Effect of delayed colostrum collection on colostral IgG concentration in dairy cows

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Objective—To determine the effect of timing of first-milking colostrum collection on colostral IgG concentration.

Design—Prospective study.

Animals—13 healthy Holstein cows.

Procedures—All calvings were observed. After parturition, calves were not allowed to suckle and were separated from the dam. Colostrum was collected from a single randomly selected quarter at 2, 6, 10, and 14 hours after parturition until all 4 quarters were sampled. Colostral IgG concentration was determined via radial immunodiffusion.

Results—Mean colostral IgG concentration was 113, 94, 82, and 76 g/L at 2, 6, 10, and 14 hours after calving, respectively. Colostrum collected 6, 10, and 14 hours after calving had significantly lower IgG concentrations than did colostrum collected 2 hours after calving. Mean colostral IgG concentration at 14 hours after calving was significantly lower than that at 6 hours after calving. Cows in their third or greater lactation had mean colostral IgG concentrations 2 hours after calving (132 g/L) that were greater than the first and second lactation cows (mean, 95 and 100 g/L, respectively).

Conclusions and Clinical Relevance—Results indicate that early or immediate colostrum collection from dairy cows will maximize colostral IgG concentration. Adjustment of routine dairy farm management procedures may be required to maximize colostrum quality and minimize prevalence of failure of passive transfer in dairy calves. (Am J Vet Res 2005;66:1375–1377)

Ingestion and absorption of colostral immunoglobulin G are important for the health of neonatal calves. In a large study, 35% prevalence of failure of passive transfer (FPT) in dairy calves was reported. Dairy heifers with inadequate or failed passive transfer of colostral immunoglobulins have reduced average daily gain, increased risk of neonatal death, increased risk of being culled, and decreased milk production in their first lactation. Consequently, FPT has profound effects on both survival and productivity. Inadequate transfer of immunoglobulin G is common in dairy cattle because dairy cows tend to produce large volumes of colostrum with a low IgG concentration. Various studies have revealed that the calf’s ability to absorb colostral IgG decreases rapidly during the first 24 hours of life. Therefore, most practitioners stress the importance of early colostrum administration to maximize calf health.

Results of a previous study suggest that the timing of colostrum collection may affect colostral IgG concentration and, consequently, may influence the prevalence of FPT in dairy calves. Although results of several studies have substantiated that colostral immunoglobulin G concentration decreases after the first milking, there is less clarity and consensus regarding the potential impact of the elapsed time between calving and colostral collection on colostral IgG concentration. Pritchett et al observed decreased colostral IgG concentration within 8 hours after parturition. Straub and Matthias observed no significant decrease in colostral IgG concentration until 12 hours after calving. Other researchers have observed a 30% decrease in colostral IgG concentration by 12 hours after calving. Hostetler et al observed that colostral IgG concentration actually decreased during the course of the first milking.

The purpose of study reported here was to determine the effect of timing of first milking colostrum collection on colostral IgG concentration.

Materials and Methods

Cows and colostrum sampling procedures—Holstein cows of various parity with confirmed breeding dates were obtained from the University of Missouri Foremost Dairy Teaching and Research herd. The study population was restricted to include only cows with 4 functional mammary quarters. In the herd, artificial insemination is used exclusively; all estrus periods and breedings are recorded, and pregnancy diagnosis is performed on all bred cows within 45 days of breeding. Consequently, accurate calving dates were available for all subjects. After recognition of impending parturition, cows were transported to the University of Missouri Veterinary Teaching Hospital and hospitalized for observation of calving. Hospital staff observed all cows at frequent intervals for signs of parturition. After the recognition of labor, an on-call investigator was contacted. All calvings were observed and attended. After parturition, the call was not allowed to nurse and was immediately separated from the dam. Colostrum was collected from a single quarter at 2, 6, 10, and 14 hours after calving. The quarter sampled at each time point was determined by random sampling without replacement from the 4 available quarters until all 4 quarters were sampled. Prior to sample collection, the teats were cleaned and sanitized by use of cotton swabs and 70% isopropyl alcohol solution. Approximately 10 mL of foremilk was discarded, and samples were collected for colostral IgG determination. Thereafter, the sampled quarter was milked out completely by use of a milking machine with 3 of the 4 teat cups occluded. The weight of milk produced by each quarter was recorded. Samples were stored at −20°C until samples were batch processed to determine IgG concentration.

Determination of colostral IgG content—Immunoglobulin G concentrations were determined via radial immuno-
odiffusion assay. Briefly, plates for measuring serum IgG concentration were prepared by dissolving 1% agarose in a sodium barbital buffer that contained 0.1% sodium azide. Rabbit anti-bovine IgG (1%) was added to the solution. Eleven milliliters of the resulting solution was added to 10-cm Petri dishes and allowed to solidify. Three-millimeter wells were cut in the agar. Colostrum samples were diluted 1:120 with sodium barbital buffer, and 5 µL of the diluted sample was inoculated in each well. Plates were incubated at 23°C. Diameter of the observed zone of precipitation was recorded after 72 hours of incubation. Colostral IgG concentrations were determined by comparing diameter of the zone for unknown samples with that for a standard curve generated by use of serial dilutions of a commercially available bovine IgG standard.

Statistical analyses—Analysis of variance for repeated measures was used to determine the effect of sampling time on colostral IgG concentration and the weight of colostrum produced. When significant (P < 0.05) sampling time effects were observed, pairwise comparisons were performed on specific sampling times via the Tukey method. Calculations were performed with the aid of a statistical software package. For all comparisons, P < 0.05 was considered significant.

Results
The study population included 3 cows in their first lactation, 4 cows in their second lactation, and 6 cows in their third or greater lactation. All cows were of the Holstein breed. Mean colostral IgG concentrations were 113, 94, 82, and 76 g/L at 2, 6, 10, and 14 hours after calving, respectively. Colostrum collected 6, 10, and 14 hours after calving had significantly lower mean IgG concentrations than did colostrum collected 2 hours after calving. The mean colostral IgG concentration at 10 and 14 hours was significantly lower than that of colostrum collected at either 2 or 6 hours after calving. The change in IgG concentration from 2 to 6 hours after calving also was significant. Colostral IgG concentration of third or greater lactation cows at 2 hours after parturition was 132 g/L, greater than that of either first or second lactation cows (95 and 100 g/L, respectively). No significant association was observed between sampling time and the weight of colostrum produced.

Discussion
Many of the recommendations to dairy farmers regarding colostrum administration practices were developed when dairy farms were smaller than present-day farms. Management practices on large, modern dairies place a premium on labor efficiency and economy. On modern farms, recently calved cows are typically milked twice daily as a group and colostrum is collected at that time. Collected colostrum is stored fresh, refrigerated, or frozen and fed to calves as needed. Little or no effort is made to match colostrum collected from a cow to the calf produced by the same cow. This practice provides a ready source of colostrum that is available to feed calves, regardless of their time of birth. However, it should be noted that managing recently calved cows as a group creates the potential for substantial delays in colostrum collection. If a cow calves immediately after fresh cows (ie, cows that have recently calved) are milked, colostrum collection will be delayed until the next time that group is milked, which is typically 12 hours later. This potential for delayed colostrum collection may be accentuated by other factors. If cows are not transferred from calving facilities to fresh-cow pens in a timely manner, they may not be brought to the milking parlor for colostrum collection. Furthermore, many dairy farmers and maternity pen managers may be loath to move recently fresh cows through the milking parlor because recently fresh cows are often weak or ataxic. Consequently, delays as long as 12 hours between calving and colostrum collection are probably common on many dairies.

Colostrum collected 6, 10, and 14 hours after calving had significantly lower mean IgG concentrations than did colostrum collected 2 hours after calving. The observed mean colostral IgG concentrations of 94, 82, and 76 g/L at 6, 10, and 14 hours after calving represent 17%, 27%, and 33% reductions in colostral IgG concentration, relative to samples collected 2 hours after calving. The results of this study substantiate that delayed collection causes decreased colostral IgG concentration. Straub and Matthaeus observed a declination of IgG concentration within 3 to 36 hours after parturition. In that study, only 25 samples were collected from 21 cows and 4 of the samples were collected from a single cow that had aborted.

The mechanism for the observed decrease in colostral IgG concentration after delayed colostrum collection is unknown. However, the absence of any significant increase in the weight of colostrum produced at 6, 10, or 14 hours after calving suggests that the observed decrease in colostral IgG concentration was not caused by a dilution effect. Our results agree with those of Pritchett et al, who observed minimal association between the time after calving to colostrum collection and weight of colostrum collected (correlation coefficient, 0.01). Consequently, on the basis of our results and previous studies, it appears that the volume of colostrum produced does not increase with delayed colostrum collection and does not cause colostrum dilution. Perhaps colostral immunoglobulins diffuse passively into the cow’s systemic circulation.

The experimental design of the present study was specifically chosen to eliminate the potential for individual variation and took advantage of multiple quarters being available on each cow to permit sequential serial sampling. This approach was used on the assumption that sampling from 1 quarter would not induce a compositional change in the colostrum collected from other quarters.

The mean colostral IgG concentration was higher than that observed in many studies. Although some studies have revealed substantially lower colostral IgG concentrations than that observed in the study reported here, in other studies, colostral IgG concentrations have been similar to those reported here. A small portion of this apparent discrepancy is likely attributable to differences in laboratory methods. Many studies specifically measure serum IgG concentration, and we chose to measure total IgG concentration. Consequently, the values we report for IgG are likely 5% to 10% higher than the IgG1 concentration. Local herd management or climatic factors also may be responsible for herd-to-herd variation in colostral IgG concentrations. Genetic variation among herds is an unlikely explanation because the widespread use of artificial insemination on dairy farms has likely caused homogenization of the
References


Selected abstract for JAVMA readers from the American Journal of Veterinary Research

Effects of caffeine on exercise performance of physically fit Thoroughbreds
Kathleen A. Savage et al

Objective—To determine the effects of a dose of caffeine (2.5 mg/kg, IV) administered to physically fit Thoroughbreds during incremental exercise testing to fatigue on a treadmill.

Animals—10 conditioned Thoroughbreds.

Procedure—Horses were randomly assigned to receive caffeine or a control solution. Each horse received both treatments in a crossover design with a 3-week interval between treatments. Each horse was administered caffeine (2.5 mg/kg) or an equivalent amount of a control solution IV. One hour after injection, each horse performed an incremental exercise test to exhaustion. Hematologic values, heart rate, oxygen consumption, carbon dioxide production, plasma lactate concentration, urine and serum concentrations of caffeine and metabolites, and time until exhaustion were monitored. Statistical analysis was performed by use of a mixed-effects linear model.

Results—Significant differences in measured values were not detected when horses were treated with caffeine or the control solution.

Conclusions and Clinical Relevance—A dose of caffeine (2.5 mg/kg, IV) appears to have no effect on any performance variable of physically fit Thoroughbreds during incremental exercise testing to fatigue. (Am J Vet Res 2005;66:569–573)