Session 2 Stress factors associated with nutrition in the subtropics and tropics

Effect of season on mineral concentrations in beef cattle in Malawi

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The true diagnosis of mineral deficiencies depends on the mineral responses to the supplementation of the deficient minerals; however, based on animal tissue analysis Cu, Mn, Ca and P are minerals that are likely to be deficient in cattle production in Malawi. Liver Cu, Fe and Mn and bone Ca and P were all significantly lower during the wet season than during the dry season.

Die ware diagnose van mineraaltekorte is afhanklik van die mineraalresponse na aanvulling van die tekorte. Dierweefselanalise het egter getoon dat Cu, Mn, Ca en P minerale is wat moontlik tekorte sal veroorsaak by beesproduksie in Malawië. Lewer Cu, Fe en Mn en been Ca en P was almal betekenisvol laer tydens die nat seisoen as wat dit tydens die droë seisoen was.

Keywords: Minerals, beef cattle, season, Malawi, Africa

Introduction

In tropical regions with long dry seasons nutrition is often cited as a major limitation to ruminant livestock production. Animals lose weight during the dry season because of low quality and quantity forage which includes low mineral concentration. A greater response to mineral supplementation has often been observed during the rainy season when forages are supplying adequate energy and protein (McDowell & Conrad, 1977), than during the dry season when these nutrients limit animal performance greatly. Rapidly growing animals or lactating cows have higher mineral requirements than slow growing animals or non-lactating cows.

Identification of borderline to deficient minerals in pasture in specific locations is, therefore, the key step to effective and low cost mineral supplementation. A systematic mapping survey technique or regional reconnaissance, whereby soil, forage and animal tissues are analysed for minerals required by grazing livestock, has been widely used to identify mineral deficiencies in South America (McDowell & Conrad, 1977).

Biopsy samples are ideal for testing the mineral status of animals (Little, 1972); however, for investigations involving many small producers, biopsy samples are socially or economically difficult, if not impossible, to obtain.

Mineral reconnaissance studies have not been conducted in Malawi and limited mineral supplementation has been based on mineral supplements formulated for South African conditions. The objective of this investigation was to determine the mineral deficiencies or toxicities in Malawi as a basis for formulating mineral supplements.

The present paper discusses the effect of season on mineral concentrations in animal tissues.

Materials and Methods

Eighteen cattle markets, each with annual sales of more than 50 head of cattle, were selected throughout Malawi. Samples were collected from the first ten animals from each market to reach the abattoir. Animals were identified by market letter, colour codes and tag numbers. They were predominantly Malawi Zebu, which averaged four pairs of teeth and did not receive any mineral supplement. Sampling was done during the dry season (July to September, 1979) and during the wet season (January to March, 1981).

Blood, liver and rib (11th rib) bone samples were prepared for shipment within six hours after collection to meet the requirements of the Animal and Plant Health Inspection Service of the United States Department of Agriculture. Disposable plastic gloves, stainless steel knives and saws were used to avoid mineral contamination of samples.

Blood serum was analysed for Ca, P and Cu; liver was analysed for Fe, Cu and Mn and bone was analysed for Ca, P and ash. The results were statistically analysed as a nested design with unequal subclass samples.

Results and Discussion

The incidence of serum Ca deficiency was higher ($P<,05$) in the rainy season than in the dry season. The percent Ca deficiency, but not the mean blood Ca, was affected by season ($P<,05$) (Table 1). Lebdosoekojo (1977) did not find

Table 1 Effect of season on serum mineral concentrations

Mineral	Season	Mean[a]	SE	% Deficiency
Ca, mg/100 ml[b]	Wet	7,67[e]	,66	100[e]
	Dry	7,63[e]	2,67	63,2[f]
P, mg/100 ml[c]	Wet	6,37[e]	1,37	12,6[e]
	Dry	4,8[e]	2,17	38,5[f]
Cu, μg/ml[d]	Wet	,3[e]	,08	100[e]
	Dry	,3[e]	,1	100[e]

[a]Means based on: n = 154 wet and n = 143 dry seasons
[b]Critical level <9 mg/100 ml
[c]Critical level <4,5 mg/100 ml (McDowell and Conrad, 1977)
[d]Critical level <0,6 μg/ml (Committee on Animal Nutrition, 1973)
[e,f]Means within a column for a mineral with different superscripts differ ($P<,05$)

a significant effect of season on serum Ca whereas Mendes (1977) in Brazil reported a significant effect. However, the animals in their experiments were receiving mineral supplements.

Mean serum phosphorus was not affected by season although others (Lebdosoekojo, 1977; Mendes, 1977) have reported significant increases during the wet season. Blood phosphorus is affected by many factors and is not recommended as a criterion for the assessment of phosphorus status in grazing cattle (Committee on Animal Nutrition, 1973).

The mean serum Cu and incidence of Cu deficiency were not affected by season. However, liver Cu which is reported to be the best criterion for the assessment of Cu status of grazing animals (Committee on Animal Nutrition, 1973) indicated a significant seasonal effect (Table 2). The incidence of liver mineral deficiencies was significantly higher and liver mineral storage was significantly lower in the wet season than in the dry season. Mendes (1977) observed similar findings in Brazil which confirms the general observation that accelerated growth rate in the wet season increases the mineral requirements of the animals and that animals mobilize minerals from their body tissues to meet the increased demand; whereas, during the dry season, the reverse is true (McDowell & Conrad, 1977).

Table 2 Effect of season on liver mineral concentrations

Mineral (ppm)[b]	Season	Mean[a]	SE	% Deficiency
Fe	Wet	241[e]	150	32,8[c]
	Dry	307[f]	160	14,6[d]
Cu	Wet	64[c]	71	71,5[c]
	Dry	84[d]	54,4	54,8[d]
Mn	Wet	5,64[e]	1,47	95,1[c]
	Dry	11,93[f]	4,63	15,4[d]

[a]Means based on n = 186 wet and n = 208 dry seasons

[b]Critical levels: Fe < 180 ppm, Cu < 75 ppm, Mn < 8 ppm (McDowell et al., 1978)

[c,d]Means within a column for a mineral with different superscripts differ ($P<,05$)

[e,f]Means within a column for a mineral with different superscripts differ ($P<,01$)

A decrease in mineral levels from the dry to the wet season because of accelerated growth rate is also indicated in both minerals (Table 3). Lebdosoekojo (1977) observed similar findings in animals receiving mineral supplements.

The criterion used to evaluate the correlation coefficients was $r \geq \pm\ 0,55$, $P<,05$ since that seemed a reasonable correlation coefficient to explain at least a quarter of the variation in mineral concentration of a tissue. There were no correlation coefficients in blood, liver and among blood, liver and bone tissues to meet the criterion ($r \geq \pm\ 0,5$, $P<,05$). Significant correlation coefficients were only obtained in bone between different parameters expressing bone Ca, P and ash. Lebdosoekojo (1977) and Mendes (1977) did not find significant correlation coefficients in blood to meet the criterion used to evaluate correlation coefficients in this study.

Table 3 Effect of season on bone mineral concentrations[a]

Mineral, %	Season	Mean[b]	SE	% Deficiency[c]
Ca	Wet	18,8[f]	3,69	99,5[d]
	Dry	27,6[g]	4,2	59,3[e]
P	Wet	10,69[d]	1,43	87,6[d]
	Dry	11,3[d]	2,36	81,3[e]
Ash	Wet	65,9[d]	1,36	100[d]
	Dry	66,5[d]	2,8	48,6[e]

[a]Dry matter, fat-free basis.

[b]Means based on: n = 186 wet and n = 208 dry seasons

[c]Critical levels, percent: Ca < 24,5, *P* < 11,5 and Ash < 66,8 (Little, 1972)

[d,e]Means within a column for a mineral with different superscripts differ ($P<,05$)

[f,g]Means within a column for a mineral with different superscripts differ ($P<,01$)

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