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Effect of magnesium supplement and housing on serum transaminase activities in beef cows *

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Summary — Eighteen groups, each containing 4 pregnant Shorthorn beef cows, were used to determine the effect of magnesium supplementation on serum transaminase activities. Three mineral supplements (no magnesium, 8% magnesium as magnesium oxide, and 0.8% magnesium as sequestered magnesium) were offered to 6 groups throughout the experiment. Six groups, 2 on each mineral supplement, remained indoors throughout the summer; the other 12 groups were turned out to pasture on May 25 and continued receiving the appropriate mineral supplement. Cows on pasture had greater ($P <$ 0.05) activities of both serum glutamic-oxaloacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT) starting about 10 d after turn out to pasture than cows housed in the barns. Supplementation of magnesium either as magnesium oxide or as sequestered magnesium had no significant effect on serum transaminase activities of cows and calves. Cows on pasture had significantly higher transaminase activities than cows housed in the barn. The SGPT activity of calves were initially less than those of cows, but by September their levels were similar to those of the cows.

housing / magnesium supplementation / SGOT / SGPT / beef / cow

Résumé — Effet de l'apport en magnésium sur l'activité des transaminases sériques chez la vache. *L'effet de l'apport de magnésium sur l'activité des transaminases sériques a été étudié sur 18 groupes de 4 vaches de race Shorthorn en gestation. L'essai a démarré en décembre, les vaches étant à l'étable en stabulation séparée par groupe. Trois suppléments minéraux ont été offerts en libre choix à 6 des 18 groupes : le premier ne contenait pas de magnésium (Mg), le deuxième contenait 8% de Mg sous forme d'oxyde de magnésium et le troisième 0,8% de Mg sous forme «séquestrée». Six groupes (2 par supplément) sont restés en stabulation tout l'été alors que les 12 autres groupes sont sortis au pâturage le 25 mai où ils ont continué à recevoir leur supplément minéral. Les vaches au pâturage ont eu des activités glutamate-oxaloacétate transaminase (SGOT) et glutamate-pyruvate transaminase (SGPT) plus élevées (P < 0,05) que les vaches maintenues en stabulation, dès le 10e jour environ après la mise à l'herbe. L'apport de magnésium sous forme d'oxyde ou sous forme «séquestrée» n'a pas eu d'effet significatif sur l'activité sérique des transaminases chez les vaches et leurs veaux.*

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Seules les activités des transaminases ont été plus élevées chez les vaches au pâturage. L'activité de la SGPT des veaux a été, intialement, moindre que celle des vaches, mais, en septembre, leurs taux ont été semblables à ceux des vaches.

stabulation / magnésium / SGOT / SGPT / viande / vache

INTRODUCTION

Serum magnesium (Mg) concentration in the Agriculture Canada, Kapuskasing Experimental Farm beef herd has been reported to be less than the accepted normal levels of 18 to 32 mg/l (Fisher *et al*, 1972). These workers also reported several cases of grass tetany following parturition. Increased serum glutamic-oxaloacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT) activities have been noted in various diseases involving tissue necrosis, including human and avian muscular dystrophy (White and Hess, 1957). Mg deficiency has been associated with muscular dystrophy, which in turn results in increased serum SGOT and SGPT activities. Thus, Mg has an indirect relationship with serum SGOT and SGPT activities.

Sekine *et al* (1988) reported that serum SGOT activity was low in the early fattening stage of steers and increased up to 80 units at mid stage and through the end of the fattening period. Cornelius *et al* (1959) reported that young calves had lower SGOT and SGPT activities than mature cows. Boots and Ludwig (1970) reported average SGOT and SGPT activities of Holstein cows of 43.4 and 23.3 Karmen units, respectively. They further noted that SGPT activity was unchanged during gestation, whereas SGOT activity increased with advancing gestation.

Little research has been conducted on the effects of Mg supplementation and type of housing on serum SGOT and SGPT activities in beef cows. It has been reported (Standish, 1977) that cattle do not regulate their intake of minerals according to their needs. The intake seems to be related to taste and appetite. Chelation and sequestrations of minerals to improve their biological availability have been tried to overcome problems arising from suboptimal intake of minerals (Hidiroglou *et al*, 1981). Our objective was to determine the effects of Mg supplementation (magnesium oxide, sequestered magnesium), housing, and pasture on serum SGOT and SGPT activities in beef cows and their offspring.

MATERIALS AND METHODS

Animals and diet

Seventy-two Shorthorn cows of second or greater parity with average body weight of 550 kg that were artificially bred with Hereford semen to calve from mid-March to May were randomly allocated to 18 groups of 4 cows each. Starting in December, all cows were wintered in an enclosed, insulated, unheated barn, with each group penned separately. Each of 3 mineral supplements was provided on a free-choice basis to 6 of the 18 groups. One mineral supplement contained no Mg, the second contained 8% Mg in the form of magnesium oxide, and the third contained sequestered Mg (Stauffer Chemical Company, Westport, CT, USA). The latter mineral supplement contained about 0.8% Mg. These two levels of Mg supplements were chosen as described by Hidiroglou *et al* (1981). The composition of the mineral supplements and their Mg content is shown in table I. The minerals were fed in the conventional type of covered containers. Until March 1, each group received formic acid-treated grass silage at the rate of 1.2 kg DM /100 kg of initial body weight. From March 1 until the end of winter feeding on May 25, silage was fed to provide *ad libitum* access. Six groups of 4 cows each, 2 groups on each mineral supplement, remained indoors throughout the summer; the other 12 groups were turned out to pasture on May 25. The 24 animals that remained indoors continued

Table I. Composition (% of dry matter) of the mineral supplements.

	Control	*Magnesium oxide*	*Sequestered magnesium*
Dicalcium phosphate	35.0	35.0	35.0
Cobalt-iodized salt	60.5	47.2	49.5
Vitamin A and D [a]	4.0	4.0	4.0
$CuSO_4 \cdot 5H_2O$	0.5	0.5	0.5
Sequestered magnesium (7.3% Mg)	–	–	11.0
Magnesium oxide (60.3% Mg)	–	13.3	–
Magnesium (%) (by calculation)	0.0	8.0	0.8

[a] 8.8 x 10^6 IU vitamin A and 8.8 x 10^5 IU vitamin D per kg.

to receive *ad libitum* access the formic acid-treated silage and the appropriate mineral supplement.

Four pastures were used during the summer, 2 received 78 kg of N/ha and 2 155 kg of N/ ha. Pasture consisted of a mixture of alfalfa and timothy grass. To continue supplying the animals with appropriate mineral supplements, each pasture was subdivided into 3 equal sections. Three groups, 1 on each supplement, were then randomly allocated to each pasture. The cows continued to nurse their calves until fall weaning.

Sampling and chemical analyses

Blood serum was obtained from all cows and calves according to the schedule shown in table II. Activities of SGOT and SGPT were determined by the method of Sigma (1957). The assay for transaminase activity is based on the transfer of the alpha-amino group of either aspartic acid or alanine to alpha-ketoglutaric acid. The oxaloacetate that results in the determination of SGOT activity is converted to pyruvic by aniline citrate. Pyruvate-dinitrophenylhydrazone is prepared next and measured colorimetrically at 505 ± 15 mμ without the extraction procedure. The Sigma (1957) method for the determination of SGOT and SGPT expresses activity in terms of transaminase units. One Karmen (kA) unit of transaminase activity is defined as that which produces a decrease in the optical density at 340 mμ of 0.001 $min^{-1}.ml^{-1}$ of serum at 25°C per cm of light path (Karmen, 1955).

Table II. Calender of sampling.

	Cow serum	*Calf serum*
January	x	–
Mid winter	x	–
48 h after calving	–	x
2 wk after calving	x	–
24 h before pasture	x	x
72 h after pasture	x	x
10 d after pasture	x	x
17 d after pasture	x	x
24 d after pasture	x	x
September	x	x

Statistical analyses

Data of SGOT and SGPT activity (Y) were analyzed according to the following model:

$$Y = \mu + R + D + H + DH + COW(DH) + T + TD + TH + TDH + E$$

where μ = overall mean; R = effect of replicate; D = effect of mineral supplement (no Mg, 8% Mg as magnesium oxide, 0.8% Mg as sequestred magnesium); H = effect of housing (barn, pasture 1 with 78 kg of N/ha, pasture 2 with 155 kg of N/ha); DH = interaction between mineral supplement and housing; COW = cow effect (error term used to test R, D, H, and DH); T = time effect; TD, TH, and TDH = interactions; E = error term used to test T and interactions with T. The data were analyzed as a repeated measures experiment using the General Linear Models procedure of SAS (1985) with time designated as a repeated measure.

RESULTS

The Mg contents of chopped pasture sample and formic acid-treated grass silage were 0.145 and 0.154 as % of DM, respectively. Serum Mg concentrations of these cows and calves have been reported by Hidiroglou *et al* (1981). The level of Mg in the sera of the cows measured in January, February, and 17 d after calving were above 20 mg/l, which can be considered normal for cattle (Todd, 1967). There was an extreme drop in Mg concentration (12 mg/l) in the serum samples of cows taken 24 h before turning out to pasture. After 17 d on pasture, serum Mg concentration returned to a normal level (20 mg/l). The serum Mg levels in the calves 48 h after birth were normal (21 mg/l) and showed a marked drop near the time the animals were put to pasture (14.5 mg/l). By September, the Mg concentration in the serum of the calves returned to the normal level.

Interactions of mineral supplement x housing (DH) and time x mineral supplement x housing (TDH) were not significant ($P > 0.05$) for serum SGOT and SGPT activities of cows and calves. Interaction of time x mineral supplement (TD) was significant ($P < 0.05$) for serum SGOT and SGPT activities of cows. Interaction of time x housing (TH) was significant ($P < 0.05$) for serum SGOT and SGPT activities of cows and calves.

Serum SGOT activities of cows and calves for each mineral supplement and method of housing during the summer are shown in table III. There was an effect ($P < 0.05$) of mineral supplement on SGOT activity at the 4 sampling times (January, 24 h pre-pasture, and 10 and 24 h after pasture turn out). Effect of housing was significant ($P < 0.05$) for serum SGOT activity of cows starting 10 d after pasture turn out and up to September. Effect of housing also was significant ($P < 0.05$) for serum SGOT activity of calves at 17 and 24 d after pasture turn out. There was a decrease ($P < 0.05$) in the SGOT activity of cows 10 d after pasture turn out and in calves 17 d after pasture turn out. Seventeen days after pasture turn out, serum SGOT activity returned to the levels similar to 72 h after pasture turn out in both cows and calves. The differences in SGOT activity of cows resulted from an increase in pasture cows rather than a change in the barn cows. For both cows and calves, SGOT activities seemed to increase towards the end of the experiment, with the activity of the pasture cows increasing the most.

Mineral supplement differences were generally not significant for SGPT activity, except in January and 14 d after calving (table IV). The effect of housing on SGPT activity was significant ($P < 0.05$) for cows starting at 17 d after pasture turn out, continuing up to September. For calves, the effect of housing on SGPT activity was generally not significant, except at 10 d after pasture turn out and in September. Activities of SGPT increased from January to September in both cows and calves, except for a significant decrease at 14 d after calving and 17 d after pasture turn out. There was no difference in the SGPT activity of cows on pastures fertilized with 78 kg or 155 kg N/ha. Cows on pasture had greater ($P < 0.05$) SGPT activity than cows housed in the barn starting 17 d after pasture turn out and up to the end of the study. The SGPT activity of calves on pasture was greater ($P < 0.05$) than that of calves housed in the barn at the end of the experiment in September.

The effect of time was significant for both SGOT and SGPT activities and differences among the different times of sampling were more extreme for SGOT than SGPT activity. Furthermore, these differences were more for the animals on pasture than for those remaining in the barn. Serum SGOT

Table III. Serum glutamic-oxaloacetic transaminase (SGOT) activity (kA units/ml) of cows and calves.

	Date of measurements								
	Jan	*Feb*	*14 d post-calving*	*24 h pre-pasture*	*72 h post-pasture*	*10 d post-pasture*	*17 d post-pasture*	*24 d post-pasture*	*Sep*
Cows									
Mineral supplement									
No Mg	60.8 [a]	64.6	63.1	72.2 [a]	79.6	67.1 [a]	77.3	69.6 [a]	70.0
8% Mg [c]	61.5 [a]	67.0	67.5	73.3 [a]	79.5	57.6 [b]	74.9	72.6 [ab]	72.6
S Mg [d]	53.7 [b]	63.5	64.3	65.7 [b]	79.8	62.6 [a]	75.2	75.4 [b]	70.1
Housing									
Barn	59.5	64.7	66.9	68.8	78.5	57.4 [a]	68.2 [a]	65.3 [a]	61.2 [a]
Pasture [1]	59.2	63.0	64.7	70.5	81.0	65.6 [b]	78.8 [b]	74.5 [b]	75.5 [b]
Pasture [2]	57.2	67.4	63.2	71.7	79.4	67.5 [b]	80.4 [b]	77.8 [b]	75.9 [b]
SEM	1.8	2.0	2.0	1.9	1.8	1.7	1.6	1.5	1.4
		48 h post-calving							
Calves									
Mineral supplement									
No Mg		53.8		49.8	66.5	50.7	48.4	63.2 [a]	73.1
8% Mg [c]		53.9		48.1	66.8	53.1	46.2	59.2 [b]	74.2
S Mg [d]		48.5		48.4	68.1	55.0	47.7	55.4 [b]	72.4
Housing									
Barn		54.8		48.1	65.4	54.2	45.7 [a]	52.9 [a]	71.55
Pasture [1]		51.9		48.0	68.0	51.2	44.8 [a]	61.0 [b]	77.58
Pasture [2]		49.3		50.2	68.0	53.9	50.9 [b]	63.9 [b]	73.54
SEM		2.5		2.3	1.8	2.0	1.5	2.0	1.8

SEM = standard error of the mean. [a,b] Means followed by different letters in the same column differ by Duncan's MRT ($P < 0.05$); [c] as magnesium oxide; [d] as sequestered magnesium. [1] 78 kg N/ha; [2] 155 kg N/ha.

and SGPT activities of cows at different times of collection are plotted in figures 1 and 2, respectively. Cows housed in the barn during summer had similar SGOT activity to those cows on pasture up to 72 h after pasture turn out. Starting 10 d after pasture turn out and up to September, cows on pasture had greater ($P < 0.05$) SGOT activities than those in the barn. There were no differences in the SGPT activity of cows housed either in the barn or on the pasture up to 10 d after pasture turn out. Starting 17 d after pasture turn out and up to September, cows on pasture had greater ($P < 0.05$) SGPT activities than cows in the barn. For SGOT activity, values for calves were less than for cows until September, when their activities were comparable (fig 3). The pattern for SGPT activity of cows *vs* calves was similar to that of SGOT. Both cows and calves showed lower ($P < 0.05$) values of SGPT at 17 d

Table IV. Serum glutamic-pyruvic transaminase (SGPT) activity (kA units/ml) of cows and calves.

	Date of measurements								
	Jan	*Feb*	*14 d post-calving*	*24 h pre-pasture*	*72 h post-pasture*	*10 d post-pasture*	*17 d post-pasture*	*24 d post-pasture*	*Sep*
Cows									
Mineral supplement									
No Mg	13.9 [a]	16.6	10.9 [a]	17.7	17.1	19.0	16.3	19.9	26.5
8% Mg [c]	16.8 [b]	17.1	13.0 [b]	19.5	17.8	18.0	15.9	20.5	27.2
S Mg [d]	12.6 [a]	16.6	12.0 [b]	18.5	16.1	17.6	15.6	21.7	25.0
Housing									
Barn	15.5	17.0	12.7	18.6	16.9	17.3	13.3 [a]	17.5 [a]	20.0 [a]
Pasture [1]	13.3	16.6	11.9	18.3	16.3	18.5	17.5 [b]	21.5 [b]	30.7 [b]
Pasture [2]	15.4	16.7	11.2	18.8	17.9	18.8	17.0 [b]	23.1 [b]	29.0 [b]
SEM	0.8	0.6	0.6	1.0	0.8	0.8	0.8	0.8	0.9
		48 h post-calving							
Calves									
Mineral supplement									
No Mg		12.0		13.0	13.5	10.8	7.6	13.5	23.9
8% Mg [c]		11.4		12.5	13.7	10.3	6.9	12.4	23.9
S Mg [d]		10.7		13.1	13.7	11.4	8.0	12.5	23.5
Housing									
Barn		11.7		13.3	13.4	10.2 [a]	7.4	11.9	21.7 [a]
Pasture [1]		12.0		12.8	14.0	10.2 [a]	7.2	12.9	24.7 [b]
Pasture [2]		10.2		12.5	13.5	12.1 [b]	7.8	13.9	24.9 [b]
SEM		0.7		0.4	0.4	0.4	0.4	0.5	0.7

SEM = standard error of the mean. [a,b] Means followed by different letters in the same column differ by Duncan's MRT ($P < 0.05$); [c] as magnesium oxide; [d] as sequestered magnesium. [1] 78 kg N/ha; [2] 155 kg N/ha.

after pasture turn out (fig 4) than at other times on pasture.

DISCUSSION

Overall average activities of SGOT and SGPT in the sera of cows measured at different times were 69.23 and 17.78 kA units, respectively, which could be considered normal for cattle (Cornelius *et al*, 1959; Boots and Ludwig, 1970). Similar values for calves were 58.30 and 13.27 kA units averaged over all collections and housing. The values for calves were slightly greater than those reported by Cornelius *et al* (1959). Serum SGOT and SGPT activities of calves were less than those of cows at all measurement times. These findings confirm the report of Cornelius *et al* (1959).

Cornelius *et al* (1963) reported that horses in training had greater SGOT activities than those not in training. In our study, cows on pasture had greater activities of SGOT and SGPT than cows in the barn starting 10 d after pasture turn out. This increase in the transaminase activity of the cows on pasture may be the result of greater exercise than by cows housed in the barn. Increased SGOT and SGPT activities following greater exercise by cows on pasture may result from increased permeability of the cell membranes resulting from the release of certain metabolites such as catecholamine. Nonetheless, this increase was only moderate and not the result of cell damage. Transaminases are dynamic enzymes, capable of responding rapidly to a large assortment of physiological challenges. It is probable that any factor that affects metabolism will affect transaminase activity. Cardinet *et al* (1963) reported that serum SGOT activities were greater in horses in training than those not subjected to exer-

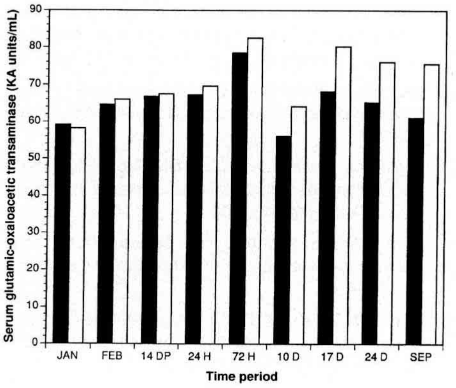

Fig 1. Effect of housing on serum glutamic-oxaloacetic transaminase of beef cows (black: barn; white: pasture).

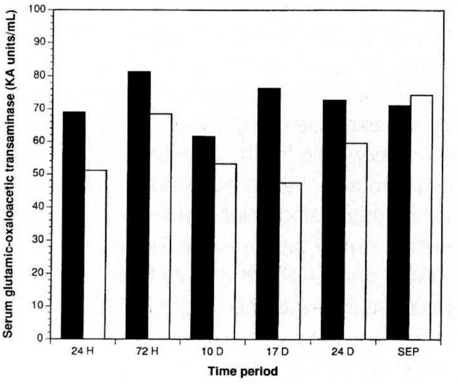

Fig 3. Average serum glutamic-oxaloacetic transaminase of cows and calves on pasture (black: cow; white: calf).

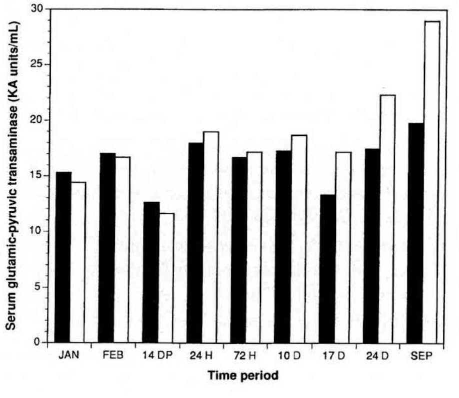

Fig 2. Effect of housing on serum glutamic-pyruvic transaminase of beef cows (black: barn; white: pasture).

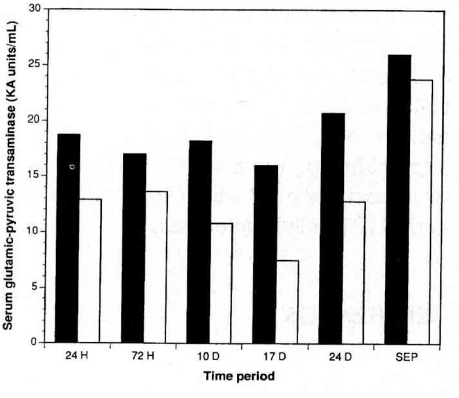

Fig 4. Average serum glutamic-pyruvic transaminase of cows and calves on pasture (black: cow; white: calf).

cise. Serum SGOT activities decreased as training progressed, but in the latter stages of training, values were elevated again. In our study, there was a sudden increase in the SGOT activity of the cows when they were turned out to pasture, followed by a decrease 10 d after pasture turn out and a gradual increase thereafter. A similar pattern also was observed for the SGPT activity of the cows, but the decrease occurred 17 d after pasture turn out. According to Zeirier (1957), anoxia, deprivation of glucose, and potassium concentration are the important stimuli for the release of certain enzymes from the cells into the extracellular fluids. These factors can be well accounted for during exercise (Singh *et al,* 1980) and may be responsible for the changes observed in enzyme activities in our study. The reason for the increasing values when animals were turned out to pasture may be the result of SGOT and SGPT that have been released from the liver into the blood. An increase in enzyme activity with advancing stage of lactation agrees with the findings of Crist *et al* (1967), who reported that plasma transaminase activity increased as lactation progressed.

Supplementation of magnesium either as sequestered magnesium or as magnesium oxide had very little effect on the serum activity of SGPT of cows and calves. This finding agrees with those of Galyean and Hallford (1983), who reported little effect of diet on serum enzymes. Sanson and Stallcup (1984) observed that the feeding of malic acid had no effect on the serum SGOT and SGPT activity in calves.

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