Effects of Rumen-protected Niacin on Cold Stress in Neonatal Beef Calves

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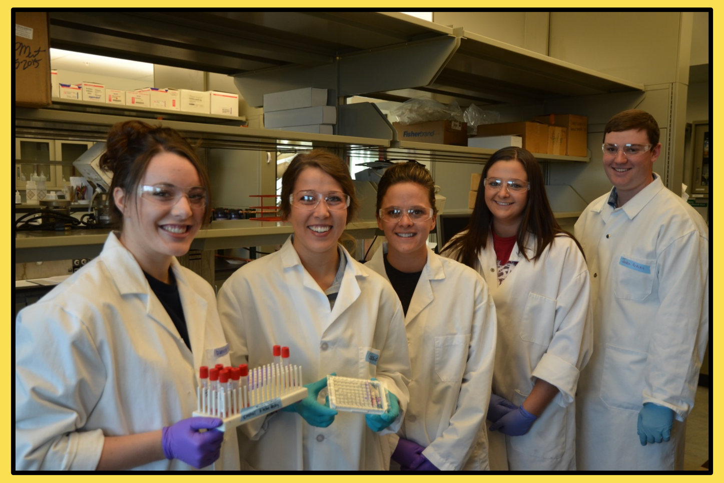
ABSTRACT

We examined the response to a rumen-protected niacin supplement (NiaShure) on neonatal beef calves. The study consisted of multiple trials over the course of two years at two separate locations. In experiment one during the first year, 11 four-year-old beef cows were utilized (Havre). During year two, 2-year-old beef heifers were used at two different locations. The first location used 11 beef heifers (Bozeman) and the second location used 34 beef heifers (Havre). Treatments were arranged in a 2x2 factorial with heifers receiving control or NiaShure. Neonatal calves were subjected to modified (-2°C) or control (15°C) environments. At 30 min intervals for 120 min, blood samples, heart rate, and rectal temperature were recorded. At 120 min in the modified or controlled environment, the calf was returned to its dam. At this time, the calf was allowed to nurse freely. Additional samples were collected over the course of a second 120 min time period at 30 min intervals. After a final sample was collected, the IV catheter and temperature probe were removed.



INTRODUCTION

Oxidation-reduction reactions are a part of several energy pathways, often involved in the transport of electrons. Niacin is a B vitamin, and its components are essential for a variety of energy pathways. Niacin derived coenzymes, NAD^+ and $NADP^+$, are crucial for fat-derived warming mechanisms such as those associated with overcoming cold stress in newborn calves (Higdon, 2000). The purpose of this project was to examine the impact of supplemented niacin on the response to cold stress in beef calves. Rumen-protected niacin supplementation is commonly utilized in the dairy industry, but there has been little research in its application to the beef industry. Typically, Montana calving occurs during the late winter and early spring. Consequently, calves are more susceptible to the direct and indirect effects of cold stress, especially with heifers that have a lack of experience and undeveloped maternal instincts. Vulnerable newborn calves are often exposed to sub-zero temperatures, heavy snowfall, and high wind speeds. Beef cattle operations can experience detrimental losses in the form of diseases, such as pneumonia, that can increase mortality and morbidity rates up to 5% and 45%, respectively (Kelly, 1986). The direct loss of life, cost of medication, and the lack of weight gain due to battling illness results in a direct loss of profit for the producer. We hypothesized that the cow-calf pairs fed an encapsulated niacin supplement would display an increased resistance to cold stress.

METHODS

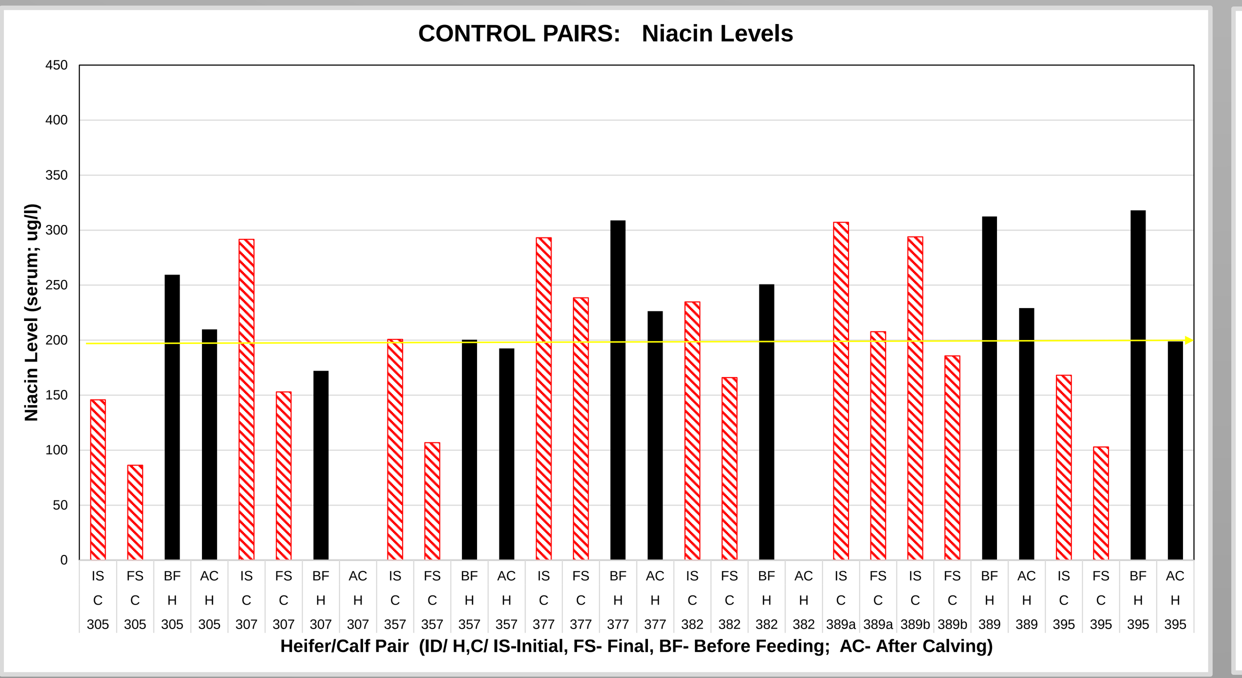
Heifers were sorted based on whether or not their expected calving dates were compatible within the timeframe of the project. The selected heifers were then bled and randomly assorted into treatment groups using a 2x2 factorial; for a 21 d period prior to parturition, heifers were fed 12 g NiaShure supplement in 0.91 kg barley or control feed (barley alone). After 14 d of receiving their feeding treatment, the heifers were bled a second time.

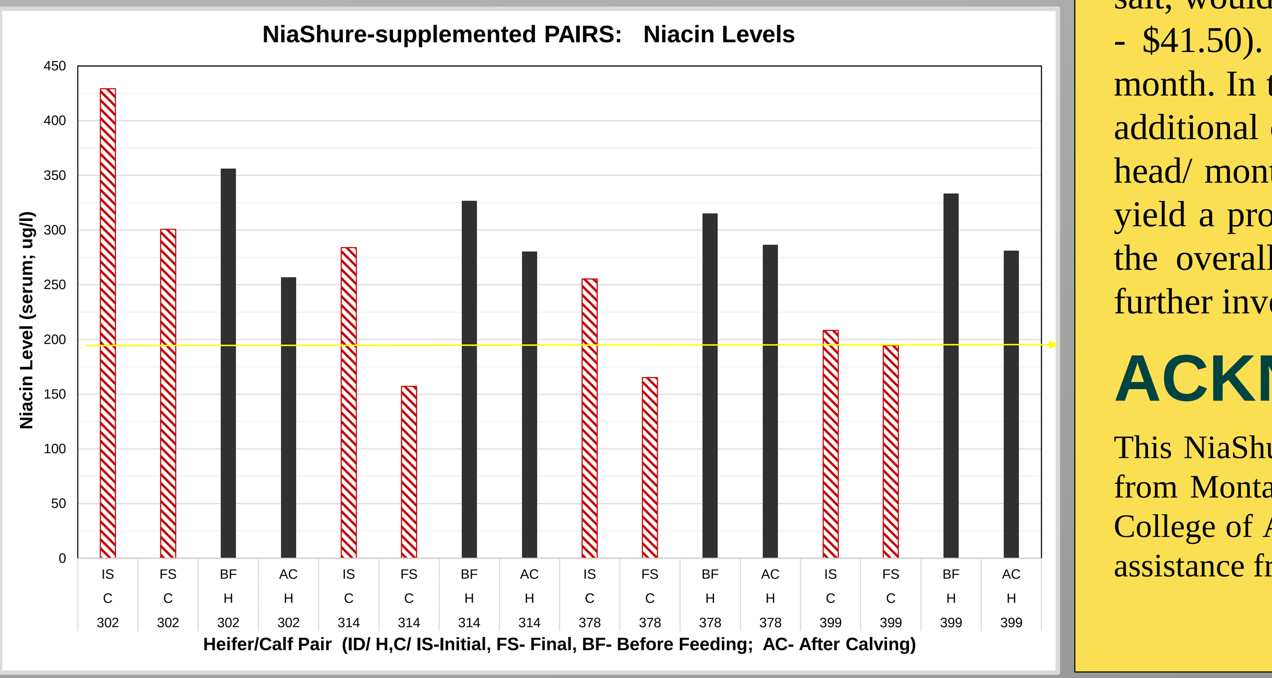
Heifers were regularly assessed for health issues. At calving, newborns were muzzled while colostrum was milked from their dams. Each calf was then bottle-fed 30 mL/kg colostrum, based on BW. Finally, calves were allowed to bond with their dams for 3.5 hours before the experiment commenced. At 3.5 hours the calf was separated from its dam and an IV catheter was inserted into the jugular vein, heart rate monitor was placed and rectal temperature probe was inserted. Once this was accomplished, calves were placed in a -2°C modified environment or a 15°C control environment. Environment treatment was assigned by random selection using a 2x2 factorial.

Blood samples, temperatures, and HRs were taken at 0, 30, 60, 90 and 120 min. In addition to the values received from the rectal temperature probe, manual rectal temperatures were also obtained to ensure that calf body temperature did not drop below the safety threshold of 36°C. If calf body temperature fell below this threshold, the calf was restored to 15°C control temperature to prevent hypothermia.

Each calf was returned to it's dam's pen after the 120 min period of treatment. Additional blood samples and measurements were taken at 150, 180, 210 and 240 min. During this time, the cow-calf pair was observed to ensure that the calf nursed and bonding was well established. At 14 d post-parturition, final blood samples were collected from the dams. All blood samples were refrigerated immediately and centrifuged within 15 hours to isolate serum for analysis.

Serum samples were analyzed using an ID Vit Niacin assay (Immundiagnostik AG). In this assay, a select strain of bacteria, *Lactobacillus plantarum*, whose growth correlates directly with niacin content, was coated on a microtiter plate. This assay measures niacin content (nicotinic acid, $NADP^+$, and nicotinamide, NAD^+) in serum. The selected samples were diluted and run alongside a niacin standard curve. After 48 hours, wells in the plate was analyzed using an optical density spectrophotometer (600 nm) to measure bacterial growth. Each sample's niacin concentration was calculated using the standard curve. HR and temperature data were compiled, plotted out, and then analyzed for significant differences among the experimental groups.





RESULTS AND DISCUSSION

Data were analyzed by using SAS (v 9.2) and classified as significant if $p<0.05$. If $p<0.10$, then it can be assumed that trends toward positive results were achieved.

Temperature

The average rectal temperature for the control calves was 38.4°C +/- 0.7. NiaShure calves displayed an average of 38.6°C +/- 1.3. No significant differences or trends were seen between NiaShure and control groups when examining rectal temperature.

Heart Rate

When HR was compared between NiaShure and control calves, a p-value of 0.6306 was noted. However, when the software analyzed the average of each treatment group's HR measurements, calves from heifers who received NiaShure supplement had an average HR of 91.24 beats/min, in contrast to control calves, which average HR values of 78.34 beats/min.

Niacin Levels in Serum

Our initial results analysis consists of samples before feeding (BF) and after calving (AC) for the heifer, as well as an initial sample (IS) and final sample (FS) for each calf. The histograms display data for control and NiaShure cow-calf pairs; results illustrate a trend of the initial samples containing a higher level of niacin than the final samples. The heifers also portray this trend when comparing samples from before feeding and after calving. We hypothesize that the reduction in niacin concentration is due to the fact that niacin, namely NAD^+ and $NADP^+$, are shunted into energy pathways as the calves and heifers require energy to exhibit shivering behaviors and parturition, respectively. While niacin levels are more variable in the control group of cow-calf pairs, the average level of niacin is significantly greater in calves whose dams received NiaShure supplement. When comparing niacin content between initial samples and final samples in control calves, the averages were determined to be 241.9-ug/L +/- 63.8 vs. 155.8-ug/L +/- 54.2. NiaShure calf averages for the same samples were 294.2-ug/L +/- 95.3 vs. 204.4-ug/L +/- 66.2, respectively. While the data from this study revealed compelling trends, the results were inconclusive. Results were inconclusive, in part, because of the unexpectedly small sample sizes (NiaShure n= 4, control n= 7). This study cannot state that supplementing NiaShure will definitively reduce cold stress in calves. Further research must be conducted to derive solid conclusions and recommendation. It would also be advisable to obtain more accurate AI records for reliable calving dates. Logistical setbacks such as delays in processing blood may have also led to inconsistencies within our results; the niacin microbiological assay is very sensitive to traces of hemolysis in serum samples. Future plans for this study will analyze calf weaning weights, which may yield further compelling evidence in favor of NiaShure supplementation. The majority of cow-calf operations' income is dependent upon weaning weights. In addition to weaning weights, disease and illness incidence is another category of data that should be compiled. If weaning weights are statistically higher and rate of illness and disease is statistically lower for the NiaShure supplemented cow-calf pairs, the long-term financial value of NiaShure supplementation would be validated.

IMPLICATIONS

This study suggests that rumen-protected niacin (NiaShure) may provide economic benefits to cow-calf operations. Economic benefits will stem from the fact that calves will theoretically show an increased resistance to stress generated from exposure to a cold environment, e.g. typical calving weather in Montana. The primary reason for using NiaShure supplementation is to promote resistance to cold stress; in theory, the result would be to obtain minimal morbidity and mortality rates, as well as higher weaning weights, the main source of profit. With these ideals realized, optimally healthy calves will enhance their performance and minimize labor and medical costs. With these results in mind, producers will benefit financially by incorporating niacin supplements into their feeding plan. The cost for the producer to feed NiaShure supplement, incorporated into mineral salt, would be approximately $70/50 lb bag (4.76 lb NiaShure included; retail cost - $41.50). This would provide 12 g of NiaShure for 6 cow-calf pairs for one month. In total, combining NiaShure supplement with mineral salt gives rise to an additional cost to the producer of $1660/ton; therefore, an additional $705.50/100 head/ month. If this supplementation regimen saves the producer one calf, it will yield a profit of over $800, based on a steer price of roughly $1500/head. Given the overall economics of the cattle industry, NiaShure supplementation merits further investigation and research.

ACKNOWLEDGEMENTS

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