Factors Affecting Calcium, Phosphorus, and Magnesium Status of Dairy Cattle on the Oregon Coast

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ABSTRACT

Blood plasma from 126 milking cows in 21 herds was analyzed for calcium, phosphorus, and magnesium in October, 1974, and in the following April. For all three minerals, time of sampling, herds, and time of sampling by herd differed. Mean values in October and April were calcium, 10.1 and 9.0; phosphorus, 5.96 and 4.88; magnesium, 1.98 and 1.85 mg/100 ml. Calcium also differed between stages of lactation. Mean calcium for cows milking <100 days, 101 to 200 days, and >200 days and dry was: 9.41, 9.70, and 9.80 mg/100 ml. Differences in winter feeding practices among herds were responsible for time of sampling, herd, and time of sampling-by-herd differences.

INTRODUCTION

Variation in components of blood calcium (Ca), phosphorus (P), and magnesium (Mg) of dairy cattle has been studied to establish norms and to identify factors which cause differences (3, 4, 6, 7, 8, 9). Greatest variation is due to differences between herds, and less, but often significant, variation is due to factors associated with season and stage of lactation or production. Changes in components of blood tend to reflect management and feeding peculiar to the area in which the herds are located, and interpretations must view these practices.

This paper reports a survey of Ca, P, and Mg in the blood plasma of dairy cows on the north coast of Oregon. This area was chosen because the climate limits feed production to adapted varieties of grass-legume forages which can be harvested as pasture, soilage, or silage, and because the diversity in feeding practices among dairymen is less than in other areas. Some dairymen pasture their entire forage acreage and purchase alfalfa hay to feed during the winter months while others harvest silage and feed it as the main winter forage supplemented with less alfalfa hay. Dairymen purchase their concentrate as premixed commercial formulas, and three feed mills supply over 90% of the concentrate in the area.

PROCEDURE

Herds were selected from a Dairy Herd Improvement Association annual production report by choice of every fourth Holstein or Jersey herd on a list arranged by annual milk production. Sixteen herds were Holstein and five were Jersey. Each cooperating dairymen was asked to selected six cows of which two had been milking <100 days, two between 100 and 200 days, and two >200 days or dry. Cows were first bled during October, 1974, and again the following April. October was chosen because it is the last month of the pasture season, and April was chosen because it is the time when most cows are turned onto spring pasture. Blood samples were collected from the jugular vein into evacuated 10 ml glass tubes containing sodium heparin2 which were kept in a cold chest. Blood samples were transported to the laboratory where plasma was separated by centrifugation within 6 h from the time of collection. Plasma samples were frozen and stored until all analyses were completed. Colorimetric procedures were employed in the analysis of each of the three minerals by Bausch and Lomb Spectronic 20 colorimeter3.

Data were subjected to analysis of variance, and where differences were significant, test for difference between class intermeans was by Tukey's w-procedure to reduce the probability of a Type I statistical error. Because sampling periods and lactation groups were fixed, a
TABLE 1. Means and SE of mineral concentrations in blood plasma of dairy cows sampled before and after the winter feeding period and in herds fed two different forage programs.

<table>
<thead>
<tr>
<th>Winter forage</th>
<th>Calcium</th>
<th>Phosphorus</th>
<th>Magnesium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>October</td>
<td>April</td>
<td>October</td>
</tr>
<tr>
<td>Alfalfa hay only</td>
<td>48</td>
<td>10.3</td>
<td>.10</td>
</tr>
<tr>
<td>Grass silage mainly and some alfalfa hay</td>
<td>78</td>
<td>10.0</td>
<td>.03</td>
</tr>
<tr>
<td>All herds</td>
<td>126</td>
<td>10.1</td>
<td>.06</td>
</tr>
</tbody>
</table>

*aAll values in table differ (P<.01).

mixed model was used to estimate the percent of variation associated with each source of variance (10).

RESULTS AND DISCUSSION

Calcium

Differences between means of blood plasma for Ca for sampling periods, herds, and lactation groups within sampling periods, and sampling periods-by-herd interaction were significant (P<.01). Eighteen of the 21 (86%) herds had significantly lower Ca in April than in October, and 8 of the 13 (62%) herds fed silage during the winter had mean Ca values in April significantly lower than in October compared to 3 of the 8 (38%) herds fed alfalfa hay as the only roughage. The average calcium for the cows in these groups is in Table 1 and represents the greatest source of variation in Ca, 32% due to period difference, 45% due to period-by-herd interaction. Apparently the rate of decline in Ca status of cows in herds fed alfalfa hay as the only roughage was sufficiently different from cows in herds fed mainly silage to cause the major portion of the variation to be attributed to the period-herd interaction. Apparently the rate of decline in Ca status of cows in herds fed alfalfa hay as the only roughage was sufficiently different from cows in herds fed mainly silage to cause the major portion of the variation to be attributed to the period-herd interaction. Differences among herds within sampling period accounted for 7% of the variation in Ca. These percentages are markedly different from those of Payne et al. (7, 8), who observed 1 and 11% of the variation due to season, and 35 and 39% of the variation due to differences among herds within season. The difference is probably due to the difference in feeding programs and possibly other environmental factors between the two populations of cows. The overall decrease in Ca during the winter as in Table 1 is associated with the observation that 6% of the cows had Ca below 9 mg/100 ml in October compared to 38% in April. Analysis of concentrate mixtures delivered to the farms from the three major suppliers indicated that the Ca content of all mixtures were adequate if they were fed in moderate to liberal amounts (5), but that the P content of these mixtures was low and would not provide adequate P to the cows, especially to those fed alfalfa hay only during the winter.

The statistical significance due to lactation groups resulted from the difference in Ca between cows milking less than 100 days and those milking a longer period or dry (Table 2). This source of variation accounted for slightly less than 2% of the total Ca variation. Although no significant change in blood Ca values due to stage of lactation was reported by Hewett (3), others have observed lower blood or serum Ca in cows in early lactation compared to cows in later stages of lactation (4, 7, 8).

Phosphorus

Differences in means of blood plasma for P for sampling periods, herds within periods, and sampling period-by-herd interaction were signif-

TABLE 2. Means and SE of concentrations of calcium in plasma of cows in early, mid, and late lactation or dry.

<table>
<thead>
<tr>
<th>Stage of lactation</th>
<th>Calcium (mg/100 ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100 days</td>
<td>9.4 .10**</td>
</tr>
<tr>
<td>100 to 200 days</td>
<td>9.7 .11</td>
</tr>
<tr>
<td>&gt;200 days or dry</td>
<td>9.8 .10</td>
</tr>
</tbody>
</table>

**P>.01.
icant (P<.01). As with Ca, the principal sources of variation were between periods (26%) and periods-by-herd interaction (24%). Again as with Ca, the between-period values are much higher than other reports (7, 8) whose estimates were 0 and 6% attributable to season. The difference between sampling periods, which is comparable to seasonal differences in other studies, has not been observed by other investigators (3, 4). The mean value for all herds was 1.1 mg/100 ml less in April than in the previous October (Table 1). This change is associated with the observation that 5% of the cows in October had P below 4.0 mg/100 ml compared to 15% in April. By subjecting the intermeans of sampling periods within herds to Tukey's-w procedure, differences between the means of P in October and in April were large enough to be significant in 8 of the 21 herds. Of the eight herds only two were fed alfalfa hay as the only roughage during the winter. Cows in herds fed silage as the main forage during the winter were probably in greater negative P balance than cows in herds fed only alfalfa hay (Table 1), and this difference caused the significant sampling period-by-herd interaction.

Magnesium

Mean values for Mg of blood plasma were significant (P<.01) for sampling period, herds within periods, and sampling periods-by-herd interaction. Some seasonal variation in blood Mg has been observed by other investigators (4, 8), and the approximate 5 mo span between sampling periods (October and April) in which a difference of .13 mg/100 ml was observed would correspond to different seasons. The large source of variation in Mg of plasma was due to herd difference (35%). This agrees with (7, 8). The Mg (Table 1) is lower than that of (3, 4, 6, 7, 8, 9) with means of 2.2 to 2.6 mg/100 ml of serum.

The desirability of supplementing the rations of cattle with Mg in the north coast of Oregon has been recognized for many years, but the amount of supplement varies widely among dairymen. Subjecting the intermeans of sampling periods within herds to Tukey's-w test showed three herds with significantly higher and nine herds with significantly lower plasma Mg in April than in October. Only one of the five herds which had higher plasma Mg values in April was fed alfalfa as the only roughage during the winter. This is reflected in the Mg in Table 1 and contrasts with that for Ca and P. Cows fed large quantities of alfalfa for an extended time would be expected to have lower plasma magnesium than cows fed little or no alfalfa in view of the results with sheep (1, 2).

This study points out the need for closer cooperation between the dairyman and his supplier of concentrate feeds so that the mineral supplied in the concentrate mixture can be adjusted more appropriately to supplement the dairyman's forage feeding program. It also points out the need to understand the cause of variations in blood minerals of a local population of cattle before an attempt is made to solve problems related to mineral nutrition.

REFERENCES