ABSTRACT

Dairy Herd Improvement data from a large, commercial dairy farm were used to evaluate the relationships of first lactation milk and fat yield and age at first calving on passively acquired immunity in Holstein heifers. Total serum Ig concentration was measured 24 to 48 h postpartum (mean = 25.5 mg/ml, SD = 19.2) on calves allowed to suckle their dams freely through 24 h postpartum. No additional colostrum was supplied and no attempt was made to ensure adequate colostrum intake. Calves were raised in Tucson, AZ until 6 mo of age, then transferred to Idaho to complete the growing phase and to be bred. Heifers were returned to Tucson during their 7th or 8th mo of gestation. Serum Ig concentration, measured shortly after birth, was an important source of variation for mature equivalent milk (b = 8.5 kg/Ig unit) and mature equivalent fat (b = .24 kg/Ig unit) production in the first lactation but did not affect age at first calving. It is impossible to ascertain from these data whether Ig concentration at birth was directly or indirectly related to production; regardless, supplying an adequate amount and concentration of colostrum at the appropriate time to dairy heifers may enhance their future productivity.

INTRODUCTION

The major line of defense against invading pathogens in the bovine neonate is Ig derived from colostrum. Calves that receive inadequate amounts or fail to absorb available Ig suffer a higher rate of morbidity and mortality (1, 2, 3, 6, 7, 8). Robison et al. (9) reported that mortality of heifer calves through 6 mo of age with less than 12 mg/ml of total Ig shortly after birth was 6.78% compared with 3.33% mortality for calves with greater than 12 mg/ml. In addition, calves that survived with low concentrations of Ig at birth failed to grow as rapidly through 180 d of age. As a continuation of the Robison et al. (9) study, these heifers were monitored through their first lactation. The purpose of this study was to evaluate the relationships of total serum Ig, measured shortly after birth, on age at first calving and subsequent milk and fat production in the first lactation.

MATERIALS AND METHODS

Blood samples from 1000 Holstein heifers were collected 24 to 48 h after birth to measure total serum Ig concentration. Heifers were born in a large, commercial dairy in Tucson, AZ from January through September of a single year. Calves were allowed to suckle their dams freely up to 24 h postpartum; no additional colostrum was supplied and no attempt was made to ensure adequate colostrum intake. Heifers were housed in individual calf pens after separation from dams. Calves were fed twice daily 2 L of whole milk obtained from cows through their first six milkings postpartum until weaning. A 16% CP calf starter was offered ad libitum from d 3 postpartum, but hay was not made available until weaning.

All calves were weaned at approximately 70 d of age. At weaning, calves were grouped into pens of 16. At approximately 3-wk intervals, these smaller groups were combined into groups of 48. After approximately 3 wk, calves were sorted by size and groups of 96 were main-
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600 d of age. Alfalfa hay was offered ad libitum from weaning through 180 d and calf starter was fed at 2 kg per calf per d. Complete management practices are given by Robison et al. (9).

Heifers were moved to Idaho at approximately 6 mo to complete the growing phase and to be bred. At certain times of the year, transfer of heifers from Tucson to Idaho resulted in subjecting those heifers to dramatic temperature and moisture changes. Heifers weighing at least 385 kg were bred and held in Idaho until their 7th or 8th mo of gestation. No growth or breeding data exist during the growing period in Idaho. Heifers were identified from the transfer period to their first lactation by matching ear tags with original identification numbers. Data from 299 heifers were lost because of incomplete culling records in Idaho and because identification numbers changed when cows were returned to Tucson. Data were accumulated on first lactation mature equivalent (ME) milk and fat (n = 641), and age at first calving (n = 701) through DHI records.

Serum samples, collected 24 to 48 h after birth, were analyzed for total Ig concentration using radial immunodiffusion (RID) gel procedure (4). Antiserum was rabbit antibovine gamma globulin. Standards for RID plates were prepared from adult bovine serum quantified by Lowry protein determination (5) and verified by replicates within 5% of the standard. For a complete discussion of Ig concentration determination see Robison et al. (9).

The effects of serum Ig concentration on ME milk and fat were analyzed with a model that included season of calving as a discrete effect and Ig concentration at 24 to 48 h as a covariate. The quadratic form of the regression was tested but was not significant. Only cows in milk 180 d and longer were used in the analysis to provide a more accurate estimate of the projected ME milk and fat. Cows were grouped by three seasons of calving: June through September, October through January, and February through May. The effects on age at first calving were analyzed by regression on serum Ig concentration. Again, the quadratic form of the regression was not significant.

RESULTS AND DISCUSSION

Six-hundred forty-one heifers of the original 1000 completed 180 d in their first lactation. The mean serum Ig concentration of these heifers at birth was 25.9 mg/ml (SD = 19.1), very similar to the mean values reported by Robison et al. (9) from the initial data set. Mean ME milk and fat production and the regression coefficients of production on Ig concentration are presented in Table 1. Season of calving was a highly significant factor affecting both ME milk and fat production. The covariate of Ig concentration at 24 to 48 h was also important for ME milk (P<.05) and ME fat (P<.10). Regression of ME milk on Ig concentration was 8.5 kg/unit Ig (mg/ml), and the regression of ME fat on Ig concentration was .28 kg/unit Ig. The regression between serum Ig concentration at birth and first lactation milk and fat production may not be a direct cause and effect relationship, and the biological basis is not apparent from this study. Perhaps calves that receive and absorb adequate amounts of Ig at birth may also receive other factors in the colostrum that influence growth and subsequent production; or calves that have adequate protection against pathogens at an early age may develop more efficient metabolic systems that contribute to growth and production.

Mean age at first calving was 26.5 mo (SD = 2.0) on the 701 heifers that entered the herd from Idaho. The Ig concentration did not affect age at first calving. Heifers were bred when they reached a minimum breeding weight, but...
TABLE 2. Summary of first lactation culling based on 24 to 48 h serum Ig concentration.

<table>
<thead>
<tr>
<th>Ig group (mg/ml)</th>
<th>n</th>
<th>Dairy Low production (%)</th>
<th>Death loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12</td>
<td>191</td>
<td>0</td>
<td>20.5</td>
</tr>
<tr>
<td>12.1 to 18</td>
<td>112</td>
<td>0</td>
<td>11.6</td>
</tr>
<tr>
<td>18.1 to 25</td>
<td>100</td>
<td>1.0</td>
<td>15.0</td>
</tr>
<tr>
<td>25.1 to 40</td>
<td>131</td>
<td>1.5</td>
<td>11.5</td>
</tr>
<tr>
<td>&gt;40</td>
<td>167</td>
<td>.6</td>
<td>16.8</td>
</tr>
</tbody>
</table>

the effects of Ig concentration on weight, as reported by Robison et al. (9), did not affect calving age.

A summary of culling is presented in Table 2. Heifers were divided into five Ig concentration groups: <12.0, 12.1 to 18.0, 18.1 to 25.0, 25.1 to 40.0, and >40 mg/ml [as in (9)]. Mortality for the five Ig groups from birth through 180 d of age was 6.8, 6.1, 3.0, 3.0, and 2.6%, respectively (9). Loss of 299 heifers from the time that the heifers were sent to Idaho to their return to Tucson resulted from death loss in Idaho and an inability to identify heifers upon their return to Arizona; data were not available to categorize losses. The loss rate in each of the five Ig groups were: 27, 25, 24, 31, and 26%, respectively. Although no exact relationships can be elucidated from such data, it appears that Ig concentration shortly after birth did not affect ability to survive and ability to conceive during the Idaho growing period.

After the heifers returned to Arizona, however, patterns were evident in the culling rate among the different Ig concentration groups. Cows that had the lowest Ig concentrations shortly after birth were culled extensively for low production (21.5% died or were culled for low production). The next highest culling rate occurred in the >40 mg/ml category, but 4.7% fewer cows were culled than the lowest concentration group.

Immunoglobulins acquired from colostrum at birth may be an indicator of subsequent growth and production. Although the increased milk and fat yields were not dramatic when evaluated alone, combining culling rate and death loss with decreased production presents an important inefficiency in production.

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REFERENCES