

Mineral profile of diets consumed by range Spanish goats in a shrubland of North Mexico

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Abstract

The study was conducted to determine mineral concentrations in diets selected by goats grazing a thorn shrubland in a semi-arid region of north Mexico. Three goats (38 ± 1.8 kg BW) fitted with oesophageal cannulae were used to collect monthly extrusa samples from February 1999 to December 2000. Animals were sampled two days each month. Sodium, Ca, Mg, K, Co, Cu, Mn, Zn and Fe, were determined by atomic absorption spectrophotometry. Phosphorus was determined by colorimetry. Data were statistically analyzed by completely randomized design. Macro-mineral concentrations of the forage selected by goats varied between months. Mean concentrations for Na, Ca, P, Mg and K were 5, 8, 3, 3 and 22 g/kg, respectively. Forage concentrations of trace minerals also varied between months. Average concentrations of Co, Cu, Mg, Zn and Fe were 25, 6, 39, 66 and 471 mg/kg, respectively. Results suggest that the concentrations of Ca, P, Mg and K were adequate to meet the requirements of adult range goats for maintenance, pregnancy and lactation. Cobalt, Zn and Fe concentrations also meet the requirements. However, Na, Cu and Mn concentrations in the diet were below requirements. Thus, a supplementation schedule is recommended. The Na and P concentrations should be considered with caution because of the saliva contamination of oesophageal samples.

Keywords: Goats, minerals, scrubland, semi-arid region

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Introduction

Minerals are required for vital cellular processes in the body. Ruminants fed forages are dependent on an adequate supply of a number of minerals to optimize rumen microbial activity (Spears, 1994). Moreover, macro or trace mineral imbalances in forages are reported to influence health and animal production (Fujihara *et al.*, 2003). Mineral deficiencies are observed in forages consumed by goats and range animals that may require mineral supplementation, especially during the harsh season or when plants are dormant (Moya-Rodríguez *et al.*, 2002). Therefore, a study was conducted to determine the mineral profile of macro and trace minerals in the diet consumed by range goats grazing in a shrubland region of North Mexico.

Material and Methods

The study was conducted in a shrubland region of North Mexico located at 24° 28' N and 103° 21' W, at an altitude of about 1800 m. The climate is considered dry semi-arid (COTECOCA, 1979) with an annual mean temperature of 17 °C and rainfall of 398 mm.

The main vegetative species in the area were: gobernadora *Larrea tridentate*; mezquite *Prosopis leavigeata*; hojaseñ *Flourensia cernua*; largoncillo *Acacia constricta*; agujilla *Condalia lycioides*; mariola *Parthenium incanum*; tasajillo *Opuntia leptocaulis*; Cardenche *O. imbricata*; nopal cegador *O. microdasys*; vara prieta *Cassia wislizeni*; granjeno *Celtis ehrenbergian*; junco *Koeberlinia spinosa*; cenizo *Leucophyllum laevigatum*; chamizo *Atriplex canescens*; zacate banderilla *Bouteloua curtipendula*; zacate tempranero *Setaria macrostachya*; zacate pajon *Sporobolus airoides*; zacate burrero *Scleropogon brevifolius*; zacates navajitas *Bouteloua barbata* and *B. simplex* and zacate mota *Chloris virgata* (COTECOCA, 1979).

Three mature goats belonging to a herd of 250 animals (38 ± 1.8 kg live weight) fitted with oesophageal fistulas (Stevens *et al.*, 1985) were used to collect oesophageal samples. Monthly extrusa samples were collected during two consecutive days from February 1999 to December 2000. The samples were collected at 11:30 and 15:30 for a period of 45 minutes (Holecheck *et al.*, 1982). Animals were allowed to browse freely from 9:00 until 20:00 in the warm months and from 9:00 until 17:00 in the cold months.

Extrusa samples from each of the three animals were incinerated in a muffle at 550 °C during 4 h in three replicates. Ashes were diluted with a 25% HCl solution and filtered through a Whatman paper No. 1. Sodium, Ca, Mg, K, Co, Cu, Mn, Zn and Fe concentrations were determined by atomic absorption spectrophotometry and P content was estimated by colorimetry (Olsen and Dean, 1965). Data were analyzed by ANOVA for a completely randomized design using PROC GLM (SAS, 1997).

Results and Discussion

Concentrations of all macro-minerals (Table 1) varied significantly ($P < 0.05$) between months. Mean sodium concentration was 5 g/kg. Ramírez (1989) reported higher values (mean value of two years = 9 g/kg) in monthly diets selected of range goats browsing in a shrubland of north-eastern Mexico. Although mineral requirements may depend upon activity and production (Perry *et al.*, 1999), in this study, Na was below the value suggested as critical concentration (< 5 g/kg).

Table 1 Mineral concentration of the forage consumed by goats (n=3) grazing a thorn shrubland (DM basis)

Months	Macro-minerals (g/kg)					Trace minerals (mg/kg)				
	Na	Ca	P	Mg	K	Co	Cu	Mn	Zn	Fe
February 1999	5	4	3	3	20	17	7	40	53	589
March	5	13	2	7	19	17	5	35	23	532
April	4	11	2	6	21	20	6	38	34	749
May	5	21	2	6	20	19	6	34	38	613
June	5	7	4	2	19	15	9	20	48	549
July	5	8	6	2	31	13	8	20	62	230
August	4	6	3	3	26	12	6	23	65	191
September	5	5	3	2	18	12	5	21	34	250
October	5	6	3	2	25	16	6	31	59	376
November	4	5	3	3	24	15	6	26	65	707
December	5	3	2	2	23	18	6	26	65	490
January 2000	5	10	2	3	18	19	5	50	74	409
February	5	5	3	2	17	19	5	28	94	599
March	4	7	2	3	19	19	6	40	58	874
April	5	5	3	3	21	22	6	41	66	803
May	4	8	2	3	24	24	4	79	46	458
June	4	22	2	4	24	25	3	114	56	99
July	5	6	4	2	29	21	6	26	65	495
August	6	6	4	2	20	30	4	29	73	292
September	5	7	4	3	27	26	4	31	70	179
October	6	6	4	3	27	32	4	35	108	166
November	7	5	6	2	19	86	6	48	136	502
December	5	11	3	3	19	74	5	58	122	679
Mean	5	8	3	3	22	25	6	39	66	471
s.e.	0.7	2	0.1	0.2	1	2	0.2	2	17	43
Significance	*	*	*	*	*	*	*	*	*	*

Mean = average of the 24 months; s.e. = standard error of the mean; * $P < 0.05$

Dietary Ca varied from 4 to 22 g/kg DM, and these values were in sufficient amounts to fulfil requirements (Maintenance = 4 g/d; end of gestation = 8 g/d; lactation = 8 g/d; Kessler, 1991) of adult goats during all months. Phosphorous content ranged from 2 to 6 g/kg. It is suggested (Fujihara *et al.*, 2003) that the critical value of P in the diet of ruminants is about 3 g/kg. In this study, with exception of the dry months (February to May), forage in all months had P to meet requirements of goats. Furthermore, Mg concentration in all months was above the critical level (< 2.0 g/kg; Kessler, 1991; Fujihara *et al.*, 2003). The same pattern was observed for K content. Values of K were higher than those required by range goats for maintenance (3 g/kg), late gestation (3 g/kg) or lactation (5 g/kg) (Kessler, 1991).

Concentration of all trace minerals varied ($P < 0.05$) between periods of sampling (Table 1). During all months, concentrations of Co in the forage were in sufficient amounts to satisfy goat needs (0.1 mg/kg; Kessler, 1991). The same pattern, as that of Co, was observed in Zn and Fe content. Moreover, these elements were in amounts to satisfy goat requirements. Results are in agreement to those reported by Ramirez (2003) who indicated a relevant potential mineral intake of Zn and Fe by range goats browsing in a shrubland of north-eastern Mexico. However, in this study, concentrations of Cu and Mn, in most months, were in lower amounts to satisfy goat needs for these minerals (9 and 40 mg/kg, respectively). Conversely, Ramírez (1989) reported higher Cu values (annual mean = 13.1 mg/kg) in the diets of range goats browsing in a shrubland from north-eastern México. Differences may be related to variations in botanical composition of selected diets, soil pH, soil fertility, etc. (Huston *et al.*, 2002).

Conclusions

Results from this study indicate that monthly concentrations of Ca, K, Mg, P, Co and Zn in forage consumed by browsing goats were adequate to meet their requirements for maintenance, pregnancy and lactation. However, Na, Cu and Mn concentrations were below the critical levels. Thus, a supplementation schedule throughout the year of Na, Cu and Mn may be considered. Phosphorus abundance should be considered with caution because of the saliva contamination of oesophageal samples.

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