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Research and Full Length Article:

Investigation Phenol, Flavonoids and Antioxidant Activity Content of *Capparis spinosa* in Three Natural Habitats of Sistan and Baluchestan Province, Iran

Morteza Saberi[A]*, Nadia Kamali[B], Farajollah Tarnian[C], Ahmad Sadeghipour[D]
[A] Assistant Professor, Department of Range and Watershed Management, Faculty of Water and Soil, University of Zabol, Iran, [*](Corresponding author), Email: mortezasaberi@uoz.ac.ir
[B] Assistant Professor, Rangeland Research Division, Research Institute of Forests and Rangelands, AREEO, Tehran, Iran
[C] Assistant Professor, Department of range and watershed management, Faculty of agriculture and natural resources, Lorestan University, Khorramabad, Iran
[D] Assistant Professor, Desert studies faculty, Semnan University, Semnan, Iran
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Abstract. *Capparis spinosa* L. is a shrub plant that in addition to its forage use, has protective importance to prevent from soil erosion in desert areas and important values in treating many diseases as well. The aim of this study was to investigate the amount of phenol, flavonoids and antioxidant activity in different organs of *C. spinosa* in Sistan, Iranshahr and Saravan counties, Iran. Morphological traits (number of fruits, wet weight of fruit, dry weight of fruit, fruit diameter, number and length of branches, plant height, leaf length, leaf width and root depth) in each habitat were measured from four individuals of *C. spinosa* randomly. In order to perform phytochemical tests, different parts of the plant (stem, leaves, flowers, fruits, and roots) were randomly collected from the habitats in the post-flowering stage in June 2019. The total phenol and flavonoid contents of all methanol extracts were measured using the spectrophotometric method and antioxidant activity was determined using the free radical trap method. Data analysis was performed as factorial experiment based on a completely randomized design in four replications. Rresults indicated significant differences between different plant organs ($P<0.01$) in aspect of the antioxidant activity, the amount of total phenol and flavonoids. Also, there was a significant interaction between plant organs and habitats ($P<0.01$). The results of the means comparison showed that the highest total phenol and total flavonoids were obtained from the methanol extract of the flower 82.8 mg of quercetin equivalent per gram dry weight and 64.3 mg of gallic acid/g of dry weight in Sistan region, respectively, and the highest antioxidant activity was 15.7% in the fruit in Iranshahr region. According to the results, the obtained methanolic extract of *C. spinosa* flower and fruit in Sistan natural habitats is recommended to the treatment of diseases as a potential source of natural antioxidants.

Key words: Medicinal Plant, Methanolic extracts, Morphological traits, Treatment

Introduction

Iran is one of the richest sources of medicinal plants in the world, which has a high diversity of environmental conditions for these plants (Davari *et al.*, 2018). Plants have been important for thousands of years in maintaining the health and quality of human life. Due to their natural origin, herbal medicines are more compatible with the physiology of the body than chemical drugs and their side effects are rare (Rehman *et al.*, 2016). Medicinal plants have beneficial properties including their antibacterial, antiparasitic, antifungal and antioxidant properties (Fazelinasab *et al.*, 2019). In recent years, herbal products (secondary metabolites) have been used to treat most human and animal diseases due to their easy availability, ease of use, and fewer side effects compared to chemical products (Fazelinasab *et al.*, 2017). On the other hand, plant-derived secondary metabolites such as phenol and total flavonoids have a strong potential to scavenge free radicals that are present in all different parts of the plant such as leaves, fruits, seeds, roots and bark. Due to the abundance of natural antioxidants found in medicinal plants, fruits and vegetables, the use of medicinal plants in different communities in the field of treatment and prevention of diseases is common (Rashedi *et al.*, 2015). Meanwhile, plants containing high total phenol and flavonoids play a very important role. Plants that are rich in antioxidant compounds can protect cells from oxidative damage. Natural antioxidants increase the potency of plasma antioxidants and reduce the risk of certain diseases such as cancer, heart disease, and brain stroke (Prior and Cao, 2000). Researchers recommend consuming plants with a high phenolic composition to provide natural antioxidants needed for body (Khazaei *et al.*, 2011). There are more than 80,000 different phenolic compounds that have many roles in cell wall construction and defense mechanism in plants (Khazaee *et al.*, 2011).

Capparis spinosa L. is one of the most valuable plant species in desert areas, which is important in various aspects including medicinal use. This perennial plant is monoicous and belongs to the *Capparaceae* family. *C. spinosa* has numerous branches covered with hairs, and the fruit of this plant is elliptical and fleshy, which is light green at first but gradually turns reddish. It is distributed in the northern, western, central and eastern parts of Iran (Fakhri *et al.*, 2008; Panico *et al.*, 2005). This species grows well in poor nutrient soils with little ecological needs; therefore, it plays an important role in the dynamics of Mediterranean ecosystems (Güleryüz *et al.*, 2009; Sharrif moghaddasi *et. al.*, 2012).

C. spinosa has a special place in traditional medicine because of its compounds such as flavonoids, pectin and glycosides (Calis *et al.*, 1999). In traditional medicine of Sistan region, *C. spinosa* roots and flowers are used to treat diseases related to liver, spleen, anemia and body weakness (Iranmanesh *et al.*, 2010). The anti-diabetic, anti-cancer and antioxidant effects of this plant have been confirmed by researchers (Tlili *et al.*, 2011; Kulisic-Bilusic *et al.*, 2012; Vahid *et al.*, 2017; Mollica *et al.*, 2017; Mollica *et al.*, 2019; Moghadamnia *et al.*, 2019). Various studies have shown the presence of various compounds including glucosinolates, isothiocyanate glucosides, glucosides, phenols, terpenes, saponins, sterols, tannins and sulfides in *C. spinosa* L. (Hamed *et al.*, 2007; Mishra *et al.*, 2007). The results of Najafi and Esmail Zadeh Bahabadi (2016) in the study of phytochemical, antioxidants and optimization of extraction of active ingredients of *C. spinosa* L. fruit in Sistan region showed that 33 compounds were identified in the essential oil of the plant. The main constituents of fruit essential oils include thymol and isothiocyanate. Rashedi

et al. (2015) studied the phytochemical and antioxidant properties of *C. spinosa* L. in Khuzestan province, Iran and stated that the highest amount of free radical trapping activity was observed by the method of 2, 2-diphenyl-1-picryl-hydrazyl (DPPH) in stem extract and the lowest amount was observed in the leaves. The highest antioxidant activity in β-carotene-linoleic acid assay is related to leaf extract and the lowest in fruit. The highest amount of phenol and flavonoids was obtained in leaf extract. In the recent study, Mollica *et al.* (2019) reported rutin was the major component of the extract of *C. spinosa*. They reported that the Soxhlet extract exhibited the strongest radical scavenging and reductive activities as compared to the other extracts, most probably due to the highest concentration of phenolics, especially rutin. Moghadamnia *et al.* (2019) stated the quercetin in *C. spinosa* extract had significant anti-tumor effects and may be regarded as an ideal natural drug for cancer therapy. Morphological and nutritional properties of *C. spinosa* seeds were investigated by El Amri *et al.* (2019) and they reported the amount of seed proteins ranged from 23.32 to 28.5% and the total lipids varied between 2.8 and 3.4%. They also mentioned that *C. spinosa* seeds contained a high level of carotenoids. Chedraoui *et al.* (2017) introduced *C. spinose* as a xerophilous species with multi values that could be considered as a potential interesting crop under the threat of global warming in arid or semi-arid regions (such as Eastern Mediterranean countries). Other studies on some medicinal aspects of *C. spinosa* were conducted by Zhang and Zhang (2018), Moufid *et al.* (2015), Mousavi *et al.* (2016), Rahnavard and Razavi (2017) and Nabavi *et al.* (2016). In addition, the effects of ecological factors on essential oil of medicinal plants were recorded by Bajalan (2016), Khalasi Ahwazi *et al.* (2016) and Karimian *et al.* (2017).

Due to the high importance of *C. spinosa* in traditional medicine in Iran and over the world, the present study was done to investigate the compounds of phenol, flavonoids and antioxidant activity of different organs of this plant to determine the best habitat and plant organs for different uses in Sistan and Baluchestan province, Iran.

Materials and Methods

Sites Information and Sampling Method

Location of the study area was indicated in Fig. 1. and some geographical attributes such as latitude and longitude along with climatic factors of study area were shown in Table 1.

The distribution areas of *C. spinosa* in Sistan (Hirmand district), Iranshahr and Saravan were determined by experts of agricultural research centers and natural resources and field visits. Then, stem, leaf, root, fruit and flower organs were randomly collected from 20 stems from each region after flowering stage in June 2019. Then, after purification, the samples were dried and ground and transferred to the laboratory for phytochemical analysis. In each of the studied habitats, 6 soil samples were taken from a depth of 0-30 cm. Physicochemical properties of soil including soil texture (*Hydrometer* method), organic matter and carbon (Walkley-*Black* method), lime percent (titration method), acidity (pH meter), and electrically conductive (EC meter) (Sparks *et al.*, 2001). The means comparison of soil properties showed a significant difference between the studied habitats in terms of measured parameters except for pH (Table 2). The percentage of sand, pH, organic carbon and organic matter in Sistan habitat is more than the other two habitats. There was no salinity limit in terms of electrical conductivity (EC) except for Iranshahr habitat which has the highest EC between studied habitats.

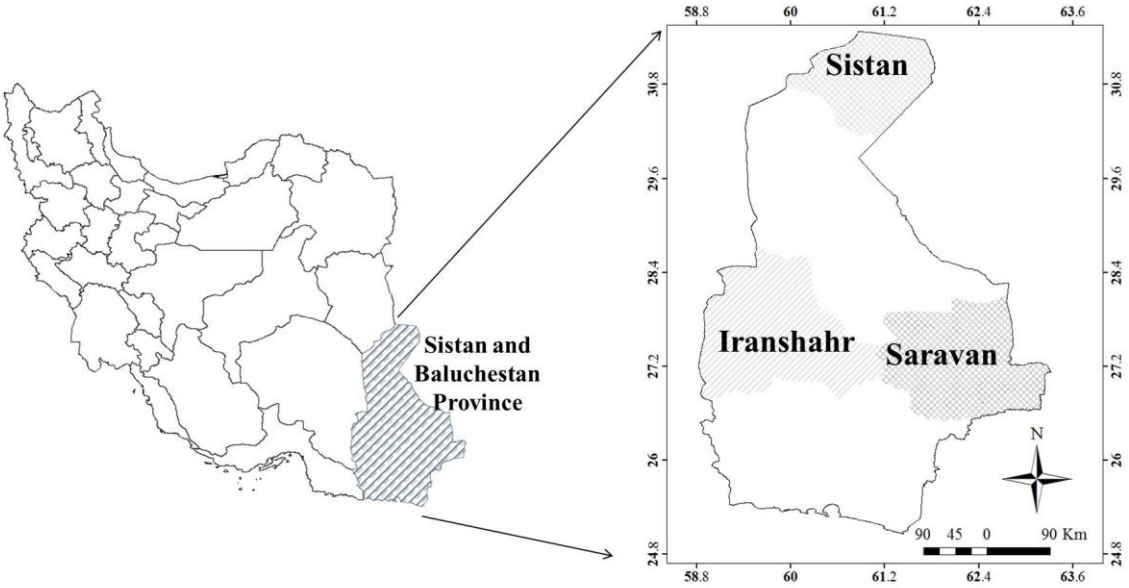

Fig. 1. Location map of the study area

Table 1. Geographical location and climatic attributes of study habitats

Attributes	Habitat		
	Sistan	Iranshahr	Saravan
Longitude	61° 48'	61° 11'	62° 20'
Latitude	31° 08'	28° 40'	27° 22'
Height above mean sea level	486	591	1195
Average annual temperature (°C)	21	25	22
Minimum absolute temperature (°C)	-10	-7.5	-11
Maximum absolute temperature (°C)	48	44	36
Average annual minimum temperature(°C)	24	22	16
Average annual maximum temperature (°C)	30	31	28
Annual rainfall (mm)	67	117	107
Relative humidity (%)	37.5	31	29

Table 2. Comparison means of physicochemical properties of soil in the studied habitats

Properties	Sand (%)	Clay (%)	Silt (%)	EC (dSm^{-1})	pH	Lime (%)	C (%)	OM content (%)
Sistan	86.7 ± 0.8^{a}	3.9 ± 0.8^{b}	8.9 ± 0.8^{b}	0.8 ± 0.8^{b}	7.9 ± 0.08^{a}	8.7 ± 0.8^{b}	0.60 ± 0.08^{a}	0.80 ± 0.08^{a}
Iranshahr	75.7 ± 4.1^{b}	13.2 ± 1.9^{a}	10.4 ± 1.4^{b}	1.2 ± 0.7^{a}	6.8 ± 0.17^{b}	9.1 ± 0.8^{b}	0.38 ± 0.08^{b}	0.62 ± 0.05^{b}
Saravan	68.6 ± 1.7^{c}	11.5 ± 0.8^{a}	19.7 ± 1.5^{a}	0.8 ± 0.6^{b}	7.0 ± 0.12^{b}	11.1 ± 0.9^{a}	0.32 ± 0.06^{b}	0.52 ± 0.07^{b}

Means with the same letter are not significantly different from each other and means with the different letter indicate significant differences.

Data Collection

C. spinosa begins to grow in March with favorable temperature conditions and it blooms in June. Fruiting occurs with flowering from June to August. The fruit ripens in late July and the seeds begin to fall in August and September. The plant blooms again in October, the seeds arrive in November and the seed fall occurs in December. With the onset of the cold season and a decrease in temperature in January, the plant goes into the dormancy process.

Morphological traits of *C. spinosa* in each of the studied habitats of Sistan, Iranshahr and Saravan (Table 1) were measured at seedling stage in 2019. Measured traits include number of fruits per each plant (randomly counting fruit of four individuals of *C. spinosa*), fresh and dry weight of fruit (weighed using digital scales), fruit diameter (caliper device), stem length (length of four stems from each plant measured randomly from the base to tip), number of stems per each plant (branches if 4 individual plant were counted randomly), plant height (from plant base to tip as meter), Leaf length and width (4 plants randomly) and rooting depth (four plants were randomly selected and rooting depth was measured by digging the ground).

Preparation of Methanolic Extract

Soaking method was used to prepare the extract. For this purpose, 50 ml of 80% methanol solvent was mixed with 5 g of dry plant powder and placed in a shaker incubator at 25°C. After 24 hours, the mixture was centrifuged at 3000 rpm and the extract was isolated to measure antioxidant activity, phenol and total flavonoids (Sukhdev *et al.*, 2008). Antioxidant activity was measured by DPPH method (Burtis and Bucar, 2000). DPPH is a stable free radical which possesses a deep purple colour and a strong absorption around 517 nm. The power of loss of electron and proton is measured by the degree of decoloration of the purple solution of DPPH in methanol. The stronger the antioxidant activity, the greater the decoloration rate is. The amount of 0.0047 g DPPH was dissolved in 200 ml of methanol to make a concentration of 6×10^{-5} mmol. Then, four concentrations of 1250, 2500, 5000 and 10000 ppm were prepared by diluting the previous concentrated extract from each plant extract. It should be noted that the initial extract was made with a maximum concentration of 10,000. After preparing the test tubes according to the number of plant samples and the treatments, at first, 1500 µl of DPPH solution was poured into all the tubes and finally, 100 µl of the prepared plant extract with different concentrations was added to the tubes. The samples were stored in the dark for 30 minutes at room temperature and then, their absorbance was read using a spectrophotometer at 570 nm. In addition to the mentioned tubes, a tube was considered for the blank sample. The tube had maximum absorption and only 1500 µl of DPPH and 100 µl of methanol were poured into it. Finally, the trapping rate of DPPH radicals was determined using the following equation:

$$\%I = \frac{\text{Acontrol} - \text{A}sample}{\text{Acontrol}} \times 100 \quad \text{(Equation 1)}$$

Where:

$A_{control}$ and A_{sample} are the absorption in control and sample, respectively.

In order to measure the amount of total phenol, 2000 µl of distilled water, 100 µl of plant extract and 200 µl of folin were added to the samples, and after 3 minutes, 100 µl of 20% sodium carbonate was also added to them. The samples were kept in the dark at room temperature for 60 minutes. Then, the sample absorptions were read by spectrophotometer at a wavelength of 765 nm. In order to prepare the blank sample, all the mentioned compounds without the presence of plant extracts were used in the test tube to calibrate the set. In order to prepare the standard curve, different concentrations of gallic acid were used and the amount of total phenol in the extract was expressed using the standard curve equation in milligrams per gram of tissue dry weight (Singleton *et al.*, 1999). To measure the amount of total flavonoids in the samples, all test tubes were prepared and 0.2 mm of the extract was added to each sample. Then, 0.1 ml of 0.2% aluminum chloride and 0.5 ml of acetic acid were added to each test tube and mixed well, and finally, the solution was

made up to 5 ml with 90% methanol and the tubes were kept at room temperature in the dark for 30 minutes. The absorption rate was read at 414 nm of wavelength and the total flavonoid content was determined in mg/g plant dry weight. In order to prepare the blank sample, all the mentioned compounds without the presence of plant extracts were used in the test tube to calibrate the set. Different concentrations of *quercetin* were used to plot the standard curves. By obtaining the standard curve equation, the concentration of flavonoids in plant samples was calculated in milligrams per gram of plant dry weight (Beketov and Liess, 2005).

Data analysis

Experimental data were analyzed using SPSS version 22 and the mean data were compared using Duncan's multiple range test.

Results

The analysis of variance for morphological traits showed that there were significant differences among the three studied habitats for fruit per each plant, number and length of stem, plant length, leaf width and root depth ($P<0.01$) and fresh and dry weight of fruit and fruit diameter had ($P<0.05$). Leaf length was the only trait that was not significant among the three habitats studied (Table 3).

Means comparison of all morphological traits showed that Sistan habitat had higher values than Iranshahr and Saravan. The highest and lowest rooting depths with average values of 1.52 and 1.22 m were obtained in Sistan and Saravan habitats, respectively (Table 3).

Table 3. Comparison of mean morphological traits of *C. spinosa* in the studied habitats

Habitat	Fruits Number (per stem)	Fruit fresh Weight (gr)	Fruit dry Weight (gr)	Fruit Diameter (mm)	Stem Number (per plant)	Stem Length (cm)	Plant Height (m)	Leaf Length (cm)	Leaf Width (mm)	Root Depth (cm)
Sistan	2.2±0.1^{a}	4.4±0.3a	2.8±0.0a	50±2.3^{a}	167±8.1^{a}	59.2±1.7^{a}	0.9±0.1^{a}	4.0±0.1^{b}	30±3.7^{a}	152±2.1^{a}
Iranshahr	2.0±0.1^{ab}	4.1±0.1a	2.5±0.1b	47±4.6^{a}	153±16.7^{a}	50.7±3.3^{b}	0.7±0.1^{b}	3.1±0.7^{b}	24±4.1^{ab}	138±10.4^{b}
Saravan	1.9±0.1^{b}	4.1±0.0a	2.4±0.0b	40±1.8^{b}	123±9.0^{b}	41.0±3.8^{c}	0.6±0.05^{b}	2.7±0.4^{b}	21±4.0^{b}	122±5.5^{c}
F test	18.5**	5.08*	6.16*	5.8*	33.8**	14.3**	10.6**	2.23^{ns}	10.05**	5.14**

**, *: significant differences between treatments at 1, 5% level; ns: non-significant differences between treatment

Note: Mean±standard division. Means with the same letter are not significantly different from each other and means with the different letter indicate significant differences.

Total phenol

Comparison of the means of total phenol data of methanolic extract of *C. spinosa* in different organs showed that flower had the highest amount of total phenol, and Sistan was the richest habitat in total phenol (82.8 mg quercetin per gram of dry matter). The phenol amount in the leaves and fruit was 52.7 and 31.4 in Sistan habitat, respectively. The lowest phenol was measured in the stem extract at Saravan habitat that was 11.7 mg of quercetin per gram of dry matter. Also, the amount of phenol in different organs of plant *C. spinosa* in Sistan habitat was more than Iranshahr and Saravan (Fig. 2).

Total flavonoids

The comparison of the flavonoid content of the methanolic extract of C. spinos showed a significant difference between the different organs and habitats studied. The highest flavonoids were measured in the flower (64.3 mg gallic acid/ gDM) and leaf organs (45.6 mg gallic acid /gDM) of *C. spinosa* in Sistan habitat, respectively.

Also, the lowest flavonoid content of methanolic extract of this plant was observed in the root in Saravan habitat (2.2 mg of gallic acid/gDM). According to the results, Sistan habitat had the highest amount of

flavonoid compounds compared to Iranshahr and Saravan habitats (Fig. 3).

Antioxidant activity

The results show that the highest antioxidant activity of methanolic extract of the studied species (16.7%) was related to the fruit of this plant in Iranshahr habitat. In all three studied habitats, the antioxidant activity of plant *C. spinosa* was reduced in leaf, flower, stem, and root organs of the extract, respectively, and the lowest percentage (2.6%) was obtained from the methanolic extract of roots of *C. spinosa* in Saravan habitat (Fig. 4).

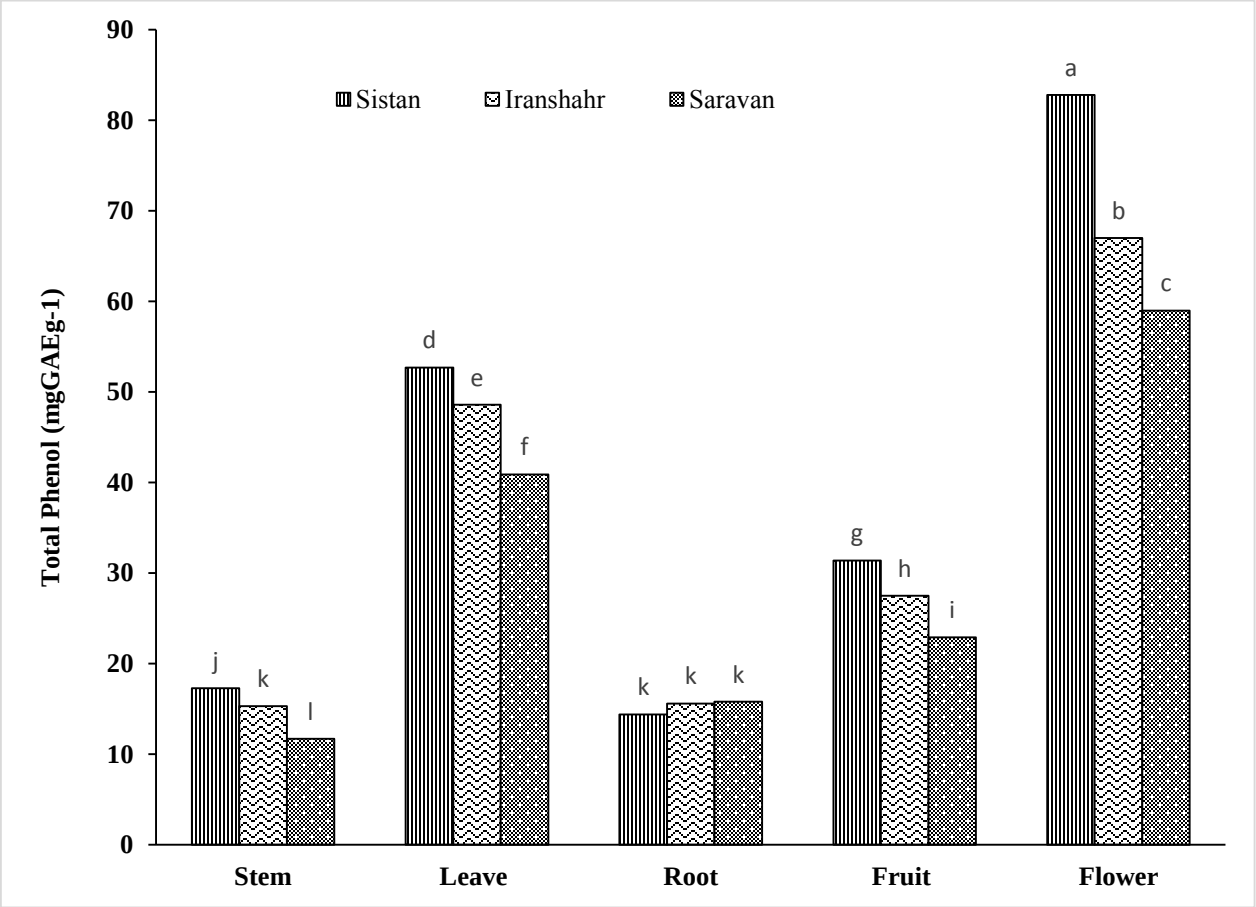

Fig. 2. Interaction of habitat and plant organs on the total phenol content of *C. spinosa* extract in three studied habitats

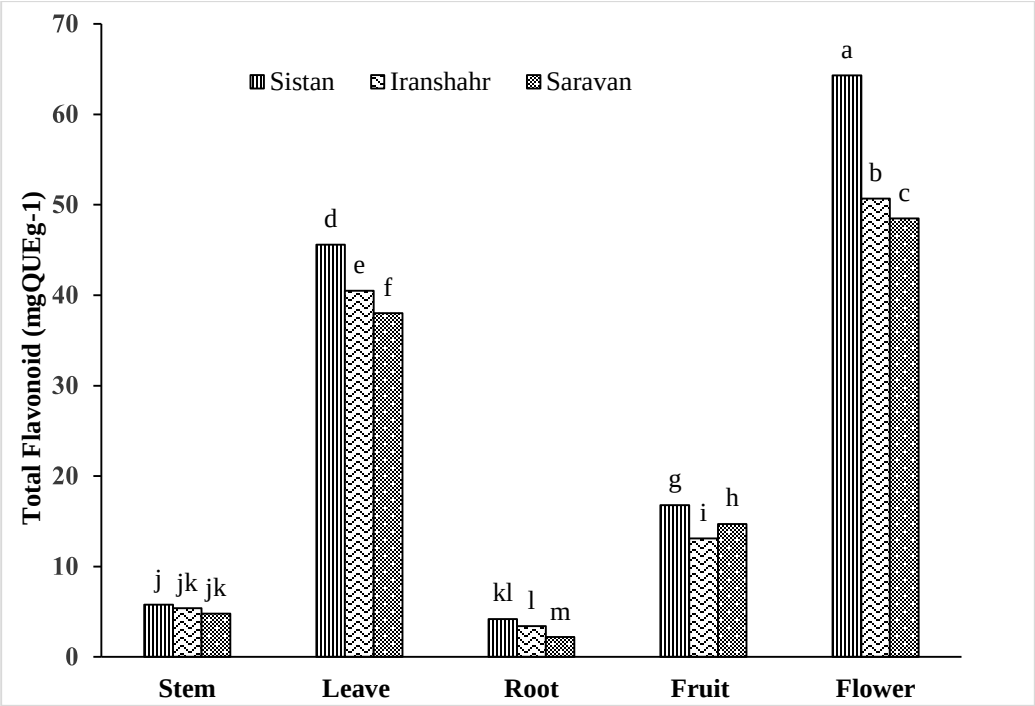

Fig. 3. Interaction of habitat and plant organs on the total flavonoid content of *C. spinosa* extract in three studied habitats

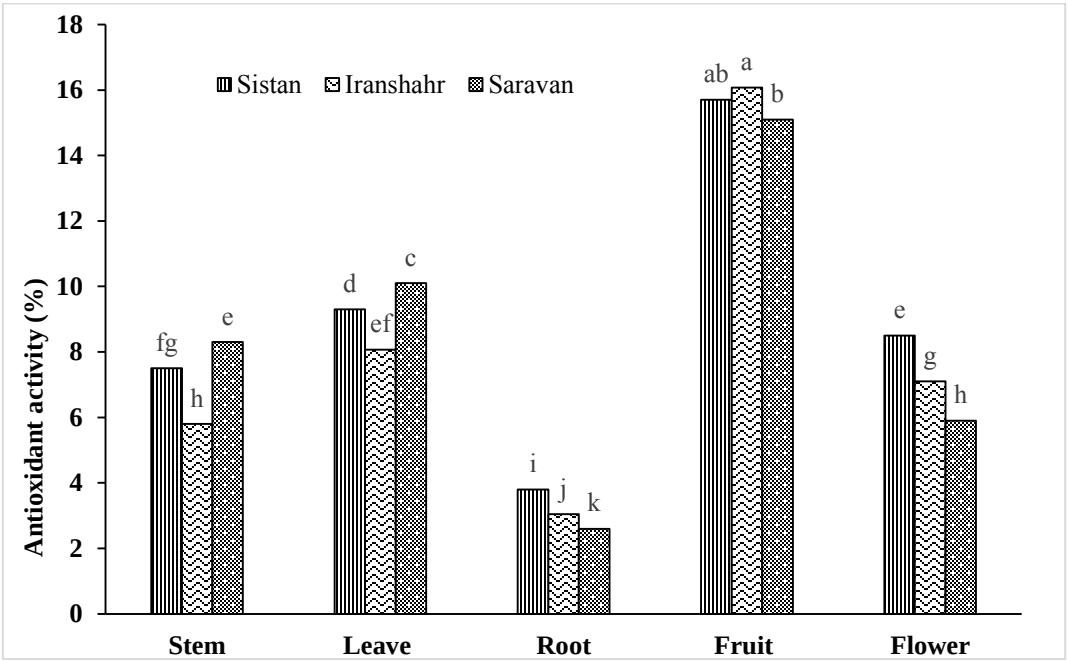

Fig. 4. Interaction of habitat and plant organs on the antioxidant activity of *C. spinosa* extract in three studied habitats

Discussion

The results of morphological characteristics of *C. spinosa* showed that this plant has an extensive root system, so this species is highly adaptable to harsh environmental conditions such as Sistan and Baluchestan province where precipitation and soil moisture reserves are low. Extensive root system retains soil as much as possible and thus provides good resistance to erosion. The results showed that each plant of *C. spinosa* covers a large area of soil so that it provides good protection against water and wind erosion. Field studies on of the vegetation period of the species in Sistan showed that the ecological functions of this plant continue for ten months in a year. In this regard, the coincidence of the growing period of this species with the 120-day winds of Sistan and the peak of wind erosion in the region has doubled its protective and environmental role. In addition to playing an important role in preventing wind erosion, this species is used as a forage and medicinal plant. The results of the present study showed a significant difference among the three habitats so that Sistan habitat had better conditions than two habitats of Iranshahr and Saravan. This can be attributed to environmental conditions, soil characteristics, microclimate, the deep rooting in Sistan habitat and the use of more groundwater moisture, which can be the reason for the better living conditions of this habitat.

In this study, some secondary metabolites were studied in different organs of plant *C. spinosa*. The results showed that the amount of total phenol and flavonoids and the percentage of antioxidant activity were significantly different between different plant organs in Sistan, Iranshahr, and Saravan habitats. A variety of organ-related antioxidant activity has been reported in various studies (Ksouri *et al.*, 2009). A similar result has been reported for the antioxidant activity of various organs of Saffron and Salvia and *Citrullus colocynthis* (Matkowski *et al.*, 2008; Saberi *et al.*, 2018).

The results showed that the highest amount of total phenol in the extracts of the stem, leaf, fruit, and flower organs were 17.7, 52.7, 31.4, and 82.8 mg gallic acid/gDM, respectively in Sistan and the root had 15 mg of gallic acid/gDM in Saravan habitat. Total flavonoids in stem, leaf, root, fruit, and flower organ extracts were obtained as 5.8, 45.6, 4.2, 16.8 , and 64.3 mg of gallic acid/ gDM, respectively in Sistan habitat. The highest percentage of free radical scavenging was obtained in extracts of root and flower organs in Sistan habitat, the fruit of Iranshahr habitat, and leaves and stems in Saravan habitat. The flower organ contains the highest amount of phenols and flavonoids among different organs, but there is the highest percentage of free radical scavening in the fruit extract of *C. spinosa.*

In the present study, the highest amount of total phenol and flavonoids was obtained from the methanolic extract of flower organ in Sistan habitat. Environmental conditions such as light, altitude, relative humidity, physical and chemical properties of soil, temperature, etc. are the most important factors affecting vegetative growth and the amount of secondary metabolites of medicinal plant (Jovancevic *et al.*, 2011; Khalasi Ahwazi *et al.*, 2016). It seems that elevation from sea level has high effects on secondary metabolites of phenol and phelavenoid in Sistan habitat because the elevation of Sistan habitat (458 m above sea level) is lower than Iranshahr with 591 m and Saravan with 1195 m. The study of relative humidity in the three studied habitats also showed that the relative humidity (37.5 %) in Sistan was higher than Iranshahr (31%) and Saravan (29 %) (Table 1), which could be another reason for increasing the amount of total phenol and flavonoids in the plant organs in this habitat. This is consistent with the results of Laurel *et al.* (1999). The importance of the effect of different

environmental conditions in different habitats on the quality and quantity of secondary metabolites of plants has already been reported (Gairola *et al.*, 2010; Jovancevic *et al.*, 2011; Rezzan *et al.*, 2013; Khalasi Ahwazi *et al.*, 2016).

Many studies have reported different distributions of secondary metabolites depending on the organ (Lisiewska *et al.*, 2006; Trabelsi *et al.*, 2012; Khalasi Ahwazi *et al.*, 2016). Also, based on Carbon *et al.* (2011), the content of polyphenols depends on various factors in plants, and depending on the species function, variety, organ, and physiological stage could be different. In the study of Rashedi *et al.* (2015) on *C. spinosa* in Khuzestan province, Iran, the highest amount of activity to free radical scavenging was observed in stem extract and the lowest was observed in the leaves extract in 2, 2-diphenyl-1-picrylhydrazyl method. The highest antioxidant activity was related to leaf extract and the lowest was observed in fruit in beta-carotene-linoleic acid method. The highest amount of phenol and flavonoids was obtained in leaf extract, which differs from the present study results. Also, in a study on the antioxidant activity of different organs of *C. spinosa*, it was observed that the amount of activity antioxidants in flower, leaf, seed and fruit were 82.78, 80.94, 64.02 and 40.62% respectively (Baghiani *et al.*, 2012). Also in the study of Zia-Ul *et al.* (2011) on *Capparis decidua*, the highest percentage of antioxidant activity of this plant was in its leaf extract, which is not consistent with our results. This may be due to genotypic and environmental differences, which could affect the effective matter of plant (Shan *et al.*, 2005; Abderrahmane *et al.*, 2011; Rezzan *et al.*, 2013; Khalasi Ahwazi *et al.*, 2016). In general, review of different researches shows that secondary metabolites are different in different plant organs. Chang *et al.* (2002) reported these differences in antioxidants activity diversity in various plant organs. Researchers believe that plant organs with high phenolic content and good antioxidant properties can be used for nutritional, medicinally and in food storage purposes (Rashedi *et al.*, 2015), that according to the results of the present study, it seems that *C. spinosa* has such a capability.

Conclusion

In general, according to the results of the present study, it seems that the *C. spinosa* had good potential in medicine as a potential source of natural antioxidants in the treatment of diseases. In this regard, among the various organs of this plant, flowers, and fruits, and in terms of habitat, Sistan had better conditions. Due to some attributes of *C. spinosa* such as long growing period, low expectations in terms of cultivation, and resistant to adverse environmental conditions, it can be used as a protective plant for natural areas and for medicinal and food consumptions and on the other hand, on the agenda of managers. The long growth period and the coincidence of this period with 120-day winds in Sistan could be very important. Therefore, the cultivation of *C. spinosa* is recommended as a multi-purpose plant in the natural areas of Sistan and areas with similar environmental conditions.

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References

Abderrahmane, S., Daoud, H. and Hani, B., 2011. Radical, metal-chelating and antibacterial activities of methonolic extract of *Capparis spinosa* buds. Advances in Environmental Biology, 5(2): 287-1.

Baghiani, A., Ameni, D., Boumerfeg, S., Adjadj, M., Djarmouni, M., Charef, N., Khennouf, S. and Arrar, L., 2012. Studies of antioxidants and xanthine oxidase inhibitory potentials of root and aerial parts of medicinal plant *Capparis spinosa* L. American Journal of Medicine and Medical Sciences, 2(1): 25-32

Bajalan, I., 2016. Investigation of Environmental Factors Regarding the Essential Oil and Antibacterial Activity of Lavandin (Case Study: Jowkar, Khoramabad, Alashtar and Aligoodarz from Iran). Rangeland Science Journal, 6(4): 344-354.

Beketov, M. A. and Liess, M., 2005. Acute contamination with esfenvalerate and food limitation: chronic effects on the mayfly, Cloeon dipterum. Environmental Toxicology and Chemistry, 24: 1281- 1286.

Burtis, M. and Bucar, F., 2000. Antioxidant activity of *Nigella sativa* essential oil. Phytotherapy Research, 14: 323-328.

Calis, I., Kuruzum, A. and Ruedi, P. D., 1999. 1H-Indole-3-acetonitrile glycosides from *Capparis spinosa* fruits. Phytochemistry, 50: 1205–1208.

Carbone, K., Giannini, B., Picchi, V., Lo Scalzo, R. and Cecchini, F., 2011. Phenolic composition and free radical scavenging activity of different apple varieties in relation to the cultivar, tissue type and storage. Food Chemistry, 127: 493– 500.

Chang, C., Yang, M., Wen, H. and Chern, J., 2002. Estimation of total flavonoid content in Propolis by two complementary calorimetric methods. Journal of Food and Drug Analysis, 10: 178-18.

Chedraoui, S., Abi-Rizk, A., El-Beyrouthy, M., Chalak, L., Ouaini, N. and Rajjou, L., 2017. *Capparis spinose* L. in A Systematic Review: A Xerophilous Species of Multi Values and Promising Potentialities for Agrosystems under the Threat of Global Warming. Frontier in Plant Science, 8: 1845.

Davari, A., Solouki, M. and Fazelinasab, B. 2018. Effects of jasmonic acid and titanium dioxide nanoparticles on process of changes of phytochemical and antioxidant in genotypes of *Satureja hortensis* L. Eco-Phytochemical Journal of Medical Plants, 5: 1-20. (In Persian).

El Amri, N., Errachidi, F., Bour, A., Bouhaddaoui, S. and Chabir, R., 2019. Morphological and Nutritional Properties of Moroccan *Capparis spinosa* Seeds. Hindawi, the Scientific World Journal, Article ID 8594820: 1-8.

Fakhri, M., Bakhshi Khaniki, Gh. and Sadeghi, M., 2008. A Survey on ecological character of *Capparis spinosa* L. Bushehr Province. Pajouhesh & sazandegi, 80: 169-175. (In Persian).

Fazelinasab, B., Moshtaghi, A. and Forouzandeh, M., 2019. Effect of Solvent Extraction on Phenol, Flavonoids and Antioxidant Activity of some Iranian Native Herbs. Scientific Journal of Ilam University of Medical Sciences, 27(3): 14-26. (In Persian).

Fazelinasab, B., Rahnama, M. and Mazarei, A., 2017. Correlation between Antioxidant Activity and Antibacterial Activity of Nine Medicinal Plant Extracts. Journal of Mazandaran University of Medical Sciences, 27: 63-78. (In Persian).

Gairola, S., Shariff, N. M., Bhatt, A. and Kala, C. P., 2010. Influence of climate change on production of secondary chemicals in high altitude medicinal plants: Issues needs immediate attention. Journal of Medicinal Plants Research, 4(18): 1825 - 9.

Güleryüz, M., Özkan, G. and Ercisli, S., 2009. Caper (*Capparis* spp.) growing techniques and economical importance, Ataturk University Agricultural Faculty Department of Horticulture Erzurum-Turkey, International Symposium on Sustainable Development, Available at: http:// eprints.ibu.edu.ba/484/.

Hamed, A. R., Abdel-Shafeek, K. A., Abdel-Azim, N. S., Ismail, S. I. and Hammouda, F. M., 2007. Chemical investigation of some *capparis* species growing in Egypt and their antioxidant activity. Evidence-Based Complementary and Alternative Medicine, 4: 25–28.

Iranmanesh, M., Najafi, Sh. and Yousefi, M., 2010. Ethnobotany study of medicinal plants in Sistan region. Journal of Herbal Drugs, 2: 61-68.

Jovancevic, M., Balijagic, J., Menkovic, N., Savikin, K., Zdunic, G., Jankovic, T. and Dekic-Ivankovic, M., 2011. Analysis of Phenolic compounds in wild populations of bilberry (*Vaccinium myrtillus*) from Montenegro. Journal of Medicinal Plants Research, 5(6): 910 -4.

Karimian, V., Vahabi, M. R., Roustakhiz, J. and Nodehi, N., 2017. Identification of some ecological factors affecting essential oil of *Verbascum songaricum* schrenk shoots (Case Study: Rangelands of Isfahan and Kohgiluyeh and Buyerahmad Provinces, Iran). Rangeland Science Journal, 7(2): 183-194.

Khalasi Ahwazi, L., Heshmati, G. H., Zofan, P., Akbarlou, M., 2016. Total phenol, flavonoid contents and antioxidant activity of *Gundelia tournefortii* L. in different phenological stages and habitats of north east of Khuzestan province. Eco-phytochemical Journal of Medicinal Plants, 4 (1): 33-46. (In Persian).

Khazaee, F. A., Etebarian, H. R., Roustaee, A. and Alizadeh, A., 2011. Study of changes in peroxidase enzyme and total phenol in golden delicious apple fruits inoculated with an antagonistic isolate of *Pseudomonas fluorescens* and *Penicillium expansum* the causal agent of apple blue mould. Seed and Plant Production Journal, 26: 419-433. (In Persian).

Ksouri, R., Falleh, H., Megdiche, W., Trabelsi, N., Hamdi, B., Chaieb, K., Bakhrouf, A., Magné, C. and Abdelly, C., 2009. Antioxidant and antimicrobial activities of the edible medicinal halophyte *Tamarix gallica* L. and related polyphenolic constituents. Food and Chemical Toxicology, 47: 2083–2091.

Kulisic-Bilusic, T., Schmoller, I., Siracusa, L. and Ruberto, G., 2012. The anticarcinogenic potential of essential oil and aqueous infusion from caper (*Capparis spinosa* L.). Food Chemistry, 132(1): 261–267.

Laurel, F. R., Servio, R. P., Valerie, B. K., 1999. Direct and indirect effects of climate change on St. John's wort, *Hypericum perforatum* L. (*Hypericaceae*). Oecologia, 120: 113-122.

Lisiewska, Z., Kmiecik, W. and Korus, A., 2006. Content of vitamin C, carotenoids, chlorophylls and polyphenols in green parts of dill (*Anethum graveolens* L.) depending on plant height. Journal of Food Composition and Analysis, 19: 134–140.

Matkowski, A., Zielińska, S., Oszmiański, J. and Lamer-Zarawska, E., 2008. Antioxidant activity of extracts from leaves and roots of *Salvia miltiorrhiza* Bunge, *S. przewalskii* Maxim., and *S. verticillata* L. Bioresouce Technology, 99: 7892–7896

Mishra, S. N., Toma, P. C. and Lakra, N., 2007. Medicinal and food value of *Capparis.* Indian Journal of Traditional Knowledge, 6(1): 230-238.

Moghadamnia, Y., Mousavi Kani, S. N., Ghasemi-Kasman, M., Kazemi Kani, M. T. and Kazemi, S., 2019. The Anticancer Effects of *Capparis spinosa* Hydroalcoholic Extract. Avicenna Journal of Medical Biotechnology, 11(1): 43-47.

Mollica, A., Stefanucci, A., Macedonio, G., Locatelli, M., Luisi, G., Novellino and E., Zengin, G., 2019. Chemical composition and biological activity of *Capparis spinosa* L. from Lipari Island. South African Journal of Botany, 120: 135–140. https://doi.org/10.1016/j.sajb.2018.02.397

Mollica, A., Zengin, G., Locatelli, M., Stefanucci, A., Mocan, A., Macedonio, G., Carradori, S., Onaolapo, O., Onaolapo, A. and Adegoke, J., 2017. Anti-diabetic and anti-hyperlipidemic properties of *Capparis spinosa* L.: in vivo and in vitro evaluation of its nutraceutical potential. Journal of Functional Foods, 35: 32–42.

Moufid, A., Farid, O. and Eddouks, M., 2015. Pharmacological Properties of *Capparis Spinosa* Linn. International Journal of Diabetology & Vascular Disease Research, 3(5): 99-104. doi: http://dx.doi.org/10.19070/2328-353X-1500020.

Mousavi, S. H., Hosseini, A., Bakhtiari, E., Rakhshandeh, H., 2016. *Capparis spinosa* reduces Doxorubicin-induced cardio-toxicity in Cardiomyoblast cells. Avicenna Journal of Phytomedicine, 6(5): 489-494.

Nabavi, S. F., Maggi, F., Daglia, M., Habtemariam, S., Rastrelli, L. and Nabavi, S. M., 2016. Pharmacological Effects of *Capparis spinosa* L. Phytotherapy Research, 30(11):1733-1744. doi: 10.1002/ptr.5684.

Najafi, Sh. and Esmail Zadeh Bahabadi, S., 2016. Essential oil composition and antioxidant optimization of *Capparis spinosa* L. fruit in Sistan region. Eco-Phytochemical Journal of Medicinal Plant. 4(15): 35-45. (In Persian).

Panico, A. M., Cardile, V., Garufi, F., Puglia, C., Bonina, F. and Ronsisvalle, G., 2005. Protective effect of *Capparis spinosa* on chondrocytes. Life Science, 77: 2479–2488.

Prior, R. L. and Cao, G., 2000. Antioxidant phytochemicals in fruits and vegetable diet and health implications. Horticultural Science, 35: 582-88.

Rahnavard, R. and Razavi, N., 2017. A review on the medical effects of *Capparis spinosa* L. Advanced Herbal Medicine, 2(1): 44-53.

Rashedi, H., Amiri, H. and Gharezi, A., 2015. Assessment of phytochemical and antioxidant properties of the *Capparis spinosa* L. in Khuzestan province. Journal of Inflammatory Diseases, 18(6): 11-1. (In Persian).

Rehman, S. U., Choe, K. and Yoo, H. H. 2016. Review on a traditional herbal medicine, *Eurycoma longifolia* Jack (Tongkat Ali): Its Traditional uses chemistry, evidence - based pharmacology and toxicology. Molecules, 21(331): 1-31.

Rezzan, A., Ozan, E. and Huseyin, S., 2013. Phenolic components, antioxidant activity, and mineral analysis of *Capparis spinosa* L. African Journal of Biotechnology, 12(47): 6643-9

Saberi, M., Niknahad-Gharmakher, H., Heshmati, H., Barani, B. and Shahriari, A., 2018. Evaluation of the Content Changes of Some Active Ingredients Extracts of *Citrullus colocynthis* Organs from Two Habitats of Sistan and Baluchestan Province. Journal of Plant Ecosystem Conservation, 5(10): 49-64. (In Persian).

Shan, B., Cai, Y Z., Sun, M. and Corke, H., 2005. Antioxidant capacity of 26 spice extracts and characterization of their phenolic constituents.

Journal of Agricultural and Food Chemistry, 53: 7749-7759.

Sharrif moghaddasi, M., Haddad Kashani, H. and Azarbad, Z., 2012. *Capparis spinosa* L. Propagation and Medicinal uses. Life Science Journal, 9(4): 684-686.

Singleton, V. L., Orthofer, R. and Lamuela-Raventos, R. M., 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. Methods in Enzymology, 299: 152-178.

Sparks, D. L., Page, A. L., Helmke, P. A., Loeppert, R. H., Soltanpour, P. N., Tabatabai, M. A., Johnston, C. T., Sumner, M. E., 2001. Methods of Soil Analysis: Part 3 Chemical Methods, 5.3. The Soil Science Society of America, Inc., American Society of Agronomy, 677 South Segoe Road, Madison, Wisconsin 53711 USA. 1309p.

Sukhdev, S., Handa, S., Singh, P., Gennaro, Kh., Dev, L. and Dutt, R., 2008. Extraction technologies for medicinal and aromatic plants, International center for science and high technology, 260p.

Tlili, N., Elfalleh, W., Saadaoui, E., Khaldi, A., Trike, S. and Nasri, N., 2011. The Caper (*Capparis* L.): Ethnopharmacology, phytochemical and pharmacological properties. Fitoterapia, 82(2): 93-101.

Trabelsi, N., Falleh H., Jallali I., Daly A., Hajlaoui H., Smaoui A, Abdelly C., Ksouri R., 2012. Variation of phenolic composition and biological activities in *Limoniastrum monopetalum* L organs. Acta Physiologiae Plantarum, 34: 87-96.

Vahid, H., Rakhshandeh, H. and Ghorbani, A., 2017. Antidiabetic properties of *Capparis spinosa* L. and its components. Biomedicine & Pharmacotherapy, 92: 293–302.

Zhang, H. and Zheng, F. M., 2018. Phytochemical and Pharmacological Properties of *Capparis spinosa* as a Medicinal Plant. Nutrients, 10(116): 1-14. Doi: 10.3390/nu10020116.

Zia-Ul-Haq, M., Cavar, S. and Qayum, M., 2011. Compositional studies: antioxidant and antidiabetic activities of *Capparis decidua* (Forsk.) Edgew. International Journal of Molecular Science, 12(12): 8846-61.

بررسی میزان ترکیبات فنل، فلاونوئید و فعالیت آنتی اکسیدانی لگجی (*Capparis spinosa* L.) در سه رویشگاه طبیعی استان سیستان و بلوچستان

مرتضی صابری[الف*]، نادیا کمالی[ب] و فرج الله ترنیان[ج]، احمد صادقی پور[د]
[الف] استادیار گروه مرتع و آبخیزداری، دانشکده آب و خاک دانشگاه زابل *(نگارنده مسئول)، پست الکترونیک: Mortezasaberi@uoz.ac.ir
[ب] استادیار پژوهشی بخش مرتع، موسسه تحقیقات جنگل ها و مراتع ایران، تهران
[ج] استادیار گروه مرتع و آبخیزداری، دانشکده کشاورزی و منابع طبیعی، دانشگاه لرستان، خرم آباد
[د] استادیار، دانشکده کویرشناسی، دانشگاه سمنان

چکیده. لگجی (*Capparis spinosa* L.) گیاهی بوته‌ای است که علاوه بر استفاده علوفه‌ای از اهمیت حفاظتی جهت جلوگیری از فرسایش خاک در مناطق بیابانی برخوردار می‌باشد. این گیاه، با ارزش دارویی در طب سنتی استان سیستان و بلوچستان برای درمان بسیاری از بیماری‌ها مورد استفاده قرار می‌گیرد. هدف از این پژوهش بررسی میزان برخی مواد موثره در اندام‌های مختلف گیاه *C. spinosa* در رویشگاه‌های طبیعی این گونه در سیستان، ایرانشهر و سراوان می‌باشد. صفات مورفولوژیک (تعداد میوه، وزن تر میوه، وزن خشک میوه، قطر میوه، تعداد و طول جست، ارتفاع گیاه، طول برگ، عرض برگ و عمق ریشه‌دوانی) در هر رویشگاه بصورت تصادفی از ۴ پایه گیاهی اندازه‌گیری شد. به منظور انجام آزمایشات بخش‌های مختلف گیاه (ساقه، برگ، ریشه، میوه و گل) در مرحله بعد از گلدهی در خرداد ماه سال ۱۳۹۸ از رویشگاه‌های مورد مطالعه به صورت تصادفی جمع‌آوری شد و محتوای فنل، فلاونوئید کل و عملکرد آنتی اکسیدانی گیاه مطالعه گردید. محتوای فنل و فلاونوئید کل عصاره های متانولی با استفاده از روش اسپکتروفتومتری و فعالیت آنتی‌اکسیدانی با روش به دام‌اندازی رادیکال آزاد اندازه‌گیری گردید. این آزمایش بصورت فاکتوریل در قالب طرح پایه کاملا تصادفی در چهار تکرار اجرا گردید. با توجه به نتایج تجزیه واریـانس بین اندام‌های مختلف گیاه در رویشگاه‌های مورد مطالعه تفاوت معنی‌دار در سطح احتمال ۱ درصد از نظر فعالیت آنتی اکسیدانی، میزان فنل و فلاونوئید کل وجود داشت. اثر متقابل اندام های گیاهی و رویشگاه‌های مختلف نیز معنی‌دار بود. نتایج مقایسه میانگین‌ها نشان داد بیشترین میزان فنل کل و فلاونوئید کل از عصاره متانولی گل به ترتیب ۸۲/۸ میلی‌گرم کوئرستین بر گرم ماده خشک و ۶۴/۳ میلی گرم گالیک اسید در گرم ماده خشک در رویشگاه سیستان و بیشترین فعالیت آنتی اکسیدانی در میوه ۱۶/۰۷ درصد و در رویشگاه ایرانشهر به‌دست آمد. بر اساس نتایج به‌دست آمده عصاره متانولی گل و میوه گیاه *C. spinosa* به دست آمده از رویشگاه‌های طبیعی این گیاه در سیستان به‌عنوان یک منبع بالقوه از آنتی اکسـیدان‌های طبیعی در درمان بیماری‌ها پیشنهاد می‌شود.

کلمات کلیدی: گیاه دارویی، عصاره متانولی، صفات مرفولوژیکی، تیمار