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FORAGE EVALUATION FOR SOME TRACE ELEMENTS: A CASE STUDY IN THE SOONE VALLEY, PAKISTAN

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Abstract

A survey was conducted in the soone valley in the north-west of the Punjab Province of Pakistan to assess the concentrations of some essential minerals during the period of whole year in forages for livestock grazing therein. Samples of dominant species of forage plants were taken, which consisted chiefly of legumes, after following the animals. The samples were analysed for Cu, Mn, Fe and Zn. Micro mineral concentrations in the forages for Mn ranged between 3.92-5.09 and 5.90-6.83; Zn; 0.027-0.076 and 0.028- 0.064, Fe; 20.72-25.43 and 25.35-32.94, Cu; 0.38-0.54 and 0.34-0.51 mg g^{-1} in the leaves and pods, respectively. The forage species had varying mineral composition in both leaves and pods. The plants showed significant differences for Zn and Mn contents of leaves and non-significant differences for pods, while Fe exhibited non-significant difference for the plant parts. Based on investigation recorded for Mn, Zn, and Fe contents, it was concluded that the forage plant species studied were found to be palatable and had much higher concentrations of those elements required for the needs of grazing livestock in that specific range and warranted no urgent need of supplementation. The results of the present investigation provide information of reasonable amounts of Mn, Fe, Zn and Cu in forages, which seems to be considerably high. Further investigations for the determination and prevention of toxicosis, if any of these trace elements on animals of the range are urgently needed.

Introduction

Soil is a heterogeneous material comprising solid, liquid and gaseous phase. Solid phase is the main reservoirs of nutrients including Na, Fe, Mn, Zn *etc*., (Davendra, 1993). However, optimal concentration of trace elements is required for various physiological and metabolic processes taking place in the body of organisms (McDowell, 2003). The uptake of these micro-nutrients in plants is essential for plant growth and development (Koike *et al*., 2004). For example Changes in concentration of trace elements in *Prosopis tamarugo* Phil were similar to those in other perennial species, in spite of a high ionic concentration in the soil suggesting high absorption selectivity for these species (Munoz *et al*., 1978). Forage plants are an important source of providing minerals to grazing livestock in extensive and low-input situations. At the same time mineral deficiencies can inhibit forage digestibility and herbage intake and ultimately decreases livestock production efficiency (Provenza, 1995; Khan *et al*., 2005b).

Mineral concentrations vary significantly among species ranging from toxic to inadequate for livestock production. Generally the concentrations in broadleaf plants including leguminous plants are more than those in grasses and other forages (Belesky *et*

al., 2001; Khan *et al*., 2006a). Mineral ion concentration decreases with increase in age both in the case of legumes and grasses (Gonzalez-V *et al*., 2006).

The range of hills extending in an irregular arc from the river Jhelum on the east to the river Indus in the west comprises this salt range covering a length of about 150 miles. It takes its name from the important salt deposits, which are being quarried at present at Khewora, Warchha and Kala Bagh. In the heart of this range lies the Soone Valley. The vegetation of the Soone Valley comprising of, leguminous as well as non-leguminous species, whereas the livestock grazed therein includes cattle, goats, sheep, horses and camels (Ahmad *et al*., 2007).

Keeping in view the importance of mineral nutrients in leguminous species in terms of their nutritional values for ruminants grazing in this particular range, the present research study was undertaken to determine whether the contents of some trace elements such as Cu, Mn, Zn and Fe in the indigenous leguminous species are below or above the critical levels for normal growth of the animals being reared in the Soone Valley the salt range of Punjab, Pakistan.

Materials and Methods

The Salt Range in the Punjab is situated between longitude 71º30′ and 73º30′ E and between the parallels of 32º23′ and 33º N latitude. The average height of the range is about 671 metres above sea level. The highest point on the range is Skasar (1527 metres); throughout its length the salt range shows a typical aspect of having steep cliffs to the south but, descending gently to the plateau to the north (Ahmad *et al*., 2007). In the heart of this Range lies the Soone Valley. The valley climate is characterized by a relatively low annual precipitation (508 mm) and average minimum temperature of 1ºC (January) while average maximum temperature is 36º C (June). Hot dry winds, prolonged periods of drought are frequent and winters are accompanied by frost. Summer and winter both are cooler than those in the neighbouring plains and the winter season is also longer than that in plains (Hussain, 2002).

Vegetation of the Soon Valley was ecologically studied during 2005 to explore the micro mineral contents of forage plants to assess the mineral needs of grazing livestock being met by the forage species. The six feeding sites or pastures within the valley were selected for sampling purpose. The pastures were away from one another at a distance of 5 km. The pastures or feeding sites were designated as Pasture A, B, C, D, E & F, respectively. These native pastures comprise leguminous plant species (*Acacia farnesiana, Acacia modesta, Acacia nilotica, Medicago denticulata, Melilotus indica, Sophora mollis, Lathyrus aphaca, Vicia sativa*) as the dominant but grasses (*Cynodon dactylon, Saccharum munja, Saccharum spontaneum, Cyperus rotundus*) make up the bulk of herbaceous cover. Native pastures are the major sources of forage for different ruminants in the valley.

Sample collection: During the survey, grazing animals were followed and forage samples (only leguminous plants) corresponding to those consumed by the ruminants were collected from each pasture. Five samples of different leguminous species, which were predominant in each pasture, were taken four times after an interval of three months. Each sample comprised five sub-samples of each plant species. Collected plant samples consisting of green leaves and pods of all available species were separated for analytical work. The procedures followed were described below:

Table 1. Micro-mineral concentrations (Mean, ± SE) of forages collected from different pastures in the Soone Valley, Punjab, Pakistan.

Pasture type	Parameter	Elements (mg g^{-1}) dry weight							
		Leaves				Pods			
		Cu	Fe	Mn	Zn	Cu	Fe	Mn	Zn
A	Mean	0.54	23.29	3.92	0.076	0.35	28.75	6.01	0.028
	±SE	±0.12	±1.48	±0.24	±0.014	±0.051	±1.81	±0.81	±0.010
B	Mean	0.47	25.43	4.66	0.040	0.46	28.27	6.83	0.046
	±SE	±0.07	±1.11	±0.23	±0.008	±0.071	±1.93	±0.28	±0.010
C	Mean	0.43	21.65	4.01	0.055	0.47	25.35	6.04	0.028
	±SE	±0.07	±0.95	±0.19	±0.007	±0.043	±1.27	±0.39	±0.008
D	Mean	0.52	22.27	4.01	0.061	0.51	28.62	6.28	0.064
	±SE	±0.06	±1.23	±0.22	±0.007	±0.018	±2.69	±0.40	±0.008
E	Mean	0.53	20.72	4.44	0.027	0.34	25.46	5.90	0.052
	±SE	±0.10	±0.94	±0.29	±0.010	±0.089	±1.19	±0.38	±0.011
F	Mean	0.38	22.73	5.09	0.057	0.39	32.94	5.97	0.047
	±SE	±0.06	±1.56	±0.21	±0.009	±0.08	±1.30	±0.27	±0.008

Digestion: Dried ground material of leaves or pods (0.5 g) was taken in digestion tubes and 5 mL of concentrated H_2SO_4 were added to each tube incubated it overnight at room temperature. Then 1/2 mL of H_2O_2 (35%) was poured down the sides of the digestion tube, ported the tubes in a digestion block and heated at 350º C until fumes were produced. They were continued to heat for another 30 minutes. The digestion tubes were then removed from the block and cooled. Then 1/2 mL of H_2O_2 was added in each tube and placed the tubes back into the digestion block. The above step was repeated until the cooled digested material become colourless. The volume of the extract was maintained up to 50 mL in volumetric flasks. The extract was filtered and used for analysis.

Analysis of ions: Copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) were analyzed by atomic absorption spectrophotometer (Perkin-Elmer Model 5000).

Statistical analysis: The data collected were analyzed by the analysis of variance technique. Duncan's New Multiple Range test at 5% level of probability that was used to test the significance of means (Steel & Torrie, 1980).

Results and Discussion

The data regarding micro-mineral contents of all forages pooled and presented in Table 1. Mean forage Mn values ranged from 3.92 to 5.09 mg/g in leaves and from 5.90 to 6.83 mg/g in pods in various plant species. Forage Mn concentrations were higher in pods of forages collected from pasture-D and the lowest level was found in the leaves of forages from pasture A. Overall, Mn levels in both leaves and pods were generally above the critical levels suggested for ruminants (Anon., 1984). Similar levels of plant Mn have already been reported in Florida (McDowell *et al*., 1982; Espinoza *et al*., 1991), and in Pakistan (Khan *et al*., 2006a, 2007).

Ruminants are mostly tolerant of excess Mn in dietary components, but if excessive amount of Mn is taken into body it can produce toxic effects, although Mn is often considered to be least toxic as compared with the other elements. The maximum level of Mn in the diets for various livestock forms has been suggested as 1000 mg kg^{-1} (Anon., 1984), but in our investigation the Mn concentration has been found above this tolerable range suggesting the toxic effect, in grazing livestock therein.

Mean Zn from different species varied from 0.04 to 0.076 mg/g in leaves and 0.028 to 0.064 mg/g in pods. The lowest values were observed in the leaves of forages collected from pasture-B and the highest values in the pods of forages from pasture-D. All mean Zn concentrations were not high enough but were at marginal deficient levels for the requirements of grazing livestock according to the critical levels established by Mayland *et al*., (1980). Zn concentration may occasionally fluctuate in plants but this concentration declines rapidly as plants (Mayland *et al*., 1987; Espinoza *et al*., 1991). Similar values of plants Zn were reported by earlier researchers (Tiffany *et al*., 2001; Khan *et al*., 2005a, 2006b, 2007) in Florida and Pakistan respectively. A concentration of Zn in dietary sources higher than 500 mg kg^{-1} is reported to essentially affect the livestock production and reproduction performance (McDowell & Arthington, 2005). In the present investigations the forage Zn levels were in acceptable ranges to livestock consumption.

Fe concentrations differed from 20.72 to 25.43 mg/g in the leaves of different leguminous plants evaluated and from 25.35 to 32.94 mg/g in pods. The highest Fe concentration was found in pods of forages from pasture-F and the lowest value in the leaves of forages from pasture-E. All mean plants Fe concentrations were higher than the critical levels for ruminants suggested by Jones (1972). The generally high plant Fe concentrations found in this investigation is in disagreement with the values found previously (Reuter and Robinson, 1997; Espinoza *et al*., 1991; Khan *et al*., 2005c, 2006b, 2007). Although Fe is least toxic of all the essential trace minerals for livestock, its maximum tolerable level in the forage/diet is about 1000 mg kg^{-1} (McDowell & Arthington, 2005). In the present investigation very high concentration of Fe has been observed which is far beyond the tolerable concentration for ruminants (McDowell & Arthington, 2005).

The mean forage Cu contents from different forage species ranged from 0.38 to 0.54 mg kg^{-1} in leaves from different pastures stand 0.34 to 0.51 mg kg^{-1} in pods, representing the lowest Cu concentration in the pods of forage species in pasture E and the highest in the leaves of forages in pasture A. Mean Cu forage concentration, however, was sufficient for the requirement of livestock according to critical level suggested by Anon., (1984). Lower than these Cu values have already been reported in Florida by McDowell *et al*., 1982 and Mcdowell, 1985) and in Pakistan by Khan *et al*., (2006b and 2007). It has been reported that higher concentration of Mo and S in forages interferes with Cu absorption (Davendra, 1983). As far as concentration of Cu in forages is concerned, very wide variation has been reported in the tolerance by various forms of livestock to chronic Cu toxicosis (Anon., 1984). Ruminants are more sensitive to Cu toxicity than non-ruminants. The tolerable range of Cu is 100 mg kg^{-1} for cattle and 25 mg kg^{-1} for sheep (Anon., 1984; McDowell & Arthington, 2005). While in our studies the forage Cu was much higher than this range suggesting the occurrence of various disorders in grazing animals.

From all the above discussion it can be concluded that the plant species studied in the present investigation are palatable and contain reasonable amounts of nutritional elements particularly Mn, Fe, Cu and Zn for livestock.

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