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VARIATION OF PROXIMATE COMPOSITION AND MINERALS WITHIN DIFFERENT PARTS OF *CAPPARIS DECIDUA* (FORSSK.) EDGEW. AS A FUNCTION OF HARVESTING SEASONS

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Abstract

Capparis decidua (*C. decidua*) is an important medicinal plant from the family Capparaceae. The present study explores the proximate (moisture, protein, crude fiber, dry matter) composition and minerals profile of various parts including stem bark, fruit shoot, root and flower of *C. decidua* harvested from Cholistan desert, Punjab, Pakistan in two seasons i.e., April and September. *C. decidua* fruits contained relatively higher amounts of proximate constituents followed by the flowers especially in case of protein while stem bark and roots mainly contained fiber. In comparison with other parts, the content of minerals was higher while traces of heavy metals i.e. Ni, Co and Cd were recorded in *C. decidua* fruits and flowers. Overall, harvesting seasons exhibited a significant ($p<0.05$) effect on the distribution of most of the constituents within different parts of *Capparis decidua*. The samples collected in September were found to be richer in protein and minerals and vice versa. The results of this study support that *C. decidua* fruits and flowers can be explored as a viable source of minerals and vegetable protein both for human beings and livestock to supplement nutrition.

Key words: Capper, flowers, fruits, protein, atomic absorption spectrophotometer, minerals potassium

Introduction

The deficiency of nutrients, especially among children and women, is considered to be a major cause of different health problems in developing and under developed countries. In a recent study Cheah *et al.* (2009) reported that globally more than half of the deaths of children occur due to malnutrition thus a setback for sustainable generation of youth in a nation (Fischer *et al.*, 2005; Chirwa & Ngalawa, 2008). Likewise, the nutritional status of women and children in Pakistanis is quite poor with an estimated 38% children between the age of six months and five years being reported as underweight due to malnutrition. Recent exponential rise in inflammation has aggravated the situation of malnutrition on global level. Nouman *et al.* (2014) reported that the people try to fulfill their nutritional requirements consuming vegetables, fruits, cereals, meat and milk, but many of these products are not affordable for middle or poor class people, especially those who live below poverty line. Therefore, in the rural communities which are mostly constituted by poor people, nutritious plants have to play a vital role towards meeting their daily nutritional requirements.

Crude protein, minerals and other nutritional elements play an important role in maintaining physiological functions and metabolism of both the human beings and the livestock. For example, the main function of the minerals is that they combine with protein for the formation of bones and teeth and smooth circulation of blood and oxygen. Some minerals are helpful for the transmutation of nerve impulse while a few others are important for enzymes and act as oxygen carrier (Soetan *et al.*, 2010).

Pakistan is blessed with fertile lands and green hilly areas rich in medicinal flora comprising about 6000 plant species with potential for bio-prospecting (Shinwari *et al.*, 2000). One of the medicinally and nutritionally important wild plant species namely *Capparis decidua* (*C. decidua*), belonging to family *Capparaceae*, is widely grown in arid, and desert areas, especially in Cholistan desert of Pakistan (Hameed *et al.*, 2011). The plant, which contains considerable amount of valuable bioactives and phenolic antioxidants, is known for its folk medicinal uses in the native medicine systems of South Asia, especially for the treatment of infectious diseases (Cronquist, 1981; Yadav *et al.*, 1997; Iwu *et al.*, 1999; Duman *et al.*, 2013; Hamed *et al.*, 2007). The plant is also considered to be a potential source of basic nutrients and minerals contributing towards nutritional benefits of this plant. For example, the plants which have higher calcium and potassium contents are valued both for livestock feed and human food (Ahmad *et al.*, 2008).

The quantity of minerals and proximate composition of plant foods is reported to be affected by different factors such as type of species, agro-climatic conditions, and harvesting seasons (Minson, 1990; Jumba *et al.*, 1996). The optimum levels of nutrients and minerals can be obtained by harvesting and consuming healthy plant foods at an appropriate seasons and stages. The present study was conducted to explore the amounts of basic nutrients and minerals in different parts of *C. decidua* in relation to two harvesting seasons.

Materials and Methods

Sample collection: Five different plants of *C. decidua* were selected randomly 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 and 78%, respectively.

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

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

A weighed (5 g) quantity of each *C. decidua* samples was used in duplicate for determination of moisture content by weighing in crucible and drying in oven at 105°C, until a constant weight obtained. CP and TP contents were found by nitrogen digestion, distillation and quantification through micro Kjeldhal method (Anon., 1990). CF was estimated by digesting the samples with 1.25% (w/v) H_2SO_4 and 1.25% (w/v) NaOH solutions (Anon., 2000a). ADF and NDF contents were also determined by following the devised protocols of (Anon., 2000b and van Soest *et al.*, 1991). NPN was calculated by subtracting TP from CP contents. Digestible dry matter (DDM) and dry matter intake (DMI) were calculated by following formulae:

$$\% \text{ DDM} = 88.9 - (0.779 \times \% \text{ ADF})$$

$$\% \text{ DMI} = \frac{120}{\% \text{ NDF} \times \% \text{ DM}}$$

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 (Anon., 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 design was used in the present study. The data was computed and analyzed by using MSTAT-C Program software (Anon., 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 composition of *C. deciduas*: Dry matter (DM) in different parts of *C. decidua* collected in April and September varied between 12.19-73.62%. Maximum DM was recorded in stem bark (73.62%) in April followed by roots and shoots of the same season while in September dry matter contents distributed as: root > stem bark > shoot > flower and fruit (67.25, 65.02, 47.99, 25.81, 12.19%, respectively) (Table 1). Moisture contents in different parts of *C. decidua* harvested in both the seasons ranged between 8.99 to 87.81% showing significant difference among parts and harvest seasons ($p<0.05$). Maximum moisture contents were observed in fruits (87.81%) in September which was statically at par with fruit (78.06%) in April followed by flower, stem bark, shoot and roots (Table 1). Moreover, digestible dry matter (DDM) was maximally found in fruits and flowers in September (78.77 and 73.58%, respectively) followed by the same part in April (78.25%) while least DDM was recorded in roots (41.90 and 42.16%) of both months (Table 1). Dahot (1993) reported the dry matter contents in flowers and fruits of *C. decidua* (26.6 and 27.55%, respectively) which were slightly higher than DM contents of fruit and flower of the present study.

The concentration of crude protein (CP), true protein (TP) and non-protein nitrogen (NPN) were found maximum in fruits (35.09, 14.36 and 17.72%, respectively) in September while minimum amounts of CP, TP and NPN were recorded in root in April (12.13, 7.95 and 7.29%, respectively) (Table 2). Ozcan (2005) also reported higher CP contents in caper ripened fruits. Due to its higher CP contents, the fruits (caper berries) are also used as pickle in Afghanistan, Pakistan and North Western India. Moreover, the caper plants are also palatable for livestock being rich in protein contents. The livestock animals utilize protein for maintaining growth and reproduction metabolism. Its deficiency leads to reduced appetite, low feed intake and poor food efficiency resulting in poor growth and development (Holechek *et al.*, 1998). The protein contents determined in the present work are also comparable with some other forage and food plants like *Moringa oleifera* (Nouman *et al.*, 2012; Nouman *et al.*, 2013; Nouman *et al.*, 2014).

Higher contents of CF and ADF were observed in roots (30.96 and 66.33%, respectively) while NDF was higher in stem bark (83.66%) in April samples. The least level of these contents were recorded in fruit of *C. decidua* sample collected in September (Table 3). Proximate composition of *C. decidua* differed significantly in both the seasons among the different parts. In the present study, it was found that ADF and NDF contents were negatively correlated with CP contents in *C. decidua* parts. Yu *et al.* (2004) reported that plant parts which possess higher CP contents with less NDF and ADF contents can be consumed easily by livestock improving their digestive system.

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

Plant parts	Moisture			Dry Matter			Digestible Dry Matter		
	April	September	Mean	April	September	Mean	April	September	Mean
Stem Bark	26.4±4.0 e	34.9±4.2 d	30.7±3.2 D	73.6±4.0 a	65.0±4.2 b	69.3±3.8 A	59.8±1.2 c	59.8±1.7 c	59.8±2.1 C
Fruit	82.6±1.2 a	87.8±1.6 a	85.2±3.1 A	17.4±1.2 e	12.2±1.6 e	14.7±0.3 D	78.2±2.2 a	78.8±2.0 a	78.5±3.3 A
Shoot	46.4±0.5 c	52.0±2.4 c	49.2±2.3 C	53.6±0.5 c	48.0±2.4 c	50.8±2.2 B	49.7±1.7 d	50.2±1.9 d	49.9±1.5 D
Root	32.7±0.8 de	28.4±2.5 de	30.6±2.7 D	71.5±0.8 ab	67.2±2.5 ab	69.4±2.6 A	41.9±1.4 e	42.2±1.1 e	42.0±1.9 E
Flowers	70.9±4.2 b	74.2±3.4 b	72.5±3.1 B	29.1±4.2 d	25.8±3.4 d	27.4±1.1 C	72.8±1.9 b	73.6±1.1 b	73.2±2.1 B
Mean	50.9± B	56.3± A		49.0± A	43.6± B		60.5±2.9A	60.9±1.7A	

Means showing different letters are statistically different (p<0.05) from each other. Data were computed from three replications. LSD (5%) value for Moisture: Plant Parts: 4.8, Seasons: 3.0, Seasons × Plant Parts: 6.8, LSD (5%) value for Dry Matter: Plant Parts: 4.8, Seasons: 3.0, Seasons × Plant Parts: 6.8, LSD (5%) value for Digestible Dry Matter: Plant Parts: 2.9, Seasons: 1.8, Seasons × Plant Parts: 4.1

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

Plant parts	Crude protein			True protein			Non protein nitrogen		
	April	September	Mean	April	September	Mean	April	September	Mean
Stem Bark	20.3±2.0 cd	22.4±1.9 c	21.3±2.1 B	8.5±0.9 cd	8.9±1.3 cd	8.7±0.9 C	11.8±2.0 bcd	13.5±1.2 bc	12.6±1.4 B
Fruit	28.6±3.8 b	35.1±3.3 a	31.8±3.7 A	12.3±1.7 ab	14.4±1.2 a	13.3±1.2 A	16.4±2.8 ab	20.7±2.3 a	18.5±1.9 A
Shoot	12.1±1.4 e	13.9±1.3 e	12.9±1.1 C	9.6±1.1 bcd	9.6±0.7 bcd	9.5±0.8 BC	2.5±1.6 f	4.3±1.1 ef	3.4±0.9 D
Root	15.5±0.8 de	15.6±2.1 de	15.5±1.7 C	7.6±1.0 d	8.6±1.0 cd	8.1±0.8 C	8.0±0.9 cdef	6.9±2.9 def	7.46±1.6 CD
Flowers	19.7±1.7 cd	24.4±3.4 bc	22.0±2.5 B	10.8±2.0 bc	11.5±1.9 abc	11.1±1.0 B	8.9±1.7 cde	12.9±2.2 cd	10.9±1.8 BC
Mean	19.3±1.2 B	22.3±3.9 A		9.7±1.8A	10.6±1.7A		9.5±2.1B	11.7±1.8A	

Means showing different letters are statistically different (p<0.05) from each other. Data were computed from three replications. LSD (5%) value for Crude Protein: Plant Parts: 4.0, Seasons: 2.5, Seasons × Plant Parts: 4.7, LSD (5%) value for True Protein: Plant Parts: 2.2, Seasons: 1.4, Seasons × Plant Parts: 3.1, LSD (5%) value for Nonprotein Nitrogen: Plant Parts: 4.2, Seasons: 2.6, Seasons × Plant Parts: 5.9

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

Plant parts	Crude fiber			Neutral detergent Fiber			Acid detergent fiber		
	April	September	Mean	April	September	Mean	April	September	Mean
Stem Bark	16.8±1.6 c	16.7±0.6 c	16.6±1.2 C	83.7±2.2 a	74.3±3.6 b	79.0±3.1 A	37.3±2.5	37.1±2.2	37.3±2.3 C
Fruit	14.9±1.1 c	14.1±1.0 c	14.5± 1.7 C	32.3±3.2 d	31.8±2.8 d	32.0±1.9 D	13.7±1.8	13.0±2.5	13.3±1.0 E
Shoot	29.6±2.4 b	28.7±1.5 ab	27.6±2.1 B	58.0±1.9 c	63.3±2.2 c	60.6±2.1 C	50.3±1.5	49.8±2.5	50.0±2.7 B
Root	30.9±1.7 a	30.3±1.4 a	30.1±2.0 A	75.7±3.9 b	71.0±2.5 b	73.3±3.1 B	60.3±1.8	59.9±1.4	60.2±3.1 A
Flowers	15.2±1.4 c	15.1±1.3 c	15.2±1.4 C	35.7±1.5 d	34.7±3.2 d	35.1±2.2 D	20.7±3.5	19.7±1.5	20.2±1.3 D
Mean	20.7±2.2 A	20.9±1.9A		57.1±2.9A	55.0±2.3B		36.4±2.8A	35.9±2.5A	

Means showing different letters are statistically different (p<0.05) from each other. Data were computed from three replications. LSD (5%) value for Crude Fiber: Plant Parts: 2.4, Seasons: 1.5, Seasons × Plant Parts: 3.4, LSD (5%) value for Neutral Detergent Fiber: Plant Parts: 4.8, Seasons: 3.0, Seasons × Plant Parts: 6.7, LSD (5%) value for Acid Detergent Fiber: Plant Parts: 3.8, Seasons: 2.4, Seasons × Plant Parts: 5.3

Minerals analysis of *C. deciduas*: Minerals profile of plants is a key factor to assess a plant's edible acceptability. The people fulfill their nutritional requirements mainly from plants and then animal products. A good food supply is essential for a healthy and socio-economically stable community. The animal products like meat, milk, butter and cheese, especially, are not affordable for a large number of communities; living below poverty line. In that case, the nutritionists suggest fulfilling the nutritional requirements from plant sources which are easily available and are sustainable.

In the present investigation, *C. decidua* parts mainly exhibited different mineral contents in different seasons. Maximum Ca contents were found in fruit samples harvested in April and September (322.50 and 317.72 mg kg^{-1}) which were statistically at par with flowers followed by shoot and stem bark while no significant difference in Ca contents was noted between seasons (Table 4). Ca contents found in the present study were also found higher than previously reported i.e., 400 mg kg^{-1} (Ozcan, 2005). Ca is an essential mineral that play its role in bone strength of human beings. No doubt, Ca contents were found in lesser amount in comparison with some other fodders and rangeland grasses but livestock species can fulfill their requirements by consuming this plant in dry months when no other fodder is available (Jumba *et al.*, 1996). A similar trend was recorded in K contents i.e., maximum were found in fruits of *C. decidua* fruits followed by flowers and shoot while seasonal variation was found at par with one another (Table 4). Higher Na contents were recorded in flowers in April (998.3 mg kg^{-1}) followed by flowers in September and fruits in April (916.6 and 675.00 mg kg^{-1}, respectively) (Table 4). K and Na jointly improve the cardiovascular system as both of these are interconnected with one another to ensure smooth blood flow (Gailer *et al.*, 2000). *C. decidua* fruits, being rich in K and with lesser content of Na, are in use as pickle in human diet.

Table 4. Seasonal variation in macro-mineral contents (mg kg^{-1}) among different parts of *C. deciduas*.

Plant parts	Calcium			Sodium			Potassium		
	April	September	Mean	April	September	Mean	April	September	Mean
Stem Bark	166.2±7.0 b	163.92±10.3 b	164.9±9.7C	283.3±21.6 d	263.3±32.8 de	273.3±18.7 C	1404.7±13.5 e	1588.0±14.5 e	1496.0±23.2 E
Fruit	322.5±12.1 a	317.7±24.5 a	320.3±23.9 A	675.0±49.8 c	648.3±24.1 c	661.7±37.6 B	11515.8±79.1 a	11865.0±63.3 a	11690.0±78.9 A
Shoot	212.6±39.1 b	210.0±34.7 b	211.8±12.3 B	158.3±14.2 f	150.0±10.6 f	154.2±7.9 E	5023.8±23.7 c	6254.0±11.3bc	5139.0±15.8 C
Root	200.9±4.4 b	312.2±15.9 a	249.6±13.7 B	241.6±30.0 de	223.3±8.9 de	232.5±17.5 D	3507.9±18.2 d	3668.0±14.7 d	3588.0±11.9 D
Flowers	314.0±14.2 a	298.2±24.4 a	313.5±19.8 A	998.3±81.4 a	916.6±18.1 b	957.5±51.2 A	5722.2±26.8bc	5905.0±18.6 b	5813.0±20.1 B
Mean	243.3±9.7B	260.8±8.8A		471.3±16.2A	440.3±12.8B		5434.9±17.2B	5656.0±14.7A	

Means showing different letters are statistically different (p<0.05) from each other. Data were computed from three replications. LSD (5%) value for Calcium Content: Plant Parts: 39.0, Seasons: 24.7, Seasons × Plant Parts: 55.1, LSD (5%) value for Sodium Content: Plant Parts: 30.4, Seasons: 19.2, Seasons × Plant Parts: 43.1, LSD (5%) value for Potassium Content: Plant Parts: 610.3, Seasons: 386.0, Seasons × Plant Parts: 683.0

Table 5. Seasonal variation in micro mineral contents (mg kg^{-1}) among different parts of *C. deciduas*.

Plant parts	Zinc			Manganese			Iron		
	April	September	Mean	April	September	Mean	April	September	Mean
Stem Bark	170.5±4.9 a	176.7±6.1 a	173.7±5.3 A	9.3±1.8 c	12.2±6.7 c	9.3±2.2 D	110.6±7.7 d	110.1±5.3 d	110.4±5.6 A
Fruit	14.4±1.9 d	20.1±2.6 d	15.3±2.3 D	21.4±3.7 b	15.2±1.9 b	21.7±2.4 B	261.0±29.6 b	259.5±6.7 b	260.4±21.3 B
Shoot	20.4±1.9 cd	27.5±3.1 cd	21.6±3.3 CD	15.0±3.3bc	9.4±5.6 b	15.3±1.9 C	164.6±11.4 c	163.6±7.2 c	164.1±17.6 C
Root	57.5±13.7 b	62.9±14.0 b	58.1±11.2 B	13.3±1.3bc	17.4±8.3bc	13.5±1.8 C	158.1±12.0 c	144.1±4.1 c	151.1±4.8 C
Flowers	27.1±10.5 cd	33.2±3.7 c	28.5±3.1 C	38.2±3.6 a	25.9±6.2 a	26.4±3.6 A	309.3±3.5 a	302.8±8.1 a	306.0±9.3 D
Mean	58.0±3.4 A	60.8±2.5 A		17.1±2.9 A	17.3±3.7 A		200.7±5.2 A	196.1±4.8 A	

Means showing different letters are statistically different (p<0.05) from each other. Data were computed from three replications. LSD (5%) value for Zinc Content: Plant Parts: 9.2, Seasons: 5.8, Seasons × Plant Parts: 12.9, LSD (5%) value for Manganese Content: Plant Parts: 4.1, Seasons: 2.6, Seasons × Plant Parts: 5.9, LSD (5%) value for Iron Content: Plant Parts: 20.4, Seasons: 12.9, Seasons × Plant Parts: 28.8

Table 6. Seasonal variation in heavy metal contents (mg kg^{-1}) among different parts of *C. deciduas*.

Plant parts	Copper			Cadmium		
	April	September	Mean	April	September	Mean
Stem Bark	3.48 ± 0.96b	3.76 ± 1.11b	3.62 ± 0.18 B	0.46 ± 0.07a	0.40 ± 0.04 a	0.43 ± 0.02 A
Fruit	9.47 ± 0.91a	9.44 ± 1.80ab	9.41 ± 0.37A	0.00 ± 0.00d	0.00 ± 0.00d	0.00 ± 0.00 D
Shoot	9.97 ±1.47a	9.34 ± 1.73a	9.55 ± 0.47A	0.29 ± 0.03b	0.27 ± 0.07b	0.28 ± 0.01B
Root	11.36 ± 0.57a	11.27 ± 1.87a	11.67 ± 0.57A	0.17 ± 0.03c	0.12 ± 0.02c	0.15 ± 0.00C
Flowers	4.01 ± 0.98b	4.50 ± 1.13 b	4.26 ± 0.17 B	0.00 ± 0.00d	0.00 ± 0.00d	0.00 ± 0.00D
Mean	7.62 ± 0.30A	7.78 ± 0.31A		0.18 ± 0.001A	0.18 ± 0.001A	
Plant parts	**Cobalt**			**Nickel**		
	April	**September**	**Mean**	**April**	**September**	**Mean**
Stem Bark	0.46 ± 0.03b	0.53 ± 0.07b	0.50 ± 0.00B	1.06 ± 0.06b	1.07 ± 0.31b	1.07 ± 0.05B
Fruit	0.00 ± 0.00 c	0.00 ± 0.00c	0.00 ± 0.00 D	0.00 ± 0.00c	0.00 ± 0.00 c	0.00 ± 0.00C
Shoot	0.063 ± 0.01c	0.08 ± 0.02c	0.07 ± 0.01C	3.73 ± 0.35a	3.89 ± 0.18a	3.81 ± 0.19A
Root	0.93 ± 0.03a	0.96 ± 0.06a	0.95 ± 0.02A	3.42 ± 0.42a	3.69 ± 0.64a	3.56 ± 0.17A
Flowers	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00D	1.07 ± 0.06 b	1.12 ± 0.41b	1.07 ± 0.04B
Mean	0.29 ± 0.01A	0.31 ± 0.01A		1.86 ± 0.07 B	1.96 ± 0.08A	

Means showing different letters are statistically different (p<0.05) from each other. Data were computed from three replications. LSD (5%) value for Copper Content: Plant Parts: 2.2, Seasons: 1.4, Seasons × Plant Parts: 3.2, LSD (5%) value for Cadmium Content: Plant Parts: 0.07, Seasons: 0.04, Seasons × Plant Parts: 0.09, LSD (5%) value for Cobalt Content: Plant Parts: 0.06, Seasons: 0.04, Seasons × Plant Parts: 0.09, LSD (5%) value for Nickel Content: Plant Parts: 0.5, Seasons: 0.3, Seasons × Plant Parts: 0.7

Data presented in Table 5 indicated the stem bark as a rich source of Zn (173.67 mg kg^{-1}) while the samples of same part were found statistically at par in September and April (176.78 and 170.56 mg kg^{-1}, respectively) followed by roots (58.57 and 57.59 mg kg^{-1}, respectively). The least Zn contents were found in fruits i.e., 15.28 mg kg^{-1}. According to Anon., (1984) and Stephanie (2010), cattle and sheep can accept Zn level up to 500 and 300 mg kg^{-1}, respectively while the human beings require lesser Zn contents in older age in comparison with early ages. Zn deficiency results in impeded growth and delayed sexual maturity in human beings (Johnson *et al.*, 1993). Zn contents in different parts of *C. decidua* varied in different seasons that might be due to climatic factors as temperature and humidity affect nutritional quality of plants (Ozcan *et al*., 2008; Nouman *et al*., 2013). In case of Mn, flowers exhibited maximum contents (38.2 mg kg^{-1}) followed by fruits (21.4 mg kg^{-1}) while no significant difference was found between the sampling seasons (Table 5). Same trend was recorded for Fe contents i.e., maximum amount was found in flowers (306.04 mg kg^{-1}) followed by fruits (260.4 mg kg^{-1}) with no significant difference observed between two seasons (Table 5). Both Fe and Zn are essential minerals for nutrition; both of these minerals are in short supply in human diet. The presence of these essential minerals in high quantities in different parts of *C. decidua* is valuable to meeting the deficiency of these minerals in human nutrition.

It has been reported in various studies that overdose of Mn might induce unfavorable effect on central nervous system (CNS) of the human beings (Tan *et al.*, 2006) so it should be consumed in lesser amount as was found in the present study. According to Ogut & Er (2010) the allowable limit for Mn in edible plants is 2 mg kg^{-1} but there is no report available for medicinal plants with established facts as a few medicinal plants possess 44.6 to 339 mg kg^{-1}Mn contents (Sheded *et al.*, 2006). Heavy metals i.e., Ni, Co and Cd were found at very low concentration in all parts of *C. decidua* which could be an advantage for the food products (Table 6) while maximum Cu contents were recorded in roots and shoots (11.67 and 9.55 mg kg^{-1}, respectively) followed by flowers and stem bark (4.26 and 3.62 mg kg^{-1}, respectively) which were statistically at par with each other (Table 6). Cu contents are important for maintaining human body health especially regulating Fe utilization in liver. FAO has established the Cu limit for edible plants as 3 mg kg^{-1} while for agricultural products Cu contents limit was suggested to be between 4 to 15 mg kg^{-1} (Anon., 2005; Tan *et al.*, 2006; Manzoor *et al.*, 2012). In the present investigation, the edible parts of *C. decidua* showed < 1mg kg^{-1} Cd, Co and Ni contents which were less than the limits suggested by WHO for medicinal plants (Anon., 2005).

Conclusion

The present study data reveal that *C. decidua* fruits and flowers are a rich source of important electrolytic mineral i.e., potassium which plays a vital role in maintaining the body fluidic balance and blood pressure control. An impressive amount of essential minerals, especially, Fe and Zn was also detected advocating the potential uses of this species to cope with the deficiency of these important minerals in human diet. Also the results of this work indicate that the harvesting season is a significant contributing factor towards defining/ characterizing the contents of basic nutrients and minerals in different parts of *C. decidua*. Hence, harvesting of *C.decidua* samples at an appropriate stage is recommended for maximal nutritional benefits of different parts of this species for livestock and human nutrition.

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