Short Paper

Selenium and iodine status of sheep in the Markazi province, Iran

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Summary

The aim of this study was to provide preliminary quantitative information on selenium and iodine status of sheep in Markazi province, Iran. Selenium and iodine status of grazing sheep were measured for 57 different flocks in 14 regions over one year. The districts were selected to represent major sheep growing areas in the province. Blood samples were collected from 2 to 3-year-old ewes during summer, autumn and winter. Samples were analyzed for blood glutathione peroxidase (GSHpx) activity and plasma inorganic iodine. There were significant differences between regions and seasonal differences in terms of blood GSHpx activity and plasma inorganic iodine concentration (P<0.01). Low levels of GSHpx activity (<60 IU/gHb) and plasma inorganic iodine (<5 µg/dl) in some regions or some seasons indicated the need for dietary supplementation of these minerals.

Key words: Sheep, Nutrition, Mineral, Selenium, Iodine

Introduction

Living organisms depend on minerals for proper function and structure. Mineral imbalances (deficiencies or excesses) in soils and forages have long been held responsible for the low production and reproductive problems of the grazing ruminants (McDowell and Arthington, 2005). Selenium is an essential constituent of glutathione peroxidase (GSHpx) that aids in protecting cellular and subcellular membranes from oxidative damage (Rotruck *et al*., 1973). The only known role of iodine is in the synthesis of thyroid hormone. Selenium deficiency depresses the activities of type I and type II, 5'-iodothyronine deiodinase in animal tissues and may exaggerate the iodine deficiency through impairing the conversion of tetraiodothyronine (T_4) to triiodothyronine (T_3) (Yuming *et al*., 1995). Iodine concentrations lower than 100 µg/L in cattle and small ruminants were reported as a sign of insufficient iodine intake (Bobek, 1998).

A primary reason for determining the selenium (Se) and iodine (I) status of an animal is to establish whether that animal is being adequately nourished with Se and iodine.

Markazi province (Fig. 1) has about 1.4 million head of sheep. Sheep production systems in this province vary between regions and seasons, with similar patterns in all regions. Sheep feeding is based mainly on existing natural resources obtained directly by grazing. Breeding ewes run on pasture during spring with feed supplements in winter. In Markazi province, like other provinces in Iran, grazing livestock often do not receive mineral supplements. Mineral supplementation, if any, is limited to common salt.

It has been reported that trace element imbalances, along with poor husbandry and inadequate diets, frequently contribute to sub-clinical deficiencies in grazing ruminants (Conrad *et al*., 1980). This is particularly true in small holder grazing areas where there is no supplementation.

Despite some reports of deficiencies of minerals in sheep, there are no published data on the incidence or severity of mineral deficiency in Markazi province.

On the basis of clinical reports (Anon., 2003) the deficiencies of selenium/vitamin E and iodine in this province is probable.

The purposes of this study were to investigate:

1) The selenium and iodine status of grazing sheep feeding on pasture or locally grown feedstuffs.

2) The seasonal changes in mineral status to identify when supplementation is required.

3) The different geographical regions to identify where it is necessary to provide supplements.

Materials and Methods

Animals

Samples were collected from 57 different flocks within 14 regions in Markazi province during three seasons. Sites were chosen to represent the main sheep-producing regions in the province. Sampling periods for selenium status were October (before the breeding season) 2005, February 2006 (late gestation) and June 2006 (end of grazing season), and for iodine status were October 2005 and February 2006, corresponding to the start and end of the grazing season and feeding stages in each region. The numbers of sheep flocks in each site were chosen proportionate to the number of sheep in that site and 5-7 ewes were sampled in each selected flock depending on flock size. The sheep sampled were young ewes during their second pregnancy and lactation (2 to 3-year-old). Samples of 285 sheep were obtained for each of the sampling periods.

Blood samples

After puncture of *v. jugularis*, blood samples were collected in heparinized test tubes. Each sample was divided into two portions: fresh whole blood and plasma. To obtain plasma, a portion of each sample was centrifuged at 3000 rpm for 20 min. Whole blood was utilized immediately for determination of selenium dependent GSHpx activity, and the plasma was frozen at -20°C for plasma inorganic iodine analysis. The GSHpx activity was determined in whole blood by a coupled enzyme assay using a commercially available kit (Ransel, Randox, UK) and the activity was expressed as units per gram haemoglobin. This method is based on that of Paglia and Valentine (1967), in which glutathione peroxidase catalyses the oxidation of glutathione by cumene hydroperoxide. In the presence of glutathione reductase and NADPH the oxidized glutathione is immediately converted to the reduced form with a concomitant oxidation of NADPH to $NADP^+$. The decrease in absorbance at 340 nm is measured (Paglia and Valentine, 1967). Iodine was measured by the ceric-arsenic redox reaction (Benotti and Benotti, 1963; Benotti *et al*., 1965). Whole serum was analyzed to obtain total serum iodine (TI) concentrations, and perchloric acid precipitates of serum were analyzed to determine the protein-bound iodine (PBI) concentration. The formula for calculating the plasma inorganic iodine (PII) is as follows: PII = TI - PBI (Vought *et al*., 1963).

Data analysis

The data were analyzed (Snedecor and Cochran, 1980) by the general linear models (GLM) procedure of the SAS system (SAS Institute Inc., 1987). Differences among means were tested using the Duncan's new multiple range test (Duncan, 1955). A p-value less than 0.05 was considered as statistically significant.

The geographical locations of the sampling points were recorded with global positioning system (GPS). The distribution point maps of selenium and iodine status of sheep were created from point measurements using moving average interpolation technique in ILWIS academic software (Figs. 2 and 3).

Results

Results of GSHpx activity and iodine status of sheep for various regions are presented in Table 1. There were marked

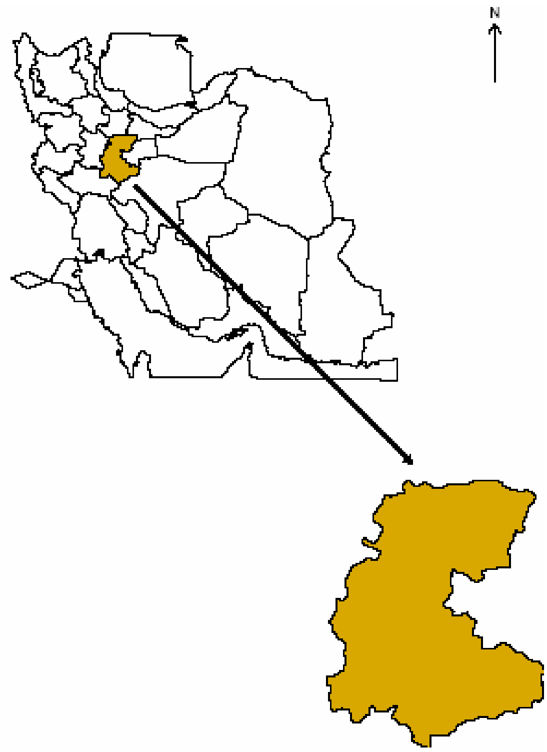

Fig. 1: The location of Markazi province in Iran

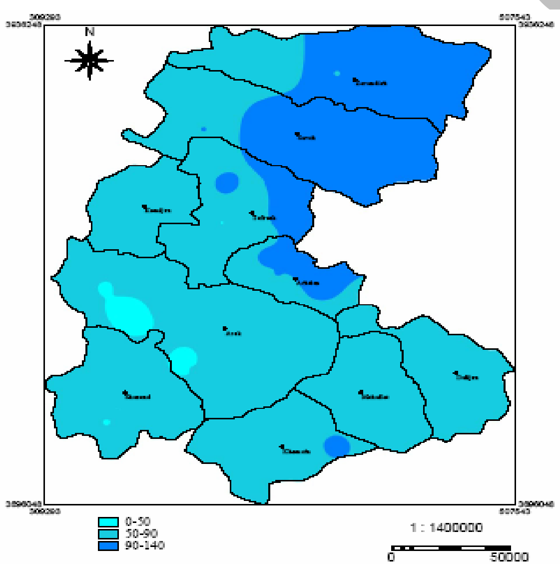

Fig. 2: Selenium status of sheep in Markazi province, Iran

differences between regions in blood GSHpx activity and plasma inorganic iodine. On the basis of the critical reported values (Andrés *et al.*, 1997; Bobek, 1998), two regions could be classified as low in selenium (<60 IU/g Hb), twelve as marginally deficient in selenium (60-100 IU/g Hb), two as deficient in iodine (<5 µg/dl) and five as marginally

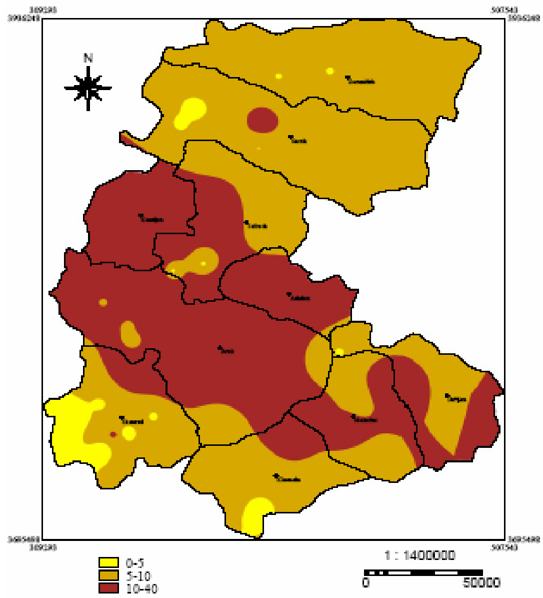

Fig. 3: Iodine status of sheep in Markazi province, Iran

Table 1: GSHpx activity (Mean ± SD) and plasma inorganic iodine (Mean ± SD) of sheep in 14 regions of Markazi province

District	GSHpx activity (IU/gHb)	plasma inorganic iodine (µg/dl)
Saveh	$95.88^{a} \pm 24.86$	$5.70^{de} \pm 5.19$
Tafresh	$95.08^{a} \pm 24.46$	$8.25^{cd} \pm 8.56$
Nobaran	$93.36^{a} \pm 19.59$	$10.67^{bcd} \pm 9.11$
Ashtian	$92.82^{a} \pm 22.91$	$15.64^{b} \pm 16.34$
Delijan	$78.86^{b} \pm 18.34$	$11.80^{bcd} \pm 14.64$
Khomein	$75.25b^{c} \pm 20.36$	$11.16^{bcd} \pm 13.73$
Farahan	$73.49b^{c} \pm 22.35$	$12.07^{bcd} \pm 10.89$
Komijan	$69.79b^{cd} \pm 7.64$	$33.15^{a} \pm 8.73$
Arak	$66.99^{cd} \pm 27.57$	$12.75^{bc} \pm 12.38$
Shazand	$66.06^{cd} \pm 29.68$	$1.68^{e} \pm 6.39$
Mahalat	$65.27^{cd} \pm 15.57$	$10.67^{bcd} \pm 13.87$
Tureh	$61.42^{d} \pm 27.34$	$1.38^{e} \pm 1.97$
Khondab	$46.42^{e} \pm 13.35$	$12.69^{bc} \pm 10.21$
Hendudar	$44.36^{e} \pm 16.20$	$5.51^{de} \pm 10.94$

Means with different superscripts in each column are significantly different (P<0.01)

deficient in iodine (5-10 µg/dl). Figures 2 and 3 represent the selenium and iodine status distribution of sheep in Markazi province, respectively. The lowest selenium status was seen in sheep in the highland areas of the southeast region, while sheep in the lower rainfall areas in the northwest areas had marginal selenium status.

There were significant differences in GSHpx activity and iodine between different seasons (P<0.01). Seasonal differences (P<0.01) were found for GSHpx activity with higher GSHpx activity in autumn and winter in comparison with summer (Table 2), and interactions of season by district were significant (P<0.01). Lower GSHpx activity was seen in the highland areas of the southeast regions in the summer season than in northwest regions in the same season.

The PII concentration in autumn was found to be significantly higher (P<0.01) compared with that in winter (Table 3).

Table 2: GSHpx activity (Mean ± SD) of sheep in different seasons in Markazi province

Variable	Season		
	Winter	Summer	Autumn
GSHpx activity (IU/g Hb)	77.26[a] ±33.93	55.85[b] ±19.21	73.34[a] ±23.03

Means with different superscripts in each row are significantly different (P<0.01)

Table 3: Plasma inorganic iodine (Mean ± SD) of sheep in different seasons in Markazi province

Variable	Season	
	Winter	Autumn
Plasma inorganic iodine (µg/dl)	3.83[b] ±6.89	14.17[a] ±13.08

Means with different superscripts in each row are significantly different (P<0.01)

Discussion

Markazi is a province with relatively large climatic, geographical and vegetation differences so that the mineral status of grazing livestock is likely to differ largely among regions. Analysis of the samples indicated that sheep in some regions of Markazi province have low intakes of selenium/vitamin E or iodine during some seasons.

Natural intake of selenium or iodine by ruminants depends primarily on the geographical position, or more specifically, on mineral concentration in soil. Many naturally occurring deficiencies in grazing livestock can be related to soil characteristics (Andrés *et al*., 1997; McDowell, 2003).

Mineral deficiencies result most often when animals are confined within a given area and are thus closely dependent upon the structure of the soil and the plant life in a very limited space (McDowell, 2003). The soil-plant-animal system is a complex system which has not been investigated adequately in developing countries. The general and well-documented principle of the control of trace element intake by the link soil-plant-animal applies also to selenium and iodine (Campbell *et al*., 1995; Groce *et al*., 1995; Kamada *et al*., 2000).

According to other studies (Stevens *et al*., 1985), there may be wide variations in the serum selenium concentrations and glutathione peroxidase activities in livestock grazing forages even within the same geographical area. Seasonal patterns in the selenium and iodine status of sheep are well recognized. McDowell *et al*. (1989) reported seasonal fluctuations in soil selenium levels, higher in the dry season and lower in the wet season. Our findings are in agreement with other reports that indicate seasonal fluctuations in the GSHpx activity of sheep with lower levels during spring-early summer than in winter (Caple *et al*., 1980; Andrés *et al*., 1999).

Also, mineral requirements are highly dependent on the level of productivity. The reported results show the selenium status of sheep approximately 60 days before sampling time, as current blood concentrations of GSHpx reflect the selenium intake of the animal at the time the present circulating erythrocytes were formed. Thus, the minimum of GSHpx belongs to the late winter and beginning of spring which is coincident with late gestation, lambing and lactation when the selenium requirement of sheep is raised. Also, this period is concurrent with end of feeding of storage, and inferior quality hay or straw with low tocopherol content. The increasing requirements of sheep in selenium/vitamin E in late gestation and lactation (NRC, 2007), and low intake of these nutrients in this period cause seasonal differences in selenium status as shown in this study. Adverse weather conditions, cold and rain may also increase the selenium/vitamin E requirements of sheep and adversely affect selenium status. This may explain the lower selenium status of sheep in the highlands area of the southeast regions with the relatively harsh weather in the winter in comparison with the northwest regions in the same season.

It is clear that sheep in major regions of Markazi province must be able to survive and produce with a 7-month period of low quality forages between June and October. This period of low feed availability is concurrent with the weaning of lambs and drying the ewes till early gestation with no major detrimental effects on productivity. The severity of these problems changes with location and seasons. In some regions, both selenium and iodine status were low. Hendudar is of particular interest as selenium deficiency may be exacerbated at iodine deficiency (Donald *et al*., 1993). Based on experiences with mineral supplements in other areas of the world, the low mineral status would be expected to limit production of sheep.

In summary, this survey suggests that deficiencies of selenium and iodine may be occurring in sheep flocks in parts of Markazi province. However, the results need to be interpreted with caution because critical values derived from foreign breeds applied to native sheep breeds and the preliminary nature of the survey can give only a very crude guide to the seasonal and geographical distribution of deficiency. Information is required on the interrelationship of minerals among soil, plant and animals and more studies are now needed to determine if mineral deficiencies are limiting grazing sheep production. Mineral supplementation studies are needed to evaluate the cost-benefit relationship of providing supplement minerals.

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