

Colostrum Quality Begins Before Calving

How maternal nutrition influences calf immunity and future performance

Alvaro Garcia, DVM, PhD

Dairy producers and calf-care professionals devote considerable attention to providing young calves with the best possible environment. Clean, dry bedding, adequate ventilation, comfortable housing, and consistent feeding practices are essential components of successful calf management. Yet even the best facilities and management practices cannot compensate for inadequate colostrum quality or insufficient transfer of maternal antibodies. A calf that begins life without adequate passive immunity remains vulnerable to disease, regardless of how carefully its environment is managed.



Colostrum is often described as the most important meal a dairy calf will ever receive, primarily because it supplies the antibodies needed for protection during the first weeks of life. However, its biological importance extends beyond immunoglobulins. Colostrum also contains nutrients, hormones, growth factors, and other bioactive compounds that support intestinal development and metabolic adaptation after birth. While considerable attention is devoted to harvesting, testing, storing, and feeding colostrum, much less emphasis is placed on the conditions that determine its composition before the calf is born.

This raises an important question for dairy producers and nutrition consultants: To what extent can maternal nutrition and metabolic health during late gestation influence colostrum quality, calf immunity, and the future performance of replacement heifers?

Recent research suggests that the nutritional and metabolic environment of the pregnant cow can influence both colostrum composition and offspring development. However, improving maternal nutrition does not necessarily increase colostrum antibody concentrations or guarantee better passive transfer. Understanding these relationships is essential for connecting transition-cow nutrition with successful calf-rearing programs.

Maternal nutrition and passive immunity

Unlike humans, dairy calves receive no maternal antibodies through the placenta. They depend on consuming and absorbing immunoglobulins, principally IgG, from colostrum shortly after birth. Because intestinal absorption of these large proteins declines rapidly after birth, the timing and quantity of colostrum feeding are critical.

Research has established that calves with inadequate passive transfer face greater risks of disease and mortality. More recently, scientists have proposed four categories of passive transfer, ranging from poor transfer below 10 g/L of serum IgG to excellent transfer at 25 g/L or greater (Lombard et al., 2020). These categories recognize that avoiding failure of passive transfer is not necessarily equivalent to achieving optimal protection.

Maternal nutrition contributes to this process through its influence on energy metabolism, protein supply, body condition, and micronutrient status. Nevertheless, supplying more dietary energy does not necessarily improve colostrum IgG concentration. Excessive body condition and substantial fat mobilization can compromise metabolic health, potentially affecting both the cow and her developing calf.

The challenge is determining which nutritional adjustments improve colostrum quality and which influence other aspects of its biological composition.

What changing the close-up diet accomplishes

A recent study involving researchers from the University of Guelph in Ontario, Canada, examined how dietary fiber concentration during the close-up period influences colostrum composition and subsequent milk production. Published in the *Journal of Dairy Science* in 2026, the experiment started 19 days before calving, with cows receiving diets containing either 55.7% or 40.6% neutral detergent fiber (NDF). The lower-fiber diet also contained more starch and supplied slightly more metabolizable energy per kilogram of dry matter.

Despite these nutritional differences, colostrum yield, IgG concentration, and total IgG production did not differ significantly between treatments, indicating that the lower-fiber, more energy-dense diet provided no measurable improvement in traditional indicators of colostrum immunological quality. However, colostrum insulin concentration increased from 69 to 114 micrograms per liter, with the response particularly evident in multiparous cows. This finding is relevant because colostrum insulin may participate in intestinal development and nutrient absorption in newborn calves. Its concentration is greater in colostrum than in mature milk, suggesting a physiological role beyond its contribution to nutrient supply.

Nevertheless, the researchers did not evaluate passive transfer, calf growth, intestinal development, or subsequent productivity. Therefore, the increase in colostrum insulin represents a change in biological composition rather than demonstrated evidence of improved calf performance. Interestingly, parity also influenced the response to dietary treatment. Multiparous cows receiving the lower-NDF diet produced more transition and mature milk, whereas pregnant heifers showed no comparable response. These findings reinforce the importance of recognizing the different nutritional requirements of growing heifers and mature cows, while illustrating that changes in maternal nutrition may influence colostrum composition without necessarily improving its antibody content.

When maternal metabolism affects the calf

The influence of maternal nutrition may extend beyond colostrum itself, as recent research suggests that metabolic conditions during gestation can affect offspring development before birth. A 2026 study published in the *Journal of Dairy Science* evaluated Holstein cows classified according to blood beta-hydroxybutyrate (BHB) concentrations during the dry period (Zheng et al., 2026). Average BHB concentrations were 0.23 mmol/L in the lower group and 0.69 mmol/L in the higher group, both below the conventional threshold for diagnosing subclinical ketosis. Although calf birth weights did not differ, offspring from cows with higher BHB concentrations exhibited shorter and narrower rumen papillae, altered expression of proteins associated with epithelial integrity, and increased expression of inflammatory markers. These differences were observed in newborn calves and at one month of age.

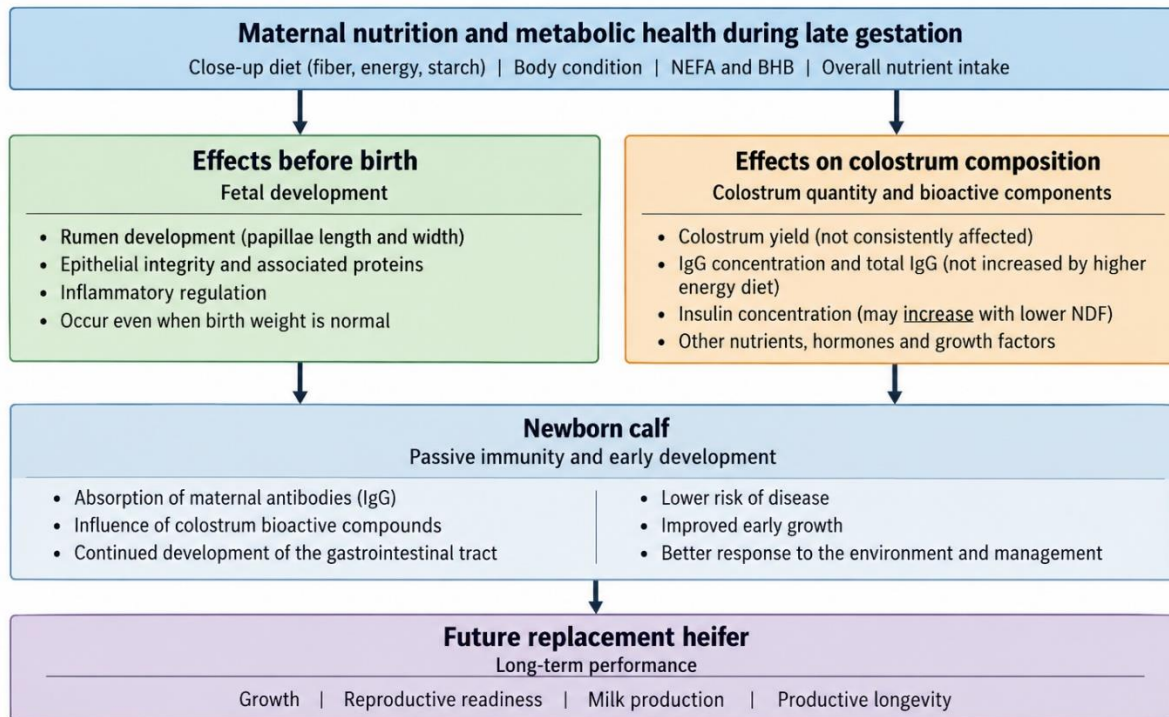


Figure 1. Conceptual diagram illustrating how maternal nutrition and metabolic health during late gestation may influence calf development through prenatal effects and changes in colostrum composition. Successful passive immunity also depends on the timely intake and absorption of adequate colostrum antibodies.

These findings suggest that maternal metabolic status may influence the development of tissues involved in digestion and immune regulation, even when calves appear normal at birth. However, because the study identified associations rather than establishing causation, the observed developmental differences cannot be attributed conclusively to elevated maternal BHB. The results also underscore an important distinction between prenatal development and postnatal immunity. While maternal metabolic conditions may influence fetal development independently of colostrum, successful passive transfer still depends on the quantity and quality of antibodies consumed and absorbed by the calf shortly after birth.

From early immunity to future performance

The importance of colostrum extends well beyond the calf's first weeks of life, with research demonstrating relationships between passive immunity, growth, survival, and subsequent performance in dairy heifers. DeNise et al. (1989) also reported an association between early passive immunity and later milk production, suggesting that the benefits of adequate colostrum intake may persist beyond weaning. Calves that avoid early disease are better positioned to maintain consistent growth, reach breeding targets, and enter the milking herd without unnecessary delays, potentially contributing to improved productive longevity.

Nevertheless, the relationship between maternal nutrition, colostrum bioactive compounds, and future milk production remains incompletely understood. Although early immunological advantages may have lasting consequences, it would be premature to assume that increasing a particular colostrum hormone or modifying prepartum dietary fiber will automatically improve first-lactation yield. What the available evidence supports is a more comprehensive approach to replacement-heifer development, beginning with maternal nutrition and metabolic health during gestation and continuing through effective colostrum management and subsequent calf care.

Connecting transition-cow nutrition with calf outcomes

For producers, the practical priority is maintaining adequate nutrient intake and metabolic health during late gestation while ensuring that every newborn calf receives sufficient high-quality colostrum promptly. As discussed in an earlier Hoard's Dairyman article (García, 2025), a Brix refractometer provides a practical method for evaluating colostrum quality, with readings of approximately 22% or greater indicating at least 50 g/L of IgG. However, identifying high-quality colostrum is only the first step. Calves must receive an adequate mass of IgG as soon as possible after birth, preferably within the first two hours, and successful passive transfer should be confirmed by measuring serum IgG, total protein, or Brix values during the first days of life.

For nutrition consultants, this presents an opportunity to evaluate dry-cow feeding programs through outcomes that extend beyond the dam. Monitoring feed intake, body condition, NEFA, BHB, colostrum quality, passive transfer, calf morbidity, and early growth provides a more complete picture of transition management. A well-formulated close-up ration should support the cow through calving while providing favorable conditions for fetal development and colostrum synthesis. Although emerging research does not support a single dietary formula for producing superior colostrum, it reinforces the importance of maintaining maternal nutritional and metabolic health as part of a comprehensive calf-rearing strategy.

The development of a productive replacement heifer begins before calving. Good maternal nutrition establishes the conditions for fetal development and colostrum production, while timely feeding of high-quality colostrum helps provide the newborn with the immunity needed to face its early environment. Neither can substitute for the other, and their combined success contributes to healthier calves, more consistent growth, and the productive longevity of the future dairy cow.

Further reading

1. DeNise, S. K., J. D. Robison, G. H. Stott, and D. V. Armstrong. 1989. "Effects of Passive Immunity on Subsequent Production in Dairy Heifers." *Journal of Dairy Science* 72: 552–554. [https://doi.org/10.3168/jds.S0022-0302\(89\)79140-2](https://doi.org/10.3168/jds.S0022-0302(89)79140-2).
2. Fischer-Tlustos, A. J., et al. 2026. "Effects of Alterations in Close-Up Dietary Neutral Detergent Fiber Content on Colostrum and Transition and Mature Milk Production and Composition in Primiparous and Multiparous Holstein Dairy Cattle." *Journal of Dairy Science* 109: 11624–11643. <https://doi.org/10.3168/jds.2026-28495>.
3. García, A. 2025. "The Tool with the Highest Return on Investment." *Hoard's Dairyman*, September 25, 498. <https://dellait.com/wp-content/uploads/2025/10/100-HD-The-tool-with-the-highest-return-on-investment.pdf>.
4. Lombard, J., et al. 2020. "Consensus Recommendations on Calf- and Herd-Level Passive Immunity in Dairy Calves in the United States." *Journal of Dairy Science* 103: 7611–7624. <https://doi.org/10.3168/jds.2019-17955>.
5. Zheng, J., et al. 2026. "Maternal β -Hydroxybutyrate During the Dry Period Is Associated with Altered Epithelial Cell Regulation and Rumen Morphology of Offspring as Calves." *Journal of Dairy Science* 109: 6201–6215. <https://doi.org/10.3168/jds.2025-27835>.