Pak. J. Agri. Sci., Vol. 52(3), 747-754; 2015
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
http://www.pakjas.com.pk

SEASONAL VARIATION IN PROXIMATE COMPOSITION AND MINERALS PROFILE OF DIFFERENT PARTS OF WILDLY GROWN *Capparis spinosa*

Tehseen Gull[1], Bushra Sultana[1,*], Ijaz Ahmad Bhatti[1] and Amer Jamil[2]

[1]Department of Chemistry, University of Agriculture Faisalabad-38040, Pakistan
[2]Department of Biochemistry, University of Agriculture Faisalabad-38040, Pakistan
[*]Corresponding author's e-mail: bushrasultana2005@yahoo.com

The present work reports the seasonal variation in the proximate analysis and minerals composition of different parts of *Capparis spinosa* harvested in two different seasons (April and September) from the Cholistan desert of Pakistan. Maximum crude protein, true protein and non-nitrogenous protein were found in fruits of *C. spinosa* in September followed by April. Conversely, the least neutral detergent fiber and acid detergent fiber were also found in fruits in both the seasons. Moreover, the flowers exhibited maximum ash contents in the present investigation. The fruits were also found to be rich in Ca, K, Na, Zn, Cu, Mn and Fe contents. The fruits and flowers were statistically at par or following each other in case of minerals composition. Non considerable contents of heavy metals (Ni, Cd and Co) were found in any part of *C. spinosa*. The results of this investigation support the selection and harvesting of this species at an appropriate season to avail maximum nutritional benefits beneficial for both human beings and livestock.
Keywords: Capparaceae, plant organs, minerals composition, heavy metals, proximate analysis

INTRODUCTION

Caper (*Capparis spinosa*) is an aromatic and medicinal shrub belonging to family Capparaceae (Capparidaceae) which consists of 39 genera and 650 species, wildly present in warm and dry tropical regions of the world. By origin, these species are native to Mediterranean Sea region but can also be found in other parts of the world including the deserts and dry regions of Afghanistan, India, Indonesia, Nepal, Pakistan, North Africa, South West Asia, Australia and South Europe up to an elevation of 1100 m (Hansen, 1991; Jiang *et al.,* 2007).
Caper plant has been used in folk medicine from ancient times due to their strong antioxidant properties, and high phenolics and flavonoid contents (Yadav *et al.,* 1997; Zuo *et al.,* 2002; Duman *et al.,* 2013; Zuo, 2014). It has been used to cure diseases such as gastrointestinal infection, diarrhea and rheumatism. Besides its medicinal attributes, caper plant also has a lot of nutritional importance. Young shoots, flower buds and fruits are used as human diet. Moreover, flower buds are also preserved in brine to make pickle, in pasta, pizza, salad and meat dishes (Ogut and Er, 2010).
The caper plants are well known for its nutritional quality being rich in minerals. The minerals play different roles than other vital nutrients like proteins, fats, carbohydrates and vitamins. The main function of the minerals are to combine with protein for bone formation and strengthening, smooth circulation of blood and oxygen, enzymes activation and physiological functions in both livestock and human bodies. Some minerals are helpful for the transmutation of nerve impulse while a few are important for enzymes and carry oxygen (Soetan *et al.,* 2010). Beside mineral composition, the caper plants have also been reported as livestock fodder due to its promising proximate values (Ozcan, 2005). The caper plants are rich in crude protein and crude fat contents with lower values of neutral detergent and acid detergent fiber (Haciseferogullari *et al.,* 2011).The variation in mineral and other nutrients might be attributed to diversity in soil, climate and seasons.
In Pakistan, *C. spinosa* and *C. decidua* give fruits twice in a year i.e., in April and September. In both of these seasons the humidity varies because April is a bit dry season with less rainfall while September receives more rainfall. The researchers have reported that the mineral composition in plants vary according to temperature and rainfall (Nouman *et al.,* 2013). Jumba *et al.* (1996) and Minson (1990) reported lower phosphorous contents in the summer with higher light intensity and temperature with low rainfall while in rainy season with high temperature, the plants were found rich in minerals including calcium and potassium. Likewise, Ramirez *et al.* (2001) and Cerrillo-Soto *et al.* (2004) reported that plant species exhibited higher mineral contents in hot and wet seasons rather than spring and dry ones.
Although *C. spinosa* is considered as a food and medicinal plant due to its nutrients however previously no data regarding to minerals and proximate composition of *C. spinosa* indigenous to Pakistan in relation to different seasons is lacking therefore, present study was conducted to evaluate and compare the mineral profile and proximate analysis of different parts of *C. spinosa* grown in Cholistan Desert of Pakistan collected in two different seasons.

MATERIALS AND METHODS

Sample collection**:** Five different plants of *C. spinosa* were selected and tagged in Cholistan desert of Punjab, Pakistan. The samples of stem bark, shoot, flower, root and fruit of each of the plants were collected in two seasons i.e., April and September, 2012. The samples were further identified and authenticated by Dr. Mansoor Hameed, Taxonomist, Department of Botany, University of Agriculture, Faisalabad, Pakistan. The average temperature and humidity were recorded in both sampling seasons. Average temperature, dew point and relative humidity recorded in April and September were 27°C, 16°C, 47% and 35°C, 22°C, 78%, respectively.

Pretreatment of sample**:** The collected samples were washed with distilled water and dried at room temperature under shade until complete dryness achieved. The samples were grinded to fine powder of 80 mesh size and saved in air tight bags for further analyses.

Proximate analysis**:** The proximate analysis of collected parts of *C. spinosa* was carried out in the laboratory of Institute of Animal Nutrition, University of Agriculture, Faisalabad. The methods of the Association of Official Analytical Chemists (AOAC, 1990) were used to determine dry matter (DM), moisture, crude protein (CP), true protein (TP), non-nitrogenous protein (NPN), crude fat, crude fiber, neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents. All the proximate values were expressed in percentage (%).

Each of *C. spinosa* samples (5 g) was used in triplicate for determination of moisture content by weighing in crucible and drying in oven at 105°C, until a constant weight obtained. Ash contents were determined by burning the samples at 550°C for 3 h (AOAC, 1990). CP and TP contents were found by nitrogen digestion, distillation and quantification through micro Kjeldhal method (AOAC, 1990). CF was estimated by digesting the samples with 1.25% (w/v) H_2SO_4 and 1.25% (w/v) NaOH solution (AOAC, 2000a). Crude fat was determined by soxhlet extraction method (AOAC, 1990). ADF and NDF contents were also determined by following the devised protocols of (AOAC, 2000b and Van Soest *et al.,* 1991). NPN was calculated by subtracting TP from CP contents. Digestible dry matter (DDM) was calculated by following formula:

Sample digestion and minerals quantification**:** The samples were digested by dissolving 1 g of sample in concentrated nitric acid and perchloric acid (2:1 v/v) at 250°C. The digested samples (1-2 mL) were then diluted with distilled water to make 100 mL volume and preserved for minerals estimation (AOAC, 1990). The flame photometer (Jenway PEP-7) was used to analyze K and Na contents in the prepared samples by using the respective filters (Chapman and Pratt, 1961). The other minerals and heavy metals i.e., Ca, Zn, Mn, Cu, Fe, Cd, Co and Ni were estimated by using an Atomic Absorption Spectrophotometer (Model: Z-8200).

Statistical analysis**:** Completely Randomized Design (CRD) with two factor factorial was used in the present investigation. The data was computed and analyzed by using MSTAT-C Program software (MSTAT, 1989). LSD test at 5% level of probability was used to determine the differences among mean values (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Proximate analysis**:** Results for proximate analysis are given in Tables 1-4. The moisture contents of different parts of *C. spinosa* harvested in both seasons ranged between 10.84-84.67% showing significant difference ($p<0.05$). Maximum moisture contents were recorded in fruits (84.67%) in September followed by flowers, shoots, roots and stem bark (69.84, 35.16, 25.98, 16.77, respectively) of the same season. Similar trend was also found in April samples however, contents were lower than earlier season. The moisture contents of fruit of *C. spinosa* were higher than *C. decidua* as reported in previous studies (Amna *et al.,* 2013).

The tested samples contained higher dry matter (DM) in stem bark (89.16%) harvested in April followed by root, shoot, flower and fruit. The same sequence was also observed in all parts of the tested specie in September. The least dry matter was recorded in fruits in both seasons i.e., April and September (17.39 and 15.33%, respectively). It was observed that maximum DDM was found in fruits and flowers in September (77.73 and 76.44%, respectively) followed by the same parts in April (73.32 and 70.20%, respectively) while least DDM was recorded in stem bark (41.12, 35.41%) of both months.

The protein contents were statistically different ($p<0.05$) in all parts of *C. spinosa* harvested in both seasons. Maximum crude protein (CP), true protein (TP) and non-nitrogenous protein (NPN) were found in fruits in the month of September (44.70, 18.13 and 26.73%, respectively). However, level of CP, TP and NPN contents decrease in following order, fruit > flower > root > shoot> stem bark. Similar trend was also found in all parts of *C. spinosa* collected in April but the values were less than September samples. Minimum CP, TP and NPN were present in stem bark (12.28, 7.64 and 4.65%, respectively) in April. Caper fruits exhibited a good amount of protein contents in both seasons which greater than *C. decidua* as reported in previous studies (Amna *et al.,*2013). Higher CP contents value also reported in caper ripened fruits (Ozcan *et al.,* 2008). Due to its higher CP contents, the fruits (caper berries) are used as pickle in Afghanistan, Pakistan and North Western India (Ozcan, 2005). Moreover, the caper plants are also palatable for livestock being rich in protein

Table 1. Seasonal variation in moisture, dry matter and digestible dry matter contents (%) among different parts of *C. spinosa*.

Plant Parts	Moisture			Dry Matter			Digestible Dry Matter		
	April	September	Mean	April	September	Mean	April	September	Mean
Stem Bark	10.84±1.18 f	16.77±0.79 f	15.51±1.11 D	89.16±1.17 a	83.23±0.79 b	86.19±1.11 A	35.41±1.68 h	41.12±2.77 g	38.26±2.09 D
Fruit	82.41±0.55 b	84.67±1.71 a	80.39±1.41 A	17.39±0.55 h	15.33±1.71 h	16.46±0.58 E	73.32±1.99 ab	77.73±2.83 a	75.53±0.89 A
Shoot	30.23±0.75 fg	35.16±1.39 d	24.21±0.35 C	69.77±0.75 d	64.84±1.39 e	67.31±0.79 C	60.34±1.68 de	65.27±1.15 cd	62.80±2.15 B
Root	17.38±0.58 g	25.98±2.17 e	17.72±1.17 D	82.62±0.58 b	74.02±2.17 c	78.32±0.52 B	53.58±2.23 f	57.48±2.29 ef	55.53±1.73 C
Flowers	67.84±0.71 c	69.79±1.10 c	73.82±1.19 B	33.47±0.71 f	30.21±1.10 g	31.84±0.73 D	70.20±1.65 bc	76.44±1.65 a	73.32±1.39 A
Mean	38.19±0.71 B	46.47±0.62 A		58.52±0.81 A	53.52±1.13 B		58.57±2.29 B	63.61±1.65 A	

Means showing different letters are statistically different ($p < 0.05$) from each other. Data were computed from three replications.

Table 2. Seasonal variation in crude protein, true protein and non-protein nitrogen contents (%) among different parts of *C. spinosa*.

Plant Parts	Crude Protein			True Protein			Non protein Nitrogen		
	April	September	Mean	April	September	Mean	April	September	Mean
Stem Bark	12.28±0.98 g	17.68±0.90 f	14.98±0.88 C	7.64±1.59 de	9.37±0.89 cd	8.50±0.83 C	4.65±1.01 g	8.31±0.92 fg	6.48±2.01 D
Fruit	38.63±2.66 b	44.70±2.15 a	41.66±1.05 A	12.30±1.35 bc	18.13±1.32 a	15.43±1.15 A	25.90±1.63 ab	26.73±1.14 a	26.23±2.14 A
Shoot	14.53±1.25 fg	17.93±2.71 f	16.23±1.35 C	5.49±1.63 e	7.55±1.62 de	6.52±1.12 C	9.05±2.42 fg	10.38±2.64 ef	9.71±1.42 D
Root	28.97±1.37 de	31.70±1.08 cd	30.34±1.21 B	7.65±1.49 de	10.71±1.86 cd	9.18±1.99 B	21.33±2.84 b	19.96±2.70 c	20.16±2.11 B
Flowers	26.44±1.02 e	33.17±1.80 c	29.80±1.56 B	11.88±1.44 bc	15.27±1.11 ab	13.57±1.31 A	14.56±1.96 de	17.89±1.84 cd	16.23±1.66 C
Mean	24.17±1.12 B	29.03±1.02 A		9.08±1.63 B	12.21±1.11 A		15.10±1.76A	16.83±1.96A	

Means showing different letters are statistically different ($p < 0.05$) from each other. Data were computed from three replications.

Table 3. Seasonal variation in crude fiber, neutral detergent fiber and acid detergent fiber contents (%) among different parts of *C. spinosa*.

Plant Parts	Crude Fiber			Neutral Detergent Fiber			Acid Detergent Fiber		
	April	September	Mean	April	September	Mean	April	September	Mean
Stem Bark	23.57±0.83 de	18.60±1.36 f	21.08±0.67 C	81.67±1.78 a	68.67±2.86 b	75.17±1.18 A	68.67±2.16 a	61.33±3.56 b	65.00±1.16 A
Fruit	21.99±1.32 def	11.10±3.09 ef	20.54±2.29 C	29.33±2.48 fg	21.33±2.16 h	25.33±1.86 D	20.00±2.55 gh	14.33±3.63 h	17.17±2.93 D
Shoot	32.19±1.38 ab	26.68±1.19 bc	30.61±0.79 B	58.67±1.78 de	52.33±0.41 e	55.50±2.08 C	36.67±2.16 de	30.33±1.47 ef	33.50±2.71 C
Root	36.04±1.19 a	31.64±0.91 ab	33.84±1.01 A	68.63±3.19 bc	61.67±5.31 cd	65.00±3.21 B	45.33±2.86 cd	40.33±2.94 c	42.83±1.64 B
Flowers	24.60±2.84 cd	19.70±2.85 ef	22.15±1.85 C	36.00±2.12 f	23.33±3.62 gh	29.67±3.52 D	24.00±2.12 fg	16.00±2.12 h	20.00±1.73 D
Mean	27.68±1.23 A	23.61±0.73 B		54.80±2.37 A	45.47±2.71 B		38.93±1.36 A	32.47±1.07 B	

Means showing different letters are statistically different ($p < 0.05$) from each other. Data were computed from three replications.

Table 4. Seasonal variation in crude fat, dry matter intake and ash contents (%) among different parts of *C. spinosa*.

Plant Parts	Crude Fat			Ash		
	April	September	Mean	April	September	Mean
Stem Bark	0.83±0.20 c	0.58±0.20 c	0.71±0.18 B	6.50±1.17 cd	3.20±1.18 e	4.85±1.82 B
Fruit	7.33±1.08 a	5.33±1.08 b	6.33±1.01 A	6.91±0.78 c	4.07±0.66 de	5.49±0.93 B
Shoot	0.83±0.20 c	0.38±0.20 c	0.61±0.24 B	10.93±0.79 ab	7.86±1.14 bc	9.39±0.72 A
Root	0.43±0.08 c	0.33±0.02 c	0.38±0.06 B	6.76±1.55 cd	6.50±0.90 d	4.91±0.82 B
Flowers	1.00±0.35 c	0.83±0.35 c	0.92±0.29 B	11.80±1.92 a	8.50±1.70 b	10.15±1.61 A
Mean	2.09±0.08 A	1.49±0.31 B		8.58±1.72 A	5.34±1.35 B	

Means showing different letters are statistically different ($p < 0.05$) from each other. Data were computed from three replications.

contents. The livestock animals utilize protein for maintaining growth and reproduction metabolism. Its deficiency leads to reduced appetite, low feed intake and meager food efficiency resulting in poor growth and development (Holechek *et al.,* 1998). During dry season, the protein rich forage is less available for livestock which hinder the growth and development of livestock, so in these days caper plants can be utilized as livestock fodder being a good source of protein. These protein contents are also comparable with some other forage and food plants like *Moringa oleifera* (Nouman *et al.,* 2012; Nouman *et al*., 2013).

The fiber contents including crude fiber (CF), neutral detergent fiber (NDF) and acid detergent fiber (ADF) were found significantly different in different parts harvested in both seasons (p<0.05). Maximum crude fiber was present in roots (36.04%) in April followed by shoot, flower, stem bark and fruit (32.19, 24.60, 23.57 and 21.99%, respectively). Moreover, the value of crude fiber for April samples was higher than September samples. Maximum NDF and ADF contents were recorded in stem bark in April (81.67 and 68.67%, respectively), while least were found in fruits in September (21.33 and 14.33%, respectively). Temperature might affect NDF and ADF contents in combination with plant maturity, soil condition etc. (van Soest *et al.,* 1991). In the present study, it was found that NDF and ADF contents were higher in April when the temperature was comparatively higher and non-humid than September. Results showed that crude fiber contents were found within the range of recommended livestock forage value i.e., 31.6% (Kafeel *et al.,* 2013). The forage which is higher in CP contents and exhibited less NDF and ADF contents can be well used for livestock fodder purposes (Yu *et al.,* 2004). The higher NDF and ADF contents in forages are negatively correlated with CP contents as evident in the present investigation.

Results for crude fat (CF) content are given in Table 4. Results showed that maximum CF (7.33%) was observed for fruit collected in April, however, other parts showed vary small amounts. The ash contents in all studied parts of *C. spinosa* showed significant differences (p<0.05). Maximum ash contents were observed in flowers in April (11.80%) followed by shoot, fruit, root and stem bark in the same month (10.93, 6.91, 6.76, 6.50%, respectively). Similar trend was recorded in all parts of investigated species in September but lower in value than April samples. The ash contents were higher than the findings of Haq *et al*. (2011) and Chinedu *et al*. (2011) who analyzed caper samples from Pakistan and Nigeria, respectively.

Mineral profile: The mineral contents (mg kg^{-1} DW) were analyzed in different parts of *C. spinosa* harvested in two different seasons are depicted in Table 5-7. Calcium (Ca) contents of different parts of *C. spinosa* were statistically different from each other in both sampling seasons i.e., April and September. Maximum Ca contents (842.22 mg kg^{-1}) were found in fruits of *C. spinosa* in September which was statistically at par with fruits (809.86 mg kg^{-1}) in April followed by flower > shoot > root > stem bark. However, the values of Ca contents in all parts of April samples were lower than September. Calcium (Ca) is a macro element and essential for strengthening of bones and teeth in human beings and reproductive ability in livestock animals (Khan *et al.,* 2004). Although, Ca contents in *C. spinosa* are less than rangeland grasses which are used for livestock, however in those seasons when no other forage is available, the livestock animals can fulfill their requirements from *Cappris* plants (Khan *et al.,* 2006). It can be observed from the results of the present study that *C. spinosa* fruits are major sources of Ca however, its level is lesser as compared to previous findings (55 mg kg^{-1}) (Dahot, 1993). Ca contents found in the present study were also found higher than previously reported i.e., 400 mg kg^{-1}. Such variation might be in due part to different climatic zones, sampling sites and available soil chemical composition.

The high amount of Potassium (K) and Sodium (Na) contents were determined in fruits (5817.60, 1228.33 mg kg^{-1}, respectively) in April followed by flowers, root, shoot and stem bark. Similar tendency for these both minerals was observed in September samples but the values were statistically lower than April. The lowest K, Na contents were recorded in stem bark in September (2341.00, 118.33 mg kg^{-1}, respectively) (Table 5). The data depicted in Table. 5 manifested that among minerals, K was found at maximum level ranging between 2373.00 to 5817.60 mg kg^{-1}. These findings are in line with other studies about the presence of mineral contents in different medicinal plants (Badri and Hamed, 2000; Ozcan and Akbulut, 2007). For example, *C. ovata* may provide K contents ranging from 4057.1 to 41267.4 mg kg^{-1} while another researcher reported 1.27% K contents in *C. ovata* while *Albezzial ebbeck*, *Zizyphus mauritiana* and *Morus alba* provided substantial K contents (0.96, 0.56 and 0.09%, respectively) (Ogut and Er, 2010; Ghazanfar *et al.,* 2011). K plays an important role in cardiovascular system in combination with Na contents. K and Na are interconnected with each other for a smooth blood flow but if Na concentration in the blood goes higher, it will reduce K concentration that may cause high blood pressure (Gailerr *et al.,* 2000). *C. spinosa* fruits (caper berries) which are used as pickle are rich sources of K but beside this, they also provide less Na contents to the consumers i.e., 263 mg kg^{-1}.

The fruits of *C. spinosa* exhibited maximum Zn contents in September (136.45 mg kg^{-1}) which were statistically at par with fruits (128.02 mg kg^{-1}) in April. Minimum Zn was present in stem bark of both seasons (17.60 and 13.46 mg kg^{-1}, respectively). Cattle and sheep can accept Zn

Table 5. Seasonal variation in macro-mineral contents ($mg\ kg^{-1}$) among different parts of *C. spinosa*.

Plant Parts	Calcium			Potassium			Sodium		
	April	September	Mean	April	September	Mean	April	September	Mean
Stem Bark	154.17±06.50 d	159.72±30.67 d	820.00±21.97 A	2373.0±186.2 e	2341±145.15 e	4035.7±106.2 C	190.0±14.14 e	118.3±21.31 bcd	391.67±17.31 BC
Fruit	809.86±105.92 a	842.22±57.80 a	716.11±17.80 A	5817.6±183.6 a	5727±126.09 b	4869.0±126.2 BC	1228.3±35.41 a	1206.7±124.16 b	284.17±13.71 CD
Shoot	328.61±51.23 c	402.22±61.28 bc	365.42±31.93 B	3730.1±123.6 cd	3492±194.39 d	2583.3±184.1 D	365.0±17.68 cde	278.3±12.42 cde	234.17±12.74 D
Root	183.33±15.59 d	227.78±7.96 cd	171.53±09.06 C	4611.1±132.6c	4594±245.33 c	5115.1±209.1 B	523.3±22.73 bc	451.7±24.06 bcd	487.50±19.89 B
Flowers	622.36±51.63 b	797.78±60.93 ab	190.97±21.27 C	5738.0±258.6 b	5621±123.36 bc	6797.6±192.2 A	1062.5±104.58a	1021.6±56.24b	917.50±12.71 A
Mean	454.75±15.19A	450.86±11.63A		4925.4±167.9A	4434±218.03B		495.3±18.42A	430.7±32.39B	

Means showing different letters are statistically different ($p < 0.05$) from each other. Data were computed from three replications.

Table 6. Seasonal variation in micro mineral contents ($mg\ kg^{-1}$) among different parts of *C. spinosa*.

Plant Parts	Zinc			Manganese			Copper		
	April	September	Mean	April	September	Mean	April	September	Mean
Stem Bark	13.46±1.29 e	17.60±1.29 de	15.53±1.31 D	10.37±0.45 def	13.51±0.45 abc	14.45±0.25 B	5.74±0.82 c	5.53±2.52 bc	3.64±1.63 C
Fruit	128.02±12.11 a	136.45±10.46 a	132.23±8.73 A	9.7±0.32 fg	11.26±0.32 bcde	12.48±0.31 BC	3.42±0.49 c	3.21±1.07 d	16.82±1.59 A
Shoot	70.56±5.73 b	77.43±4.84 b	73.99±3.32 B	5.07±0.24 f	6.59±0.24 cde	9.33±0.18 C	6.36±1.45 bc	6.06±4.96 a	16.21±2.34 A
Root	19.66±2.55 cde	25.24±2.03 cde	22.45±2.44 D	17.41±0.98 a-d	22.22±0.98 ab	19.81±0.36 A	1.87±0.93 c	1.83±3.51 b	7.76±1.19 B
Flowers	30.22±4.27 cd	37.09±4.02 c	33.66±2.93 C	23.6±1.23 a	24.89±1.23 a	16.74±1.13 AB	3.86±2.01 c	3.56±2.43 c	13.71±3.53 AB
Mean	52.38±3.37B	58.76±3.19A		13.23±2.85B	15.89±1.09A		3.22±1.21 B	20.04±2.81 A	

Means showing different letters are statistically different ($p < 0.05$) from each other. Data were computed from three replications.

Table 7. Seasonal variation in heavy metal contents ($mg\ kg^{-1}$) among different parts of *C. spinosa*.

Plant Parts	Iron			Cadmium		
	April	September	Mean	April	September	Mean
Stem Bark	149.36±10.75 bc	104.91±08.39 c	127.13±06.79 C	0.052±0.003 f	0.20±0.02 d	0.13±0.00 D
Fruit	292.46±37.01 b	286.43±22.50 bc	254.44±18.39 B	0.030±0.010 def	0.12±0.05 def	0.14±0.03 D
Shoot	76.21±05.44 c	74.49±17.45 c	95.85±09.33 C	0.200±0.004 f	0.71±0.09 b	0.37±0.01 B
Root	463.33±65.85 a	454.10±116.7 a	496.67±28.93 A	0.750±0.023 ef	0.96±0.09 a	0.52±0.04 A
Flowers	535.09±116.7 a	530.00±98.81 a	504.09±20.76 A	0.125±0.003 de	0.34±0.09 c	0.27±0.06 C
Mean	302.89±31.79A	288.39±38.87B		0.102±0.005 B	0.47±0.03 A	
	Cobalt			Nickel		
	April	September	Mean	April	September	Mean
Stem Bark	0.000±0.00 b	0.000±0.00 b	0.3801±0.00	3.495±0.07 b	3.428±0.41 b	3.512±0.12 A
Fruit	0.020±0.00 b	0.019±0.34 ab	0.3096±0.00	0.000±0.00 d	0.000±0.00 d	0.000±0.00 C
Shoot	0.196±0.04 ab	0.186±0.46 ab	0.3462±0.02	0.000±0.00 d	0.000±0.82 d	0.000±0.00 C
Root	0.515±0.07 ab	0.478±0.23 ab	0.4959±0.14	4.595±0.07 1	4.362±0.82 a	3.578±0.34 A
Flowers	0.249±0.07 ab	0.123±0.71 a	0.5400±0.32	1.395±0.14 bc	1.262±0.70 c	1.126±0.64 B
Mean	0.192±0.47 B	0.637±0.71 A		1.377±0.59B	1.462±0.63A	

Means showing different letters are statistically different ($p < 0.05$) from each other. Data were computed from three replications.

Table 8. Correlation matrix among crude protein (CP), acid detergent fiber (ADF), ash, crude fiber (CF), digestible dry matter (DDM) and neutral detergent fiber (NDF) contents on different part of *C. spinosa.*

	ADF	Ash	CF	DDM	NDF
Ash	-0.3143				
CF	0.1868	0.2158			
DDM	-1.0000	0.3143	-0.1868		
NDF	0.9489	-0.2147	0.4769	-0.9489	
CP	-0.7302	-0.2729	-0.2684	0.7302	-0.7653

level upto 500 and 300 mg kg^{-1}, respectively while the human requirements for Zn decrease with the increase in age (NRC, 1984). In human beings, Zn plays a main role in the immune system, affecting a number of aspects of cellular immunity and as coenzyme for more than 200 enzymes (Stephanie, 2010). Its deficiency in human beings results in retarded growth, delayed sexual maturity, diarrhea and unbalanced appetite (Johnson *et al.,* 1993). The Zn contents in different parts of *C. spinosa* differ in its quantity in different seasons. No previous data is available regarding Zn contents in *C. spinosa* but it can be compared to other species of the same genus. It has been reported that *C. ovata* exhibited Zn contents ranging between 2.3 to 38.7 mg kg^{-1} in different parts. This difference might be due to soil conditions, water source, genetic variation and ecological zones/climatic factors (Ozcan *et al.,* 2008). This is important to understand that FAO and WHO proposed Zn uptake limit for edible plants at 27.4 mg kg^{-1} which is below than Zn occurrence in these medicinal plants but still World Health Organization did not set any Zn limit for medicinal plants (WHO, 2005; Ghani *et al.,* 2012). The proposed range limit for agricultural products is 15-200 mg kg^{-1}. Cereals, pulses and legumes provide 25-50 mg kg^{-1} Zn contents while polished rice has 10-25 mg kg^{-1} and fish contain even less than 10 mg kg^{-1} Zn contents (Allaway, 1968; Sandstorm, 1989).

As the variation of manganese (Mn) contents is concerned, the flowers in September exhibited highest level of Mn (24.89 mg kg^{-1}) followed by roots, stem bark, fruit and shoot (22.22, 13.51, 11.26, 6.59 mgkg^{-1}, respectively). Same sequence of Mn contents was depicted by April samples. The overdose of Mn may have an adverse effect on central nervous system (CNS) function and mood of the human beings (Tan *et al.,* 2006). So, its lower amount in an adequate way let it to perform its function in order. In edible plants, the permissible limit for Mn is 2 mg kg^{-1} but it has not yet been established for medicinal plants (Ogut and Er, 2010). Some medicinal plants have been reported with Mn contents ranging from 44.6 to 339 mg kg^{-1} (Sheded *et al.,* 2006).

The average copper (Cu) contents were maximally found in shoot (6.36 mg kg^{-1}) in April.Cu contents in *C. spinosa* ranged 1.87 to 6.36 mg kg^{-1} in April and 1.83 to 6.06 mg kg^{-1}in September however, their edible parts contained very less amount of Cu. Cu contents are important for maintaining human body health especially regulating Fe utilization in liver (Swenson, 1985). FAO has decided the Cu limit for edible plants as mg kg^{-1} while for agricultural product, Cu contents limit was suggested between 4 to 15 mg kg^{-1} (WHO, 2005; Tan *et al.,* 2006; Manzoor *et al.,* 2012).

In case of iron (Fe), maximum contents were recorded in flowers and roots in September (535.09, 463.33 mg kg^{-1}, respectively) followed by fruits in April (292.46 mg kg^{-1}). The least amount of Fe was present in shoot of both seasons (74.49, 76.21 mg kg^{-1}, respectively) (Table 7). Children between the age 4-6 and 7-10 years require 0.23 and 0.32 mg day^{-1} Fe for their body growth and metabolic functions while male and female adults require 0.60 and 0.35 mg day^{-1}. The present investigation manifested that edible parts of caper which are edible parts for human beings have 292.46 and 286.43 mg kg^{-1} Fe contents in April and September, respectively. Moreover, NRC suggested the Fe tolerable level for cattle at 1000 mg kg^{-1} but WHO did not yet establish any limit for Fe uptake and absorption for medicinal plants (WHO, 2005; Tan *et al.,* 2006). It can be found between 261 to 1239 mg kg^{-1} in many Egyptian medicinal plants.

Trace metals i.e., Ni, Co and Cd were very low in amount in all parts of *C. spinosa* which could be an advantage for the food products. In present investigation, the edible parts of *C. spinosa* showed < 1mg kg^{-1} Cd, Co and Ni contents which are less than the limits suggested by WHO for medicinal plants (WHO, 2005)

***Conclusion*:** The fruits and flowers of *C. spinosa* exhibited appreciable levels of minerals and other nutrients in both seasons especially in September. Being edible parts for human beings, the flowers and fruits of this species can be used as a potential source for dietary minerals intake. The presence of heavy metals was noted to be in low quantities than the alarming level and thus an advantage from food or fodder view point. It can be concluded that consumption of this species for both human beings and livestock can provide appreciable amounts essential nutrients including minerals for their metabolic functions.

***Acknowledgement*:** Authors are thankful to Higher Education Commission of Pakistan (HEC-Pakistan) for providing funding for the accomplishment of the work through PhD indigenous fellowship program.

REFERENCES

Allaway, W.H. 1968. Agronomic controls over environmental cycling of trace elements. Adv. Agron. 20:235-274.

Amna, I., F. Anwar, R. Nadeem, B. Sultana and M. Mushtaq. 2013. Proximate composition and minerals profile of fruit and flower of Karir (*Capparis decidua*) from Different regions of Punjab (Pakistan). Asian J. Chem. 26:360-364.

AOAC. 1990. Official Methods of Analysis of the Association of Official Analytical Chemists, Helrich, Washington, DC.

AOAC. 2000a. Official Method 962.09. Fiber (crude) in animal feed and pet food. In: W. Horwitz (ed.), Official Methods of Analysis of AOAC International, Section 4.6.01. AOAC International, Gaithersburg, MD.

AOAC. 2000b. Official Method 973.18. Fiber (acid detergent) and lignin (H_2SO_4) in animal feed. In: W. Horwitz (ed.), Official Methods of Analysis of AOAC International, Section 4.6.03. AOAC International, Gaithersburg, MD.

Badri, M.A. and A.I. Hamed. 2000. Nutrient value of plants in an extremely arid environment (Wadi Allaqi biosphere reserve, Egypt). J. Arid Environ. 44:347-356.

Cerrillo-Soto M.A., G. Nevarez-Carrasco, R.G. Ramírez-Lozano, A. Núñez-González, G. García-Díaz and A.S. Juárez-Reyes. 2004. Mineral profile of diets consumed by range Spanish goats in a shrubland of North Mexico. South Afr. J. Anim. Sci. Suppl. 1:117-119.

Chapman, H.D. and P.F. Pratt. 1961. Methods of Analysis for Soils, Plants and Water. University of California, Berkeley, California, USA.

Chinedu, S.N., A.C. Olasumbo, O.K. Eboji, O.C. Emiloju, O.K. Arinola and D.I. Dania. 2011. Proximate and phytochemical analyses of *Solanum aethiopicum* L. and *Solanum macrocarpon* L. Fruits. Res. J. Chem. Sci. 1:63-71.

Dahot, M.U. 1993.Chemical evaluation of the nutritive value of flowers and fruits of *Capparis decidua*. J. Chem. Soc. Pak. 15:78-81.

Duman, H., D. Canatan, G. Alanoglu, R. Sutcu and T. Nayir. 2013. The antioxidant effect of *Capparis ovata* and deferasirox in patients with Thalassemia major. J. Blood Disorders Transf. 4:1-4.

Gailer, J., G.N. George, I.J. Pickering, S. Madden, R.C. Prince, E.Y. Yu, M.B. Denton, H.S. Younis and H.V. Aposhian. 2000. Structural basis of the antagonism between inorganic mercury and selenium in mammals. Chem. Res. Toxicol. 13:1135-1142.

Ghani, A., Z. Ali, M. Ishtiaq, M. Maqbool and S. Parveen. 2012. Estimation of macro and micro nutrients in some important medicinal plants of Soon Valley, District Khushab, Pakistan. African J. Biotechnol. 11:14386-14391.

Ghazanfar, S., A. Latif, I.H. Mirza and M.A. Nadeem. 2011. Macro-minerals concentration of major fodder tree leaves and shrubs of district Chakwal, Pakistan. Asian Network Sci. Info. 10: 480-484.

Haciseferogullari, H., M.M. Ozcan and E. Duman. 2011. Biochemical and technological properties of seeds and oils of *Capparis spinosa* and *Capparis ovata* plants growing wild in Turkey. J. Food Process. Technol. 2:1-6.

Hansen, J.M. 1991. The Palaeoethno botany of Franchthi Cave. India University Press, Bloomington 119:38-39.

Haq, M.Z.U., S. Cavar, M. Qayum, I. Imranand and V. de Feo. 2011. Compositional studies: Antioxidant and antidiabetic activities of *Capparis decidua* (Forsk.) Edgew. Int. J. Mol. Sci. 12:8846-8861.

Holechek, J.L., R.D. Pieper and C.H. Herbel. 1998. Range management. Principles and practices, 3rd ed. Prentice Hall, Upper Saddle River.

Jiang, H.E., X. Li, D.K. Ferguson, Y.F. Wang, C.J. Liu and C.S. Li. 2007. The discovery of *Capparis spinosa* L. (Capparidaceae) in the Yanghi tombs (2800 years B.P.), NW China, and its medicinal implications. J. Ethnopharma. 113:409-420.

Johnson, R.K., T. Widerholm and D.M. Rosenberg. 1993. Freshwater biomonitoring using individual organisms, populations, and species assemblages of benthic macro-invertebrates. In: D.M. Rosenberg and V.H. Resh (eds.), Freshwater Biomonitoring and Benthic Macro-invertebrates. Chapman and Hall, New York, pp.40-158.

Jumba, I.O., N.F. Suttle and S.O. Wandiga. 1996. Mineral composition of tropical forages in the mount Elgan region of Kenya. 1. Macro minerals. Trop. Agric. 73:108-112.

Kafeel, A., M. Shaheen, F. Mirzaei, Z.I. Khan, S. Gondal, A. Fardous, A. Hussain, F. Arshad and T. Mehmood. 2013. Exploration of concentration of two macro-minerals in different wild forages in relation to nutrient requirements of livestock. Agric. Sci. 6:302-308.

Khan, Z.I., A. Hussain, M. Ashraf and L.R. McDowell. 2006. Mineral status of soils and forages in southwestern Punjab-Pakistan: Micro-minerals. Asian-Australian J. Anim. Sci. 19:1139-1147.

Khan, Z.I., A. Hussain, M. Ashraf, E.E. Valeem, M.Y. Ashraf and M.S. Ahmad. 2004. Soil and forage (Trace elements) status of grazing pasture in the semiarid region of Pakistan. Pak. J. Bot. 4:851-856.

Manzoor, M., F. Anwar, Z. Mahmood, U. Rashid and M. Ashraf. 2012. Variation in minerals, phenolics and antioxidant activity of peel and pulp of different varieties of peach (*Prunus persica* L.) fruit from Pakistan. Molecules 17:6491-6506.

Minson, D. J. 1990. Forage in ruminant nutrition. Academic Press, Sun Diego, USA, p.483.

MSTAT Development Team. 1989. MSTAT User's Guide: A Microcomputer Program for the Design Management and Analysis of Research Experiments. Michigan State University, East Lansing, Michigan, USA.

Nouman, W., M.T. Siddiqui, S.M.A. Basra, H. Farooq, M. Zubair and T. Gull. 2013. Biomass production and nutritional quality of *Moringa oleifera* as a field crop. Turk. J. Agric. Fores. 37:410-419.

Nouman, W.M.T. Siddiqui, S.M.A. Basra, I. Afzal and H. Rehman. 2012. Enhancement of emergence potential and stand establishment of *Moringa oleifera* Lam. by seed priming. Turk. J. Agric. Fores. 36:227-235.

NRC. 1984. Nutrient Requirements of Beef Cattle, 6th Ed. National Academy Press, Washington, DC.

Ogut, M. and F. Er. 2010. Mineral contents of different parts of caper (*Capparis ovata* Desf.). J. Food Agric. Environ. 8:216-217.

Ozcan, M.M. 2005. Mineral composition of different parts of *Capparis ovata* Desf var. *canescens* (Coss.) Heywood growing wild in Turkey. J. Med. Food. 8:405-407.

Ozcan, M.M. and M. Akbulut. 2007. Estimation of minerals nitrates and nitrite contents of medicinal and aromatic plants used as spices, condiments and herbal tea. Food Chem. 106:852-858.

Ozcan, M.M., A. Unver, T. Uear and D. Arslan. 2008. Mineral contents of some herbal teas by infusion and decoction. Food Chem. 106:1120-1127.

Ramirez, R.G., G.F.W. Haenlein and M.A. Nunez-Gonzalez. 2001. Seasonal variation of macro and trace mineral contents in 14 browse species that growth in northeastern Mexico. Small Rum. Res. 39:153-159.

Sandstrom, B. 1989. Dietary pattern and zinc supply. In: C.F. Mills (ed.), Zinc in Human biology. Springer-Verlag, Devon, U.K., pp.350-363.

Sheded, G.M., I.D. Pulford and I.A. Hamed. 2006. Presence of major and trace elements in seven medicinal plants growing in the South-Eastern desert. Egypt J. Arid Environ. 66:210-217.

Soetan, K.O., C.O. Olaiya and O.E. Oyewole. 2010. The importance of mineral elements for humans, domestic animals and plants: A review. Afric. J. Food Sci. 4:200-222.

Steel, R.C.D., J.H. Torrie and D.A. Deekey. 1997. Principles and Procedures of Statistics: A biometric approach, 3rd Ed. McGraw-Hill Book Co. Inc. New York.

Stephanie, S. 2010. Trace elements. Curr. Anaesthesia Crit. Care. 21:44-48.

Swenson, M.J. 1985. Minerals and Bones. In: Dukes' Physiology of Domestic Animals, 10th Ed. Cornell University Press. pp.449-466.

Tan, J.C., D.L. Burns and H.R. Jones. 2006. Severe ataxia, myelopathy and peripheral neuropathy due to acquired copper deficiency in a patient with history of gastrectomy. J. Parental Nutr. 30:446-450.

vanSoest, P.J., J.B. Robertson and B.A. Lewis. 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci. 74:3583-3597.

WHO. 2005. Quality control methods for medicinal plant materials, revised, Geneva.

Yadav, P., S. Sarkar and D. Bhatangar. 1997. Action of *Capparis decidua* against alloxan-induced oxidative stress and diabetes in rat tissues. Pharmacol. Res. 36:221-228.

Yu, P., D.A. Christensen and J.J. McKinnon. 2004. *In situ* rumen degradation kinetics of timothy and alfalfa as affected by cultivar and stage of maturity. Can. J. Anim. Sci. 84:255-263.

Zuo, Y. 2014. High-Performance Liquid Chromatography (HPLC): Principles, Procedures and Practices. Nova Science Publishers, Inc. New York.

Zuo, Y., C. Wang and J. Zhan. 2002. Separation, characterization and quantitation of benzoate and phenolic antioxidants in American cranberry fruit. J. Agric. Food Chem. 50:3789-3794.