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Differences in the serum immunoglobulin concentrations between dairy and beef calves from birth to 14 days of age

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The changes in serum levels of immunoglobulins G, M and A of dairy and beef calves of well-managed herds were monitored from birth to 14 days post partum using single radial immunodiffusion. Serum levels of all three immunoglobulin classes reached its peak at 24 hours in both groups of calves after birth, at which time there were very high levels of each immunoglobulin present. The mean IgM and IgA levels of the two groups became same at 6 days and 8 days of age, respectively but the mean IgG level of beef calves was approximately twice that of dairy calves throughout the experiment.

Key words: beef calf, dairy calf, serum immunoglobulins

Introduction

During the first two weeks of life, calves are at highest risk for death and especially during the first week. Septicemic and enteric diseases are most common in this period. The failure of passive transfer of colostral immunoglobulins (Ig) is a major determinant of septicemic disease during this period [7,15]. It also modulates the occurrence of mortality and severity of enteric and respiratory diseases in early life of calves [18].

The major Ig in colostrum is IgG, but there are also significant amounts of IgM and IgA [4]. Following ingestion by the newborn calves, a significant proportion of these Igs ingested in the colostrum is absorbed across the epithelial cells of the small intestine during the first few hours of life and transported via the lymphatic system to the blood [3]. Igs in the blood are further varyingly distributed to extravascular fluids and to body secretions depending upon its class [2].

These absorbed Igs protect against systemic invasion by microorganisms and septic disease during the neonatal period. Unabsorbed Igs and Igs re-secreted back into the gut play an important role in protection against intestinal disease for several weeks following birth [13]. In calves, it is known that passive immunity also influences the occurrence of respiratory disease during the first months of life and may be a determinant of lifetime productivity.

The amount of circulating Igs acquired from colostrum is primarily dependent upon two factors [1,18]. One is the amount or mass of Ig present in a feeding of colostrum. The mass of Ig fed is determined by the concentration of Ig in the colostrum and the volume that is fed. There can be substantial variation in the concentration of Ig in colostrum of dairy cows. And a significant proportion of dairy calves may fail to ingest adequate colostrum volumes before onset of the closure process in natural suckling situations and so early assisted suckling is needed. In contrast, with beef breeds relatively effective colostral Ig transfer is achieved with natural suckling.

The other is the efficiency of absorption of Igs by the calf. Under normal conditions complete loss of the ability to absorb Ig occurs by 24-36 hours after birth in calves and there is a significant reduction in absorptive ability by 8-12 hours following birth. Thus, the time from birth to feeding of the colostrum is a crucial factor affecting the absorption of colostral Igs. Compared to the beef breeds, natural suckling of dairy calves is commonly associated with a high rate of passive transfer failure due to delays in sucking coupled with low intakes [11,19]. Thus, the volume of colostrum that is ingested in dairy calves is controlled in artificial feeding systems using nipple bottle feeders or esophageal tube feeders [2,5].

The transfer of colostral Igs in both dairy and beef calves is well documented [10-12]. Kim and Han [8,9] studied the transfer of colostral Igs in the Korean native calves. In the present study, attempts were made to find the differences in the serum Ig concentrations between dairy and beef calves during the first two weeks of life. The cows and calves used in this study were from

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National Livestock Research Institute herds well-managed with adequate veterinary surveillance and provision of the nutritional requirements.

Materials and Methods

Cows and calves

Pregnant Korean native cows (20) and Holstein cows (15) 2-8 years old were chosen from the herds of National Livestock Research Institute, RDA. Approximately one day before the estimated calving, each cow was moved into an individual calving pen (3.4 × 8.0 m) with straw bedding.

The Korean native calves were born between April and August 2000, and all the dams and their calves (8 heifers and 12 bulls) were continuously observed for 6 hrs after birth. The beef calves stayed with their dams in the calving pen throughout the experiment so that they could suckle freely all the time.

The Holstein calves were born between February and July 2000, and the calves (5 heifers and 10 bulls) were left with their dams after birth for 30-40 minutes to allow each dam to clean and stimulate its calf. During the time, 500-1,000 ml of maternal colostrum was hand-milked from each dam and bottle-fed to the calf. Calves were then moved to the individual calf barn bedded with straw and weighed. The ensuing feedings of colostrum were at 10 : 00 and 16 : 30 next day for five days. The amounts of whole colostrum fed by bottle were 80 ml/kg BW every day. From day 6 on, calves were fed whole milk 8% of their body weight throughout the experiment.

All calves were single-born after normal durations of pregnancy and normal parturitions. Prevalence of scours and signs of respiratory tract infections and other illnesses were monitored daily until the termination of the experiment.

Sample collection and analysis of immunoglobulin concentration

Blood samples (10 ml) were collected from the calves by jugular venipuncture into evacuated containers without anticoagulant before suckling or colostrum-feeding (0 hrs), at one and four days, and thereafter at two-day intervals up to 14 days after birth. Blood samples were allowed to coagulate, and serum was obtained by centrifugation (1,500 × g) for 15 minutes. Serum samples were stored at −70°C prior to analysis of IgG, IgM and IgA by single radial immunodiffusion (SRID) test (VMRD™ Inc., Pullman, USA) [1].

Data analysis

The serum IgG, IgM and IgA concentrations at each sampling time for both dairy and beef calves were compared using Student's *t*-test of SAS [21].

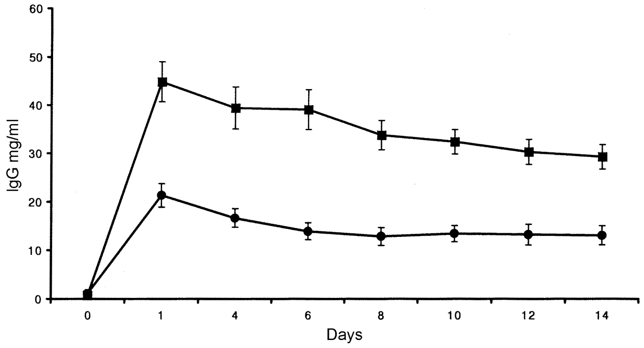

Fig. 1. Changes in the mean (with standard errors) serum IgG levels of Korean native calves (--■--) and Holstein calves (--●--) during the first two weeks after birth. The serum IgG levels were higher in Korean native calves than in Holstein calves throughout the experiment (p<0.001).

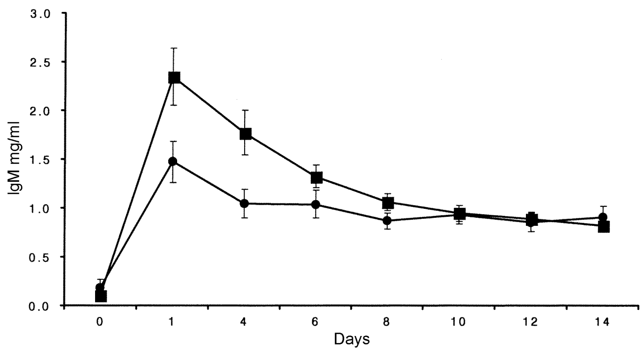

Fig. 2. Changes in the mean (with standard errors) serum IgM levels of Korean native calves (--■--) and Holstein calves (--●--) during the first two weeks after birth. The serum IgM levels were higher in Korean native calves than in Holstein calves at day 1 and 4 (p<0.05) after birth.

Results

In the present study, no signs of scours, respiratory tract infections or other illnesses were observed in the calves from birth to the termination of the experiment.

Serum IgG, IgM and IgA concentrations for dairy and beef calves from birth to 14 days of age are graphically represented (Figs. 1-3). As was expected, serum levels of all three Ig classes reached its peak at 24 hours after birth, at which time there were very high levels of each Ig present.

Mean serum IgG levels were significantly higher in beef calves than in dairy calves throughout the experiment ($p < 0.001$). At 24 hours post partum, the mean serum IgG level reached the peak in both groups of calves; not a calf in both groups was found to be hypogammaglobulinemic in the serum IgG level, although individual level varied between 10.6 and 78.2 mg/ml. The IgG level of beef calves was more than twice that of dairy calves at that age. After 24 hours, the levels fell gradually, but not significantly

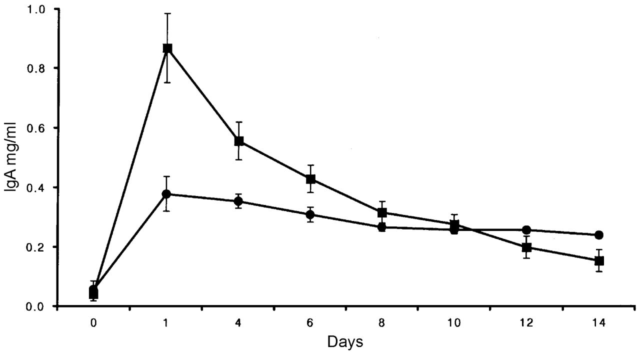

Fig. 3. Changes in the mean (with standard errors) serum IgA levels of Korean native calves (--■--) and Holstein calves (--●--) during the first two weeks after birth. The serum IgA levels were higher in Korean native calves than in Holstein calves at day 1 and four ($p<0.01$) to day 6 ($p<0.05$) after birth.

until 14 days after birth.

Mean serum IgM level reached the peak at 24 hours post partum in both groups of calves and fell sharply until six days after birth. Thereafter, it remained steady until 14 days after birth. The level was significantly higher in beef calves than in dairy calves at 24 hours and four days after birth ($p < 0.05$).

Mean serum IgA level reached the peak at 24 hours post partum in both groups of calves. In beef calves, it fell sharply at four days after birth and thereafter, it remained steady until 14 days after birth. In contrast, mean serum IgA level of dairy calves did not change from 24 hours post partum to 14 days of age. The IgA level was significantly higher in beef calves than in dairy calves at 24 hours ($p<0.01$), four ($p<0.01$) and six days ($p<0.05$) after birth.

Discussion

In a study involving dairy farms in northern California [14], calf mortality averaged 17.3 to 20.2%. Of all deaths in calves less than 5 weeks old, 55% occurred during the first week of life, and 27% occurred during the second week of life. Later study [15] confirmed that 89% of the diseased calves that died between 2 to 7 days of age had not absorbed adequate amounts of Ig. In the present study, serum IgG, IgM and IgA concentrations for dairy and beef calves from birth to 14 days of age were determined. All calves used were single-born after normal durations of pregnancy and normal parturitions. Signs of scours, respiratory tract infections and other illnesses were monitored continuously from birth up to 14 days of age. No clinical signs were observed in any one of the calves in both groups during the period. As was indicated, all of them were from well-managed herds.

The calves in this study had very high levels of three Ig classes present at 24 hours post partum, and the levels fell gradually but remained quite high until the end of the experiment. These data paralleled those in other reports in both dairy [1,19] and beef calves [9,12,15], except that not a calf was found to be hypogammaglobulinemic in both groups of calves in this study.

There is a marked difference in neonatal feeding methods between dairy and beef calves, and it is well-known that feeding method can significantly influence on the serum Ig concentrations of the newborn [12,20]. It was found in the present study that beef calves had higher levels of each Ig present. The mean IgM and IgA levels of the two groups became same at 6 days and 8 days of age, respectively but the mean IgG level of beef calves was approximately twice that of dairy calves until 14 days of age. This could explain that Korean native cattle are more resistant to the various infectious diseases than dairy cattle.

Natural suckling of dairy calves is known to be associated with a high rate of passive transfer failure of colostral immunity due to delays in sucking coupled with low intakes [11,19]. To help avoid the failure, the volume of colostrum that is ingested in dairy calves is controlled in artificial feeding systems using nipple bottle feeders or esophageal tube feeders. There are various methods used in early assisted suckling, especially the amount and time of colostrum feeding after birth [6,16,17]. In view of the results in the present study, the method employed for early assisted suckling by National Livestock Research Institute, RDA seems to be acceptable. The calves did not have hypogammaglobulinemia from birth to 14 days of age.

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