Relationship between birth weight and calving ease with passive transfer of immunoglobulins in neonatal beef calves

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This project evaluated immunoglobulin production in first-calf commercial beef heifers and absorption by their offspring. Behavioral and phenotypic traits were measured to determine if these traits have any impact on the passive transfer of immunity from dam to offspring. Increased birth weight and incidence of dystocia negatively influenced serum immunoglobulin concentrations in newborn beef calves.

Summary

The absorption of immunoglobulins (Ig) found in colostrum is a passive transfer of immunity that neonatal calves receive from their dams. Calves that do not receive adequate levels of Ig from their dams can experience increased morbidity and mortality. Commercial crossbred beef heifers (n = 53) were used to evaluate the relationship of the passive transfer of immunity and Ig absorption from colostrum on various neonatal traits. Heifers were fed, in a drylot, a total mixed ration meeting 100 percent of National Research Council requirements through parturition and were calved in March and April. Onset of the third stage of labor, time to birth, time to stand and time of first nursing were recorded. Calving ease (CE), calf vigor (CV), birth weight and 24-hour blood samples for serum Ig were taken from each calf via jugular venipuncture. Mothering score, colostrum samples for colostral Ig, weight, body condition score, udder suspension and teat size were recorded from the dams. All statistical analyses were conducted using regression and correlation procedures in SAS (SAS Ins. Inc., Cary, N.C.). We found a negative correlation between serum immunoglobulin G (IgG) and CE (P = 0.02), positive correlations between birth weight and CE ($P < 0.001$), and udder suspension and teat size (P = 0.002). A negative correlation was found between serum IgG and birth weight (P = 0.05) and a tendency of a positive correlation between serum IgG and teat size (P = 0.08). For measurements with significant correlations, stepwise regression calculations were completed. We found a linear effect between CE and serum IgG (P = 0.01) and a quadratic effect between birth weight and serum IgG (P = 0.04). Difficulties during third-stage labor increased as calf birth weight increased. The increases in CE scores were associated with decreased serum IgG found in the calf after 24 hours. This depression of serum IgG due to calving difficulty may impair the ability of calves to adequately defend against pathogen exposure and may influence subsequent growth and performance.

Introduction

Calf health is vital to North Dakota beef producers. Colostrum absorption is one of the most important factors in shaping calf health. Calves that fail to absorb enough Ig in colostrum have high preweaning mortality rates, up to 89 percent in the first week of life (McGuire et al., 1976), as well as other short- and long-term losses related to animal health, welfare and productivity (Godden 2008).

Adequate Ig absorption requires calves to receive a sufficient volume of their dam's colostrum within the first 24 hours of birth. Colostrum is vital to the calf due to the bovine placental type, which prevents transmission of protective Ig. The absorption of Ig helps protect the calf against diseases until its own immature immune system becomes functional.

The interaction of the dam and her offspring also is vital for the calf to absorb the necessary amounts of Ig needed to mount a defense against pathogens. Stresses during birth such as dystocia, environment and individual handling of the animals can affect each animal differently. These stresses can impact the dam and her offspring negatively and may lead to a decrease in Ig within colostrum secreted by the dam and absorbed by her calf. Understanding the stress that the animal is under during late pregnancy may be beneficial for North Dakota cattle producers.

Experimental Procedures

Commercial Angus-crossbred heifers (n = 53) from the NDSU Central Grasslands Research Extension Center were used to evaluate the relationship of the passive transfer of immunity and Ig absorption from colostrum on various maternal and

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neonatal traits. Heifers were synchronized, artificially inseminated and then exposed to Black Angus cleanup bulls. Heifers calved in March and April. When forage no longer was available, the females were kept in a drylot and fed a total mixed ration meeting 100 percent of NRC requirements through parturition.

Onset of third-stage labor, time to birth and time to stand were recorded. Third-stage labor started when the amniotic sac appeared at the vulva and ended when the calf was expelled from the dam. Stop time was subtracted from the start time to achieve a birthing time. A 1 to 5 calving ease score was assigned post-labor (1 = no assistance; 5 = caesarian section). Time to stand started when the calf made its first movements and ended when the calf could step without falling. This was observed while the dam was in drylot unless calving difficulty was noticed. If calving difficulty was noticed (the amniotic sac was at the vulva for two hours and the calf was not expelled) the heifer was brought into the calving barn and assistance was given.

After time to stand was recorded, calf and dam were brought into the calving barn working chute. The dam was weighed and body condition score was recorded. Udder suspension (1 = very pendulous with a broken floor; 9 = very tight) and teat size scores were assigned to the dam (1 = very large, balloon–shaped; 9 = very small). A colostrum sample was taken from one of the front quarters. Ten strips of colostrum were removed before a 5-milliliter (mL) sample was collected and frozen. The calf was weighed and tagged. Both dam and calf then were moved to a pen in the calving barn, where the calf and dam were allowed to interact freely and the calf was allowed to nurse.

The first nursing event was timed, starting when the calf was nursing actively and obtaining colostrum and ending when the calf showed little interest, moved away and laid down. The calf then was brought back into the working room and weighed again. Throughout the calving process, a mothering score (1 = the dam was up within 10 minutes after delivery, is actively licking the calf to stimulate standing and is vocalizing to the calf, encouraging it to nurse; 4 = cow shows aggression toward the calf, will not let the calf nurse and does not vocalize) was assigned to the dam and a calf vigor score (1 = normal; 5 = stillborn) was assigned to the calf.

At 24 hours after birth, a blood sample was taken via jugular venipuncture from each calf. The whole blood was centrifuged and a 5 mL sample of serum was frozen. Both colostrum and serum samples were shipped to the Saskatoon Colostrum Co. Ltd., where radial immunodiffusion was used to calculate total IgG concentration in the colostrum and serum samples. All data were analyzed using the correlation and regression procedures of SAS (SAS Ins. Inc., Cary, N.C.). Correlations on all variables were calculated first, and all significant correlations then were analyzed using stepwise regression. The statistical model included all variables listed and all interactions. No experimental treatments were applied to these animals. Significance was determined with an alpha of $P \leq 0.05$.

Results and Discussion

We found a positive correlation between the time the calf took to stand and the labor time of the dam ($P < 0.001$). An increase in labor time may influence the time the calf takes to stand. Birth weight was correlated positively with the time the calves took to stand ($P = 0.009$). Larger calves took longer to stand and nurse from their dams. Birth weight also had a positive correlation with third-stage labor time ($P < 0.001$); thus, dams with larger calves experienced prolonged labor times.

The time to stand was correlated negatively with serum IgG concentrations of the calf ($P = 0.001$). Calves that took longer to stand after birth tended to have lower serum IgG concentrations. A negative correlation was seen between serum IgG and birth weight of the calf ($P = .047$). Larger calves may absorb less IgG than smaller calves within the first 24 hours after birth.

Dams that needed birthing assistance manually or by caesarian section due to increased calf weight had increased labor times and calves that look a longer time to stand and start nursing. Calving ease score had a positive correlation with birth weight ($P < 0.001$); (Figure 1). Therefore, calving ease score had a positive correlation with time of third-stage labor ($P < 0.001$; Figure 2) and time to stand ($P < 0.001$; Figure 3). Calving ease score had a negative relationship with serum IgG concentrations in the calf at 24 hours ($P = 0.02$). Increased time of labor and the increased stress of labor were associated with a decrease in serum IgG concentrations in the calf.

Mothering score had a positive relationship with calf vigor score ($P = 0.007$). Aggressive dams were more likely to have calves that were weak and needed assistance. Udder and teat scores were correlated positively with each other ($P = 0.002$); therefore, dams with larger, more pendulous quarters also had large, more bulbous teats. Udder suspension was related to body condition score, and dams that have larger body condition scores also were more likely to have larger, more bulbous quarters ($P = 0.03$).

However, teat score had a negative relationship with cow weight ($P = 0.02$). Further research is needed to

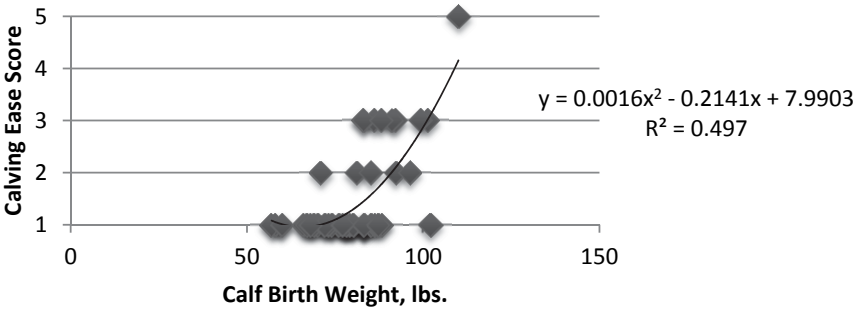

Figure 1. The relationship of calving ease score and calf birth weight in commercial beef heifers.

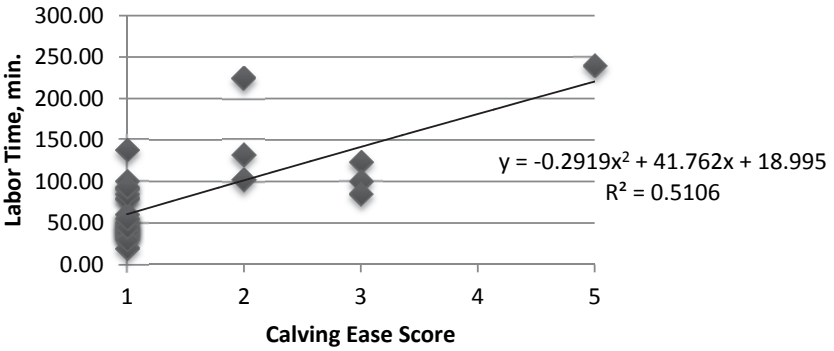

Figure 2. The relationship of labor time and calving ease score in commercial beef heifers.

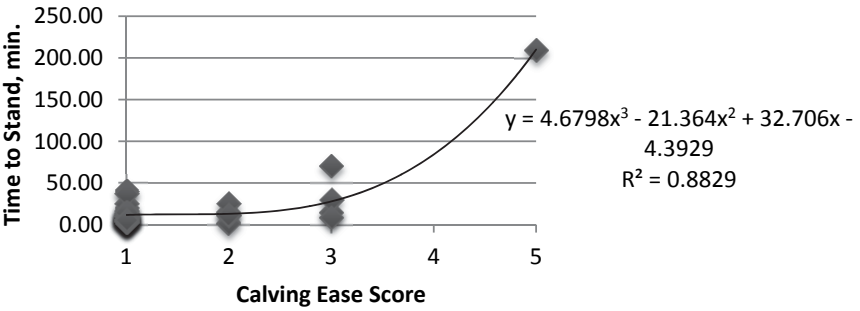

Figure 3. The relationship of time to stand and calving ease score in commercial beef heifers.

repeat these studies and understand the mechanisms regulating these relationships.

The first 24 hours postpartum are vital to calves' performance throughout life. This research was done on first-calf beef heifers, and these relationships may be different on multiparous cows. No nutritional treatments were applied to the dams or their calves in this trial; therefore, further research is needed to evaluate if diet influences the relationship between colostrum production and Ig absorption by the calves. Understanding which factors affect the concentration of antibodies absorbed by the calf are important to North Dakota producers to maximize productivity in their herd.

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