

Colostrum Management for Dairy Calves

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During gestation, the placenta of the cow effectively separates the blood of the fetus from that of the dam and prevents any transfer of protective immunity while in the uterus. Therefore, the calf is born completely dependent on the absorption of maternal antibodies from colostrum after birth. Colostrum is the milk produced from the mammary gland in the first 24 hours after birth. A calf's gastrointestinal tract is designed to temporarily allow the absorption of large molecules including antibodies (immunoglobulins) from the small intestine, called "passive transfer." Passive transfer only occurs during the first 24 hours after birth. Although colostrum contains several different types of immunoglobulins (immunoglobulin G or "IgG," immunoglobulin A or "IgA," and immunoglobulin M or "IgM"), IgG accounts for roughly 85 percent of the total volume. IgG absorption is most efficient in the first four hours of life and declines rapidly after 12 hours of age. At 24 hours, the gut is completely closed and there is no further immunoglobulin absorption. These absorbed antibodies must be consumed in order to protect the calf from disease organisms until its own immune system becomes functional.

Failure of passive transfer of immunity (also called "FPT") occurs when a calf fails to absorb an adequate quantity and quality of immunoglobulin. It can be diagnosed with a blood sample drawn between 24 and 48 hours of age; calves are defined as having failure of passive transfer if the calf serum IgG concentration is less than 10mg/mL. FPT has been linked with increased calf morbidity (sickness), mortality (death), and a reduction in calf growth rate and feed efficiency. It is estimated that of the calf deaths occurring in the first three weeks of life, approximately one-third are due to inadequate

colostrum intake. Early and adequate consumption of high quality colostrum is considered the single most important management factor in determining health and survival of the neonatal calf. The long-term consequences include delayed onset of puberty, decreased first and second lactation milk production, and an increased culling rate of heifers in the first lactation. According to the 2007 National Animal Health Monitoring System survey, approximately 19 percent of dairy heifer calves in the United States had failure of passive transfer.

Four key factors contribute to the goal of successful passive transfer of immunity:

1. Feeding high quality colostrum with a high immunoglobulin concentration (>50 g/L of IgG)
2. Feeding an adequate volume (4 quarts) of colostrum
3. Feeding colostrum promptly after birth (within one to two hours and by six hours maximum)
4. Minimizing bacterial contamination of colostrum by proper udder preparation, collecting the colostrum in a clean container, and proper storage in a refrigerator or freezer within an hour

In order to achieve these four important factors, it is necessary to examine each one individually and determine what practices can be used by producers to reach this goal.

Colostrum quality is considered to be high if the IgG level is greater than 50 g/L. One recent study found that the average Holstein cow's colostrum was 76 g/L, but the samples ranged from 9 g/L to 186 g/L. Many factors come into play in quality colostrum production, including breed, age, vaccination status, length of the dry period, season of the year, amount

of colostrum produced, and the time it was collected. Although several of these factors are beyond a producer's control, the most important of these is the time of collection. **To collect the highest quality colostrum, producers should aim to milk the cow within one to two hours after calving with a maximum delay of 6 hours. The concentration of IgG is highest immediately after calving but decreases over time.** It is important not to pool colostrum from multiple fresh cows. Large volumes of low-quality colostrum may dilute smaller volumes of high-quality colostrum. If a cow produces more than 18 pounds at first milking, the chances are less than 50 percent that it will contain sufficient immunoglobulins. Secondly, with pooled colostrum there is a greater risk of exposing multiple calves to disease pathogens if all of the colostrum is mixed together and fed to all of the newborns. Watery or bloody colostrum or colostrum from a cow with clinical mastitis should not be used. Additionally, cows with a dry period of less than 45 days often have poor-quality colostrum as well as those animals that experienced poor nutrition or heat stress during the dry period. Older cows tend to have more IgGs than first-calf heifers, as they have been exposed to a greater number of pathogens during their lifetimes. Several tools are available for use on the farm to differentiate high- and low-quality colostrum, although none of them are exceptionally accurate. A colostrometer is an instrument that can estimate the IgG concentration by measuring specific gravity (a specific gravity > 1.050 approximates IgG concentration > 50g/L) but the readings are affected by factors such as milk fat content and temperature. A commercially available kit (Colostrum Bovine IgG Quick Test Kit, Mid-land Bio-Products, Boone, Iowa) will

give a positive or negative result within 20 minutes, but will not give an actual IgG concentration.

Feeding an adequate volume is essential especially when colostrum quality cannot be assessed. An average 90 pound Holstein calf should receive a minimum of 100g of IgG in the first feeding or 10 percent to 12 percent of her body weight. **Researchers have found that 85 percent of colostrum samples will be of high enough quality to provide greater than 100 g of IgG if calves are fed 4 quarts in the first feeding.** The typical amount in a normal-sized calf bottle is 2 quarts, so two full bottles must be fed. If possible, feed an additional two quarts to all calves 12 hours after birth. One study illustrated this by measuring serum IgG levels of calves at 24 hours of age. Those calves fed 4 liters (4.2 quarts) of colostrum at birth and an additional 2 liters (2.1 quarts) at 12 hours had an average serum IgG level of 31.1 mg/mL as compared to calves fed 2 liters at birth then an additional 2 liters at 12 hours, which had an average serum IgG level of 23.5 mg/mL or 24 percent lower.

The most important factor affecting absorption efficiency is the age of the calf. **The aim is to feed all calves within one to two hours after birth and by six hours at the latest.** This protocol is best accomplished by removing the calf from the dam within one to two hours of birth, then hand feeding a known volume of colostrum using either a bottle or esophageal feeder. It is generally accepted that either method of feeding achieves acceptable results as long as a sufficient volume is consumed. In the YouTube video “How to Use an Esophageal Feeder,” Dr. Sheila McGuirk gives an excellent presentation on how to administer colostrum to calves via an esophageal feeder (<http://www.youtube.com/watch?v=GLHOe6xInJg>). Calves should not be left on the cow to nurse as these animals experience an exceptionally high rate of failure of passive transfer, mostly due to the delay in suckling. Recent studies have found 46 percent to 61 percent of calves fail to suckle in the first six hours after birth. Reasons for this delay include a low, pendulous udder; large teats; or poor mothering ability. Calves born in very cold weather or those experiencing a difficult, prolonged birth

definitely need to be hand fed promptly due to their delayed ability to stand and nurse.

Minimizing bacterial contamination is important for two main reasons:

1. Bacteria bind up the immunoglobulins in the gut so they do not pass into the bloodstream (decrease efficiency of transport).
2. Contaminated colostrum is one of the earliest potential exposures to infectious agents that cause diarrhea and septicemia such as salmonella, mycoplasma, and fecal coliforms as well as the organism which causes Johne's disease, *Mycobacterium avium* subspecies *paratuberculosis* (MAP).

Colostrum should have a total bacteria count of <100,000 colony forming units (cfu)/mL and <10,000 cfu/mL total coliform count. Preventing bacterial contamination includes avoiding colostrum from infected cows, avoiding pooling, using proper collection from a prepped udder into a clean container, and using proper storage. If not fed immediately, it should be frozen or refrigerated within the hour. Frozen samples may be used for up to one year provided there is no freezing and thawing. The IgG in colostrum is considered stable in the refrigerator for approximately one week although bacteria counts may reach unacceptable levels if not cooled quickly enough. Refrigerating colostrum in small containers surrounded by frozen water bottles will quickly cool colostrum and decrease the growth of bacteria. The addition of the preservative potassium sorbate is also an option to aid in halting bacterial growth. An excellent tool to reduce bacterial contamination is pasteurization at 60° C (140° F) for 60 minutes. Typical milk pasteurization is at a higher temperature and takes less time, but this process is necessary to maintain the IgG activity while eliminating important pathogens. Immunoglobulins are sensitive to high temperatures, so a warm water bath rather than a microwave should be used when thawing frozen colostrum.

Routine monitoring of the colostrum program allows producers to identify and correct problems to avoid failure of passive transfer in their calves. Multiple tests are available at veterinary diagnostic

laboratories to measure blood serum IgG levels (such as radial immunodiffusion or the zinc sulfate turbidity test), but the expense and inconvenience of sample submission makes continued compliance difficult. A simple, rapid, and inexpensive on-farm tool that can measure serum total solids (STS) is the hand-held refractometer. The STS is a reasonably good estimation of serum IgG but works best on a herd or group level basis rather than the individual animal. It is recommended to collect blood samples from a minimum of 12 clinically normal (not scouring) calves between 24 hours and seven days of age. The goal is for 80 percent or more to exceed an STS of 5.5 g/dL and 90 percent to exceed 5.0g/dL. Interpreted at the group level, STS results accurately reflect the proportion of calves that have FPT and may trigger an investigation into the flaws within the colostrum program.

Lastly, producers must be prepared when clean, high-quality colostrum is not available to a newborn calf. The use of a colostrum replacement product offers a convenient method to improve passive immunity by mixing a powdered commercial product containing bovine IgG with water and feeding the calf. A colostrum replacer contains a minimum of 100g of IgG per dose, protein, minerals, vitamins, and energy and is designed to be fed when no maternal colostrum is available. This should not be confused with a colostrum supplement product that is designed to be fed *in addition to* and after natural colostrum. Colostrum supplements are significantly less expensive than replacement products because they contain less than 50 mg IgG per dose and have no added nutritional value. Calf managers should use supplements as an extender, to fortify poor-quality colostrum, or when inadequate amounts of fresh or frozen colostrum exist.

In summary, milking the cow within one to two hours after calving then feeding the calf the correct amount (4 quarts) of high-quality colostrum immediately (at one to two hours of age) are the recommended best management practices for optimal calf nutrition, health, and survival. Colostrum (the milk produced from the mammary gland in the first

24 hours after birth) contains immunoglobulins that, when absorbed by the calf's gut, help protect the calf from common disease challenges. The pass-

ing of this protection from dam to calf is called passive transfer. Research has clearly shown that calves with adequate passive transfer grow better, have lower

mortality and health cost, and as adults have improved first and second lactation milk production, when compared to calves with failure of passive transfer. Producers should pay close attention to this critical phase of a calf's life through exemplary colostrum management.

Where trade names are used, no endorsement is intended, nor criticism implied of similar products not named.