SHORT NOTE [NOTA CORTA]

CONCENTRATION OF SOME ELEMENTS IN BLOOD SERUM OF NONLACTATING GOATS IN A SUBTROPICAL REGION OF SOUTHWEST OF MÉXICO STATE

[CONCENTRACIÓN DE ALGUNOS ELEMENTOS MINERALES EN EL SUERO SANGUÍNEO DE CABRAS NO LACTANTES EN UNA REGIÓN SUBTROPICAL DEL SUROESTE DEL ESTADO DE MÉXICO]

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SUMMARY

The objective of this study was to determine the mineral levels in blood serum of nonlactating adult goats in the south of the State of México during the dry and rainy seasons. Eighty four multiparous (>2 calving and non-lactating) does were sampled (LW 39 ± 8 kg). Blood samples were collected by jugular vein punction, followed by separation of blood serum by adding 10% trichloroacetic acid for later laboratory analysis. Data were analyzed as a completely randomized factorial experiment. There was as effect (P<0.05) of season on serum concentrations of P, and there was an interaction (P<0.01) of season*region for Ca, Na, Cu and Zn. Mg was unaffected by treatments. Results suggest possible deficiencies in the diets of P, Ca, Cu and Zn.

Key words: season; blood serum in goats; mineral status.

RESUMEN

El objetivo del presente trabajo fue hacer un diagnóstico mineral en suero sanguíneo de cabras adultas no lactantes de la región sur del estado de México, durante la época de secas y lluvias, se muestrearon 84 hembras (PV 39± 8 kg) multíparas con más de dos años de edad. Las muestras de sangre se obtuvieron por punción directa en la vena yugular. A las muestras de sangre se les obtuvo el suero sanguíneo y este se trato con acido tricloroacetico al 10%, para su posterior análisis en el laboratorio. Para el análisis de los datos se uso un diseño completamente al azar con arreglo factorial. Las concentraciones séricas de P se observaron diferencias significativas (P<0.05) en el efecto de época. Los niveles de Ca, Na, Cu y Zn presentaron diferencias significativas (P<0.01) en la interacción época*región. Para el caso de Mg se observaron que no hubo diferencias significativas en época y municipio así como y en la interacción época*región. Concluyendo que los minerales que se encontraron deficientes fueron P, Ca, Cu y Zn.

Palabras clave: cabras; suero; época; minerales.

INTRODUCTION

Production of goats frequently occurs in regions with low income levels and the milk and meat products are often destined for self consumption (Devendra, 1991; Hernández, 2000 Gallegos et al., 2005). This activity is often carried out by traditional families under traditional extensive systems and use of modern technologies is very low (Devendra, 1988; Hernández, 2005; Cotler et al., 2006). The State of México accounts for 2% of Mexico's national goat inventory (Medrano, 2000; Rebollar et al., 2007), and the south-western region of the state is the most important contributor to Mexican goat meat production. Several studies have shown that the mineral profiles of the local forages very lead

to deficiencies in mineral consumption according to established animal requirements. In particular, mineral levels are reported to be from marginal to deficient relative to requirements for production (NRC, 2007).

Several studies have been completed on the mineral status of cattle and sheep (Dominguez and Huerta 2007; Morales et al., 2007), but there is very little information about goats making it difficult to assess their mineral status, or to determine a mineral supplement (Meschy, 2000). Thus the objective was to determine the mineral status of adult goats based upon their blood serum levels in four localities of the southwest region of the state of Mexico during the dry and rainy seasons.

MATERIALS AND METHODS

Area of samples collection

The study was completed in the Tejupilco, Amatepec, Luvianos and Tlatlaya localities of south-western Mexico State. This region is located between 18º 45' 30" north latitude, and 100º 36' 45" west longitude, at 1330 mosl. Sandy soils is predominant (Table 1) and the climate is classified as tropical sub-humid with rain during summer (García, 1986). Average temperature and relative humidity during the experimental period were 25 ± 5; 33 ± 4 °C and 55 ± 3; 45 ± 4 % for the rainy and dry seasons respectively (Meteorological experimental station of Centro Universitario UAEM-Temascaltepec). In this region of 3534 km^2, the landscape has a very steep slope and the vegetation is relatively homogeneous. During the rainy season, forage biomass is suitable to provide sufficient feed for animals, but during the dry season forage is scarce and a small quantities of grain are also fed to animals.

Animals

Eighty four clinically healthy non-lactating goats from four goat flocks (Tejupilco, Amatepec, Luvianos, Tlatlaya, 21 goats per locality) were used in a grazing study in the in dry and rainy season in the southwest of México state. The average live weights were 39 ± 8 kg. The genotype of the animals was variables degrees of cross breeding. The flocks were kept extensively and fed native forages resources. During the rainy season the goats consumed a variability of forages such as: grasses; *Cynodon plectostachyus*, *Andropogon gayanus*, browse shrubs; Q*uercus laeta, Pithecellobium dulce, Lysiloma acapulsencis, Leucaena leucocephala, Heliocarpus velutinus, Guazuma ulmifolia,* which provide sufficient feed intake for the animals to maintain live weight but, during dry season, these forages are scarce and animals are fed corn stover and some tree foliages such as *Quercus laeta, Pithecellobium dulce* and *Lysiloma acapulsenci.* Producers normally feed the animals small quantities of grains such as corn or sorghum.

Sample collection and preparation

Blood samples were collected from the 84 non-lactating goats described above during the dry (April-May) and rainy (August-September) seasons of 2008. Same goats were sampled in each season. Blood samples were collected by jugular vein puncture with a syringe and needle, and then drawn by vacuum into evacuated tubes. Blood samples were then centrifuged at 3000 rpm for 15 min and plasma was placed into polyethylene tubes and frozen at -20^{o}C. Samples were then prepared for mineral assay according to Fick et al. (1979). Concentrations of Ca, Mg, Na K, Cu and Zn were determined by atomic absorption (Perkin Elmer 210) and P concentration was determined by colorimetry using a spectrophotometer with visible UV.

Statistical analyses

A completely randomized design with a factorial arrangement of treatments (Steel and Torrie, 1980) was used. Factors were season and locality according to the model: $Y_{ijk} = \mu + S_i + M_j + S*M_{ij} + E_{ijk}$, where**:** Y_{ijk} = response variable (P, Na, K, Ca, Mg, Cu, Zn), μ= General mean, S_i= dry and rainy season effect, L_j= Effect of locality (Tejupilco, Luvianos, Amatepec, Tlatlaya), $S*L_{ij}$= interaction of season and locality and E_{ijk}= Error term. Data obtained were analyzed using Statistical Analysis System (SAS, 2006) software and differences among means were ranked using Tukey's test (Steel and Torrie, 1980).

RESULTS

Phosphorous (P), calcium (Ca), magnesium (Mg) and potassium (K) concentration in blood serum

Amatepec locality had the highest P values (4.79 mg/dl), while the rest had similar values ranging from 3.05 to 4.33 mg/dl (Table 2). The Ca concentration was higher during the rainy season (11.20 mg/dl), than during the dry season (9.54 mg/dl). For the rest of the localities, values ranged from 7.81 to 9.54 mg/dl. There were no differences among season or localities of Mg, and values ranged from 2.44 to 2.85 mg/dl. Luvianos locality had the highest Na ($P<0.01$) during the dry season (411.76 mg/dl) and Tejupilco region had the lowest value during the dry season (322.0 mg/dl). The K concentration differed ($P<0.01$) during dry season with Tlatlaya having the highest K value (29.50 mg/dl) and Tejupilco the lowest (17.31 mg/dl).

Table1. Some physicochemical characteristics in the soil of a subtropical region in the south-western of Mexico State

pH	OM	N %	CIC cmol/kg	AD	Texture	EC (µHOS)
5.37	2.94	0,612	45.722	1.0817	sandy	48

OM: Organic matter, N: Nitrogen, ICC: Cationic interchange capacity, AD: Apparent density, EC: Electric conductivity. (Ramírez, 2009).

Table 2. Macromineral concentration (mg/dl) in blood serum of non lactating goats.

Season	Regions	P	K	Ca	Mg	Na
Dry	Tejupilco	3.06 ^{b}	17.31 ^{d}	9.85 ^{b}	2,82	322.00 ^{c}
	Luvianos	3.29 ^{b}	23.96 ^{b}	7.8 ^{d}	2.51	411.76 ^{a}
	Amatepec	3.19 ^{b}	23.49 ^{b}	9.54 ^{b}	2.85	378.33 ^{ab}
	Tlatlaya	3.05 ^{b}	29.50 ^{a}	8.77 ^{bcd}	2.75	385.23 ^{ab}
Rainy	Tejupilco	3.46 ^{ab}	25.84 ^{ab}	8.79 ^{bcd}	2.47	377.90 ^{ab}
	Luvianos	3.92 ^{ab}	18.50 ^{cd}	8.36 ^{bcd}	2.71	360.57 ^{bc}
	Amatepec	4.79 ^{a}	21.94 ^{bc}	11.20 ^{a}	2.68	401.00 ^{ab}
	Tlatlaya	4.33 ^{ab}	23.95 ^{b}	9.33 ^{bc}	2.44	385.38 ^{ab}
Season		0.0001	0.1281	0.0261	0.1102	0.356
Regions		0.1272	<.0001	<.0001	0.5776	0.0005
Season*Regions		0.1828	<.0001	<.0001	0.169	<.0001
SEM		0.307	0.933	0.269	0.134	10.51

Means in same column with different superscripts differ (P<0.05).
SEM= standard error of the mean.

Cupper (Cu) and Zinc (Zn) concentration in blood serum

Tlatlaya had the highest serum Cu concentration during dry season compared with the rainy season (0.192 and 0.080 mg/dl, respectively). The rest of localities had similar Cu concentration rangeing from 0.082 to 0.111 mg/dl. The Zn concentration had the same trend, but their was a season*locality (P<0.0004), with Luvianos having higher concentration during the dry season (0.117 mg/dl) than during the rainy season (0.056 mg/dl) whereas, for the rest of localities, values ranged from 0.059 to 0.096 mg/dl (Table 3).

DISCUSSION

Phosphorous (P), calcium (Ca), magnesium (Mg) and potassium (K) concentration in blood serum

Circulating blood levels of P in small ruminants have been well documented. Levels of P in adult cattle and sheep was range between 4 to 8 mg/dl (NRC, 2007), and McDowell (1997) reported P concentrations in grazing ruminants of 3 to 8 mg/dl, which are considered inadequate. Dominguez and Huerta (2007) reported similar levels, which ranged from 10.7 to 12.1 mg/dl, in animals in an extensive grazing system, which were considered adequate. In our study, there were lower P levels than reported in the literature and it is suggested that the goats could experience productive and reproductive deficiencies caused by the lack of P which could compromise many hormonal, metabolic and structural functions, as well as reduced appetite, which could compromise efficient utilization of the diet (Ternouth, 1990).

Table 3. Microminerals concentration (mg/dl) in blood serum of non lactating goats.

Season	Regions	Cu	Zn
Dry	Tejupilco	0.090 ^{bc}	0.096 ^{c}
	Luvianos	0.111 ^{bc}	0.117 ^{bc}
	Amatepec	0.125 ^{b}	0.159 ^{a}
	Tlatlaya	0.192 ^{a}	0.150 ^{ab}
Rainy	Tejupilco	0.106 ^{bc}	0.098 ^{c}
	Luvianos	0.091 ^{bc}	0.056 ^{d}
	Amatepec	0.082 ^{bc}	0.128 ^{abc}
	Tlatlaya	0.080 ^{c}	0.162 ^{a}
Season		<.0001	0.0034
Regions		0.0006	<.0001
Season*Regions		<.0001	0.0004
SEM		0.010	0.307

Means in same column with different superscripts are differ (P<0.05).
SEM= standard error of the mean.

Calcium is a mineral which is involved in many biological functions in the body. While the structural part of the skeleton contains 98 to 99% of Ca within the body (Underwood, 1981), Ca also functions in soft tissues. Several research studies report blood Ca values of 8 to 12 mg/dl (NRC, 2007; Khan et al., 2007), which contrasts with our findings. Recently, Khan et al. (2007) reported Ca levels between 6.36 and 9.71 mg/dl in adult ewes grazing extensively in semiarid regions of Pakistan. These levels are similar to those we found in Luvianos. Levels reported by Dominguez and Huerta (2007), from adult ewes in the Toluca valley, were similar to those at Amatepec during the dry and rainy seasons.

NRC (2007) for small ruminants reported desirable blood Mg values 1.8 to 3.5 mg/dl, which are lower than those of the non-lactating goats in our four localities. However, Dominguez and Huerta (2007) reported Mg levels of ewes at Toluca valley ranging from 2.1 to 2.9 mg/dl, which are similar to our results.

Blood Na concentrations in small ruminants have been widely reported under conditions where animals were fed exclusively on forages, and it is often used as an indicator of animal mineral status (McDowell, 1997). The NRC (2007) for small ruminants reported normal blood Na levels of 322 to 350 mg/dl. Our goats had higher values suggesting that reproductive or productive problems related to deficiencies of Na were unlikely. This was likely because the goats received common salt on a daily basis as a normal practice (Kawas et al., 1997).

Considering the values reported by the NRC (2007) regarding K (15 to 20 mg/dl), goats from our region would not likely be deficient in this mineral. Dominguez and Huerta (2007), reported levels of 26.1 mg/dl in adult ewes, which are similar to those in our study. However K is a mineral not frequently studied as deficiencies are not common in ruminants (Underwood, 1981), and few studies have been completed using blood serum K as an indicator of K status.

Cupper (Cu) and Zinc (Zn) concentration in blood serum

Among the trace minerals, Cu is one which can be impacted by antagonists which is why blood concentrations are not necessarily a good indicator of animal status (Underwood and Suttle, 1999). In grazing cattle, Cu levels from 0.08 to 0.150 mg/dl were reported (McDowell, 1997; NRC, 2007) but, in goats, Galbraith (1997) reported levels of 0.090 to 0.138 mg/dl. Khan et al. (2007), working with goats grazing native pastures in a semi arid region of Pakistan found that blood Cu levels in summer fluctuated from 0.071 to 0.078 mg/dl, whereas in winter values varied from 0.114 to 0.146 mg/dl. These findings, overall, suggest that the blood Cu values in this study range from deficient to marginal. Copper deficiency, after P, was found to be an important mineral limitation for grazing cattle in tropical regions (McDowell, 1997). Moreover, secondary deficiencies of Cu could be due to interference with other minerals provided in excess, such as Fe, S or Mb in the diet. Immature forages had high levels of S that interferes with Cu absorption (McDowell, 1997).

Normal values of Zn reported by NRC (2007) range between 0.08 and 0.120 mg/dl, whereas Ahmed et al. (2001) determined serum levels of 0.120 to 0.256 mg/dl in Nubian goats. In our study, the goats from Tejupilco, Amatepec and Tlatlaya were above this range, while does from Luvianos could be Zn deficient as a result of levels below the normal range, in particular during the rainy season. Indeed, low Zn levels were associated with high Ca, mainly at Luvianos during the rainy season.

CONCLUSION

Levels of blood P and Ca from the four regions of south western Mexico State during the dry and rainy season had low values, indicating a probable deficiency of these elements. Potassium, and in particular Na, were above levels reported in the literature. With respect of Cu and Zn, non-lactating goats could have reproductive problems due to their deficient to marginal levels in blood serum of these minerals.

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