Mineral Status of Grazing Cattle in Paraguay of South America

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SUMMARY

This study was conducted to evaluate the effects of environmental factors on mineral status of grazing cattle in Paraguay of South America. Intake levels of P, Na, Zn, and Cu from grass of natural grassland at 2 farms in East Paraguay may be severely deficient for grazing cattle throughout the year, since those concentrations in grass were very low and they were not significantly different between dry and wet seasons. Also, there was mineral unbalance by excesses of Fe and Mn in grass. Low concentrations of P, Na, K, Zn, and Cu in grass of natural grassland in East Paraguay may be mainly due to low concentrations of those in soil. Mineral content and mineral balance in grass at West Paraguay was almost adequate, but there may be borderline Cu deficiency of grazing cattle. Grass of artificial pasture contained these minerals at high levels in comparison with that of natural grassland. It is suggested that there are borderline mineral deficiencies of grazing cattle in Paraguay and borderline deficiencies of P and Cu are severe problems for grazing cattle.

INTRODUCTION

Mineral deficiency, unbalance, and toxicity are most frequently observed in grazing ruminants in tropical and subtropical countries and reduce the productivity of grazing cattle[1-5]. In Paraguay, which is a subtropical country of South America, mineral status in grazing cattle have not been well investigated. Thus, it may be important to analyse mineral concentration in soil, plant, and animal tissue in Paraguay in order to clarify mineral status in grazing cattle. Also, it is possible to increase the productivity and reproductivity of grazing cattle, if mineral status in grazing cattle can be clarified and then some useful treatments are done against mineral deficient cattle.

This study was, therefore, conducted to evaluate the effects of environmental factors on mineral status of grazing cattle in Paraguay. Thus, soil, grass, feed, serum, and bone samples were collected from several farms in Paraguay and mineral concentrations in samples were determined.

MATERIALS AND METHODS

Grass samples obtained from natural grassland of Est. Buena Vista and Barrerito at East Paraguay during 1985 and 1986 were used in analysis. Also, soil and grass samples were collected from Est. Buena Vista, Barrerito, and Quyquyo at East Paraguay and Est. Buena Vista and Pozo Azul at West Paraguay from October to November 1986. Soil, grass, serum, and bone samples were

collected from Est. Cordillerita of East Paraguay in November, 1986.

Soil samples were taken about 1–2 kg from 2–4 points at surface layer (0–5 cm) in a field or a farm. Eatable parts of grass or eatable grasses by cattle were collected in preventing soil contamination in grass and grass samples collected with soil were taken at the same points of soil sampling. Soil samples were dried for a week at room temperature on plate and ground with mortar. Grass samples were dried for 2 days with a forced air oven at 60°C and ground with stainless-steel Wiley mill.

Serum samples were taken from the jugular vein and centrifuged after sampling and also keeped at 4°C. Bone samples were taken from scapula and ashed in muffle.

Samples, except for serum, were digested in nitric-perchloric acid and serum samples were diluted with deionized water. Calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), iron (Fe), zinc (Zn), copper (Cu), and manganese (Mn) concentrations in samples were determined by atomic absorption spectrophotometry and phosphorus (P) was done by colorimetric analysis[6].

RESULTS AND DISCUSSION

Major mineral and trace element concentrations in grass of natural grassland at Est. Buena Vista and Barrerito at East Paraguay for dry and wet season are shown in Table 1 and 2. There may be not seasonal changes in mineral concentrations in grass of natural grassland, since mineral concentrations in grass were not significantly different between dry and wet seasons. However, Fe and Mn concentrations in grass at Est. Buena Vista were significantly higher than those at Est. Barrerito. Also, compared to the suggested value of NRC standards[2], mineral intakes, especially P, Na, Zn, and Cu, from grass may be deficient for grazing cattle, since those concentrations in grass were extremely lower than the suggested value of NRC standards[2]. Therefore, grazing cattle at Est. Buena Vista and Barrerito may be severely deficient in P, Na, Zn, and Cu throughout the year, if cattle was not supplemented with mineral mixture or other mineral sources.

However, Fe and Mn concentrations in grass were extremely high values. Since excesses of Fe and Mn have been reported to interfere with availability of other minerals[1–5], there may be mineral unbalance by excesses of Fe and Mn in grass. Therefore, improved grassland or feeding management such as mineral supplementation and fertilization may be needed at Est. Buena Vista and Barrerito in order to increase the productivity and reproductivity of grazing cattle. In this case, it is also necessary to pay attention to energy and protein deficiency in relation to improved feeding management. Also, mineral supplementation may be useful to improve the growth rate and reproduction at wet seasons, since daily gain and reproductive ability in grazing cattle may be increased at wet seasons in tropical and subtropical countries[3].

Major mineral and trace element concentrations in soil and grass of natural grassland at East and West Paraguay are shown in Table 3. Compared to West Paraguay, major mineral concentrations, except for Ca, in soil at East Paraguay were very low. Also, P, Na, and K concentrations in grass of

Table 1. Major mineral concentration in grass of natural grassland at 2 farms in East Paraguay for dry and wet seasons during 1985 and 1986

Farm	Number of samples	Ca	P	Mg	Na	K
Buena Vista		% on dry basis				
Dry(Mar.–Aug.)	4	0.251±0.036[3)a]	0.090±0.024[a]	0.168±0.051[a]	0.026±0.018[a]	0.667±0.345[a]
Wet(Sep.–Feb)	4	0.284±0.164[a]	0.087±0.045[a]	0.179±0.136[a]	0.019±0.020[a]	0.448±0.159[a]
Total	8	0.268±0.111[c]	0.088±0.032[c]	0.174±0.095[c]	0.023±0.018[c]	0.557±0.275[c]
Barrerito						
Dry(Mar.–Aug.)	4	0.234±0.035[b]	0.089±0.030[b]	0.114±0.019[b]	0.015±0.012[b]	0.603±0.129[b]
Wet(Sep.–Feb.)	4	0.249±0.055[b]	0.093±0.036[b]	0.111±0.036[b]	0.012±0.007[b]	0.553±0.224[b]
Total	8	0.243±0.042[c]	0.091±0.031[c]	0.112±0.028[c]	0.013±0.009[c]	0.578±0.172[c]
Suggested value(NRC)[1)]		0.23	0.18	0.10	0.08	0.65
Below the value(%)[2)]		18.8	100	25.0	100	62.5

1) Mineral requirement for beef cattle of NRC (1984), 2) % of samples below the suggested value of NRC (1984).
3) Mean ± S. D.
a, b, c; Values within column with same superscripts are not significantly different ($P > .05$)

Table 2. Trace element concentration in grass of natural grassland at 2 farms in East Paraguay for dry and wet seasons during 1985 and 1986

Farm	Number of samples	Fe	Zn	Cu	Mn
Buena Vista		ppm on dry basis			
Dry(Mar.–Aug.)	4	676±375[3)a]	21.4±5.2[a]	4.13±1.63[a]	735±121[a]
Wet(Sep.–Feb.)	4	491±382[a]	18.6±5.5[a]	3.13±1.28[a]	565±114[a]
Total	8	584±364[c]	20.0±5.2[c]	3.62±1.46[c]	650±142[c]
Barrerito					
Dry(Mar.–Aug.)	4	238±245[b]	15.4±3.5[b]	3.10±2.49[b]	426±106[b]
Wet(Sep.–Feb.)	4	282±126[b]	19.5±6.0[b]	2.38±0.40[b]	524± 82[b]
Total	8	260±182[d]	17.4±5.1[c]	2.74±1.70[c]	475±102[d]
Suggested value(NRC)[1)]		50	30	8	40
Below the value(%)[2)]		0	100	100	0

1) Mineral requirement for beef cattle of NRC (1984), 2) % of samples below the suggested value of NRC (1984). 3) Mean ± S. D.
a, b; Values within column with same superscripts are not significantly different ($P > .05$)
c, d; Values within column with different superscripts are significantly different ($P < .05$)

natural grassland at East Paraguay were lower than those at West Paraguay, although Mg concentration in grass at East Paraguay was slightly higher. However, Ca concentration in soil and grass was not different between East and West Paraguay.

Also, Zn and Cu concentrations in soil at East Paraguay were extremely lower than those at West Paraguay, although those in grass at East Paraguay were slightly lower. Therefore, low concentrations of P, Na, K, Zn, and Cu in grass of natural grassland at East Paraguay may be mainly due to low concentrations of those in soil. However, it is not clear that there were direct

Table 3. Mineral concentration in soil and grass of natural grassland at 5 farms in East and West Paraguay

Farm	Number of samples	Ca	P	Mg	Na	K	Fe	Zn	Cu	Mn
Soil[1]		% on dry basis					ppm on dry basis			
B. Vista (East)	1	0.059	0.015	0.049	0.012	0.035	7328	15.2	2.75	425
Barrerito (East)	1	0 087	0.012	0.039	0.018	0.055	7947	15.8	3.76	66
Quyquyo (East)	1	0.109	0.010	0.050	0.012	0.103	7715	13.7	4.05	250
B. Vista (West)	1	0.097	0.043	0.178	0.059	0.383	10825	36.6	7.88	145
Pozo Azul(West)	2	0.122[2]	0.073	0.264	0.066	0.736	12388	33.2	8.78	102
Grass		% on dry basis					ppm on dry basis			
B. Vista (East)	1	0.524	0.151	0.377	0.049	0.582	652	26.0	4.40	599
Barrerito (East)	1	0.326	0.146	0.143	0.012	0.509	470	25.4	2.52	613
Quyquyo (East)	1	0.552	0.164	0.284	0.005	1.262	592	29.0	7.83	259
B. Vista (West)	1	0.311	0.241	0.137	0.151	0.952	331	38.1	5.33	252
Pozo Azul(West)	2	0.368[2]	0.309	0.254	0.122	2.156	236	27.2	6.02	170

1) Total content in soil 2) Mean of 2 samples.

relationships between Fe and Mn concentrations in soil and grass, since Fe concentration in soil and grass was adverse relationship between East and West Paraguay, and Mn concentration in grass was highest at Est. Barrerito but that in soil was lowest. Thus, excesses of Fe and Mn concentrations in grass at East Paraguay may be partly due to those concentrations in soil, but other factors, such as soil type, available level in soil, etc., may be important in this case.

Major mineral and trace element concentrations in soil and grass at Est. Pozo Azul are shown in Table 4. Mineral concentrations in soil and grass at Est. Pozo Azul varied widely and there were not direct relationships between mineral concentrations in soil and grass. This is suggested that it is difficult to diagnose mineral deficiency of grazing cattle from soil analysis within one farm or narrow areas. However, grass analysis may be important to diagnose mineral status in cattle, since there were some tendencies among mineral concentrations in grass. Except for Na and Fe, mineral concentrations in grass of artificial pasture, such as Colonial and Bermuda, were tended to be higher than those in grass of natural grassland. Therefore, it is suggested that grass of artificial pasture contained minerals at high levels in comparison with that of natural grassland. Also, mineral content and mineral balance in grass at West Paraguay may be almost sufficient for grazing cattle in comparison with East Paraguay. However, more attention needed on borderline Cu deficiency at West Paraguay, since Cu concentration in grass at West Paraguay was slightly low level.

Major mineral and trace element concentrations in soil, grass, serum, and bone of cattle at Est. Cordillerita of East Paraguay are shown in Table 5. In detecting mineral deficiency of grazing cattle, mineral concentrations in animal tissue are often better indicators of mineral status in cattle than either plant- or soil-mineral concentrations, and serum or blood is widely used for diagnosing mineral status in cattle[1-5]. Also, it is considered that bone is the best indicator of Ca and P status in cattle among another indicators, since bone is main storage organs of these elements in the body[3]. Compared to critical level of mineral concentrations in serum (Ca, 8 mg/100ml; P, 4.5 mg/100ml; Mg, 1–2 mg/100ml; Zn, 0.6–0.8 μg/ml; Cu, 0.65 μg/ml)[3], Ca, P, Mg, and Zn

Table 4. Mineral concentration in soil and grass at Pozo Azul in West Paraguay

Item	Number of samples	Ca	P	Mg	Na	K	Fe	Zn	Cu	Mn
Soil[1]		---------- % on dry basis ---------					--- ppm on dry basis ---			
Natural grassl.	2	0.122[4]	0.073	0.264	0.066	0.736	12388	33.2	8.78	102
Pasture-Col.	2	0.374[4]	0.090	0.246	0.037	0.684	11396	43.3	12.58	244
Pasture-Ber.	1	0.232	0.092	0.381	0.074	1.015	17278	55.9	17.90	425
Grass		---------- % on dry basis ---------					--- ppm on dry basis ---			
Wild grass[2]	2	0.368[4]	0.309	0.254	0.122	2.156	236	27.2	6.02	170
Colonial[3]	2	0.429[4]	0.500	0.254	0.052	2.552	130	45.2	3.66	48
Bermuda[3]	1	0.714	0.521	0.250	0.041	2.329	194	53.0	6.37	162

1) Total content in soil. 2) grown on natural grassland. 3) grown on artificial pasture. 4) Mean of 2 samples.

Table 5. Mineral concentration in soil, grass, serum, and bone of cattle at Cordillerita in East Paraguay

Item	Number of sample	Ca	P	Mg	Na	K	Fe	Zn	Cu	Mn
Soil		..... % on dry basis					..... ppm on dry basis			
	2	0.044[2]	0.015	0.044	0.009	0.062	9224	18.4	5.10	85
		± 0.029	± 0.001	±0.009	± 0	± 0.008	± 4381	± 2.0	± 0.49	± 88
Grass		..... % on dry basis					..... ppm on dry basis			
	3	0.225[2]	0.104	0.154	0.006	0.786	931	18.8	4.38	289
		± 0.028	± 0.038	±0.054	± 0.003	± 0.174	± 851	± 4.7	± 0.48	±176
Serum		..... mg/100ml					..... μg/ml			
	8	9.12[2]	8.09	3.22	265.8	19.7	1.7	0.9	0.65	-[1]
		± 1.60	± 2.05	±0.60	± 32.8	± 5.4	± 0.8	± 0.2	± 0.18	
Bone		..... % on bone ash basis					..... ppm on bone ash basis			
	1	33	19.6	0.32	0.47	0.073	13961	184	132	80

1) Not detected 2) Mean ± S. D.

concentrations in serum were high value but Cu concentration is low level. Also, compared to critical level of Ca and P in bone (Ca, 37.6%; P, 17.6%)[3], P concentration in bone was higher but Ca was lower. Therefore, judging from soil, grass, and serum analysis, there was borderline Cu deficiency of cattle at Est. Cordillerita. Also, there may be borderline P, Na, and Zn deficiencies of cattle from the result of those concentrations in grass. However, it is not clear whether P is severely deficient in cattle at Est. Cordillerita, because data of bone was limited on only one sample and hemolysis often occurred at serum sampling. Thus, it is necessary to collect many samples from different areas in Paraguay and to diagnose mineral status in cattle.

According to McDowell[3], the mineral deficient for grazing cattle in tropical and subtropical countries is most likely P, and then followed by Cu and cobalt (Co). Also, there were numerous reports of mineral deficiencies or toxicities of ruminants in tropical and subtropical countries of Latin America, Africa, and Asia[3]. In this study, it is suggested that there is borderline mineral deficiencies of grazing cattle in Paraguay and borderline deficiencies of P and Cu are severe problems for grazing cattle.

Also, it is recognized that mineral requirements have not been well established with Zebu cattle and Zebu crossbred cattle living under tropical countries, and mineral requirement of Zebu cattle or Zebu

crossbred cattle under tropical countries may be different from European breeds[3]. In this study, there were some findings of mineral nutrition of grazing cattle in Paraguay, but further studies are needed to evaluate mineral status in grazing cattle. In addition, it is more necessary, in future, to clarify the mineral requirements for grazing cattle in Paraguay in order to improve the productivity and reproductivity of grazing cattle.

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