10.7±2.0	11.4±7.5

±: Standard error of mean, dw: dry weight

Table 3: The list of the species collected from different altitudinal locations and the presence (p, %) of each species in each locality

		P (%) at altitude (m)						
Families	Species	25	140	420	770	1400	1900	2220
Acanthaceae	*Blepharis ciliaris* (L.) B. L. Burtt			5	15	15	20	20
	Ruellia grandiflora (Forssk.) Blatter				30			
	Hypoestes forsskalii (Vahi)Roem.and Schult						+	10
Aizoaceae	*Aizoon canariense* L.		10	20				
Aloeaceae	*Aloe officinalis* Forssk							20
Amaranthaceae	*Aerva javanica* (Burm. f.) Juss. ex J. A.Schult		20	20	20	20	30	+
	Amaranthus graecizans L. ssp. Sylvestris (Vill.) Brenan		20					
Apiaceae	*Ferula communis*							+
(=Umbelliferae)	Pimpinella cretica Poir var. arabica Boiss.		+					
Apocynaceae	*Rhazya stricta* Decne.		60	30	20	5		
Asclepiadaceae	*Calotropis procera* (Aiton) W. T. Aiton	20	25	20	10	10	5	+
	Gomphocarpus fruticosus (L.) W. T. Aiton						20	+
	Gomphocarpus sinaicus Boiss					+	+	20
	Leptadenia pyrotechnica (Forssk.) Decne.		+	+				
	Monolluma quadrangular (Forssk.) Plowes (Caralluma)						+	+
	Pergularia tomentosa L						20	
	Pergularia daemia (Forssk.) Plowes							+
Asphodelaceae	*Asphodelus* sp. Aff. aestivus Brot.						+	
	Asphodelus tenuifolius Cav.		+					+
Astraceae	*Achillea biebersteinii* Afan.					+	+	+
(= Compositae)	*Centaurea sinaica* DC.					+	20	10
	Conyza stricta Willd.						+	+
	Echinops hystrichoides Kit Tan					10	30	30
	Euryops arabicus Steud.						10	30
	Felicia abyssinica (A. Rich.) Dandy						+	+
	Felicia dentata (A. Rich.) Dandy						+	+
	Kleinia odora (Forssk.) DC.						+	10
	Launaea capitata (Spring.) Dandy		+					20
	Launaea massauensis (Fresen.) Sch-Bip. ex Kuntze						+	
	Launaea nudicaulis (L.) Hook. f.							20
	Onopordon heteracanthum C. A. Mey.				+	+	+	+
	Osteospermum vaillantii (Decne.) T. Norl.					+	+	+
	Psiadia punctulata DC.						40	30
	Pulicaria crispa (Forssk.) Oliv.					30	60	40
	Pulicaria schimperi DC.		20					
	Senecio asirensis Boulos and J. R. I. Wood					+	+	10
	Sonchus tenerrimus L.		+					
Barbeyaceae	*Barbeya oleoides* Schweinf							+
Boraginaceae	*Alkanna orientalis* (L.) Boiss.							+
	Arnebia decumbens (Vent.) Coss. & Karlik							10
	Arnebia hispidissima (Lehm.) DC							+
	Heliotropuium arbainense Fresen.		10		10		+	

Table 3: Continued

Families	Species	P (%) at altitude (m) 25	140	420	770	1400	1900	2220
	Heliotropium bacciferum Forssk.		+					
	Heliotropium ramosissimum (Lehm.) Sieb. ex A. DC.				20			
Brassicaceae	*Dolichorhynchus arabicus* I. C. Hedge and Kit Ta					+		
(= Cruciferae)	*Eruca sativa* Mill.			10				
	Farsetia longisiliqua Decne.		20	+				30
	Farsetia stylosa R. Br.		20	+				30
	Morettia parviflora Boiss.		+	+				
	Schouwia purpurea (Forssk.) Schweinf.		10					
Cactaceae	*Opuntia ficus- indica* (L.) Mill						+	+
Capparaceae	*Cleome chrysantha* Decne.				10			
	Dipterygium glaucum Decne.		20	80	30		30	
	Maerua crassifolia Forssk.	20	5					
	Maerua oblongifolia (Forssk.) A. Rich.		+	10				
Caryophyllaceae	*Polycarpaea repens* (Forssk.) Asch. & Schweinf		+					
Chenopodiaceae	*Arthrocnemum macrostachyum* (Moric.) K. Koch		50					
	Chenopodium murale L.		+					
	Salsola spinescens Moq.					50		
Convolvulaceae	*Convolvulus hystrix* Vahl			10				
Cucurbitaceae	*Citrullus colocynthis* (L.) Schrad.	10	35	50	60	50	40	20
	Cucumis prophetarum L. var. prophetarum				20			
Cupressaceae	*Junperus procera* Hochst.ex Endl.						+	30
Euphorbiaceae	*Clutia myricoides* Jaub. and Spach							20
	Euphorbia granulata Forssk. var. glabrata (Gay) Boiss.		+	40				
	Ricinus communis L.					10	+	+
Fabaceae	*Acacia asak* (Forssk.) Willd.							10
(= Leguminosae)	*Acacia ehrenbergiana* Hayne		20	+				
	Acacia origena R. Br. ex Hunde							10
	Acacia tortilis (Forssk.) Hayne		+	+	15	20	+	
	Astragalus sieberi DC.					+	10	+
	Crotalaria microphylla Vahl.		+					
	Indigofera hochstetteri Baker		+					
	Indigofera spinosa Forssk.		+	80	35	5	+	+
	Senna italica Mill.		40	55	30			
	Trigonella stellata Forssk.						10	
	Trigonella glabra Thunb.							10
Lamiaceae	*Lavandula coronopifolia* Poir.							+
(= Labiatae)	*Lavandula dentate* L.				+	15	30	20
	Lavandula pubescens Decne.					10	20	10
	Marrubium vulgare L.						+	
	Nepeta deflersiana Schweinf. Ex I. C. Hedge						+	+
	Teucrium polium L.					+	10	+
Malvaceae	*Abutilon pannosum* (G.forst.) Schtdl	10	10	20				
	Abutilon sp				20	10	+	+
	Malva parviflora var. microcarpa L.		+	+	+			20
Molluginaceae	*Glinus lotoides* L.		+					
Nyctaginaceae	*Boerhavia diffusa* L		+	20				
	Commicarpus helenae (Schult.) Me	10						
	Commicarpus grandiflorus (A. Rich.) Standl							20
Oleaceae	*Olea europaea* L. ssp. Cuspidate (wall. ex. G.Don) *ciferri formadulcis* p.s. Green						20	5
Papaveraceae	*Argemone ochroleuca* Sweet				20	80	50	40
	Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray				10	+		+
Poaceae	*Aristida funiculate* Trin. and Rupr.		+					
(= Gramineae)	*Aristida mutabilis* Trin. and Rupr			30				
	Avena sp.		+					
	Cenchrus ciliaris L.		90	20	10	+	+	
	Cenchrus pennisetiformis Hochst and Steud.		+					
	Hyparrhenia hirta (L.) Stapf							+
	Panicum turgidum Forssk.	50	30	25	15			
Polygalaceae	*Polygala erioptera* DC.		+					
	Polygala sp. aff. Steudner Chod. sp. A						10	
Polygonaceae	*Rumex vesicarius* L.						+	20
Portulacaceae	*Portulaca quadrifida* L.		+					
Resedaceae	*Caylusea hexagyna* (Forssk.) M. L. Green							10

Table 3: Countinued

Families	Species	P (%) at altitude (m) 25	140	420	770	1400	1900	2220
	Ochradenus baccatus Delil					40	20	
	Reseda decursiva Forssk					+	+	
Rhamnaceae	*Rhamnus lycioides* L. ssp. oleoides (L.) Jahand. & Maire					+		
	Sageretia thea (osbeck) M. C. Johnst					10	10	+
	Ziziphus spina-Christi (L.) Desf. var. spina Christa					+	+	+
Rutaceae	*Ruta chalepensis* L						+	5
Sapindaceae	*Dodonaea angustifolia* L. F.						35	20
Scrophulariaceae	*Kickxia pseudoscoparia* D. Sutton						10	+
	Schweinfurthia pterosperma A. Braun		+					
Solanaceae	*Datura innoxia* Mill.						15	+
	Lycium shawii Roem. and Schult.					5	+	+
	Solanum incanum L.		+	+		10	20	+
	Solanum macracanthum A. Rich.							+
	Withania somnifera (L.) Duna					10	20	+
Tamaricaceae	*Tamarix aphylla* (L.) karst.			10	5	30		
Tiliaceae	*Corchorus trilocularis* L .			+				
Urticaceae	*Forsskaolea tenacissima* L.	10		+		+	+	+
Zygophyllaceae	*Fagonia indica Burm.* F.						5	+
	Fagonia schweinfurthia Hadidi	15		20	30	30	60	50
	Peganum harmala L..					50	25	20
	Tribulus pentandrus Forssk.	+		10				
	Zygophyllum simplex L.	15		5	5	+	+	

Presence of values are given in precentage. +: Less than 5% presence frequency

Al-Shoaibah location was *Panicum turgidum* (p = 50%). In the second location, Wadi-Fatimah (140 m a.s.l.), 47 species were recorded and the annual plant species *Cenchrus ciliaris* recorded a high presence (90%), while *Rhazya stricta* was the dominant species (60%) between perennials. 32 plant species were recorded in Al-Shraie location (420 m a.s.l.), the dominant species were *Dipterygium glaucum* and *Indigofera spinosa*, where the presence of each species recorded 80%. The vegetation decreased in the West slope where 24 species were recorded in Al-ymmanyah (770 m a.s.l.) and the dominant species was *C. colocynthis* (60%). The degree of vegetation increased with increasing altitude for the last three locations. In Al-Hawiah location (1400 m a.s.l.) 39 species were recorded and *Argemone ochroleuca* was the dominant species (80%).

In Al-Shafa location (1900 m a.s.l.) the dominant species was *Pulicaria crispa* and *Fagonia schweinfurthia* (each of 60%). 71species were found in the last and highest location, Al-Hamra (2220 m a.s.l.) and the most dominant species was *Fagonia schweinfurthia* (50%). Each location is characterized by different vegetation especially the upper locations, while there were only two species present in all locations (*Calotropis procera* and *C. colocynthis*). This landscape gave clear indication that the vegetations changes with increasing altitude, some of the species disappeared and some other species appeared and this characterized each location.

DISCUSSION

This study was curried on seven different altitudinal locations at the western region of Saudi Arabia on the area extended from the coastal plain (25 m above the sea level) to the high mountains (2200 m a.s.l.). These chosen locations are characterized by the presences of *Citrullus colocynthus* species. The distribution and composition of various plants associated with *C. colocynthus* showed a clear dependence on geological structure, elevation above sea level, soil texture, soil water content and human impact, which may lead to the appearance and disappearance of various species (Batanouny and Ismail, 1985).

The present study showed variation in the flora of each locality. The numbers of the recorded species in the seven localities were dependent on their ecological factors.

The vegetation abundance increased by increasing elevation depending on the temperature, participation and soil texture. The high salinity near the sea coast affected the plant growth which leads to low vegetation growth and low level of variation (six species only). In the desert plain, however, the variation is increased more than that in sea coast because the low level of salinity and more rainfall especially in the wadis and near the foothills. Also, the high temperature lead to severe evapo-transpiration, so the vegetation dominated by some under shrubs, shrubs and annuals such as *Senna italica*, *Rhazya stricta*

and *Malva parviflora*. The distance between Makkah and Taif (the West slope) characterized by much reduced aridity where the vegetation is mainly dominated by shrubs and trees such as *Fagonia schweinfurthia* and *Acacia tortilis* subsp. *tortilis.* Locations of higher altitudes (over 1400 m a.s.l.) are characterized by different and special vegetation associated with *C. colocynthus*. Thirty five species were recorded in the fifth location (1400 m) dominated by some plants such as *Peganum harmala*, *Argemone ochroleuca* and *Salsola spinescens*. The last two locations (1900 and 2220 m) have special vegetation differ from all other locations depending on the altitude, rain fall and soil properties. The number of species recorded in these two locations were almost the sum of the other five locations, they characterized by the presence of some new species growing in this part of Saudi Arabia such as *Dodonaea angustifolia*, *Euryops arabicus, Junperus procera*, *Hypoestes forsskalei* and *Psiadia punctulata.* These results are in agreement with other studies in different areas of the south of Saudi Arabia (Konig, 1986; Hajar *et al*., 1998).

The results showed the possibility of dividing the studied area into three different ecological sectors. The first one includes only Al-Shoaiba location (Alt. 40 m), where the salty and sandy soil, high temperature and low rates of rainfall are found. The number and the species density were low in this sector (only six species belonging to seven families). The second sector includes Wadi Fatimah (Alt. 140 m), Al-Sharaie (Alt. 420 m) and Al-Yamanyah (Alt. 770 m) locations. This sector characterized by the high temperature, low rates of rainfall and their sandy soil. There were 46, 31 and 23 companying species belong to 25, 18 and 14 families in the locations of this sector respectively. Al-Hawiah, Al-Shafa and Al-Hamra constitute the third sector at the high. mountains, which characterized by low temperature rates, high amounts of rainfall and low sandy soil rich in organic maters. The companying species of *C. colocynthus* increased in number; there were 36, 58 and 68 species belonging to 18, 27 and 28 families in the sites of this third sector, respectively. *Asclepidaceae* and *Malvaceae* families were found to be exist in all of the studies locations and the other reported families varied in their distribution between locations.

REFERENCES

Batanouny, K.H. and N.A. Ismail, 1985. Plant communities along Medina-Badr road across the Hedjaz Mountains, Saudi Arabia. Plant Ecol., 53: 33-43.

Bendjeddou, D., K. Lalaoui and D. Satta, 2003. Immunostimulating activity of the hot water-soluble polysaccharide extracts of *Anacyclus pyrethrum, alpinia galangal* and *Citrullus colocynthis*. J. Ethnopharmacol., 88: 155-160.

Braun-Blanquet, J., 1964. Plant Sociology. 1st Edn., McGraw Hill Book Co. Inc., New York.

Bridson, D. and L. Forman, 1998. The Herbarium Handbook. 3rd Edn., Whitstable Litho Printers Ltd., London, UK.

Chaudhary, S.A. and A.A. Al-Jowaid, 1999. Vegetation of the Kingdom of Saudi Arabia. National Agriculture and Water Research Center, Riyadh, Saudi Arabia.

Chaudhry, S.A., 2001. Flora of The Kingdom of Saudi Arabia Illustrated. Vol. 1 (Part-1), Ministry of Agriculture and Water, Riyadh.

Collenette, S., 1999. Wildflowers of Saudi Arabia. Ist Edn., NCWCD., Riyadh, Saudi Arabia.

Daradka, H., M.M. Almasad, W.S. Qazan, N.M. El-Banna and O.H. Samara, 2007. Hypolipidaemic effects of *Citrullus colocynthis* L. in rabbits. Pak. J. Biol. Sci., 10: 2768-2771.

Duke, J.A., 1978. The quest for tolerant germplasm Proceeding of the ASA Special Symposium 32, Crop Tolerance to Suboptimal Land Conditions American Society Agronomy, 1978, Madison, WI, pp: 1-61.

Hajar, A., M. Yousef and N. Baeshin, 1998. Studies on the plant ecology and phytosociology of Al-Bahah region, Saudi Arabia: 1. Area along Al-Bahah-Al-Qonfodah road. Bull. Fac. Sci., 27: 53-84.

Huseini, H.F., F. Darvishzadeh, R. Heshmat, Z. Jafariazar, M. Raza and B. Larijani, 2009. The clinical investigation of *Citrullus colocynthis* (L.) schrad fruit in treatment of type II diabetic patients: A randomized, double blind, placebo-controlled clinical trial. Phytother Res., (In Press).

Jackson, W.A. and G.W. Thomas, 1960. Effect of KCl and dolometic limestone on growth and ion uptake of sweet potato. Soil Sci., 89: 347-352.

Konig, P., 1986. Zonation of vegetation in the mountainous region of South-Western Saudi Arabia (Asir, Tihama). Beihefte Tubinger, 24: 137-166.

Kumar, S., D. Kumar, K. Saroha, N. Singh and B. Vashishta, 2008. Antioxidand and free radical scavenging potential of *Citrullus colocynthis* (L.) Schard. methanolic fruit extract. Acta Pharm., 58: 215-220.

Miller, A.G. and T.A. Cope, 1996. Flora of Arabian Peninsula and Socatra. Edinburgh University Press in Association with Royal Botanical Gardens Edinburgh and Royal Botanical Gardens Kew, England.

Nayab, D., D. Ali, N. Arshad, A. Malik, M.I. Choudhary and Z. Ahmed, 2006. Cucurbitacin glucosides from *Citrullus colocynthis*. Nat. Prod. Res., 20: 409-413.

Qazan, W.S., M.M. Almasad and H. Daradka, 2007. Short and long effects of *Citrullus colocynthis* L. on reproductive system and fertility in female Spague-Dawley rats. Pak. J. Biol. Sci., 10: 2699-2703.

Rahuman, A.A., P. Venkatesan and G. Gopalakrishnan, 2008. Mosquito larvacidal activity of oleic and linoleic acids isolated from *Citrullus colocynthis* (Linn.) Schrad. Parasitol. Res., 103: 1383-1390.

Seger, C., S. Sturm, M.E. Mair, E.P. Ellmerer and H. Stuppner, 2005. 1H and 13C NMR signal assignment of cucurbitacin derivatives from *Citrullus colocynthis* (L.) Schrader and *Ecballium elaterium* L. (Cucurbitaceae). Magn. Reson. Chem., 43: 489-491.

Shaltout, K.H. M.G. Shededw, H.F. El-Kady and Y.M. Al-Sodanyz, 2003. Phytosociology and size ssstructure of *Nitraria retusa* along the Egyptian Red Sea coast. J. Arid Environ., 3: 331-345.