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TIME-COURSE CHANGES IN SELENIUM STATUS OF SOIL AND FORAGE IN A PASTURE IN SARGODHA, PUNJAB, PAKISTAN

KAFEEL AHMAD[1], ZAFAR IQBAL KHAN[1]*, MUHAMMAD ASHRAF[2] ZAHID ALI SHAH[2], ABID EJAZ[2], AND EHSAN ELAHI VALEEM[3]*

[1]*Department of Biological Sciences, University of Sargodha, Sargodha, Pakistan,*
[2]*Department of Botany, University of Agriculture, Faisalabad-38040, Pakistan,*
[3]*Public Private Partnership Unit (PPPU), Planning and Development Department, Government of Sindh, Karachi-74200, Pakistan.*
[*]*Corresponding authors: drzafar10@hotmail.com*

Abstract

This study was carried out to determine the effects of pasture and sampling periods on selenium status of soil and forage at a livestock farm in district Sargodha, Punjab, Pakistan. All animals at this farm received a basal diet consisted of different forage species in the pasture. Soil and forage samples were collected four times on monthly basis and analyzed after wet digestion to determine the selenium concentrations. Soil and forage exhibited very low levels of Se which were far below the critical level for plant growth and animal requirements for various metabolic processes. According to these results, forage and soil selenium concentrations showed both pasture and sampling period effects. High incidence of deficiency was found particularly in some months of sampling compared to the other intervals. These findings suggest the need of application of selenium containing fertilizers for pasture or supplementation with mixture containing selenium for animals being reared therein.

Introduction

Micro-mineral imbalances may affect a multitude of processes in animals including their production, growth, and reproductive potential. These imbalances can be easily recognized and corrected. However, the borderline deficiencies are commonly not identified and may cause a constraint in reproduction potential of the ruminants (Underwood, 1981; Judson *et al.,* 1987). These nutritional imbalances in animals may occur due to very small amounts of these minerals in the soil and forage plants consumed by the animals. These deficiencies/toxicities are often encountered in grazing ruminants which are mostly dependent on pasture and locally grown feed for fulfilling all their mineral requirements. Sometimes, these imbalances occur due to interactions between various elements or between elements and other nutrients in the body of animal (Masters *et al.*, 1993). In Pakistan, micro-element imbalances affect both ruminant production and animal health. Khan *et al*., (2005) in an investigation found deficient Se level in soil, plant-animal system and reported that pastures contained Se concentrations less than the requirements of grazing livestock (Anon., 1990). Such estimates of requirements usually include a safety margin and are not often related to deficiency symptoms in ruminants. The low concentrations of selenium in forages are reflected in animal tissues. The marginal selenium deficiency in reproducing sheep commonly causes reduced growth of wool, fibre diameter and affects lambs at birth and weaning (Masters *et al.,* 1993). The minimum requirement of selenium for sheep is between 30-50 µg/kg. Low level of selenium has been reported to cause white muscle disease in lambs (Davis *et al.,* 2008). There are various reports on animals with selenium concentrations below the critical level

of 20µg/L during dry season of the year and low contents of forage selenium often responsible for low level in plasma of the ruminants. Deficiency in selenium is a debilitating problem to take seriously into consideration as it has been reported to contribute to the occurrence of various disorders in sheep (Langlands *et al.,* 1986; Masters *et al.,* 1993). The selenium requirement for livestock most often has been reported to be 0.10 ppm to maintain its normal level for different metabolic processes in the living system (Anon., 1985) and it has also been suggested that the difference between the minimum required and maximum tolerable level (5 ppm) is very narrow in range in livestock (Anon., 2005; Davis *et al.,* 2006; 2008). Various complications have been reported to be arisen due to deficiency of Se in newborn ruminants which may seriously reduce the profit margin of the farmers or stockers in different parts of the world (McDowell & Arthington, 2005). In developing countries, the ruminants are often under backyard management, where they depend mainly on available grasses and other forages and crop residues. The micro-minerals derived from these feedstuffs are commonly insufficient to meet the requirement, and these ruminants usually do not receive supplementation at the animal farms. As a consequence, the livestock do not show symptoms of mineral deficiencies such as copper, selenium and zinc (Serra *et al.,* 1997). Therefore, for prevention of complications or disorders caused by Se deficiency in various classes of ruminants, its requirement can be fulfilled through supplementation for grazing ruminants. Most studies done in the past were on grazing ruminants and forages in areas structurally different, but in this animal ranch there have been limited efforts to appraise the selenium status of soil, forage and animals being reared there. Keeping in view the importance of selenium to livestock, this investigation was carried out to evaluate the selenium status in soil and forages in order to ascertain whether the Se requirements of livestock are adequate.

Materials and Methods

The present study was carried out at an Agricultural farm “Chak NO.102NB” located approximately 15 km in the north of Sargodha, Punjab, Pakistan. Average annual rainfall was 200 mm, and daily temperature ranged from 4º C in winter to a high of 50º C in summer. Two replicate pasture plots (Pasture I and Pasture II) were located in the grazing region. The soil of the two pastures was loamy in texture. The predominant pastures were mostly legumes and grasses available to animals throughout the study period. Two pastures at a distance of 0.5 km were selected for soil and forage sampling. Soil and forage samples were taken randomly from three different places/locations within each pasture in five replications. The collected forage plants were from mostly grown species that were most frequently grazed by the animals in this ranch. Forages were harvested four times during each sampling period after one month interval. Forage plants were dried at 60º C to constant dry weight and ground to pass through a 1 mm sieve for chemical analysis. Ground samples were stored in appropriate sample bags until their analysis. After grinding and sieving, the soil selenium concentration was extracted following Rhue & Kidder (1983).

After wet digestion with nitric and perchloric acid, Se in forage samples was analyzed by the fluorometric method of Watkinson (1966). Data on soil and forage species during each season were pooled after chemical analysis to appraise the status of soil Se and the requirements of selenium for animals in forage as established by Anon. (1985). Data were analyzed statistically following Steel & Torrie (1980). Significant levels ranged from 0.05 to 0.001.

Results and Discussion

Results of soil and forage analyses for Se related to pasture and sampling period are presented in Table 1. Mean soil Se contents ranged from 0.05—0.10 mg/kg in pasture I and from 0.032—0.09 mg/kg in pasture II among all sampling periods during this survey. Lower levels ($p<0.05$) of soil Se were observed in October in pasture I and January in pasture II. Mean soil Se concentrations above the critical value of 0.1mg/kg (McDowell et al. 1984) were found during all months in both pastures. On this basis, approximately 100% of all soil samples analyzed were Se deficient. Similar low levels of soil Se have all ready been reported by Khan *et al*., (2005, 2008b) from a similar animal ranch in another area of Punjab, Pakistan, McDowell *et al*., (1989) and Pastrana *et al*., (1991) in Florida while working on tissue mineral levels of grazing cattle in relation to soil and forage trace mineral contents.

Forage Se varied from 0.08 – 0.10 mg/kg in pasture I and from 0.11 – 0.18mg/kg in pasture II. Forage Se concentrations were high during January in pasture I and during October in pasture II. However, mean forage Se concentration was higher ($p<0.01$) in pasture II than that in pasture I. All mean forage Se levels except those during January in pasture II were below the critical value of 0.10 mg/kg as suggested by McDowell *et al*. (1984). Mean forage values were higher than those recorded by Tiffany *et al*., (2000), McDowell *et al*., (1989) in Florida and Khan *et al*., (2005, 2008a) in Pakistan. Conversely, mean forage Se levels recorded in the present survey were significantly lower than those reported previously by Youssef *et al*., (1999) in West Indies. Dietary Se requirements of different ruminant forms according to Anonymous (1980) range from 0.10 to 0.30 mg/kg and it has also been established by Stowe *et al*., (1998) that the high Se concentration of 0.3 mg/kg for dairy livestock as suggested by Anonymous (1989, 2005) is often warranted to alleviate the problem of deficiency of Se in grazing livestock, particularly in calves and other young animals to enhance the potential of the viability and passive immune responsiveness (Youssef *et al*., (1999). The low level of Se in forages found in the present investigation may indicate the hazards of poor reproduction capabilities and other related problems to reproduction in animals. Based on the results of soil and forage analyses, it was plausible to conclude that the Se deficiency may be a limiting factor for livestock production in the studied livestock farm. Therefore, soil amendment with fertilizer containing Se in available form must be done to amend the soil and forage Se levels. Furthermore, there is a dire need of supplementation studies to assess the requirements and economic returns of Se supplementation to livestock grazing therein at the livestock farms.

Table 1. Soil and forage selenium levels (mg/kg d.wt) as related to pasture and sampling periods.

Variable soil	Critical value[a]	Sampling periods			
		I	II	III	IV
Pasture-I	0.5	0.05±0.001	0.07±0.003	0.09±0.002	0.10±0.003
Pasture-II		0.03±0.002	0.04±0.002	0.05±0.001	0.09±0.003
Forage	0.10	0.09±0.004	0.08±0.003	0.07±0.002	0.10±0.002
Pasture-I		0.18±0.005	0.11±0.002	0.12±0.003	0.15±0.005
Pasture-II					
n[c]		20	20	20	20

[a=].McDowell et al. (1984),[c=]No. of observations

References

Anonymous. 1985. *Nutrient Requirements of Domestic Animals. Nutrient Requirements of Sheep* (6th. Revised edn). National Academy of Science-National Research Council, Washington, D.C., pp.50

Anonymous. 1990. *Feeding Standards for Australian Livestock*. Standing Committee on Agriculture Ruminants. CSIRO: Melbourne.

Anonymous. 1996. *Nutrient Requirements of Domestic Aanimals. Nutrient Requirements of Beef Cattle*. 7th. Ed., National Academy of Sciences-National Research Council, Washington D.C., 1-242 pp.

Anonymous. 2005. *Mineral Tolerance of Domestic Animals*, 2nd Ed. National Academy of Sciences-National Research Council, Washington, D.C.

Anonymous.1980. National Research Council, Mineral tolerance of Domestic Animals, Washington, DC, National Academy of Sciences.

Anononymous.1989. National Research Council. Nutrients Requirements of Domestic Animals: Nutrients Requirements of Dairy Cattle, 6th edn, Washington, DC. National Academy of Sciences.

Burk, R.F and K.E. Hill. 2000. Trace elements in man and animals-10. In: (Eds.): P.W. Fisher, M.R. Labbe, K.A. Cockell and R.S. Gigson. 10th (Ed.), Kluwer Academic/ Plenum Publishers, NY., 837 p.

Davis, P.A., L.R. McDowell, N.S. Wilkinson, C.D. Buergelt, R. Van Alstyne, R.N. Weldon and T.T. Marshall. 2006. Effects of selenium levels in ewe diets on selenium in milk and the plasma and tissue selenium concentrations of lambs. *Small Ruminant Research,* 65: 14-23.

Davis, P.A., L.R. McDowell, R. Van Alstyne, T.T. Marshall, C.D. Buergelt, R.N. Weldon and N.S. Wilkinson. 2008. Effects of form of parental or dietary selenium supplementation on body weight and blood, liver and milk concentrations in beef cows. *The Professional Animal Scientist*, 24 52-59.

Judson, G., I.W. Caple, J.P. Langslands and D.W. Peter. 1987. Mineral nutrition of grazing ruminants in southern Australia, *Temperate Pastures-Their Production, Use and Management*. (Eds.): J.L. Wheeler, C.J. Pearson and G.E. Robards. Australian Wool Corporation/CSIRO, Melbourne, pp. 377-384.

Khan, Z. I., M. Ashraf, A. Hussain. H. W. Koyro and B. Huchzermeyer. 2005. Seasonal variation in the status of selenium in goats grazing native and improved pastures in a semiarid region of Pakistan. *Deutsche Tierarztliche Worchenschrift*, 112: 460-465.

Khan, Z.I., A. Hussain, M. Ashraf and L.R. McDowell. 2008a. Assessment and comparison of blood plasma mineral concentrations of different classes of grazing sheep. *Trace Elements and Electrolytes*, 25: 7-13.

Khan, Z.I., M., Ashraf, M. Danish, K. Ahmad and E.E. Valeem. 2008b. Assessment of selenium content in pasture and ewes in Punjab, Pakistan. *Pakistan Journal of Botany*, 40(3): 1159-1162.

Langlands, J.P., J.E. Bowles, G.E. Donald and A.J. Smith. 1986. Selenium excretion in sheep. *Australian Journal of Agricultural Research*, 37: 201-209.

Masters, D.G., D.B. Purser, S.X. Yu, Z.S. Wang, R.Z. Yang, N. Liu, L.H. Wu, J.K. Ren and G.H. Li. 1993. Mineral nutrition of grazing sheep in Northern China. II. Selenium, copper, molybdenum, iron and zinc in pasture, feed supplements and sheep. *Asian-Australian Journal of Animal Science*, 6: 107-113.

McDowell, L.R. and J.D. Arthington. 2005. *Minerals for grazing ruminants in tropical regimes*. Bulletin (4th ed.). University of Florida, Ginessville, pp. 1-86.

McDowell, L.R.,Y.Salih.,J.F.Hengton.,R.M.Mason-Jr and C.J.Wilcox.1989.Effecct of Mineral Supplementation on Tissue Mineral Concentration of Grazing Brasman Cattle. II.Trace Minerals. *International Journal of Animal Science*, 4: 6-13.

McDowell, L.R. 2003. *Minerals in animal and human nutrition*. 2nd Ed., University of Florida, Gainesville, 235-276 pp.

Pastrana,R.,L.,R.Macdowell.,J.H.conrad and N.S.Wilkinson.1991.*Mineral status of sheep in the Paramo Region of Colombia.II.Trace minerals. Small* Ruminants Research, 5: 23-24.

Serra, A.B., E.A. Orden, L.C. Cruz, T. Ichinohe and T. Fujihara. 1997. Trace mineral nutrition of Philippine goats and sheep. Constraints and potential. In: *Rumen Microbes and Digestive Physiology in Ruminants*. (Eds.): R. Onodera, H. Itabashi, K. Ushida, H. Yano and Y. Sasaki. Japan Science Society Press. Tokyo. pp. 179-187.

Rhue, E.D.and G.Kidder.1980.Analytical Procedures Used by the IFAS Extension Soil Testing Laboratory and Interpretation of Results. Soil Science Department, University of Florida, Gainesville, FL.

Steel, R.G.D. and J.H. Torrie. 1980. *Principles and procedures of statistics*. A Biometrical approach (2nd Ed.). Mcgraw Hill Book Co. New York.

Stowe ,W.H.,J.W.Thomas.,T.Johnson.,JB.Martenuih .,D.A.Morrow and D.E.Ullray.1988.Response the of Dairy Cattle to long term and short term supplementation with oral Selenium and Vitamin E. *Journal of Dairy Science*, 71: 1830-1839.

Tiffany, M.E., L.R. Macdowell, G.A.O. Connor, H. Nguyen, F.G. Martin, N.S. Wilkinson and E.C. Cardoso. 2000. Effects of pastures applied bio-solids on forage and soil concentration over a grazing season in North Florida. II. Micro-minerals. *Communication in Soil Science and Plant Analysis*, 31: 215-227.

Underwood, E.J. 1981. *The mineral nutrition of livestock*. Commonwealth Agricultural Bureaux, Slough, England, p. 10.

Underwood, E.J and N.F. Suttle. 1999. *The Mineral Nutrition of Livestock*. (3rd ed.). Midlothian, UK, 283-392 pp.

Watkinson, J.H. 1966. Semi-automated fluorometric determination of selenium in biological materials with 2,3 diaminonaphthalene. *Analytical Chemistry*, 38: 92-97.

Youssef, F.G., L.R. Macdowell and R.A.I. Brathwail. 1999.The status of certain trace minerals and sulphur of some tropical grasses in Trinidad. *Tropical Agriculture (Trinidad*), 76: 57-62.

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