

SECADERA - A NUTRITIONAL WASTING DISEASE IN CATTLE GRAZING ACIDIC, SULFUR-DEFICIENT, TROPICAL SAVANNAS

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Introduction

Wasting diseases of nutritional origin in domestic livestock are infrequently seen under systems of modern management. They are seen, however, in animals grazed under extensive management systems, particularly in cattle maintained solely on tropical forages grown on low-fertility acidic soils. *Secadera* is one of the wasting diseases which occur in the South American tropics^{1,2,3,4}. This report, which further characterizes the disease and its treatment, is based on research conducted in the oxisol savannas of the Altillanura, the least fertile area of the Llanos Orientales (Eastern Plains) of Colombia.

Signalment

Secadera, as observed in a population of over 5000 cattle (*Bos indicus*, *Bos taurus* and their crosses) pastured in the Altillanura, was characterized by progressive inanition with evidence of failure of intermediary metabolism and homeostasis. The untreated condition progressed to produce functional abnormalities in every body system, especially the integumentary (100% of the cases), musculoskeletal (90% of the cases), and the cardiovascular (83% of the cases) systems. In all, more than 50 distinct clinical, clinicopathological, and pathological signs were noted within a group of affected cattle.

Path analysis⁵ identified 27 correlated ($p < 0.05$) clinical signs of secadera. Twelve of these were characteristic of thiamin deficiency as evidenced in ruminants and other species but without the cerebral necrosis seen in bovine polioencephalomalacia (PEM). Six of the signs were typical for ruminants suffering cobalamin (vitamin B12) but not cobalt deficiency, such animals having an apparent predilection "for neurological rather than megaloblastic lesions"⁶. Five more signs were attributed to a deficiency of either thiamin or cobalamin.

Six of these signs- anorexia, weight loss, integumentary changes (including dry, brittle hair which curled away from the body, melanotrichia, and melanoderma), cardiac arrhythmia, jugular pulse, and hyperirritability- were present in all cases during the first 10 days after they became visually identifiable. During this same period, half of the cases showed either constipation (attributable to B12 deficiency) or diarrhea and abdominal pain (B1 deficiency) and rumen atony (attributable to either). The remaining signs, which developed in untreated animals during the following 15 to 60 days, involved further deterioration in the functioning of the musculoskeletal, cardiovascular, and nervous systems. Myxedema became evident at 35 days after onset; ketosis occurred in 10% of

recovering cases 50 to 70 days after the visual onset of secadera. All pregnant cows affected with secadera during the last trimester of gestation aborted.

Histologically, hyaline degeneration of myocardium and mineralization of epicardium was encountered in 4 of 4 cases examined. Five of 8 cases showed thinning of the right ventricular wall; 3 of these had right heart dilatation. Four of 4 cases showed renal tubular pathology. Two of 2 cases examined showed slight to moderate cerebral edema but no evidence of malacia or demyelination.

In sum, the clinical picture indicated, in addition to deficient intermediary metabolism and energy production, (1) the presence of physical and/or biochemical lesions in the cranial nerves, (2) biochemical lesions in the cerebellum and/or basal ganglia, and (3) biochemical lesions in the hypothalamus accompanied by hypopituitarism, hypothyroidism, hypoadrenocorticism and all that these deficits imply for the functional balance between sympathetic and parasympathetic branches of the autonomic nervous system and homeostasis.

Etiology

More than 500 forage and 200 soil samples were collected from the tropical savannas of the Colombian Llanos between 1968 and 1984. Consecutive monthly forage collections were made during the period 1981-1984. Chemical analyses of these samples included all essential macro- and microminerals⁴. Various temporal or permanent deficiencies and imbalances between elements were noted, including very low available soil sulfur. (Fig. 1) Total soil sulfur was also extremely low in the Altillanura⁷. Low forage magnesium content may have contributed to the thiamin deficiency⁸ but, more significantly, forage sulfur content below the critical level for ruminants (0.10 %) was found consistently during the months of July/August through November/December for all forage species collected in the Altillanura where secadera predominates. (Fig. 2) Among all of the essential minerals, the occurrence of secadera was significantly correlated ($p < .05$) only with this periodic deficit of dietary sulfur.

Because there is little or no storage of readily available sulfur in the animal body⁹ and because supplementation of sulfur in the diet reduced the incidence of secadera (see treatments, below), it was hypothesized that the sulfur-deficient diet depleted body sulfur stores. It was further hypothesized that the sulfur deficiency resulted in diminished intraruminal synthesis of thiamin (which contains sulfur as an integral part of its structure) and of cobalamin (the carbon atoms of which are derived, through cobyrinic acid, only from the sulfur-containing amino acid, methionine)¹⁰.

Finally, it remains to be determined whether or not the fungi (found only by incubating fresh forage samples at or above 30°C) associated with 25.6% of all forage samples collected in this study and having peak infection levels in July and August (Fig. 3), may contain thiaminases which contribute to thiamin deficiency and/or produce sufficient free cyanide to deplete cobalamin⁶.

Morbidity and Mortality

In the secadera outbreaks observed, 85% to 100% of all annual cases (420) occurred between August and December. (Fig. 2) Without treatment, overall mortality between herds and years varied from 1.9% to 4.2%. Overall morbidity was significantly different ($p < .01$) between cattle (all ages and sexes) which received no sulfur supplementation (240 cases in 2307 animals at risk = 10.4%) and those which received elemental sulfur^a (115 cases in 2758 cattle = 4.2%). Comparing

^a Elemental sulfur comprised, by weight, an average of 11% of the salt and mineral mix consumed *ad libitum*. At an average daily consumption of 70 gm of the mixture per adult animal and a 30% availability of sulfur (ref. 11) it was calculated that the supplement provided about 45% of the daily sulfur requirement.

FIG. 1: AVERAGE SOIL pH AND AVAILABLE SOIL SULFUR (S) COLOMBIAN ALTILLANURA

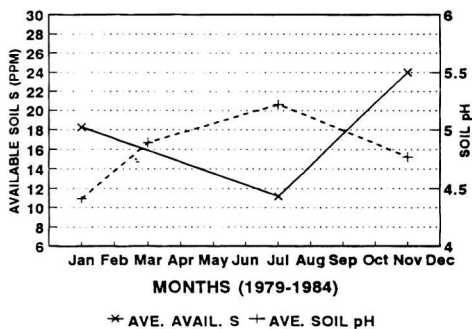


FIG. 2: SECADERA - COMPARISON OF PERCENTAGE OF ANNUAL CASES BY MONTH WITH MONTHLY SULFUR CONTENT OF FORAGE GRAZED - NAPOLES RANCH

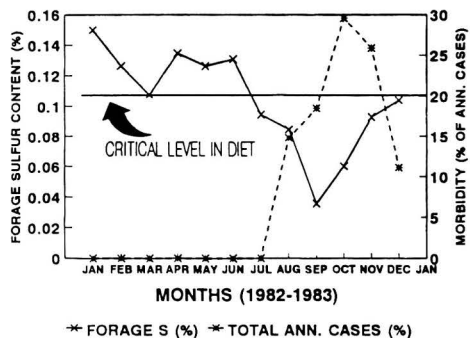
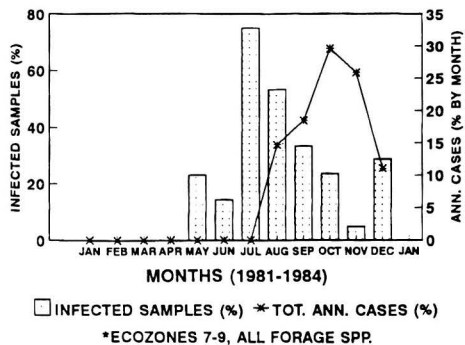


FIG. 3: SECADERA - PERCENT BY MONTH OF TOTAL ANNUAL CASES AND OF FORAGE SAMPLES INFECTED WITH FUNGI*



*ECOZONES 7-9, ALL FORAGE SPP.

only adult cattle, the incidence in non-supplemented (5.3%) versus those which received supplemental sulfur (2.4%) was significantly different ($p < 0.05$).

There was no statistically significant difference in the incidence of secadera in cattle pastured on native grass species (201 cases in 2040 total population at risk) versus those pastured exclusively on improved forage species ($N = 39/267$).

Cattle of all sexes under 30 months of age had a significantly ($p < 0.01$) higher attack rate ($172/1025 = 16.8\%$) than mature cattle ($72/1364 = 5.3\%$). The incidence in 438 lactating cows (6.6%) was not significantly different from the incidence (4.4%) in 725 dry cows .

Response to Treatments

Case fatality rates with and without treatment were significantly different ($p < 0.01$). The case fatality rate in untreated cows ($N = 25$) was 56%. Intramuscular or subcutaneous injections (1-3 given weekly) of low doses of thiamin HCl (0.5-0.8 mg/kg body weight) alone or in combination with low doses of vitamin B12 (0.5-1.0 microgram/kg body weight) reduced fatalities to 9.1% ($N = 22$).

Treatment of all ages and sexes with doses of thiamin estimated to equal normal body stores (3 - 5 mg/kg of body wt.) alone or combined with low or high doses (1 or 8 micrograms/kg) of vitamin B12 (cobalamin) prevented death in all cases ($N = 24$). This treatment also reduced the recovery period significantly. (It should be noted that the effective dosage of thiamin in treating secadera was only 30% of that recommended for the treatment of PEM.) The use of this latter treatment in several hundred cattle in the field was effective in preventing new cases and curing clinical cases of secadera.

Treatment with low doses of vitamin B12 alone had no effect on the course of the disease. High doses of vitamin B12 alone were not included in the experimental regimen.

Besides being affected by treatment with B vitamins, the rate of recovery in 26 cows correlated directly with packed cell volumes (PCVs), perhaps because of the importance of red blood cells in the transport of thiamin. In turn, PCVs in 10 animals (24% to 35%) were inversely related to the percentage (0 to 0.6) of red blood cells parasitized with the enzootic hemoparasites, *Anaplasma marginale* and/or *Babesia bigemina*.

Soil-Plant-Animal Interaction

Investigating the etiology of secadera has led us to document interactions in the soil-plant-animal continuum not previously suspected. Natural increases in soil pH during the first half of the calendar year were accompanied by marked decreases in the availability of several soil minerals for plant uptake and various changes in forage mineral content^{4,12}. Changes measured in the present study in soil pH, soil sulfur, forage sulfur content and their relation to secadera were indicated in Figs. 1 and 2.

The changing relationships in the soil-plant-animal system appeared to be initiated by the annual progressive increase in the pH of unamended soils during the period from January to June/July. These changes in soil pH were independent of local variables, including climatic differences, but were highly correlated ($p < 0.01$) with the annual cycle of variation measured in the geomagnetic values for South America.

Review of the international literature covering the period from the 1930's to the present, revealed an annual decrease in livestock productivity, globally, from June/July through August/September, especially in areas of the world having acidic soils⁴. Agronomic production data (for crops, forages and livestock) from many research publications document this annual cycle, which includes "summer slump" in the United States. Secadera is a severe expression of this process in cattle maintained on forages grown on acidic soils of tropical savannas.

Summary

Secadera is a thiamin-responsive nutritional wasting disease seen in cattle pastured on tropical savannas of South America having acidic, sulfur-deficient, soils. Investigation of the etiology of secadera revealed a progressive, significant ($p < 0.01$), increase in the pH of unamended oxisol soils from January through June/July. These increases were significantly correlated ($p < 0.01$) with reductions, beginning in July of each year, in available soil sulfur (S) and the S content of native or improved savanna forages. The dietary deficiency of S from July to December was correlated ($p < 0.05$) with signs of thiamin and cobalamin deficiency which, in various years, affected more than 10% of an observed population of over 5000 grazing cattle. Effective treatment consisted of 1 to 3 weekly doses of 3 to 5 mg thiamin HCl/kg body wt. parenterally. Dietary S supplementation reduced the incidence of secadera significantly. The changes in soil pH were highly correlated ($p < 0.01$) with annual variations in the local magnetic field strength of Earth.

Resumen

Secadera es una enfermedad caquética de origen nutricional que se encuentra en bovinos pastoreados en las sabanas tropicales de Sur América que tienen suelos ácidos y deficientes en azufre (S). Investigación de la etiología de la secadera mostró, en suelos del orden oxisol no abonados, aumentos progresivos y significativos ($p < 0.01$) en el pH desde enero hasta junio/julio. Este aumento correlacionó significativamente ($p < 0.01$) con reducciones, empezando en julio, en la disponibilidad a las plantas del S del suelo y el contenido de S en los forrajes de sabana, nativos o mejorados. La deficiencia dietética del S desde julio hasta diciembre correlacionó ($p < 0.05$) con signos de deficiencia de tiamina y cobalamina, los cuales, en distintos años, afectaron a más del 10% de una población en exceso de 5000 bovinos observados en pastoreo. Se resolvió la secadera a base de 1 a 3 inyecciones semanales de tiamina en una dosis de 3 a 5 mg/kg de peso por vía parenteral. Suplementación de S bajó significativamente la incidencia de la secadera. Los cambios en el pH del suelo correlacionaron altamente ($p < 0.01$) con las variaciones anuales en la potencia del campo magnético de la tierra en la zona geográfica del estudio.

Sommaire

La Secadera est an maladie nutritionnel (résponsif á thiamine) qui se trouvé dans les vaches paîtrent sur les savane tropicales de l'Amérique du Sud quand le sol est acidic et deficiant du soufre. Une investigation de las etiologie de la secadera a trouvé une augmentation progressif entre janvier et juin/juillet du pH, significative ($p < 0.01$), dans les sols du ordre oxisol sans amendement. Une correlation significative ($p < 0.01$) été observé entre une reduction, commencent in juillet chaque année, in le soute (S) disponible dans le sol et le S disponible dans le fourage natif et améliorer. En plus, une correlation significative ($p < 0.01$) été observé entre la deficit nutritionnel du S entre juillet et decembre et des signe du deficit du thiamine et cobalamin quede, dan quelques annees, a afflicté plus de 10% d'une population observé de plus de 5,000 vâche. Un traitement effectif a consisté de 3 a 5 mg du thiamine HCl/kg par poids du corps via parenteral un fois par semaine pendant 1 a 3 semaines. Une augmentation du S dans le regime a fair une reduction en la incidence de la secadera. Les changements du pH du sol correspondent à les variations annual du champs magnetique locale de la planète ($p < 0.01$).

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