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THE MINERAL STATUS OF CATTLE IN COLOMBIA AS RELATED TO A WASTING DISEASE ("secadera")[1]

R Vargas D[2], L R McDowell, J H Conrad, F G Martín, Claus Buergelt & G L Ellis

Departamentos de Ciencia Animal, Ciencias Veterinarias y Estadística, Universidad de Florida, Gainesville, Fl 32611, U.S.A.

A study was conducted in the Eastern Plains of Colombia to determine the mineral status of beef cattle and to compare healthy animals with those affected with the "secadera" condition, a unique wasting disease. Sampling periods corresponded to the middle of the rainy season and the beginning of the dry season. Soil, forage, blood, liver and rib bone samples were analyzed from a total of ten ranches during both seasons. Percent nutrient concentrations below critical levels (in parentheses) and sugestive of deficiency were as follows, for the rainy and dry seasons, respectively: Soil (ppm)- Ca (71) 59, 69; P (5) 79, 59; K (30) 53, 26; Mg (9.1) 38, 18; Mn (5) 33, 38; Zn (6) 100, 100; Cu (1) 81, 85; forage - Ca (0.30%) 100, 95; P (0.25%) 83, 92; K (0.80%) 13, 15; Na (0.06%) 100, 100; Mg (0.20%) 42, 56; Zn (30 ppm) 89, 74; Cu (10 ppm) 100, 100; Co (0.1 ppm) 72, 31; Se (0.1 ppm) 38, 74; protein (7%) 13, 29; Mo:Cu ratio (< 2.1) 21, 41; bone-bone ash (66.8%) 81, 94; % bone ash-Ca (37.6%) 81, 74; P (17.6%) 94, 94; liver (ppm) - Mn (6); 4, 9; Zn (84) 17, 9; Cu (75) 15, 25; blood serum (mg/100 ml)-Ca (8) 15, 21; Mg (2) 43, 40. On the basis of the analyses, deficiencies of calcium, phosphorus, sodium, magnesium, zinc and copper are likely. Deficiencies specifically related to the "secadera" condition would likely be zinc and copper, aggravated in some instances by excess of molybdenum.

Key words: Mineral status, cattle, Colombia, "secadera".

Mineral deficiencies, imbalances and toxicities have been reported to severely inhibit tropical cattle production (McDowell 1976). Lebdosoekojo et al (1980), working with grazing cattle in the Colombian Eastern Plains, found deficiencies of the following elements: calcium, phosphorus, sodium, magnesium, zinc and copper. Corrier et al (1978), in a cattle health survey in the Eastern Plains, found the "secadera" condition to be disease of highest incidence, with a mortality index of 30%. "secadera" is a wasting disease present at the time of the year when forages apparently are at highest quality. Mateus and Gómez (1981) considered hemoparasites to be the main cause of the problem. However, Mullenax (1982) considered zinc deficiency to be contributory to the condition. Miles and McDowell (1983) reported the elimination of "secadera" through the use of a "complete" mineral supplement fortified with additional quantities of zinc, copper, sulfur and selenium. The present study was initiated to evaluate the mineral status of farms reporting the condition of "secadera".

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[2] INPEC, Ltda., Calle 61 No. 5-08, Bogotá, Colombia.

Materials and Methods

Soil, forage, blood, liver and bone samples were collected from ten cattle ranches located in the following three regions of the Eastern Plains of Colombia: 1) pie de monte, 2) high savannas, and 3) low savannas. Both normal animals and those presenting clear signs of the "secadera" condition were selected for sampling. Sampling periods corresponded to the rainy season (July 1981) and the beginning of the dry season (January 1982). Animals of both sexes ranged from one to ten years and were Zebu-Criollo with varying degrees of cross-breeding. A total of 67 soil, 75 forage, 70 bone biopsy, 104 liver biopsy and 102 blood serum samples were obtained.

Sample collection and analysis

Liver and bone biopsy and blood samples were obtained using procedures described by Fick et al (1979). Sample processing and mineral analysis of animal tisue and forage samples were carried out according to the methods described by Fick et al (1979). Methods of sample preparation and analysis were those of Mitchell and Rhue (1979). Minerals were extracted from soils using the double extractant method (0.025 N H_2SO_4 plus 0.05 N HCl), and concentrations of calcium, phosphorus, potassium, sodium, magnesium, manganese, iron, zinc, copper and cobalt were determined by atomic absorption spectrophotometry (Perkin-Elmer 1973).

Forage and bone phosphorus analyses were carried out according to the method described by Fiske and Subarrow (1925) as modified by Fick et al (1979). Selenium analyses of forages, liver and serum were carried out using the fluorometric technique described by Whetter and Ullrey (1978). Forage calcium, magnesium, sodium, potassium, copper, iron, zinc and manganese, liver manganese, iron, zinc and copper, serum calcium, magnesium, zinc and copper, and bone calcium were determined using atomic absorption (Perkin-Elmer 1973). An atomic absorption spectrophotometer equipped with a graphite furnace and D2 corrector (Perkin-Elmer Model 503) was used to determine forage and liver cobalt and molybdenum. Forage crude protein analysis was carried out following the method of Technicon Industrial Systems (1978). Bone specific gravity was measured using the method of Little (1972).

Statistical analysis

Analysis of variance was applied to the data for a nested design with unequal subclass replications (Snedecor and Cochran 1973). Appropriate F-tests were constructed for detecting differences between regions and among farms within regions. Correlation coefficients between minerals were estimated, pooled analysis of variance was used for detecting differences between sick and healthy animals, regions, farms (regions), and health x status and health x region interactions were measured whenever possible. Data were analyzed by the General Linear Model of the Statistical Analysis System (Barr et al 1976).

The word "critical" is used in this paper to note a concentration in forages below (or above in cases of excess) the quantity estimated by the NRC (1976) to be the requirement for cattle. Total comsumption per day, not concentration in forage, would be used to determine the true adequacy of a mineral element. Animal tissue concentrations designated as "critical" were determined on the basis of their relation to values associated with specific clinical signs reported in the literature.

Results and Discussion

Soil analysis

Mean seasonal analyses of soils are presented in Table 1. Among the macroelements, phosphorus presented the highest deficiency (< 5 ppm), with 79 and 59 % of samples deficient in the rainy and dry seasons, respectively. Calcium was found to be deficient (< 71 ppm) in 69 and 59 % of the samples in the rainy and dry seasons, respectively. In the Bolivian tropics, Peducassé (1982) found phosphorus deficiency in 100% of soil samples and only a slight deficiency in soil calcium, with 4.5 and 7.1 % of samples below critical levels. Potassium was found to be below the critical concentration of 30 ppm in 53% of the samples of the rainy season samples and 26% of the dry season samples.

Table 1:

Mean soil mineral concentration and pH as related to season and critical concentration (CC)[a].

Element (ppm)	CC[a]	Rainy season Mean	Rainy season S.D.	Rainy season % of samples below CC	Dry season Mean	Dry season S.D.	Dry season % of samples below CC
Calcium	71	50[c]	63	69	154[b]	237	56
Phosphorus	5	4.3	6.0	78	7.9	8.2	59
Potassium	30	27	15	53	35	17	26
Sodium		15	5		6.83	6.84	
Magnesium	9.1	30.6	39.0	39	32.8	34.5	18
Manganese	5	15[b]	25.6	33	49[c]	69	38
Iron	20	81	78	0	132	62	0
Zinc	6	0.86	0.99	100	1.36	1.15	100
Copper	1	0.58	0.47	81	0.66	0.32	85
Aluminum		602	280		793	568	
pH		4.69	0.19		4.46	0.38	

[a] McDowell *et al.* (1983).
[b,c] Means between seasons with different superscripts differ ($P < 0.05$).

Among the microelements, zinc was below the critical concentration of 5 ppm in 100% of the soil samples in both seasons. Sánchez (1981) reported that zinc is more soluble in acid soils but, in spite of this, a minimum level of 1.5 ppm zinc in soil correlates positively with a plant concentration of 14 ppm. Copper was found to be deficient (< 1 ppm) in 81 and 85 % of the samples for the rainy and dry seasons, respectively.

Magnesium was borderline to deficient, with 39 and 18 % of samples below the critical level of 9.1 ppm for the rainy and dry season, respectively. Soil manganese concentrations were below the critical level of 20 ppm suggested by Cox (1973) in 39 and 38 % of the samples in the rainy and dry seasons, respectively.

Mean aluminum values of 602 ppm in the rainy season and 793 ppm in the dry season were found. Mean iron values of 81 and 132 ppm were reported for the rainy and dry season, respectively. Acid soil conditions tend to favor iron availability from the soil (Cox 1973); since most Latin American soils are acid, an iron deficiency would not be expected. The pH values were extremely low, ranging from 3 to 5.4; the mean value for the rainy season was 4.69 and for the dry season, 4.46. Under such conditions typical of oxisols and ultisols, aluminum and iron can reduce phosphorus uptake by plants and also affect plant root development and hence plant development and composition (Sánchez 1981).

Significant ($P < 0.01$) differences were found for calcium concentrations between seasons and pH among farms within region. Interactions were found for season x farms within regions. Significant ($P < 0.05$) differences were also found for manganese between seasons; phosphorus, potassium, magnesium and iron among regions; and phosphorus among farms within regions. Interactions were found in magnesium, manganese and pH levels for season x region.

Forage analyses

Forage mineral and crude protein concentrations for the rainy and dry seasons for regions 1 (pie de monte), 2 (high savanna) and 3 (low savanna) are shown in Table 2 in comparison with critical concentrations suggested by McDowell et al (1983). The percentage of total samples found below critical concentrations for the rainy and dry season, respectively, were as follows: Ca, 100, 95; P, 83, 92; K, 13, 15; Na, 100, 100; Mg, 42, 56; Zn, 89, 74; Cu, 100, 100; Co, 72, 31; Se, 38, 74; crude protein, 13, 29. Molybdenum was found to be relatively high in individual samples, with mean concentrations of 1.80 and 1.28 ppm for rainy and dry seasons, respectively, below the value of 6 ppm suggesting possible toxicity (McDowell 1976). However, due to extremely low forage copper, the mean copper-to-molybdenum ratio was close to or less than 2:1 suggested by Miltimore and Mason (1971) as the point at which there is a possibility of conditioned copper deficiency. The percent of samples in which this ratio was lower than 2:1 was 21% in the rainy and 41% in the dry season.

In addition to the forage minerals presented in Table 2, four forage samples were analyzed for sulfur and found to be low, containing 0.048, 0.086, 0.093 and 0.129 %. Ten forages from the llanos regions of both Colombia and Venezuela were previously analyzed for sulfur and found to be low, averaging 0.060% and ranging from 0.032 to 0.088 % (Miles and McDowell 1983). The relationship of sulfur to copper and molybdenum metabolism has been studied, with a few investigations indicating the effect of sulfur deficiency on grazing livestock performance. Miles and McDowell (1983) summarized four sulfur supplementation trials in which

Table 2:

Mean seasonal forage mineral and crude protein (CP) concentrations (dry basis) for three regions.[a]

Element	CC[b]	Season	Region 1		Region 2		Region 3		Overall		% of sample below CC
			Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Calcium, %	0.30	Rainy	0.18[c]	0.05	0.14[d]	0.06	0.15[d]	0.04	0.16	0.05	100
Calcium, %	0.30	Dry	0.23	0.14	0.14	0.04	0.14	0.04	0.16	0.03	95
Phosphorus, %	0.25	Rainy	0.19	0.06	0.15	0.06	0.12	0.07	0.17	0.06	83
Phosphorus, %	0.25	Dry	0.18	0.11	0.17	0.07	0.13	0.03	0.16	0.07	92
Potasium, %	0.80	Rainy	2.20	1.11	1.28	1.68	1.04	0.46	1.70	0.96	13
Potasium, %	0.80	Dry	1.80[c]	0.79	1.17[c]	0.57	1.59[d]	0.71	1.50	0.67	15
Sodium, %	0.06	Rainy	0.02	0.11	0.03	0.03	0.03	0.01	0.03	0.02	100
Sodium, %	0.06	Dry	0.02	0.01	0.01	0.00	0.02	0.01	0.02	0.01	100
Magnesium, %	0.20	Rainy	0.23	0.02	0.17	0.51	0.18	0.07	0.20	0.07	42
Magnesium, %	0.20	Dry	0.21	0.04	0.19	0.67	0.19	0.04	0.18	0.05	56
Manganese, %	40	Rainy	168	57	170	120	332	270	209	163	0
Manganese, %	40	Dry	244	143	291	135	275	133	264	131	0
Iron, ppm	30	Rainy	100	49	192	152	205	183	139	127	0
Iron, ppm	30	Dry	103	38	169	111	139	61	171	122	0
Zinc, ppm	30	Rainy	24.5	5.6	16.8	4.9	28.0	16.1	23.5	9.78	89
Zinc, ppm	30	Dry	27	12	30	13	18	7.21	24	124	74
Copper, ppm	10	Rainy	5.0[c]	1.8	2.5[d]	1.1	1.8[d]	0.8	3.6	2.1	100
Copper, ppm	10	Dry	4.6	1.6	2.3	1.7	2.8	1.8	2.8	1.9	100
Molybdenum, ppm	6	Rainy	0.45	0.61	2.45	1.7	2.3	2.6	1.4	1.8	0
Molybdenum, ppm	6	Dry	0.15	0.12	0.90	1.74	0.48	0.53	0.88	1.28	0
Cobalt, ppm	0.10	Rainy	0.05	0.04	0.19	0.33	0.67	0.81	0.24	0.49	72
Cobalt, ppm	0.10	Dry	0.1	0.07	0.40	0.40	0.20	0.37	0.20	0.21	31
Selenium, ppm	0.10	Rainy	0.14	0.06	0.07	0.05	0.14	0.08	0.12	0.07	38
Selenium, ppm	0.10	Dry	0.11	0.03	0.09	0.04	0.10	0.03	0.11	0.04	74
PC, %	7	Rainy	10.2	2.9	9.3	2.6	7.2	2.0	9.3	2.8	13
PC, %	7	Dry	10.9	2.8	8.4	2.2	9.1	2.7	9.2	2.7	29

[a] Means based on the following number of samples for the rainy and dry seasons, respectively: Region 1 (19, 11); Region 2 (8, 6); Region 3 (8, 19).
[b] CC represents critical concentrations according to McDowell *et al.* (1983).
[c,d] Means among regions with different superscripts differ ($P < 0.05$).

cattle received basal diets containing 0.04 to 0.10 % sulfur. In these studies, voluntary feed intake increased from 7% to 260%, and production of milk and/or meat from 6% to more than 400% that of animals receiving low sulfur diets.

Lebdosoekojo et al (1980), studying mineral composition of grasses in the high savannas of the Eastern Plains of Colombia, found significant differences between seasons for forage calcium and magnesium concentrations. Native and molasses grass gave the following results, respectively: calcium, 0.13, 0.21 %; phosphorus, 0.12, 0.21 %; zinc, 13, 18 ppm; Cu, 1.7, 2.6 ppm; and Na, 0.012, 0.008 %. These data are in agreement with the present study illustrating deficiencies of calcium, phosphorus, zinc, copper and sodium. Deficiencies found by Wills (1982), working in the pie de monte region of the Eastern Plains of Colombia, ranged between 50 and 92 % for calcium and 93% for phosphorus, and were 100% for sodium and zinc when compared with NRC (1976) critical concentrations in samples of four species collected monthly during one year.

In evaluation of nutrient concentration differences between seasons and among regions and farms within regions, the most significant differences ($P < 0.01$) were found for concentrations of phosphorus and molybdenum among farms within regions; potassium, copper, molybdenum and crude protein among regions; sodium and iron between seasons; sodium for seasons x farms; and sodium and molybdenum for seasons x farms within regions. Differences ($P < 0.05$) were also found in iron for the interaction seasons x farms within regions and for molybdenum between seasons x regions.

Serum analyses

Mean serum mineral concentrations as related to season and critical concentrations (McDowell et al 1983) are presented in Table 3. There was no difference ($P > 0.05$) between sick and healthy animals in serum minerals for either season. Percent of samples below critical levels in rainy and dry seasons, respectively, were as follows: magnesium, 43, 40 %, and calcium, 15, 21 %. Fifteen percent of serum selenium values were deficient in the rainy season only.

Table 3:

Mean serum mineral concentration and critical concentrations (CC) as related to season (dry basis).[a]

Element	CC[b]	Rainy season			Dry season		
		Mean[a]	S.D.	% of total samples below CC de CC	Mean[a]	S.D.	% of total samples below CC de CC
Calcium, mg/100 ml	8	10.2	0.22	15	10.7	1.12	21
Magnesium, mg/100 ml	2	2.1	0.66	43	2.0	0.58	40
Zinc, µg/ml	0.4	1.8	0.49	0	2.1	0.63	0
Copper, µg/ml	0.6	1.7	0.42	0	1.5	0.50	5
Selenium, µg/ml	0.03	0.05	0.02	15	0.10	0.08	0

[a] Means based on the following number of samples for the rainy and dry season, respectively: sick (23, 20) and healthy (23, 43).

[b] McDowell *et al.* (1983).

In the dry season, differences ($P < 0.01$) were found among regions for serum magnesium and zinc; region 3 had lower serum magnesium levels and region 2 had lower zinc levels. Differences ($P < 0.01$) were also found for serum calcium and zinc levels in the rainy season and for calcium, phosphorus, magnesium and copper levels in the dry season. Correlation coefficients ($P < 0.01$, $r = \pm 0.5$) between serum minerals were found, for the rainy season, as follows: phosphorus-calcium ($r = 0.63$), magnesium-calcium ($r = 0.53$), selenium-phosphorus ($r = -0.63$). No significant ($P > 0.05$) correlations were found between serum minerals during the dry season.

Liver analyses:

Mean liver mineral concentrations in sick and healthy animals as related to season and critical levels (McDowell et al 1983) are presented in Table 4. For the rainy season, the elements deficient in

Table 4:

Mean liver mineral concentrations (ppm) as related to season and critical concentrations (CC) comparing sick and healthy animals (dry basis).[a]

Element	CC[b]	Rainy season					Dry season				
		Mean	S.D.	% samples below CC(sick animals)	% samples below CC (healthy animals)	% of total samples below CC	Mean	S.D.	% samples below CC(sick animals)	% samples below (healthy animals)	% of total samples below CC
Manganeso	6	11.49	3.47	6	0	4	11.18	4.21	8	9	9
Hierro	180	468	259	0	0	0	589	274	0	0	0
Zinc	84	136	94	19	17	17	125	48	15	7	9
Cobre	75	209	128	14	10	15	143	98	50	17	25
Molibdeno	4	11.18	12.52	63	41	72	3.38	1.98	36	21	26
Cobalto	0.05	1.95	3.43	0	0	0	0.63	0.57	0	0	0
Selenio	0.25	1.30	0.51	0	0	0	1.43	0.51	0	0	0

a Means based on the following number of samples for the rainy and dry seasons, respectively: sick (16, 14) and healthy (10, 29).

b CC represents critical concentrations according to McDowell *et al.* (1983).

the largest number of samples were zinc, with 17% below the critical level (84 ppm) and copper, with 15% below the critical level (75 ppm). Mean liver molybdenum was 11.18, with 72% of the samples above 4 ppm suggestive of a dietary excess (McDowell et al 1983). During the dry season, 25% of liver copper values and 9% of zinc values were below the critical level (75 and 84 ppm, respectively) while 26% of liver molybdenum values were above 4 ppm. Langlands et al (1981) reported that molybdenum pasture fertilization increased liver molybdenum ($P < 0.05$) and kidney molybdenum ($P < 0.05$) values while there was a significant decline in liver copper in grazing sheep.

For the rainy season, differences ($P < 0.01$) were found for liver selenium values between sick and healthy animals; both males and healthy animals had higher ($P < 0.01$) concentrations. In the dry season, higher ($P < 0.05$) liver copper and zinc values were found for healthy versus sick animals. Significant differences ($P < 0.01$) for farms within regions were found for liver copper and zinc concentrations. Significant correlations were found in the rainy season for liver copper and zinc ($P < 0.05$; $r = 0.5$) as well as for selenium and molybdenum in the dry season ($P < 0.01$, $r = 0.96$).

Bone analyses:

Mean rib bone mineral concentrations as related to season and suggested critical levels are presented in Table 5. There was no difference ($P > 0.05$) between sick and healthy animals in bone minerals for both seasons. However, both sick and healthy animals had high indices of calcium and phosphorus deficiencies which ranged from 55 to 100% depending on the criteria used. These results were in agreement with forage and soil data. Working in the tropical grasslands of Bolivia, Peducassé (1982) found 100 and 94 % of bone samples below critical levels for calcium and phosphorus, respectively, as expressed on a dry fat-free bone basis. When the same samples were expressed on a bone ash basis, 96 and 45 % of the samples were found to be below the critical levels for calcium and phosphorus, respectively.

Table 5:
Mean bone mineral concentrations and critical concentrations (CC) as related to season (dry basis).[a]

Element	CC[b]	Rainy season			Dry season		
		Mean	S.D.	% of total samples below CC	Mean	S.D.	% of total samples below CC
Calcium, % dry fat-free bone	24.5	23.5	2.7	61	24.0	4.2	81
Calcium, % bone ash	37.62	36.0	3.2	81	6.0	3.8	74
Phosphorus, % fat-free bone	11.5	10.2	1.5	90	10.1	1.5	100
Phosphorus, % bone ash	17.6	15.6	2.0	94	15.8	2.5	94
Bone ash, % dry fat-free bone	66.8	64.0	3.4	81	63.6	6.1	94
Specific gravity	1.68	1.45	0.14	87	1.65	0.20	55

a Means based on the following number of samples for the rainy and dry seasons, respectively: sick (22, 9) and healthy (9, 22).
b McDowell *et al.* (1983).

Differences ($P < 0.05$) were found in the rainy season for the following values: calcium (% bone ash) between sexes (males higher than females) and calcium (% dry fat-free bone and % bone ash) among farms within regions. Differences ($P < 0.01$) were found in the dry season for the following: calcium (% bone ash) among farms within region, highest for region 3; and phosphorus (% dry fat-free bone) among regions, highest for region 3.

Analyses related to "secadera":

For a clear understanding and interpretation of the results in relation to "secadera", the following considerations must be made: sick animals on all farms received mineral supplementation during the dry season only, and the quantity and quality of mineral supplements among farms was highly variable. Sick animals usually were placed in special pastures where they could be observed more closely, and in some cases, were treated with medications including antibiotics, vitamins, antihelmintics and injectable mineral solutions. These factors can affect mineral concentrations of animal tissues and must be considered in order to make correct interpretations.

In the rainy season, liver selenium was lower ($P < 0.05$) for sick animals, but all samples were above the critical concentration of 0.25 ppm (McDowell, 1976). Mean liver molybdenum concentration in sick animals during the rainy season was 14 ppm, with 63% of samples above the critical concentration of 4 ppm, suggesting dietary excess (McDowell *et al.*, 1983). Mean molybdenum concentration for healthy animals was 6.7 ppm, with 40% of samples above the critical concentration of 4 ppm. Serum selenium was found to be below critical levels (.03 ppm) in 25% of the sick animals but adequate in all healthy animals.

In the dry season, liver zinc and copper concentrations were lower ($P < 0.05$) for sick animals. Liver molybdenum was above the critical concentration of 4 ppm suggestive of dietary excess in 36 and 21 % of sick and healthy animals, respectively. Serum zinc concentrations were lower ($P < 0.05$) in sick animals (1.9 vs 2.2 ppm). From the results of analyses in the dry season, animals affected with the "secadera" condition generally, although not always, had significantly lower tissue values than did healthy ones. The results suggest that zinc and copper are the elements most closely related to the "secadera" problem. Copper tissue levels would be decreased by relatively high forage molybdenum concentrations. Selenium must be taken into account since it was deficient in 25% of the serum samples from sick animals. Selenium requirements and critical concentrations are still under investigation and some changes in recommendations can be expected (Underwood, 1981). The necropsy findings from a cow in farm 3 which suffered from "secadera" and was slaughtered were as follows: the liver showed petechial hemorrhages, the thyroid gland was atrophied, and the duodenum had hemorrhagic lesions and thickened walls. No internal parasites or hemoparasites were found. Mullenax (1982) reported one case of "secadera" with adenocarcinoma in the duodenum, the principal site of zinc absorption.

Mullenax (1982) considers low forage zinc concentrations to be one of the major factors in the etiology of the "secadera" condition since forage concentrations are low at the time of the year when the highest incidence of the disease is observed (September-October). Lebdosoekojo et al (1980) also reported low levels of forage zinc in the Eastern Plains of Colombia for the same period. Recent research and clinical data from Colombia suggest that "secadera" is primarily an acute, induced thiamin deficiency complicated in some geographic areas by deficiency or imbalance of zinc, copper and, less frequently, cobalt and selenium (Mullenax 1983).

In conclusion, deficient elements such as calcium, phosphorus, magnesium and sodium are affecting the mineral status of both healthy and sick animals. Elements such as zinc and copper are affecting noth groups of animals but its incidence in animals affected with the "secadera" condition is higher. Molybdenum can aggravate the "secadera" problem because it can produce a secondary copper deficiency. Selenium must be considered as having a possible role in relation to "secadera". Nutritional factors seem to place the ruminant in a precarious metabolic equilibrium that can be disrupted by stress factors such as parasites, infectious diseases, parturition, lactation, etc. These factors may be a triggering mechanism for increased susceptibility to "secadera".

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