USDA Animal and Plant Health Inspection Service
U.S. DEPARTMENT OF AGRICULTURE

Colostrum Feeding and Passive Immunity of Preweaned Holstein Heifer Calves NAHMS Dairy 2014 Study Calf Component

Information Brief

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INTRODUCTION

Colostrum production in cattle begins several weeks before calving, and its composition is influenced by the feeding and management practices used for dry cows. Cow management in the dry period is important for the survival, health, and growth of newborn calves.[1] Colostrum provides essential nutrients and passive immunity to calves through immune factors and immunoglobulins, primarily immunoglobulin G (IgG). Calves are born with little or no immunoglobulins and rely on colostrum to provide immune factors such as IgG.[2]

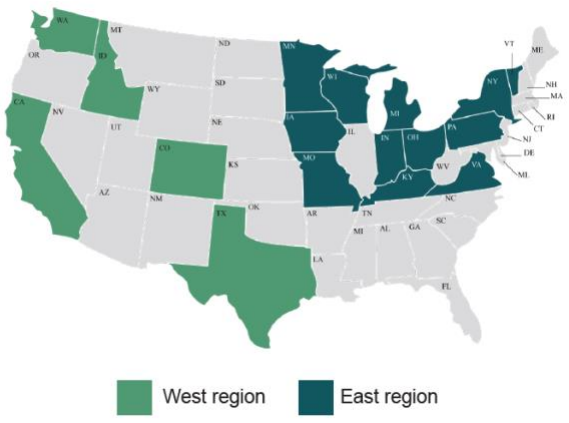
Although colostrum is mostly promoted for its immunoglobulins and passive immunity benefits, it also provides additional benefits to calves. At birth, calves are monogastric and rely on liquid milk for nutrients.[3] Colostrum has 50 percent more fat and almost five times as much protein as milk.[4] Colostral fat provides energy and is critical for thermoregulation, while the protein is composed primarily of immunoglobulins. Colostrum has relatively high levels of vitamins A, D, and E and, since these vitamins are not readily absorbed across the placenta, it is essential for the neonate to absorb them from colostrum.[1] Colostrum is usually hand-fed to dairy calves at about 102°F, which serves as a heat source and is important for thermoregulation. Colostrum also provides essential fluids, which increases blood volume, improves circulation, and improves calf survival.

Therefore, colostrum feeding and passive immunity are extremely important to the overall health of newborn calves. This info brief provides information on colostrum management, the evaluation of passive immunity, and updated standards on passive immunity.

NAHMS DAIRY 2014 STUDY CALF COMPONENT

U.S. Department of Agriculture's National Animal Health Monitoring System (NAHMS) conducted the Dairy 2014 study, which collected data on dairy health and management practices from 17 of the Nation's major dairy States (figure 1). These States represented 80.5 percent of U.S. dairy operations and 81.3 percent of U.S. dairy cows in 2014. The Dairy 2014 Calf Component included 104 operations in 13 of the Nation's major dairy States.* Two objectives of the Calf Component were to evaluate colostrum quality and the passive immunity status of calves. Overall, 1,972 colostrum samples fed to Holstein calves were evaluated for quality, and blood samples from 1,623 Holstein calves were tested to evaluate their passive immunity status.

Figure 1. States/regions that participated in the NAHMS Dairy 2014 study



West region: California, Colorado, Idaho, Texas, Washington
East region: Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, Wisconsin

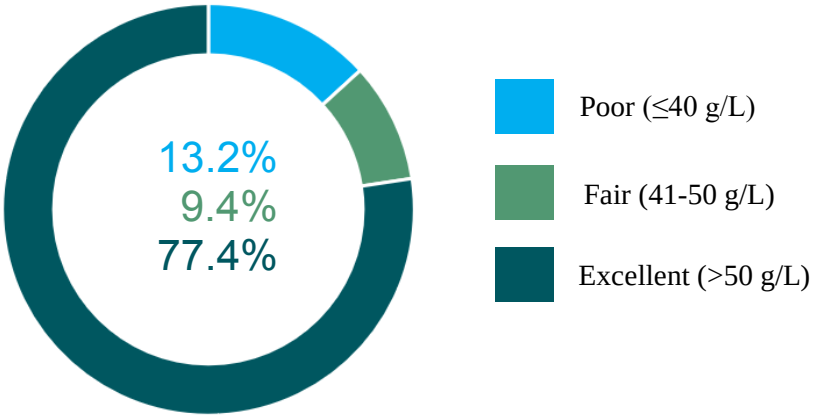
*Idaho, Indiana, Kentucky, and Texas did not enroll calves in the calf component.

COLOSTRUM MANAGEMENT

The most important factors related to colostrum management are the quality and quantity of colostrum fed, the timing of feeding colostrum, and cleanliness of the colostrum.[5] These factors are critical in providing calves with passive immunity. High quality colostrum is defined as having greater than 50 g/L concentration of IgG;[5] 77.4 percent of samples in this study met this criterion (figure 2). Overall, the average colostral IgG concentration was 74.4 g/L. The greater the concentration of IgG in colostrum, the higher the probability of successful transfer of passive immunity.[6] In this study, factors that influenced colostrum quality included the lactation number of the colostrum donor and environmental conditions. Colostrum IgG concentration was highest for third-lactation or greater dams and lowest when using a commercial colostrum replacer. Colostrum produced by cows in warmer temperatures (>21°C, >70°F) was generally higher in IgG concentration than colostrum produced in cooler temperatures.

To obtain the recommended quantity of colostral IgG, calves should be fed at least 10 percent of their birth weight in the first feeding. In this study, about 85 percent of calves were fed the recommended quantity of colostrum in the first 24 hours (3.79 L, 4 qt). Colostrum must be fed to calves soon following birth because the absorption of IgG is minimal by 24 hours of age, after which immunoglobulins can no longer be absorbed.[1]

Figure 2. Percentage of Holstein heifer calves by quality (IgG/L) of colostrum fed



EVALUATING COLOSTRUM QUALITY

More than 75 percent of calves were fed high quality colostrum (IgG ≥50 g/L). To improve beyond this percentage, producers should measure colostrum quality and feed calves only high-quality colostrum.[7] Brix refractometers are often used to determine colostrum IgG concentration. Colostrometers are also used, but these devices are temperature sensitive and fragile, making them difficult to use in farm environments. About 12 percent of dairy producers used a colostrometer for evaluating colostrum quality.[8] Brix refractometers, however, are easier to use and the values obtained compare well with the gold standard laboratory test.[9] About 4 percent of producers used a Brix refractometer. It is recommended that percent Brix colostrum readings be greater than or equal to 22 percent, to ensure high quality colostrum and increase the probability of adequate passive immunity in calves.[10]

PASSIVE IMMUNITY

Calves are categorized as having poor passive immunity if their serum IgG concentration is less than 10 g/L when measured between 1 and 7 days of age.[6] Poor passive immunity is associated with increased calf morbidity and mortality and decreased growth.[11] [12] Poor passive immunity can also lead to decreased productivity later in life, including decreased first- and second-lactation milk production and increased culling rate during the first lactation.[13] [14] Calves with serum concentrations greater than 15 g/L are less likely to develop respiratory problems.[15] In this study, 1,623 Holstein calves were evaluated for IgG levels: 35.5 percent had serum IgG levels greater than or equal to 25 g/L, and 12.0 percent had poor passive immunity (serum IgG levels less than 10 g/L) (figure 3).

Figure 3. Percentage of Holstein heifer calves by serum IgG level (g/L)

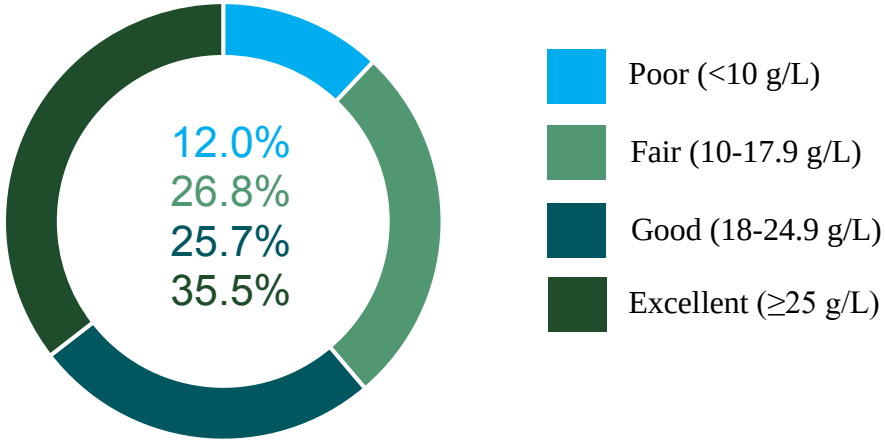
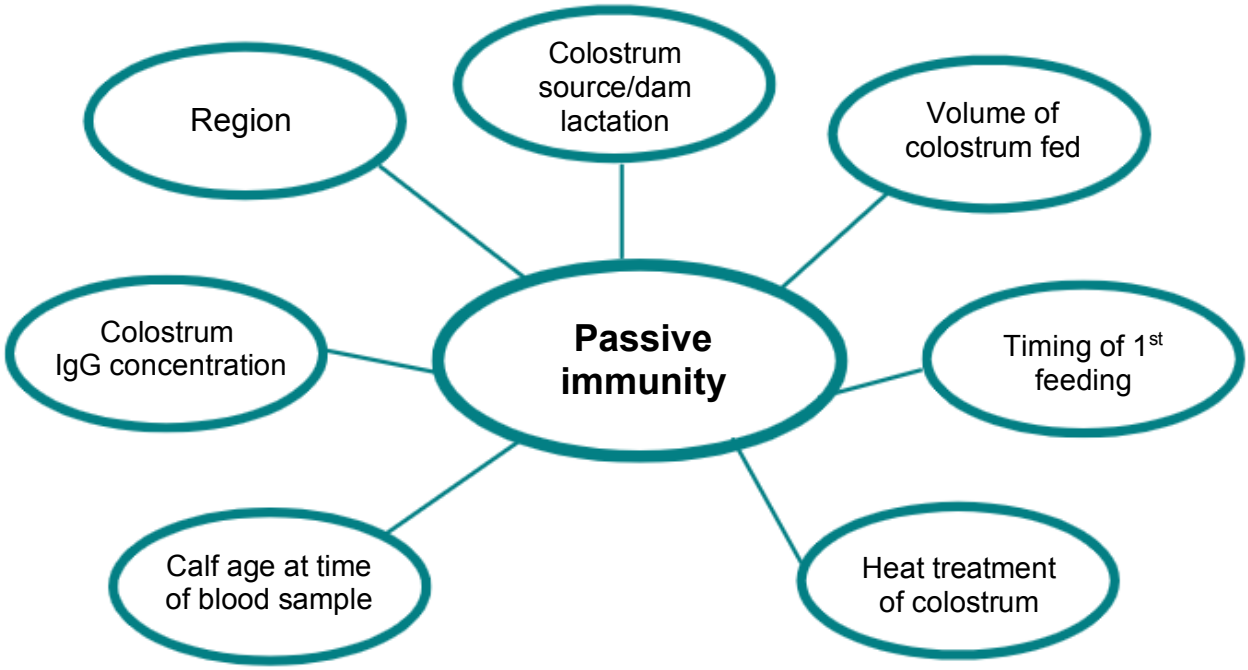


Figure 4 shows important factors that influence passive immunity.

Figure 4. Factors influencing passive immunity of calves



Passive immunity is influenced, in part, by colostrum quality (i.e., the amount of colostral IgG); quantity (i.e., volume); and the timing of first feeding (e.g., within 4 hours following birth). Serum IgG levels were highest for calves that received colostrum from first- lactation dams and lowest for calves fed colostrum replacer. Heating colostrum to 60°C for 60 minutes was also associated with higher serum IgG concentrations.

The 12.0 percent of calves with poor passive immunity in this study might have had factors that contributed to their low serum IgG levels: receiving poor quality colostrum (serum IgG concentrations <50 g/L), receiving the first feeding of colostrum more than 4 hours following birth, and receiving low volumes of colostrum (<3.79 L) in the first 24 hours of life.

Almost 50 percent of calves with poor passive immunity had multiple risk factors: 46.2 percent were administered poor quality colostrum; 36.6 percent did not get their first feeding of colostrum within 4 hours following birth; and 58.8 percent were fed a low total volume of colostrum within 24 hours of birth.

EVALUATING PASSIVE IMMUNITY

Although serum IgG concentrations are the best measure of passive immunity, testing for IgG levels requires that blood samples be sent off-farm for relatively expensive testing. The most common method of evaluating passive immunity on-farm was measuring serum total protein concentration. Brix refractometers are also a good on-farm tool for testing serum from calves that are 1 to 7 days old.[10] Since the Brix refractometers can be used to evaluate colostrum quality and serum for passive immunity, producers can use one tool for evaluating their colostrum management program.[10] Percent Brix scores below 8.4 are correlated with failure or poor passive immunity as are serum IgG concentrations <10 g/L.[10] When measuring total protein with a Brix refractometer, values between or exceeding 5.0 to 5.5 g/dL predict successful passive immunity.[16]

RECOMMENDATIONS FOR MANAGING COLOSTRUM AND KEY STUDY FINDINGS

1. Use a Brix refractometer to measure colostrum quality. Feed colostrum with a Brix reading of at least 22 percent, which equates to an IgG concentration of more than 50 g/L.[5]
    - Less than 20 percent of operations in the study measured colostrum quality.
    - About 78 percent of all colostrum samples tested as part of the study met the recommended IgG levels, and about 68 percent met the recommended Brix percentage.
    - Colostrum from older cows was higher in IgG concentration.
    - Colostrum produced in warmer temperatures (>21°C, >70°F) was higher in IgG concentration.

2. For their first feeding, calves should receive at least 10 percent of their body weight in colostrum: approximately 3.9 L (4 qt) for an average sized calf of 40 kg (~85 lb).[6]
    - On average, calves were fed only 2.9 L (3.1 qt) of colostrum at first feeding, which does not meet recommendations

3. Feed colostrum as soon as possible following birth, or at least within 4 to 6 hours of birth.[2]
    - On average, colostrum was fed at 2.8 hours following birth, which exceeds recommendations.

4. Measure passive immunity status in calves aged 2 to 7 days. Passive immunity can be measured using serum IgG or serum total proteins. IgG concentrations equal to or greater than 10 g/L at 24 hours of age indicate adequate passive immunity.[15] Percent Brix readings of >8.3 percent or total protein values of >5.5 g/dL indicate adequate passive immunity. [17]
    - In total, 88 percent of calves had serum IgG concentrations greater than 10 g/L.
    - For percent Brix readings, about 80 percent of calves met recommendations, and about 67 percent of calves met recommendations for total protein.
    - Serum IgG was higher when calves were fed colostrum from first-lactation dams.
    - Feeding a larger volume of high-quality colostrum within 4 to 6 hours of birth increased serum IgG concentrations.
    - Serum IgG was highest for calves fed heat-treated colostrum (60°C for 60 min).
    - Feeding commercial colostrum replacer resulted in lower serum IgG concentrations.
    - Geographically, serum IgG concentration in calves was higher in the West region than in the East region.

This informational sheet summarizes the colostrum and passive immunity component of the 2014 study which has been published.[18]

NEW PASSIVE IMMUNITY STANDARD

Based on information collected during this study, a group of calf experts were convened, and new passive immunity standards were proposed.[19] The new standard has 4 categories of passive immunity compared to 2 levels for the previous standard. The new serum IgG standard, equivalent total protein and % Brix, and the targeted percentage of calves on a farm in each category is shown below (table 1).

Table 1. Consensus passive immunity categories with equivalent measurements, and percentage of calves recommended in each category

Passive Immunity Category	Serum IgG (g/L)	Equivalent Total Protein (g/dL)	Equivalent Brix (%)	Percent calves*
Excellent	≥ 25.0	≥ 6.2	≥ 9.4	> 40
Good	18.0 – 24.9	5.8 – 6.1	8.9 – 9.3	~ 30
Fair	10.0 – 17.9	5.1 – 5.7	8.1 – 8.8	~ 20
Poor	< 10.0	< 5.1	< 8.1	< 10

* Consensus recommendation for percent of a farm's calves in each category

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To see new and exciting publications regarding this study, please visit www.aphis.usda.gov/nahms or scan the QR code. Materials will be updated regularly as they become available.

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