Effect of Serum Magnesium and Feed Intake on Serum Growth Hormone Concentrations

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ABSTRACT
Concentration of serum growth hormone was increased and feed intake was reduced in lactating dairy cows fed an 84% concentrate diet supplemented with either 100.8 g MgO or 121.2 g of Mg(OH)₂. Analysis of serum growth hormone, feed intake, and serum Mg showed an interaction of serum Mg and feed intake, which suggests low concentrations of serum Mg lessen the increase of concentration of serum growth hormone caused by reduced feed intake. Also, compared with control, treatments with Mg supplementation and reduced feed intake increased growth hormone concentration 12 d into the subsequent treatment.

INTRODUCTION
Dietary alkalizing agents such as NaHCO₃ and MgO have been widely used to increase feed intake and milk fat percent in cows fed liberal amounts of grain or silage (2). Dussault et al. (1) reported supplemental NaHCO₃ decreased serum Mg and growth hormone. As part of a comparison of forms of Mg on production of milk fat, we examined the effect of supplemental Mg(OH)₂ and MgO on serum Mg and growth hormone.

MATERIALS AND METHODS
Twelve Holstein cows in mo 4 to 6 of their first lactation were adapted for 17 d to a diet of 67% high moisture ear corn, 16.5% soybean meal, 5% haylage, 8% corn silage, and minerals. This basal diet contained .16% Mg, 18% crude protein and met other nutrient requirements according to National Research Council (7). Basal diet was fed to provide approximately 8% refusal. After 17-d adaptation, 8 cows were selected on the basis of good health and diminished concentration of milk fat for a four diet, Latin square experiment with four 2-wk periods. Cows were assigned to one of the two squares on the basis of milk production. The design provided for all cows to receive all treatments with each treatment following every other treatment an equal number of times to compensate for and estimate residual effects of treatments by the method of Williams (13, 14) as described by Gill (4).

All cows were fed the basal diet daily at 1330 h, and supplemental Mg was stirred into the diet of individual cows at the time of feeding. Supplements were: none, 100.8 g MgO (54% Mg, basic chemical feed grade powder), 60.4 g Mg(OH)₂ (40% Mg), and 121.2 g Mg(OH)₂. Feed and refusals were weighed daily with data reported for the same days milk was sampled. Milk was weighed and sampled on d 9, 11, and 14 of each period. A blood sample was obtained from a tail vessel on d 10 and from a jugular catheter on d 12 of each period to quantify serum Mg by atomic absorption spectrophotometry (6). On d 12, additional samples of blood were collected from the jugular catheter at .5-h intervals from 1200 through 1800 h to quantify for serum growth hormone as in (10) with substitution of a newly validated antibody. Statistical inferences were based on a Latin square, split-plot analysis of variance (5). Treatments with Mg supplementation were compared with control using Dunnett’s test (3). The logarithmic transformation of growth hormone concentrations were used for statistical tests.
TABLE 1. Treatment responses of cows to magnesium supplementation.

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>100.8 g MgO</th>
<th>60.4 g Mg(OH)₂</th>
<th>121.2 g Mg(OH)₂</th>
<th>SED¹</th>
<th>N²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter intake, kg/d</td>
<td>16.9</td>
<td>15.3**</td>
<td>15.5**</td>
<td>14.7**</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4% Fat-corrected milk, kg/d</td>
<td>16.4</td>
<td>16.1</td>
<td>16.8</td>
<td>16.9</td>
<td>.7</td>
<td>8</td>
</tr>
<tr>
<td>Milk fat, %</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
<td>2.1</td>
<td>.1</td>
<td>8</td>
</tr>
<tr>
<td>Serum Mg, mg/100 ml</td>
<td>2.5</td>
<td>2.7*</td>
<td>2.5</td>
<td>2.6</td>
<td>.1</td>
<td>8</td>
</tr>
<tr>
<td>Serum growth hormone, ng/ml</td>
<td>6.7</td>
<td>8.1***</td>
<td>7.2</td>
<td>8.0**</td>
<td>.2</td>
<td>8</td>
</tr>
<tr>
<td>GH³ adjusted for intake</td>
<td>7.4</td>
<td>7.9</td>
<td>7.1</td>
<td>7.6</td>
<td>.3</td>
<td>8</td>
</tr>
<tr>
<td>Residual effect on serum GH,⁴ ng/ml</td>
<td>...</td>
<td>1.0**</td>
<td>.6</td>
<td>.7*</td>
<td>.2</td>
<td>8</td>
</tr>
</tbody>
</table>

¹Standard errors of differences of means.
²Animals per treatment.
³Growth hormone.
⁴Residual effect relative to control 12 d after end of treatment.
• Differ from control (P<.06).
• * Differ from control (P<.01).

RESULTS AND DISCUSSION

Responses of cows to the Mg supplements are in Table 1. Intake of feed was decreased (P<.01) by the greater Mg supplementation. All cows gained at least 14 kg body weight during the last 49 d of the trial, indicating that all cows were in positive energy balance. Production of fat-corrected milk did not differ among forms and amount of supplemental Mg and control. Milk fat percentages were not significantly different among the treatments and control, although fat concentration tended to increase with Mg supplementation in agreement with (2, 6). We cannot explain the failure of 60.4 g Mg(OH)₂ to increase serum Mg.

Serum Mg tended to increase with 121.2 g of Mg(OH)₂ supplementation and was increased (P<.06) by MgO supplementation. Serum growth hormone increased (P<.01) during the larger Mg supplementations but increased only slightly with the smaller Mg supplementation. As expected (11), growth hormone concentrations decreased with time after feeding (Figure 1). In agreement with (8), milking did not affect growth hormone concentrations. Treatment by time interaction was not significant (P>.2).

High Mg supplementation with MgO or Mg(OH)₂ had a significantly greater residual effect than control on growth hormone concentration on d 12 of the next period. These treatments also had reduced intake, although intake in the next period was not effected by d 9. Residual effects were not seen for any of the other dependent variables.

Depressed feed intake can increase circulating growth hormone as demonstrated by (9, 12). When growth hormone concentration averaged across time was analyzed with intake as a covariate, none of the Mg supplements were different from control. To examine the relationship of intake and Mg, a linear regression
of growth hormone concentration was done on intake (I), serum magnesium (SMg), and the interaction of intake and serum Mg. Intake ($P<.001$) and the interaction of intake and serum Mg ($P<.1$) were significant, but serum Mg was not. The regression equation is:

\[
\text{Growth hormone concentration (ng/ml)} = -52.1 + (3.7 \times I\text{kg/d}) + (26.4 \times \text{SMg mg/100 ml}) - (1.7 \times I \times \text{SMg})
\]

$R^2 = .48$ with variance distributed 38% to I, 2% to SMg, and 8% to the interaction, $n = 32$.

Results suggest that at low serum Mg concentration reduced intake increases growth hormone concentration less than at higher serum Mg concentrations (Figure 2). One study (1) has shown reduced serum Mg and growth hormone concentration in rations supplemented with NaHCO$_3$. In another study (12) where intake was controlled, NaHCO$_3$ decreased the concentration of growth hormone.

Data presented suggest that low serum Mg inhibits the ability of reduced feed intake to increase the concentration of serum growth hormone. Also, treatments that reduce feed intake may increase serum growth hormone concentration up to 12 d after the treatments are stopped.

**REFERENCES**