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Colostrum feeding: what's new?

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It has been determined that newborn calves with serum antibody (immunoglobulin; IgG) levels below 10 g/L are much more susceptible to infectious disease. Most of these antibodies must be provided by the dam via colostrum, and absorbed by the neonatal intestinal tract in a process called "passive transfer" of maternal antibodies. Achieving antibody levels above this value requires timely feeding of an adequate volume of high quality colostrum; it's an essential management practice for maximizing the survival and productivity of calves.

Failure of passive transfer to newborn calves is associated with an increased risk of bacterial infections, death before two months of age, reduced weight gain, and decreased first-lactation milk production. Dr. Jerry Olson, Senior Technical Services Veterinarian for Pfizer Animal Health, estimates that a gallon of good quality colostrum fed at an appropriate time is worth more than $400 in additional income (Table 1).

Surveys have repeatedly documented the high incidence of passive transfer failure in dairy calves. In 1992 the National Dairy Heifer Evaluation Project (USDA/NAHMS) found that 40 percent of calves had serum IgG levels of less than 10 g/L 24 to 48 hours after birth. It was estimated that 22 percent of all calf deaths in the study were attributable to failure of passive transfer.

Fifteen years later, the USDA/NAHMS Dairy 2007 study found that passive transfer failure was still present in 19 percent of calves, illustrating that colostrum feeding programs could still be improved. In this same study it was also found that the following factors were associated with failure of passive transfer:

- Allowing calves to nurse from the dam.
- Feeding less than four quarts of colostrum at the first feeding.
- Feeding colostrum more than four hours after birth.
- Feeding pooled colostrum.
- Not measuring serum IgG or total protein in calves.

Given the importance of a good colostrum feeding program and the apparent room for improvement that still exists for achieving adequate passive transfer of maternal antibodies to newborn calves, recent studies evaluating basic colostrum management assumptions will be reviewed in this article.

Figure 1

Measurement of colostrum immunoglobulin

The importance of colostrum quality was documented in a study comparing calves fed low quality colostrum with those fed high quality colostrum. Regardless of the time after birth and the volume fed, none of the calves fed low quality colostrum achieved adequate passive transfer of maternal antibodies. Serum IgG of all calves fed higher quality colostrum exceeded 20 g/L. Because not all colostrum has adequate IgG content, producers need a simple and reliable method of testing IgG content in every batch of colostrum collected.

The traditional method for evaluating colostrum quality on the farm is by using a colostrometer (Figure 1) which measures the specific gravity (SG) of colostrum. The specific gravity is an indirect measurement of the concentration of immunoglobulin in the colostrum.

Table 1: Value of 2 quarts of high quality colostrum.

• 4.6 more calves weaned per 100 calves: 4.6 calves X $400 per calf/100 calves X 40%	$7.40
• 2 lbs. more milk per day for 2 lactations: Income over feed cost of 9¢/lb. milk X 660 days	$118
• Reduced calf health care	$9.74
• Increased weight gain in heifer: 170 lbs. X $.45/lb. (for cull cow)	$76.50
Total for 2 qts.	**$211.64**

It has disadvantages, however: Colostrum SG is more strongly associated with protein than antibody concentration, and it is affected by temperature. Furthermore, it falsely classifies poor quality colostrum as good quality more than 75 percent of the time. Only 13 percent of operations reported estimating Ig content of colostrum (USDA Dairy 2007), and of those 13 percent only 44 percent used the colostrometer.

A Brix sugar refractometer (Figures 2

and 3) is an instrument used primarily in the equine industry which also allows simple and rapid measurement of colostrum quality. When the Brix method was compared to the colostrometer for measuring bovine colostrum antibody content, the Brix values were more highly correlated with colostrum IgG values, the instrument was simpler to use, and it was unaffected by temperature of the colostrum.

Measurement of calf immunoglobulin

It has been shown that simply monitoring the level of serum IgG will reduce the percentage of calves with failure of passive transfer. Calves can be tested for passive transfer of maternal antibodies by measuring their serum IgG at between 2 and 7 days of age. This age range is important: by 2 days of age the calf has absorbed all the maternal antibody it can before its intestine no longer allows antibodies to pass through. At 7 days of age the calf will start making its own antibodies. Thus, between 2 and 7 days of age any antibody measured is absorbed from the colostrum.

Several indirect methods of IgG measurement have been evaluated in calves. Zinc and sodium sulfate turbidity tests cause antibodies to precipitate, so serum will become cloudy and the degree of cloudiness can be measured. Total protein can be measured in serum using a refractometer; serum protein includes the IgG proteins.

Researchers compared these three techniques (zinc sulfate turbidity, sodium sulfate turbidity, and serum refractometry) and found that a high percentage of calves were correctly classified with refractometry, using a 5.0 g/dL endpoint to correlate with failure of passive transfer. A serum protein concentration of 5.2 g/dL was equivalent to 10 g/L serum IgG, the cutoff described above for adequate passive transfer. Other researchers found that serum protein level below 4.4 and 4.0 mg/dl was associated with a relative risk of mortality of 3.1 and 4.6, respectively.

Colostrum feeding timing and method

Ever since a Washington State study found that failure of passive transfer occurred in 61.4 percent of calves that were allowed to nurse their dams it has been recommended that dairy personnel hand-feed colostrum to maximize passive transfer. Colostrum absorption declines dramatically after birth, and it is commonly recommended that calves be fed at least one gallon of colostrum as soon as possible after calving. Hopkins and others found that only 1 of 10 calves consumed the entire gallon offered within 3 hours of birth; on average they consumed about 0.75 gallon.

The method and time after birth that colostrum is fed may affect absorption of maternal antibodies. Should the calf be tube-fed the remainder? Or should calves be tube-fed one gallon at birth?

Researchers fed a group of calves 0.5 gallon in two feedings within 12 hours. All calves achieved more than 16 g/L serum IgG. In a series of experiments Dr. Dawn Morin and others fed calves low quality vs. high quality colostrum; 0.75 gallon vs. 1.0 gallon of colostrum at birth; and supplemented low quality colostrum with dried colostrum supplement. The highest calf serum IgG levels were obtained by feeding 1.0 gallon of colostrum high in IgG immediately after birth. Feeding colostrum supplement did not affect calf serum IgG.

A number of factors affecting calf serum IgG were evaluated in a recent study by Dr. Munashe Chigerwe in Dr. Tyler's laboratory. They found that by allowing calves to ingest as much colostrum by nipple bottle as they could within four hours after birth and at 12 hours of age, failure of passive transfer was significantly reduced.

The authors recommended that calves that have not ingested at least 0.75 gallon of colostrum within the first 4 hours after birth should receive 0.5 gallon of colostrum at 12 hours of age by esophageal feeder tube. They also found that voluntary colostrum intake did not differ whether the calves received their first feeding at 1, 2, 3, or 4 hours after birth.

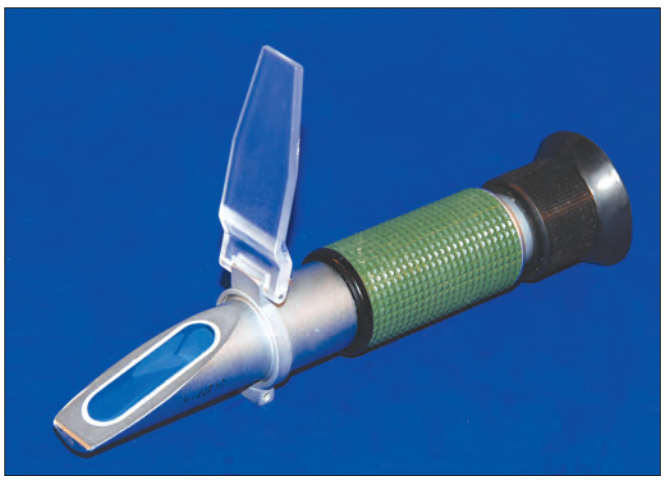

Figure 2

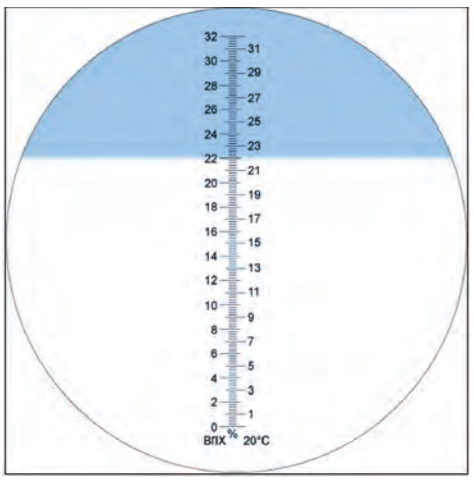

Figure 3

It has been hypothesized that compared with bottle feeding, colostrum administration by esophageal feeder tube may result in lower serum IgG. It is known that colostrum fed by tube ends up in the rumen rather than in the abomasum, and its movement into the abomasum from the rumen is delayed. While a direct comparison of tube and bottle feeding awaits publication, several studies have found that high rates of passive transfer can be achieved by tube-feeding more than 0.5 gallon of excellent quality of colostrum.

Esophageal tube feeding presents some risks to the calf if proper technique is not used. In spite of the bulb on the end of the tube, it can rarely be introduced into the trachea and death will ensue if a significant volume of colostrum is administered into the trachea and lungs. Also, the esophagus can be injured by the tube if it is not inserted carefully. In the 2007 NAHMS study (USDA 2007), it was found that 59 percent of farms hand-fed colostrum from a bucket or bottle, while 4.3 percent used an esophageal feeder tube.

Delaying first milking

Some dairy producers find it more convenient to not collect first milking colostrum until the next milking for the group of recently calved cows. In herds milking fresh cows 2x, the collection of first milking colostrum may thus be delayed up to 11 hours after calving.

Dr. Malantus Moore and others at the University of Missouri collected colostrum from quarters of 13 cows at 2, 6, 10, and 14 hours after calving. All colostrum samples contained adequate quantities of colostral IgG (50 g/l or more), but colostrum collected two hours after calving had significantly higher IgG than colostrum collected at 6, 10, and 14 hours after calving (113 vs 94, 82, and 76 g/l respectively).

Take-home lessons

1. Good colostrum is a valuable commodity ($432/gallon). Calves that fail to absorb adequate maternal antibodies will experience decreased survival, decreased growth rates, and decreased first lactation milk production.
2. Collect colostrum as soon as possible after calving, but collection can be delayed a few hours if colostrum quality is high.
3. Test all colostrum. Use the colostrometer or Brix refractometer when it becomes available.
4. Feed only good quality colostrum (50 g/L or higher).
5. Feed 1.0 gallon of good quality colostrum as soon as possible after birth.
6. Feed with a nipple bottle; if a calf will not drink then give by esophageal tube.
7. Be very careful and gentle passing the esophageal tube.
8. Test calves' serum protein regularly between 2 and 7 days of age. Use the results as a way to evaluate the colostrum management program and report the results to calf feeders.

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