Tropical and Subtropical Agroecosystems, 11 (2009): 249 - 253

Tropical and Subtropical Agroecosystems

SHORT NOTE [NOTA CORTA]

ASSESSMENT OF MACRO-MINERALS STATUS IN SOIL, WATER, FEED RESOURCES AND ITS INFLUENCE ON BLOOD PLASMA OF SHEEP AND GOATS IN CENTRAL MIX CROPPING ZONE OF PUNJAB, PAKISTAN

[DETERMINACIÓN DEL ESTATUS DE MACRO-MINERALES EN SUELO, AGUA, RECURSOS ALIMENTICIOS Y SU INFLUENCIA SOBRE EL PLASMA SANGUINEO DE OVINOS Y CAPRINOS EN LA ZONA CENTRAL DE COSECHAS MIXTAS DEL PUNJAB, PAKISTAN]

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SUMMARY

This study was undertaken to assess the effects of season, soil, water and feedstuffs on macro-mineral status of blood plasma of sheep and goats in the central mix cropping zone of Punjab, Pakistan. Five sub-locations were selected randomly from the study area. From each sub-location, 20 blood samples were collected each from adult sheep, goats, kids and lambs, both in winter and summer season (5 sub-locations x 20 blood samples x 2 species X 2 age groups x 2 seasons = 800). In addition a total of 90 feedstuff (5 sub-locations x 9 feedstuff samples x 2 seasons = 90), 6 soil (5 sub-locations x 6 soil samples x 2 seasons = 60) and 6 water samples (5 sub-locations x 6 water samples x 2 seasons = 60) were collected form each sub-location in both the seasons. Lower sodium (Na) and potassium (K) levels were found in soil and feedstuffs of the area. However, in different sources of water, Na values were nearly within the range but K was slightly higher. This was followed by lower plasma Na concentration both in sheep (114.23 $\pm$ 10.21 mEq / L) and goats (121.78 $\pm$ 12.35 mEq / L). However, concentration of K was within the critical limit in sheep (4.05 $\pm$ 0.40 mEq / L) and goats (5.10 $\pm$ 12.4 mEq / L). Plasma Na and K in both species showed effects of season, animal class and interaction of season and animal class ($P \leq 0.05$). Lower calcium (Ca) concentrations were found in soil, feedstuffs and water. A similar trend was observed in plasma Ca concentration of sheep (3.2 $\pm$ 0.98 mg / 100ml) and goats (3.4 $\pm$ 1.26 mg / 100ml) during winter. In contrast, phosphorous (P) was marginally deficient in soil, water and feedstuffs as well as in blood plasma of adult sheep (3.60 $\pm$ 1.32 mg / 100ml) and goat (3.12 $\pm$ 2.02 mg / 100ml) during winter. The levels of Ca and P were marginally deficient in summer season in adult animals. Soil magnesium (Mg) values were slightly higher, whereas, water and feedstuffs were deficient. Blood plasma concentration of Mg was higher many fold both in sheep (5.25 $\pm$ 1.85 mg / 100ml) and goats (4.76 $\pm$ 1.23 mg / 100ml). However, plasma Mg was affected by season and animal class ($P \leq 0.05$).The data were all analyzed using one way ANOVA test and significant differences between means were tested using Duncan's multiple range test. From these blood analyses, we concluded that macro-mineral levels were significantly different ($P \leq 0.05$) in blood plasma of sheep and goats on these areas of Punjab and that animals need supplementation with implication of similar needs for other regions of Pakistan.

Key Words: *Macro-minerals, sheep and goats, feedstuffs, soil and water*

INTRODUCTION

The essentiality of minerals in animal's feed can't be denied as they play crucial role in growth, production, reproduction and normal physiological functions of animal body. However, there is greater degree of uncertainty in the mineral requirements of animals depending upon age, breed, level of production, dietary antagonist, animal adaptation and interrelationship with other nutrients (Engle *et al*., 2001).

In this country, the supply of macro-minerals often comes largely from pasture herbage, hays and straw based diets which are found to be border line to deficient in macro-minerals. Moreover, these are high in silicate, oxalates and tannins which interfere with the utilization of these nutrients (Khan *et al*., 1999). The macro-mineral status of fodder may be altered by plant species, stage of harvesting, season of the year, fertilization application rate, soil type and soil pH (McDowell, 1997). Most soils of Pakistan are generally alkaline and calcareous which are low in phosphorous (P) and adequate in potassium (K). Furthermore, there is great degree of variation in the

mineral profile of water obtained from various sources in different seasons. The P ranged from 7.0-45.0 mg / kg and 10.65-20.30 / kg in river and canal water, respectively and higher during the months of October, November and December. There are other animal factors and mineral interactions as well which also play an important role (Khan, 1999).

For several decades, biochemical measurements of the minerals in soil, water, plant, and animal tissue or fluid have been analyzed but the task is challenging one in view of diverse nature of the soil and agro-climatic conditions. This study was planned to determine macro-mineral levels in the feed, soil, water and to observe their influence on blood plasma level of small ruminants in the central mix cropping zone of Punjab.

MATERIALS AND METHODS

Investigation Area

This study was conducted in five different sites of Okara district of Punjab province. The investigated area was divided into 5 sub-locations on the basis of topography, soil type and livestock availability. Samples were taken once in summer and once in winter and analyzed for P, Calcium (Ca), Sodium (Na), K and Magnesium (Mg).

Feed and Forage Samples Collection

A total of 9 feedstuff samples were taken from each sub-location in both the seasons (5 sub-locations x 9 feedstuff samples x 2 seasons = 90). The representative sample of 1-2 kg was taken and dried in a hot air oven at 100 ^{0}C for 24 hrs, ground in a Willey mill through 1-mm screen and kept in tightly stoppard bottles. The sample of 0.5g was digested, then filtered and diluted up to 100 ml.

Soil and Water Sampling

From each sub-location, 6 soil (5 sub-locations x 6 soil samples x 2 seasons = 60) and 6 water samples (5 sub-locations x 6 water samples x 2 seasons = 60) were collected in both the seasons. Soil representative samples of 1 kg at 15-18 cm depth were collected using soil auger. They were dried at 100^{0}C, ground in a Willey mill through 2mm screen and wet digestion was done for further analysis. For water analyses, 500 ml water was preserved and filtered (Singh *et al*., 2005).

Blood Sampling

From each sub-location, 20 blood samples were collected each from adult sheep, adult goats, kids and lambs, both in winter and summer season (5 sub-locations x 20 blood samples x 2 species X 2 age groups x 2 seasons = 800). Blood samples of 8-10 ml were taken by jugular puncture in sterilized vacutainer containing heparin, then treated with 10% tri-chloro acetic acid, centrifuged at 3000 rpm for 15 minutes and filtered. Na and K in feed, soil, water and blood plasma were analyzed by Flame Photometer, whereas, Mg, P and Ca were analyzed by Atomic Absorption Spectrophotometer (Singh *et al*., 2005).

Statistical Analysis

The data thus obtained was statistically analyzed using one way ANOVA for differences among mean mineral concentrations of different sub-locations and t-test for comparison between species, seasons and age groups. Regression model was used for interactions among different variables. The significant differences between means were tested by Duncan's Multiple Range test (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Calcium, Phosphorous and Magnesium

Both sheep and goats plasma Ca was influenced by season, age group and interactions of season by age group and soil with animal class ($P \leq 0.05$) (Table 1). These findings were in accordance with Khan *et al.* (2005), who reported that the plasma Ca in non-lactating sheep was higher during both seasons than in lactating animals due to more secretion in milk. Similarly, in earlier study McDowell (2003) observed that in lactating sheep, the Ca homeostasis was maintained by increased dietary Ca absorption, decreased urinary Ca excretion and mobilization of bone Ca under the action of parathyroid hormone, calcitonin and vitamin D. Mtimuni *et al.* (1990) observed that assessment of mineral status of animals involved the influence of forage consumed and the soil upon which the forage was grown. Thus, soil-plant-animal system as well as other dietary antagonistic showed significant influence on mineral concentration of blood.

In the current work, plasma P level was highly influenced by the animal class and interaction of season and soil with the animal class and animal age group was also highly significant ($P \leq 0.05$) (Table: 2). These findings were in line with the earlier study conducted by McDowell (1986) in which he determined that Ca, Na and P concentration in the serum indicated marginal deficiency during late dry season. In another study, Masters *et al*. (1993) reported that low P content in the dry season in the forage

material might be due to the low soil P during that season. Orden *et al*. (1999) concluded that the seasonal variation in these elements could be related to the fluctuations in climatic condition and P showed the lowest concentration for the dry season. These findings were also in accordance with the Mtimuni *et al.* (1990) who suggested that the information on interrelationships of the minerals among soil, plants and animals could give the exact profile of the blood plasma minerals in the developing world.

In the current work, Mg level in the blood plasma was influenced by the season and animal class as well as by the interaction of season with animal class and soil with animal class and age group ($P \leq 0.05$) (Table:2). These findings were in accordance with the Khan *et al*. (2003) who observed that excretion of Ca and Mg through the feaces was maximum during winter than summer, thus less absorption through the gastro-intestinal tract. It might be due to certain interactions and antagonistic role of certain minerals as well as controlling mechanism under the action of hormones. In another study, Khan *et al*. (2003) observed that livestock fulfilled majority of their minerals requirements from the forages which uptake these essential nutrients from the soil.

Potassium and Sodium

In the present study, plasma K was influenced by the season, animal class and age group as well as interaction of season and soil with animal class and age group ($P \leq 0.05$) (Table: 1). These findings were in accordance with the Khan *et al.* (2003) who found that plasma K was low in goats as compared to other classes which might be due to the secretion of the K through the milk. The seasonal difference in milk K might also be related to the stage of the lactation. In another study, Tiffany *et al.* (2000) reported that the low soil K in the summer might be due to the K leaching with the rain water.

Similarly, Na level was influenced by the season and age group of animals as well the interaction between the season and animal class and soil with animal class and age group was highly significant ($P \leq 0.05$) (Table: 1). These results were in accordance with the Khan *et al.* (2003) who observed higher amount of plasma Na in sheep and goats during the winter than in the summer. Furthermore, the deficient level of plasma Na was most likely to be occurred during lactation due to Na secretion in the large quantities in the milk as well as through the sweat or due to low Na content in the pasture. McDowell (2003) reported that age and class of animals could effect requirements of minerals through changes in the efficiency of absorption. Similarly, San Martin and Bryant (1989) found that soil-plant relationship with the animals influenced a lot towards this flow of minerals from the soil to the blood plasma by altering their concentrations in the forages.

Conclusion

The investigation on macro-mineral status suggested that Ca, Na, P and K were deficient in soil as well as in plasma of sheep and goats, however, Mg was slightly higher in soil, feedstuffs and blood plasma. This trend in both seasons was influenced by the age group of animals as well as the soil-plant-animal interrelationship. Therefore, supplementation with an area specific mineral mixture is needed to cope up deficiency.

Acknowledgement

Pakistan Agriculture Research Council for funding to conduct this study.

REFERENCES

Engle, T.E. 2001. Trace minerals, vitamins and preventative nutrition. Feedstuffs. 73, 11-18.

Khan, G.S., Ikram, M, Gondal, M.Z. 1999. Evaluation of water quality of Ravi and Chenab rivers and their sediments. J. Drain. Wat. Manag. 3, 48-55.

Khan, Z.I., Ashraf, M., Ashraf, M.Y., Rahman, Z., Hussain, A. 2003. Evaluation of potassium status of grazing goats in south Punjab, Pakistan. J. Anim. Vet. Adv. 2, 375-381.

Khan, Z.I., Hussain, A., Ashraf, M., Ashraf, M.Y., McDowell, L.R. 2005. Macromineral status of grazing sheep in a semi-arid region of Pakistan. Small Rumin. Res. 68, 279-284.

Masters, D.G., Purser, D.B., Yu, S.X., Wang, Z.S., Yang, R.Z., Liu, N., Lu, D.X., Wu, L.H., Ren, J.K., Li., G.H. 1993. Mineral nutrition of grazing sheep in Northern China. 1 Macro-minerals on pasture feed supplement and sheep. Asian-Aust. J. Anim. Sci., 6, 99-105.

McDowell, L.R. Conrad, J.H., Ellis, G.L. 1986. Mineral deficiencies and toxicities of tropical forages for grazing livestock. In: International Rangeland Development Symposium, Orlando, FL. pp. 139-146.

McDowell, J.K. 1997. Minerals for grazing ruminants in tropical regions. Extension Bulletin, third ed. Department of Animal Science, Center for Tropical Agriculture, University of Florida, Gainesville, Florida, USA. pp. 1–81.

McDowell, L.R. 2003. Minerals in animals and human nutrition (2nd ed.), Elsevier Science, Amsterdam. pp. 644.

Mtimuni, J.P., Mfitilodze, M.W., McDowell, L.R. 1990. Interrelationships of minerals in soil-plant-animal system at Kuti Branch, Malawi. Commun. Soil Sci. Plant Anal., 21, 415-427.

Orden, E.A., Serra, A.B., Serra, S.D., Aganon, C.P., Cruz, L.C., Fujihara, T. 1999. Mineral concentration in blood of grazing goats and some forage in Lahar-Laden area of Central Luzon, Philippines. Asian-Aust. J. Anim. Sci. 12, 422-428.

San Martin, Bryant, F.C. 1989. Nutrition of domestic South American llamas and alpacas, Small Rumin. Res. 2, 191-216.

Singh, D., Chhonkar, P.K., Dwivedi, B.S. 2005. Manual for soil, water, plant and fertilizer analysis. Westville Pub., New Delhi, India. pp. 117-142

Steel, R.G.D., Torrie, J.H. 1997. Principles and Procedures of Statistics, second ed. McGraw-Hill Book Co Inc., New York, USA.

Tiffany, M.E., McDowell, L.R., O'Connor, G.A., Nguyen, H., Martin, F.G., Wilkinson. N.S., Cardoso, E.C. 2000. Effects of pasture-applied biosolids on forage and soil concentrations over a grazing season in North Florida. I. Macrominerals, crude protein and *in-vitro* digestibility. Commun. Soil. Sci. Plant Anal., 31, 201-213.

Table 1: Concentrations of sodium, potassium and calcium in blood plasma of sheep and goats with relation to season, soil, water and feedstuffs

Variables	Significance of season, soil, animal specie or age group	Interaction of soil with animal species and age group	Interaction of season with animal species and age group	Seasons	Animal class			
					Sheep		Goat	
					Adult	Lambs	Adult	Kids
Na^+, C.L: 152 mEq/L	S*, A**, G*	SiA**, SiG**	SA*, SG:ns	Winter	120.96 ± 11.42	131 ± 13.50	128.96 ± 8.12	129 ± 12.0
				Summer	107.50 ± 9.0	120 ± 9.75	114.60 ± 16.58	121 ± 10.50
K^+, C.L: 5.4 mEq/L	S*, A**, G*	SiA**, SiG**	SA**, SG**	Winter	4.12 ±.32	4.41 ± 2.78	5.42 ± 1.04	5.6 ± 1.25
				Summer	3.98 ± .48	4.1 ± 0.72	4.78 ± 1.44	4.91 ± 1.78
Ca^{2+}, C.L: 13mg/100ml	S*, A:ns, G**	SiA** SG:ns	SG** SA:ns	Winter	3.2 ± .80	6.53± 1.22	3.4 ± 1.26	7.88 ± 1.97
				Summer	10.23 ± .98	12.77 ± 2.48	9.2 ± 1.20	11.54 ± 1.76

Means are based on 100 samples in each season for each specie and age group (adult and lamb/kid). S: season, A: animal specie, G: age group, SA: season x animal specie, SG: season x age group, ns: non-significant, SA: season x animal specie, SG: season x age group, ±: S.E,
C.L. critical limits: Radostits *et al.,* (2000) *: Significant at 0.05 level., **: Significant at 0.01 level.

Table 2: Concentrations of phosphorous and magnesium in blood plasma of sheep and goats with relation to season, soil, water and feedstuffs

Variables	Significance of season, soil, animal specie or age group	Interaction of soil with animal species and age group	Interaction of season with animal species and age group	Seasons	Animal class			
					Sheep		Goat	
					Adult	Lambs	Adult	Kids
P^{+}, C.L:7.3mg/100ml	A*, S:ns G:ns	SiA*, SiG**	SA**, SG**	Winter	3.60 ± 1.32	3.68 ± 1.01	3.12 ± 2.02	3.40 ± 0.96
				Summer	3.89 ± 1.13	3.91 ± 0.92	3.69± 0.78	3.74 ± 1.22
Mg^{2+}, C.L:2.8mg/100ml	S*, A*, G:ns	SiA*, SiG**	SA*, SG:ns	Winter	4.61 ± 1.62	4.80 ± 1.78	4.27 ± 1.45	4.72 ± 2.73
				Summer	5.89 ± 2.08	5.70 ± 1.67	5.25 ± 1.01	5.67 ± 1.29

Means are based on 100 samples in each season for each specie and age group (adult and lamb/kid). S: season, A: animal specie, G: age group, SA: season x animal specie, SG: season x age group, ns: non-significant, SA: season x animal specie, SG: season x age group, ±: S.E, C.L. critical limits: Radostits *et al.*, (2000). *: Significant at 0.05 level., **: Significant at 0.01 level

Submitted June 17, 2008 – Accepted February 18, 2009