Nutrients Composition of Common Plant Species of Asteraceae in Quetta at Two Growth Stages

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Summary: Wild plants play an important role in non-traditional fodder producing plants. Therefore, eight common plant species of Asteraceae were collected from four different localities of Quetta at two different growth stages *viz.*, vegetative and flowering. The plant material (particularly leaf) was shade dried and ground them into fine powder. Thereafter they were analyzed for mineral nutrients *viz.*, N, P, K, Na, Zn and Mn following standard procedures. Results showed that different plant species at both the growth stages did significantly produced different amount of total mineral nutrients *viz*. sum of N, P, K, Na, Zn, and Mn. Statistically maximum amount of total mineral nutrients (65.66 mg g^{-1}) were produced by *Seriphidium quettense* (Podlech) Ling, Bull. Relatively minimum (45.02 mg g^{-1}) amount of the total mineral nutrients was observed on *Achillea wilhelmsii* C. Koch. This amount for the remaining six plants was in an order of *Hertia intermedia* Boiss > *Echinops griffithianus* Boiss > *Carthamus oxycantha* M. Bieb > *Centaurea iberica* Trev.ex Spreng > *Acroptilon repens* (L.) Hidalgo > *Conyza bonarensis* (L.) Cronquist, respectively. Results also showed that generally vegetative growth stage produced 7.74% greater amount of total mineral nutrients overall in all the studied Asteraceae species [except *Seriphidium quettense* (Podlech) Ling, Bull] over than their respective reproductive growth stage. Statistically overall maximum increase (13.84%) in mineral nutrients was produced by *Achillea wilhelmsii* C. Koch. While minimum (1.81%) for the same is recorded for *Centaurea iberica* Trevir. ex Spreng. Therefore, based on the highest concentration of total mineral nutrients, *Seriphidium quettense* (Podlech) Ling, Bull; *Hertia intermedia* Boiss, and *Echinops griffithianus* Boiss of Asteraceae are respectively recommended as forage and fodder for feeding of ruminants particularly at their vegetative growth stage.

Keywords: Mineral Nutrients, Asteraceae, Vegetative, Flowering; Reproductive, Quetta.

Introduction

Area wise Balochistan is the largest province representing 44% of the total land cover of Pakistan. Quetta is its capital district, which lies between latitude 30° - 03' and 30° - 27'N and longitude 66° - 44' and 67°-18'E. Mountains are the general character of this district. Fairly arid climate prevails in the Quetta valley. The district is situated at an altitude of 1652 m above sea level, lies at the mouth of Bolan Pass. It has three large craggy mountains. Chiltan, Zarghoon and Koh-e-Murdar, that seems to brood upon this pleasant town. The weather is extremely dry. The winter is very cold, and its minimum temperature ranges between -7 to -17°C. Summer is comparatively mild and the maximum temperature ranges between 32 to 35°C. July is generally the hottest month [1].

However, rangelands of the province have been degrading very fast by overgrazing and removal of vegetation for fuel purposes. Local plant species have evolved under the prevailing stresses of the Quetta region and have the ability to exploit natural resources on account of limited availability of alternate resources. In arid and semi arid rangelands (including Quetta), re-establishment of important native plant species is vital to maintain diversity, structure, function, and stability of the landscape. Seedling growth rate in their natural environment reflects potential of their sustainability in their native or local habitat. Germination of seeds, their establishment and survival are important parameters of colonization and population dynamics of plants [2]. Seeds are a source of C, N and P nutrients for the growing seedling. Seeds N and P are more important than seed C in accounting for seedling mass in 85% studied plants. In nutrient and water limited environments, large seeds routinely provision the seedling with N and P that enhance C-fixation and thus general growth in the first wet season. This system is so effective that growth response to soil nutrients may be negligible in first year seedling arising from seeds > 15mg mass, 5mg N content and 1.6mg P contents [3]. Seed germination and growth of desert plants are greatly depending upon seedbed characteristics especially soil moisture contents [4], and temperature [5]. In arid environment, any microsite that prevents desiccation might be a suitable site for seedling survival [6].

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Due to its peculiar geographical position, Pakistan harbors a great miscellany of flora. More than 6000 vascular plant species occur in this region [7], out of which 5,600 species have been described to date in the Flora of Pakistan, representing 22 families and about 150 genera [8]. In Balochistan 177 plant species belonging to family Asteraceae has been reported. *Seriphidium quettense* belonging to the plant family Asteraceae is the most prevalent plant species of Quetta specifically and Balochistan generally. Research studies revealed that there are 4 main plant communities in the study area *viz., Artimisia herba-alba*, *Artimisia – Poa – Taeniatherum*, *Bromus – Prunus* and *Artimisia – Sophora* which are comprised up of 112 plant species [9]. While common dominant plants of Asteraceae, found in Quetta are *Achillea welhemsii* C. Koch, *Acroptilon repens* (L.) Hidalgo, *Carthamus oxycantha* M. Bieb, *Centaurea iberica* Trev.ex Spreng, *Conyza bonarensis* (L.) Cronquist, *Hertia intermedia* Boiss, *Echinops griffithianus* Boiss, *Seriphidium quettense* (Podlech) Ling, Bull, *Cousinia heterophylla* Boiss, *Lactuca persica* Boiss, *Pulicaria angustifolia* DC and *Sonchus asper* L. [10, 11, 12]. *Seriphidium quettense* (Podlech) synonym *Artemisia quettensis* is a dominant shrublet in Hazarganji, Balochistan, Pakistan [10]. This shrub provides forage to small ruminants when other range species produce limited dry matter particularly under drought conditions. Likewise, this shrub provides many benefits to humans and animals including feed for livestock and wildlife, erosion control and industrial products [13]. Genus *Seriphidium*, due to its high number of species, ecological and economic importance, has been the object of a diversity focused studies [14]. Presently, 38 plant species of *Seriphidium* have been identified and botanically reported in Pakistan, mainly in arid and semiarid areas of Balochistan, Khyber Pakhtunkhwa (KPK), Northern Punjab and Kashmir forming an important component of *Artemisia* steppes [8]. *Seriphidium* is a widespread and varied genus of the family Asteraceae with great therapeutic and economic importance. It has greater than 500 species throughout the globe (the number varies depending on the authors [15].

Plant nutrition is traditionally treated as two separate topics: Organic nutrition and Inorganic nutrition. Organic nutrition focuses on the production of carbon compounds, specifically the incorporation of carbon, hydrogen and oxygen via photosynthesis, while inorganic nutrition is concerned primarily with the acquisition of mineral elements from the soil. Most plants require a relatively small number of nutrient elements in order to successfully complete their life cycle. Those that are required are deemed to be essential nutrient elements [16]. The essential nutrients are generally classed as either macronutrients or micronutrients. Distinction between macro and micro nutrients simply reflects the relative concentrations found in tissues or required in nutrient solutions and does not infer importance relative to the nutritional needs of the plants. H, C, O, N, P, K, Ca, Mg, S are macronutrients and Cl, B, Fe, Mn, Zn, Cu, Ni, Mo are listed as micronutrients or trace elements. The macronutrients contribute to over 95% of a plant's entire biomass on a dry matter weight basis. Whereas micronutrients are present in plant tissue in quantities measured in parts per million (ppm), ranging from 200 ppm or less than 0.02% dry weight [16, 17]. Wild plants play an essential role in non-traditional fodder producing plants. These plants are rich with their nutritive values are their water requirements are low [18]. The mineral nutrition is an important aspect as it plays an essential role in organism's life healthy growth. Such type of mineral is easily available in wild edible plants [19]. In addition to some earlier research carried on this topic [20, 21], recently researchers have investigated the nutritional value of non-traditional wild plants as renewable resources for raw materials [22, 23, 24, 25].

Many efforts have been made to establish the potential benefits of waste land herbs and shrubs. These have long been considered as an important source of nutrition for gazing animals in Pakistan, especially in those areas having pronounced dry season like Quetta [26]. Herbs, shrubs and trees are generally not only serves as food, fodder and medicine, but also provide shade and shelter for human beings and animals. They all provide forage for livestock through out the globe, when the values of grasses are below the minimum requirements for the maintenance of livestock. In the arid and semi-arid areas of the Mediterranean regions fodder herbs and shrubs, as forage plants can fill the gap of feed livestock during harsh environmental conditions. The presence of large quantity of minerals in fodder shrub leaves may not ensure the full nutritional diet as preferred by the animals [27]. The concentration of mineral elements in forage depends upon the interaction of a number of factors *viz.* soil, plant species, maturity stage (i.e., vegetative/reproductive), yield and existing climate [28]. Differences in mineral composition are reported by many researchers [29, 30, 31]. Minerals maintain the constituents of body fluid and tissue electrolytes. According to [32] plant species of Balochistan are deficient in total digestible nutrients with respect to animal requirement. Previously research was

conducted only on quantifying the crude protein of range forages of Balochistan [26, 33], but limited research work is carried out on quantifying the seasonal variation of the nutrients. However, this is important to know the macro and micro-nutrients status of those rangeland plants on which the animals are grazing [34]. The main objective of the present study is to know that which plant species of *Asteraceae* and at which growth stage of life it can produce the highest concentration of total mineral nutrients (i.e. N, P, K, Na, Zn and Mn), which can thereafter be recommend as forage and fodder for feeding of ruminants, because these macro and micronutrients are mainly involved in the growth and development of ruminants. Ca, Mg, S, Mo, Cu, and Fe are also important macro and micro-nutrients, but due to lack of analytical facility they were not included in the present study.

Experiment

In present study eight common plant species of family Asteraceae (*Achillea wilhelmsii* C. Koch, *Acroptilon repens* (L.) Hidalgo, *Carthamus oxycantha* M. Bieb, *Conyza bonarensis* (L.) Cronquist, *Echinops griffithianus* Bioss, *Centaurea iberica* Trevir. ex Spreng, *Hertia intermedia* Boiss and *Seriphidium quettense* (Podlech) Ling, Bull.), were randomly collected for 2 consecutive years from 4 different localities of Quetta *viz.* University of Balochistan campus, Wali Tangi, Hanna Urak, and Hazar Ganji. Each locality was considered as replicate. The selected plants were collected under technique of SRS (Simple Randomized Sampling) at two respective stages of plant development i.e., vegetative and flowering stages. Each plant sample was collected thrice. Sampling was done in year 2009 and 2010 and identification of plants was made with the help of Flora of Pakistan [35]. The voucher specimens were prepared and submitted to the Herbarium of Botany Department, University of Balochistan, Quetta. The collected plant samples (particularly leaf) were then shade dried in Laboratory and ground them in fine powder form. However, the leaves of *Achillea* and *Echinops* were hard and spiny so dried their leaves along with twigs. This powder was then kept in glass jars and used for the quantitative analyses of various macro and micro-nutrients like N, P, K, Zn, Mn and Na.

*Digestion***:** Digestion of plant samples was done by mixing 2g plant powder in 3mL perchloric acid and 10mL nitric acid (HNO_3). Then mixed it well and kept in digestion unit at medium heat for 30 minutes until liquid became transparent and powder fully dissolved. An aliquot 2mL of this sample was mixed with distilled water to make volume up to 100mL. And then each sample was used for quantification of the following different nutritional elements.

Nitrogen (N): Nitrogen was quantified by adopting the procedure of [36]. Pipette out about 50ml of aliquot diluted to 50mL with distilled water into a 125mL Erlenmeyer flask. Now neutralized boric acid absorbing solution by adding 2mL Nessler reagent. Mixed the flask thoroughly after putting cap and rubber stopper. Let the solution stand for 30 minute to develop color. Distilled was used as blank at 425nm wavelength. Read the nitrogen concentration in mg g^{-1} from standard calibration curve. UV-Vis spectrophotometer (Model 6505, Jenway Ltd., Feisted, Dunmow, Essex, UK) was used for the purpose.

Sodium (Na) and Potassium (K): These two major essential macronutrients were analyzed manually on Flame Photometer (JENWAY PFP 7) for their quantitative determinations.

Phosphorus (P): Phosphorus was quantified by following the procedure of [37]. Stock solutions of phosphorus (100ppm) was made by dissolving 0.4394g of potassium dihydrogen orthophosphate in 500mL beaker and transferred to a 1L volumetric flask to make the volume upto to 1L by distilled water. Then 10ppm of P was made by diluting 2mL of 100ppm stock solution to 20mL using distilled water. For calibration, standards were made up in 25ml volumetric flasks. Pathlength was 1cm and 5cm for 0.15-1.0 ppm and for 0.01 to 0.25ppm phosphorus, respectively. An aliquot of sample was pipetted into 25mL volumetric flask. Three 3 drops of 2, 4-DNP were added, then 5N HCl was added to make solution clear and turned yellow. The pH was adjusted 3 by adding 5N HCl. About 4mL of reagent solution freshly prepared by dissolving 12g ammonium paramolybdate in 250 mL distilled water x dissolving 0.291g of potassium antimony tartrate in 100mL distilled water. The reaction was mixed with 5N H_2SO_4 to 1000mL, then to 2000mL. Now 1.32g ascorbic acid was added into 250mL of above mentioned freshly prepared solution to a certain volume with distilled water. Fifteen minutes were allowed for blue color development and its absorbance was recorded against blank at 880nm by using UV/Vis-spectrophotometer.

Zinc and Manganese: They were analyzed on (SOLAAR AA Spectrometer) Atomic Absorption spectrometer following "AA Spectrometers Methods Manual". Each of the individual mineral nutrients was calculated with the following formula:-

$$N\ (\%) = \frac{\text{Mineral nutrients at vegetative or reproductive growth stage X 100}}{\text{Total nutrient contents at both vegetative and reproductive growth stages}}$$

The P, K, Na, Zn, and Mn contents were also calculated by the above mentioned formula.

Statistical analysis: The observed data were analyzed by using "STATISTIX 9.0 Version" computer software. Initially, data was submitted to linear model for analysis of variance (ANOVA). Furthermore LSD was computed for factorial design (2 factors). As software is designed for agricultural sciences, inbuilt probability level was 5%. Level of significance was recorded for all eight plant species and also for the two growth stages. The interaction between these two factors (growth stage and plant species) was also established.

Results and Discussion

Results of quantitative determination deciphered that mineral nutrient *viz.,* N, P, K, Zn, Mn, and Na in all members of Asteraceae as well as at both growth stages (except Na) were found significantly different ($P<0.01$). Results also deciphered that interaction between plant species and growth stages were found significant too (except Na) (Table-1).

Nitrogen (N): Results showed that all test plant species possess higher concentration of N at vegetative stage when compared with its reproductive stage. Statistically maximum amount of N (12.33 mg g^{-1}) is noted in *Seriphidium quettense* (Podlech) Ling, Bull. While minimum (8.50 mg g^{-1}) for the same is recorded for *Echinops griffithianus* Boiss at its vegetative stage. Whereas remaining six plant species falls in between the range with a sequence of *viz. Achillea wilhelmsii* C. Koch (12.00 mg g^{-1}); *Acroptilon repens* (L.) Hidalgo (11.83 mg g^{-1}); *Hertia intermedia* Boiss (11.500 mg g^{-1}); *Conyza bonarensis* (L.) Cronquist (10.23 mg g^{-1}) and *Carthamus oxycantha* M. Bieb (9.40 mg g^{-1}). While result based on mean values, all test plant species produced an increase of 14.72% nitrogen in vegetative stage than those in reproductive stage (Table-2). Results also showed that *Hertia intermedia* Boiss produced a maximum of 33.18% increase of N in vegetative over reproductive growth stages. While a minimum difference (6.41%) for the same is recorded for *Carthamus oxycantha* M. Bieb (Fig. 1).

Phosphorus (P): Results depicted that all test plant species contained significantly high amount of P in their vegetative when compared with their reproductive stage. Statistically maximum significant amount of P i.e. 3.40 and 3.33 mg g^{-1} is recorded for *Hertia intermedia* Boiss and *Carthamus oxycantha* M. Bieb, respectively. While minimum i.e. 1.23 mg g^{-1} for the same is recorded for *Achillea wilhelmsii* C. Koch, at its vegetative stage. Whereas remaining five plant species of Asteraceae fell in between the range with a sequence *viz. Centaurea iberica* Trev.ex Spreng (2.90 mg g^{-1}); *Echinops griffithianus* Boiss (2.50 mg g^{-1}); *Acroptilon repens* (L.) Hidalgo (2.47 mg g^{-1}); *Conyza bonarensis* (L.) Cronquist (2.10 mg g^{-1}); and *Serriphedium quettense* (Podlech) Ling, Bull (1.40 mg g^{-1}). While Result based on average values, all test plant species produced an increase of 29.51% P in vegetative than those of reproductive stage (Table-2). Results also depicted that *Achillea wilhelmsii* C. Koch produced a maximum of 32.25% increase of P in vegetative over reproductive growth stages. While a minimum difference of 3.36% for the same is recorded for *Acroptilon repens* (L.) Hidalgo (Fig. 2).

Potassium (K): Results deciphered that all test plant species of Asteraceae possessed significantly high amount of K in their vegetative when compared with their respective reproductive growth stages (except *Centaurea iberica* and *Seriphidium quettense*). Because they do not share common letters for their mean values. Statistically maximum significant amount of K (21.33 mg g^{-1}) is noted for *Seriphidium quettense* (Podlech) Ling, Bull and minimum i.e. (9.33 mg g^{-1}) for the same is noted for *Achillea wilhelmsii* C. Koch at its vegetative growth stage. Whereas remaining five plant species of the test plants fall in between the range with a sequence *viz. Hertia intermedia* Boiss (19.33 mg g^{-1}); *Echinops griffithianus* Boiss (16.33 mg g^{-1}); *Carthamus oxycantha* M. Bieb (15.33 mg g^{-1}); *Conyza bonarensis* (L.) Cronquist (13.33 mg g^{-1}); and *Centaurea iberica* Trevir. ex Spreng (10.67 mg g^{-1}). While Result based on average values, all test plant species of Asteraceae produced an increase of 2.70% K in vegetative than those of reproductive growth stage (Table-2). Results also deciphered that *Conyza bonarensis* (L.) Cronquist produced a maximum of 21.23% increase of K in vegetative over reproductive growth stages. While no difference between both growth stages for the same is recorded for *Acroptilon repens* (L.) Hidalgo. However, in case of *Seriphidium quettense* (Podlech) Ling, Bull and *Centaurea iberica* Trev.ex Spreng they both produced 12.26 and 12.33% decrease of K in vegetative over reproductive growth stages, respectively (Fig. 3).

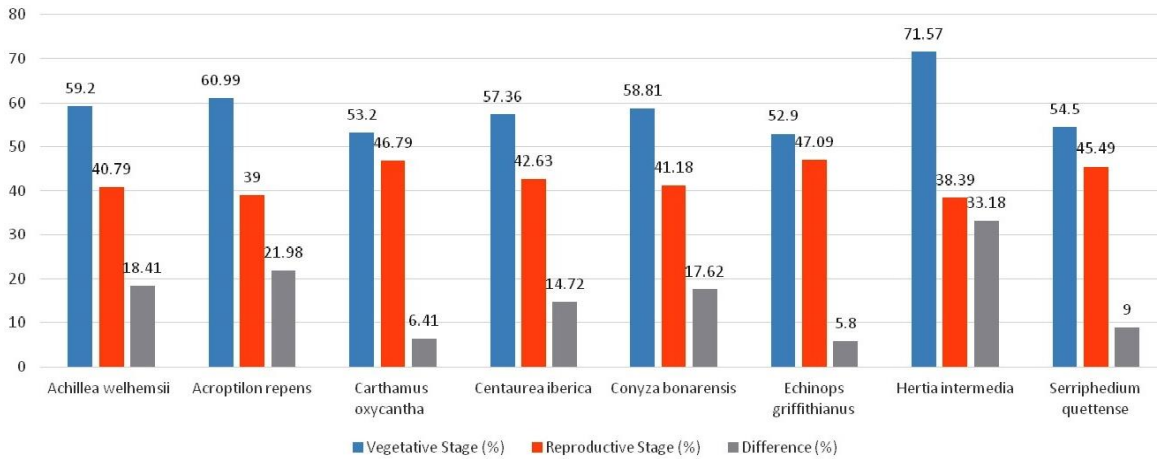

Fig. 1: Nitrogen percentage at vegetative and reproductive growth stages (and their differences) of eight wild plant species of Asteraceae found in Quetta.

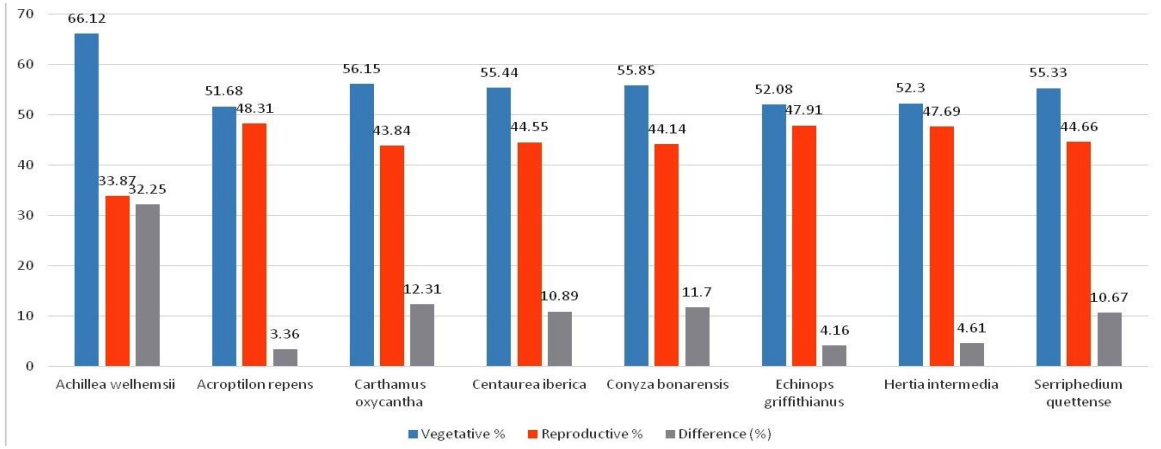

Fig. 2: Phosphorus percentage at vegetative and reproductive growth stages (and their differences) of eight wild plant species of Asteraceae found in Quetta.

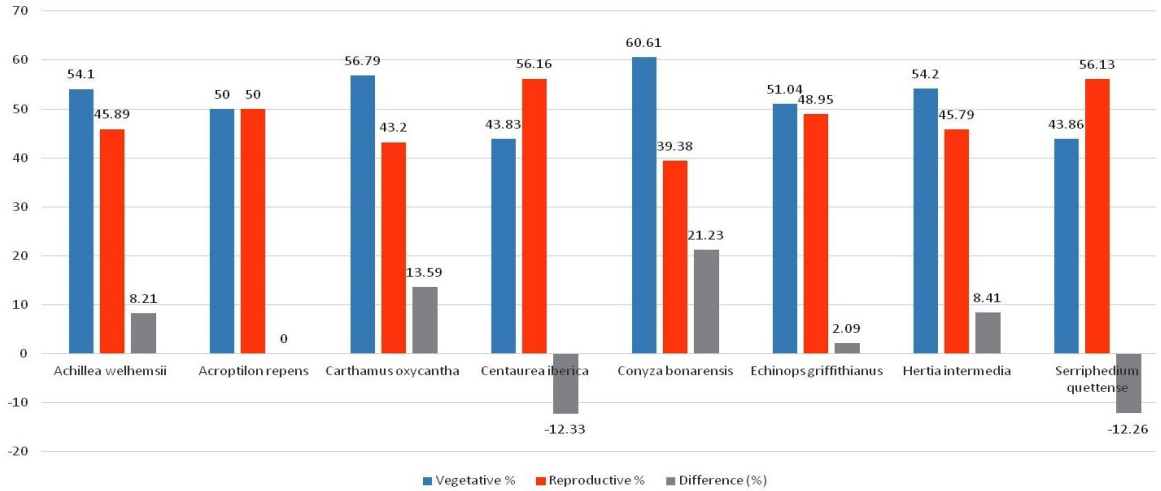

Fig. 3: Potassium percentage at vegetative and reproductive growth stages (and their differences) of eight wild plant species of Asteraceae found in Quetta.

Table-1: Results of general factorial ANOVA for distribution of mineral nutrients (N, P, K, Zn, Mn, Na) at vegetative and reproductive growth stages in eight test plant species of Asteraceae.

Source of variation	D F	Nitrogen (mg g^{-1})			Phosphorus (mg g^{-1})			Potassium (mg g^{-1})			Zinc (mg g^{-1})			Manganese (mg g^{-1})			Sodium (mg g^{-1})		
		SS	MS	F	SS	MS	F	SS	MS	F	SS	MS	F	SS	MS	F	SS	MS	F
Replications	2	0.439	0.2194		0.0650	0.03250		58.875	29.4375		3.04	1.521		215	107.3		2.529E-05	1.264E-05	
Growth Stages (A)	1	93.521	93.5208	1955.71**	2.0008	2.0008	103.19**	6.750	6.7500	2.13**	546.75	546.750	59.51**	7252	7252.1	32.21**	3.333E-07	3.333E-07	0.16NS
Plants (B)	7	42.690	6.0986	127.53**	27.0725	3.86750	199.47**	467.917	66.8452	21.08**	4469.25	638.464	69.49**	95764	136880.6	60.76**	1.106E-04	1.581E-05	7.41**
A × B	7	18.526	2.6465	55.34**	0.4525	0.06464	3.33**	110.583	15.7976	4.98**	253.25	36.179	3.94**	11038	1576.9	7.00**	1.333E-05	1.905E-06	0.89NS
Error	30	1.435	0.0478		0.5817	0.01939		95.125	3.1708		275.63	9.188		6755	225.2		6.404E-05	2.135E-06	
Total	47	156.610			30.1725			739.250			5547.92			121024			2.137E-04		

DF = Degree of freedom, SS = Sum of square, MS = Mean square and F = Fisher's test. While NS = Non-significant, * Significant and ** highly significance at 5% and 1% probability levels, respectively.

Table-2: Pair wise mean comparison for N, P, K, Na, Zn and Mn (mg/g) of eight test plant species of Asteraceae at two different growth stages.

S. No.	Name of plant species	Growth stages	Nitrogen (mg/g)	Phosphorus (mg/g)	Potassium (mg/g)	Sodium (mg/g)	Zinc (mg/100g)	Manganese (mg/100g)	Percent Increase of Vegetative over Reproductive Stage
1	*Achillea wilhelmsii* C. Koch	Vegetative	12.000 ab	1.2333 gh	11.000 fghi	0.0367 bcde	0.2100 gh	1.1433 de	
		Reproductive	8.267 g	0.6333 l	9.333 hi	0.0333 cde	0.1300 i	0.9867 ef	13.84%
2	*Acroptilon repens* (L.) Hidalgo	Vegetative	11.833 bc	2.4667 cd	11.333 fghi	0.0533 abc	0.2733 ef	1.8733 b	
		Reproductive	7.567 h	2.300 de	11.333 fghi	0.0467 abcd	0.1167 hi	1.5700 c	13.14%
3	*Carthamus oxycantha* M. Bieb	Vegetative	9.400 f	3.333 a	15.333 cde	0.0467 abcd	0.2000 gh	2.2167 a	
		Reproductive	8.267 g	2.6000 de	11.667 fgh	0.0633 a	0.1667 hi	2.2567 a	10.21%
4	*Centaurea iberica* Trevir. ex Spreng	Vegetative	11.167 d	2.9000 b	10.667 ghi	0.0367 bcde	0.4667 a	1.8487 b	
		Reproductive	8.300 g	2.3330 d	13.667 def	0.0533 abc	0.4433 ab	1.3233 cd	1.81%
5	*Conyza bonarensis* (L.) Cronquist	Vegetative	10.233 e	2.1000 e	13.333 efg	0.0667 a	0.3667 cd	2.0100 ab	
		Reproductive	7.167 l	1.6667 f	8.667 l	0.0667 a	0.2467 fg	1.1333 de	19.47%
6	*Echinops griffithianus* Boiss	Vegetative	8.500 g	2.5000 cd	16.333 cd	0.0633 a	0.3200 de	1.9433 b	
		Reproductive	7.567 h	2.3000 be	15.667 cde	0.0533 abc	0.2667 f	2.0767 ab	3.00%
7	*Hertia intermedia* Boiss	Vegetative	11.500 cd	3.4000 a	19.333 ab	0.0600 ab	0.4100 bc	1.4633 c	
		Reproductive	7.167 l	3.1000 b	16.333 cd	0.0700 a	0.3533 d	1.3533 cd	12.06%
8	*Seriphidium quettense* (Podlech) Ling, Bull	Vegetative	12.333 a	1.4000 g	16.670 bc	0.0233 de	0.3600 cd	0.8433 fg	
		Reproductive	10.333 e	1.1333 h	21.333 a	0.0133 e	0.3433 d	0.8733 g	-3.66%
	Average values	Vegetative	10.87	2.42	14.25	0.0483	0.3258	1.6677	
		Reproductive	8.08	2.00	13.50	0.0499	0.2583	1.4467	7.74%
	Grand average values		9.475	2.210	13.875	0.0491	0.2920	1.5572	

Concentrations of nutrients (mg/g) in a column with mean values sharing the same letter(s) are non-significantly different at P>0.05.

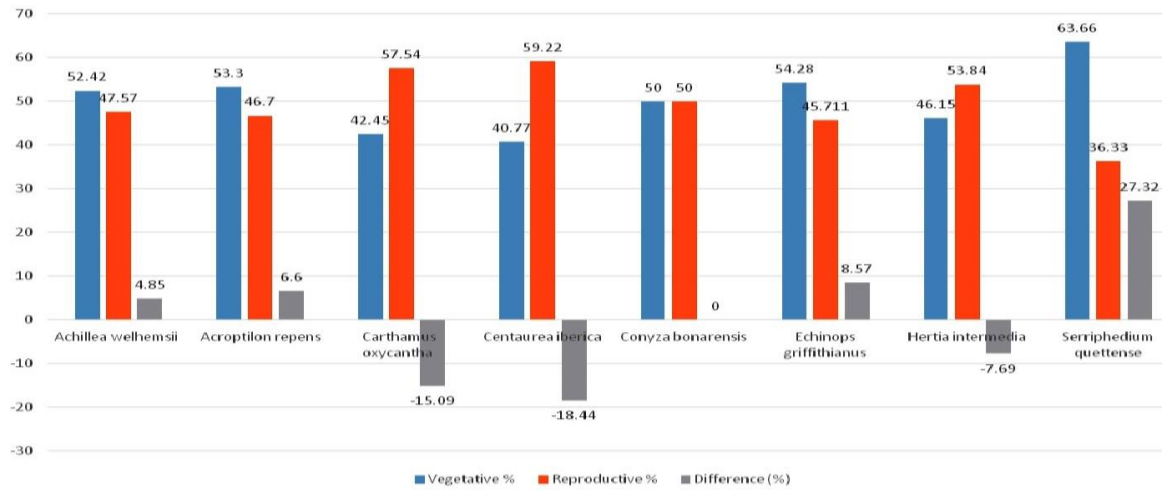

Fig. 4: Sodium percentage at vegetative and reproductive growth stages (and their differences) of eight wild plant species of Asteraceae found in Quetta.

Sodium (Na): Results showed that all test plant species exhibited a mixed trend of Na concentration with respect to their vegetative and reproductive growth stages. Out of eight, four plant species *viz*., *Achillea wilhelmsii* C. Koch; *Acroptilon repens* (L.) Hidalgo; *Echinops griffithianus* Boiss and *Seriphidium quettense* (Podlech) Ling, Bull contained greater concentration of Na in vegetative as compare to their respective reproductive growth stage. While reverse trend for the same is found for *Carthamus oxycantha* M. Bieb; *Centaurea iberica* Trevir. ex Spreng and *Hertia intermedia* Boiss. However, non-significant difference in *Centaurea iberica* Trevir. ex Spreng occurred at either growth stage. While result based on average values, all test plant species produced an increase of 1.62% Na in reproductive compared with those of vegetative stage (Table-2). Results also showed that *Seriphidium quettense* (Podlech) Ling, Bull produced a maximum of 27.32% increase of Na in vegetative over reproductive growth stages. While a minimum difference (4.85%) for the same is recorded for *Achillea wilhelmsii* C. Koch, but no difference in Na nutrient is recorded for *Conyza bonarensis* (L.) Cronquist at both growth stages. However, reverse trend for Na distribution in case of *Centaurea iberica* Trevir. ex Spreng; *Carthamus oxycantha* M. Bieb and *Hertia intermedia* Boiss in term of growth stage is recorded (Fig. 4).

Zinc (Zn): Results depicted that all test plant species contained significantly higher quantity of Zn nutrient in their vegetative when compared it with their respective reproductive growth stage. Statistically maximum significant amount of Zn (46.667 mg $100g^{-1}$) is recorded for *Centaurea iberica* Trevir. ex Spreng. While minimum (20.00 mg $100g^{-1}$) for the same is noted for *Carthamus oxycantha* M. Bieb at its vegetative growth stage. Whereas remaining six plant species were in the order of *viz. Hertia intermedia* Boiss (41.00 mg $100g^{-1}$); *Conyza bonarensis* (L.) Cronquist (36.67 mg $100g^{-1}$); *Seriphedium quettense* (Podlech) Ling, Bull (36.00 mg g^{-1}); *Echinops griffithianus* Boiss (32.00 mg g^{-1}); *Acroptilon repens* (L.) Hidalgo (27.33 mg $100g^{-1}$), and *Achillea wilhelmsii* C. Koch, (21.00 mg g^{-1}). While result based on an average value, all test plant species produced an increase of 11.56% Zn in vegetative than those of reproductive growth stage (Table-2). Results also depicted that *Acroptilon repens* (L.) Hidalgo produced a maximum of 40.15% increase of Zn content in vegetative over reproductive growth stages. While a minimum difference of 2.37% increase for the same is recorded for *Seriphidium quettense* (Podlech) Ling, Bull (Fig. 5).

Manganese (Mn): Like sodium, Mn also exhibited a significant but mixed trend of distribution in term of growth stages. Statistically a maximum significant amount of Mn (225.67 and 221.67 mg $100g^{-1}$) is noted in *Carthamus oxycantha* M. Bieb at both in reproductive and vegetative growth stages, respectively. While minimum (84.33 mg $100g^{-1}$) for the same is noted for *Seriphidium quettense* (Podlech) Ling, Bull at its vegetative growth stage. Whereas, remaining six test plant species of Asteraceae lies in between this range. While result based on an average values of all test plant species produced an increase of 7.08% Mn in vegetative than those of reproductive growth stage. Result also exhibited that based on total values of all mentioned nutrients; vegetative growth stage produced an increase of 7.73% nutrients over reproductive growth stage of all test plant species of Asteraceae (Table-2). Results further enumerated that *Conyza bonarensis* (L.) produced a maximum of 27.89% increase of Mn in vegetative over reproductive growth stages. While a minimum difference of 3.9% increase for the same is recorded for *Hertia intermedia* Boiss. However, reverse is true in case of *Echinops griffithianus* Boiss; *Seriphidium quettense* (Podlech) Ling, Bull and *Carthamus oxycantha* M. Bieb, respectively (Fig. 6).

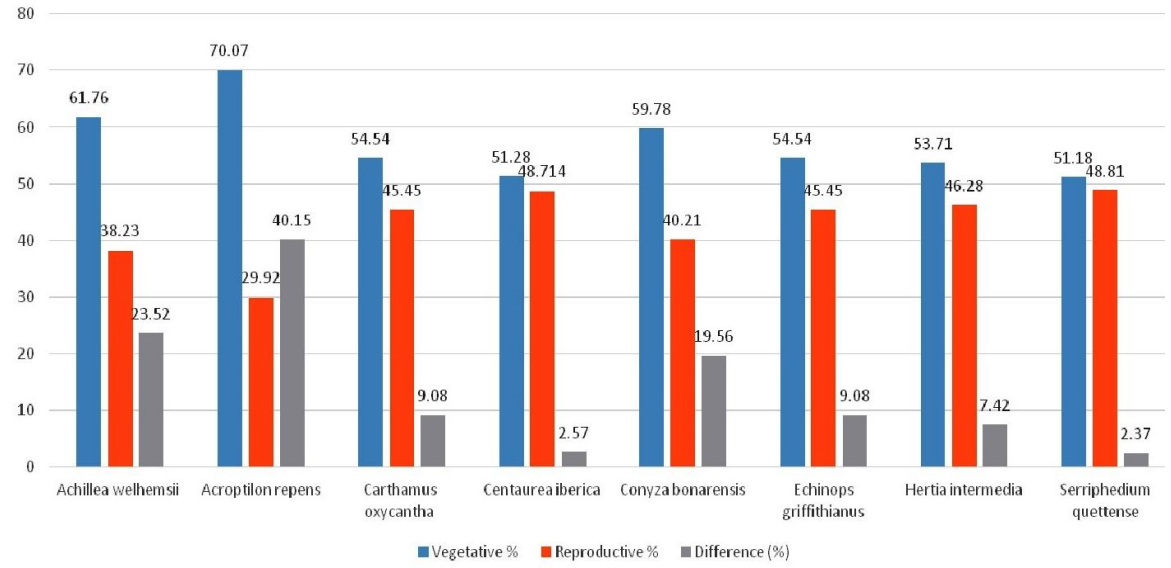

Fig. 5: Zinc percentage at vegetative and reproductive growth stages (and their differences) of eight wild plant species of Asteraceae found in Quetta.

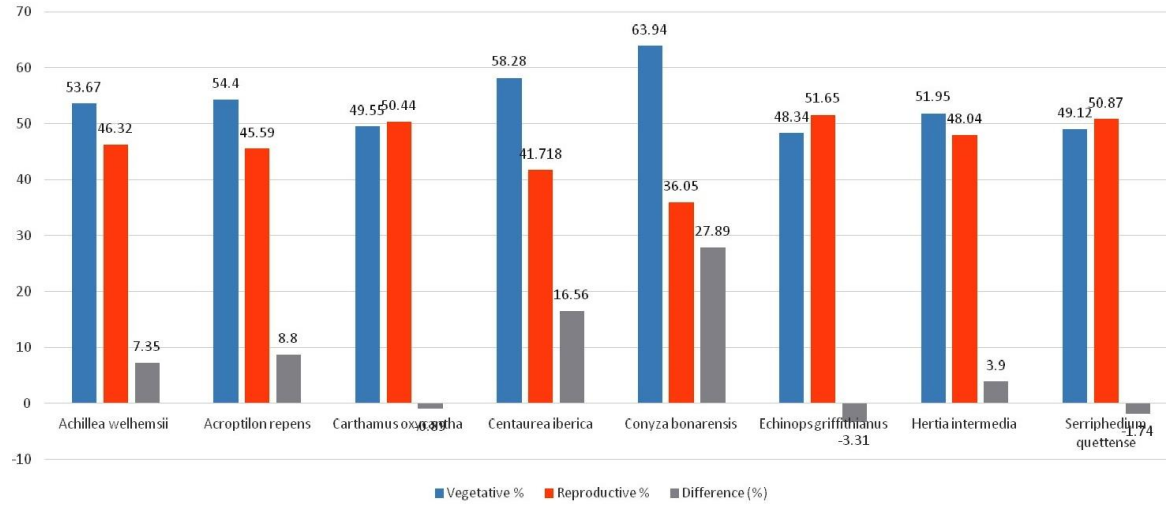

Fig. 6: Manganese percentage at vegetative and reproductive growth stages (and their differences) of eight wild plant species of Asteraceae found in Quetta.

In present study, eight selected plant species *viz. Achillea wilhelmsii* C.Koch, *Acroptilon repens* (L.) Hidalgo, *Carthamus oxycantha* M. Bieb, *Conyza bonarensis* (L.) Cronquist. *Echinops griffithianus* Bioss., *Centaurea iberica* Trevir. ex Spreng., *Hertia intermedia* Boiss, *and Seriphidium quettense* (Podlech) Ling, Bull belonging to plant family Asteraceae were sampled at two growth stages i.e., foliar and reproductive (floral) stages, and analyzed them for their nutritional contents like N, P, K, Na, Zn and Mn. Results of the nutrient analysis and their statistical interpretation generally portrayed a clear picture of distribution of higher levels of above mentioned mineral nutrients at foliar stage when compared with its respective reproductive growth stage. While reverse was true for polyphenols (like flavonoids, phenolics and tannins) of the same test plant species [38]. [18] also observed that except of Na, shoot produced significantly greater amount of N, K, P, Mn and Zn over their respective roots in 4 studied wild plants i.e. *Calligonum polygonoides*, *Cakile maritime*, *Senicio glaucus* and *Zygophyllum album*. They recorded an average of 26.47, 23.15, 3.61, 2.73 mg g^{-1} of N, K, P, Na and 1.59 & 1.05 mg 100 g^{-1} Mn & Zn, respectively. Whereas, the amount of said nutrients in presently studied plants of

Asteraceae were comparatively found much lower than these plants. *Cychorium intybus* (L.) is wild perennial chicory belongs to family Asteraceae. The elemental composition for Ca, Mg, Na, K, Cu, Zn and Mn were also analyzed in the roots, leaves and seeds, which showed that substantial amount of these mineral nutrients, were present with slight variation specific to each plant parts [39]. Difference in botanical structure of a plant and mineral composition of soil can be a reason for differences in concentrations of various analyzed elements. Another reason for the differences in the level of different nutrients can be due to plant's ability to accumulate the elements from surrounding aerial or aquatic environment either for their physiological requirement or as a precautionary measure [40]. During foliar stage i.e., vegetative stage, plants were found with high levels of mineral nutrients (N, P, K, Mn), whereas sodium didn't show any clear cut significant difference in its concentration at both growth stages. Pattern of distribution for Zn was found similar to that of [41]. [42] also reported that concentration of phosphorus is highly affected by seasons. More phosphorus was observed during spring and summer than in autumn and winter. Similar results are also reported by [43] who found P content as 0.22% from tropical crops. Sodium in shrubs is non-significantly different ($P>0.05$) from trees studied. While low sodium content was reported from grasses and legumes (0.09 and 0.06%) as reported by [44]. High sodium content was found during winter season, maximum amount (0.42%) of dry matter (DM) was observed in *C. ambigua* from Hazargangi during this season. High (0.32%) DM was found in *Prunus eburnea* and *Sophora mollis* during winter season from Hazargangi. Lowest amount (0.3%) DM was found in *Perpvskia abrotanoides* from Zarghoon during spring season [45]. Their work supports the present results. As being beneficial element, Na was present in very low concentrations as compared to other macro and micro nutrients but being helpful in stress tolerance; its level was comparatively high when plant was at flowering. Results are also in agreement with statement of [32], who reported that flavonoids, a group of polyphenolic compounds that include tannins are also compounds that chelate metals such as iron and zinc, and reduce the absorption of these nutrients. They also inhibit digestive enzymes and may precipitate proteins.

Conclusions

On the basis of obtained results, it can be concluded that both plant species and growth stages did significantly produce high amount of total mineral nutrients *viz.* N, P, K, Na, Zn, and Mn. Statistically maximum amount of total mineral nutrients were produced by *S. quettense*. While minimum for the same was achieved by *A. wilhelmsii*. However, remaining six plants were in order of *H. intermedia* > *E. griffithianus* > *C. oxycantha* > *C. iberica* > *A. repens* > *C. bonarensis*. It can also be concluded that generally vegetative growth stage comparatively produced greater amount of total mineral nutrients (except *S. quettense*) over than their respective reproductive stage. Statistically maximum increase in total amount of mineral nutrients percentage was produced by *A. wilhelmsii*. While minimum for the same is recorded for *C. iberica*. Therefore, based on the highest amount of total macro and micro mineral nutrients *S. quettense*, *H. intermedia*, and *E. griffithianus* of Asteraceae family at their vegetative growth stage are respectively recommended for feeding of ruminants.

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