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The Effect of High Maternal Milk Production During Pregnancy on Neonatal Health and Metabolism

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INTRODUCTION

- The efficiency of the dairy industry relies heavily on the production of healthy calves since they are raised for meat/veal production and as replacement animals.
- 5.8% of calves in the U.S. die due to causes unrelated to predation. One factor that could predispose calves to increased disease susceptibility is maternal programming caused by high maternal milk production during pregnancy.
- Maternal programming is defined as changes in the intrauterine environment that can impact the growth and development of the fetus. Maternal programming can have long lasting consequences on offspring growth and development, with negative impacts to the productivity and overall health of these individuals.
- High maternal milk production during pregnancy may utilize nutrients and other resources for milk production that are also needed to support the growing neonatal calf. Therefore, it is possible that high maternal milk production can modify both the levels of antioxidants and oxidants (oxidative stress), as well as the metabolism of total cholesterol (TC) and circulating triglycerides (TG) in a neonate's body, through maternal programming. These lipids, in the form of TC and TG, will provide energy to the calf in the case of a negative energy balance or diseased state. They also effect other organ/tissue function because of their role in biological membranes, as well as the synthesis of several organic substances and hormones.
- We hypothesized that calves born to high producing dams would exhibit increased oxidative stress as well as increased circulating triglyceride and total cholesterol concentrations.

MATERIALS AND METHODS

Animals

- Cows (n = 17) that produced ≥ 25,792 kg of milk during their lactations were classified as high producers. Alternately, cows (n = 18) that produced ≤ 18,896 kg of milk during their lactation were classified as low producers.
- Blood samples from the corresponding calves were collected within 24 hours of birth (n = 5 to 13 per group per gender). Calves born to low and high producing dams are referred to as LOW and HIGH, respectively.

Plasma/Serum Analysis

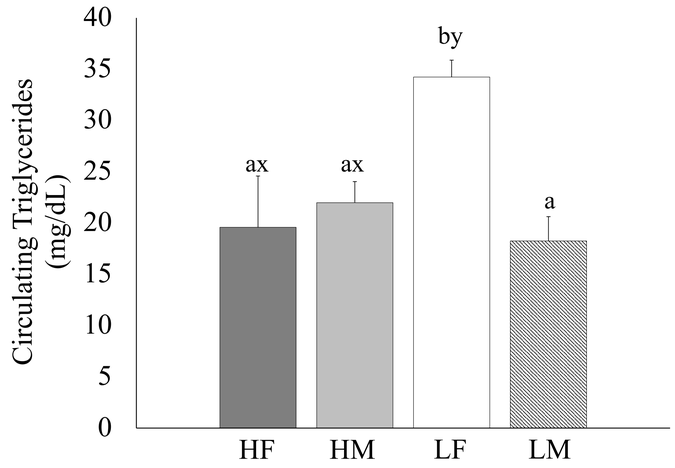
- Total serum triglycerides (TG) and total cholesterol (TC) were analyzed at the University of Missouri Veterinary Diagnostic Laboratory.
- Oxidative stress was measured using a plasma protein carbonyl assay (Sigma-Aldrich, St. Louis, MO).

Data Analysis

- Data were analyzed in SAS using PROC MIXED with maternal milk production as a covariate.
- Differences were considered statistically significant when $P \leq 0.05$ and a tendency when $0.05 < P \leq 0.10$.

RESULTS

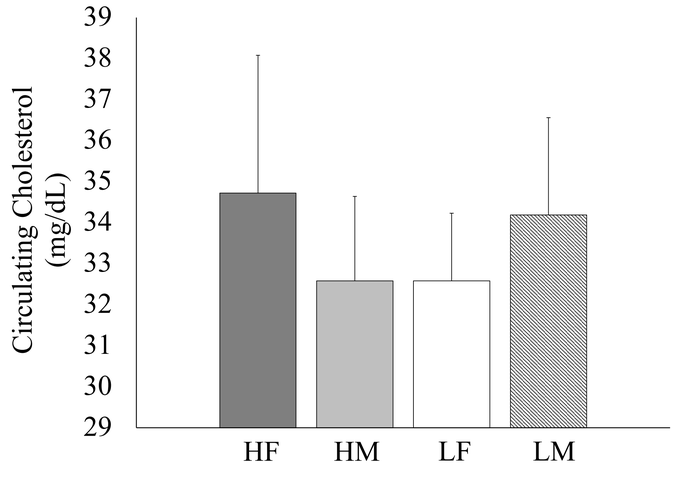
Figure 1: Maternal Milk Production During Gestation Affects Circulating Triglyceride Concentrations in Neonatal Calves



HF: Female calves born to high producing cows, LF: Female calves born to low producing cows, HM: Male calves born to high producing cows, LM: Male calves born to low producing cows. a,b: $P \leq 0.05$ and x,y: $0.05 < P \leq 0.10$

Interpretation: A treatment by gender effect was observed for circulating triglyceride concentrations (P = 0.02). LOW female calves had greater circulating TG concentrations (34.23 ± 1.65 mg/dL) when compared with LOW male calves (18.24 ± 2.37 mg/dL; P < 0.01), HIGH male calves (21.98 ± 2.06 mg/dL; P = 0.08), and HIGH female calves (19.57 ± 3.36 mg/dL; P = 0.06). Circulating triglyceride concentrations appear to differ with calf gender. Differences observed between genders as well as LOW female calves vs. HIGH female calves could be due to alterations in TG absorption for colostrum or TG production. It is possible that increased TG concentrations in LOW female calves could aid in maintaining energy balance.

Figure 2: Effects of Maternal Milk Production During Gestation on Total Cholesterol Concentrations in Neonatal Calves

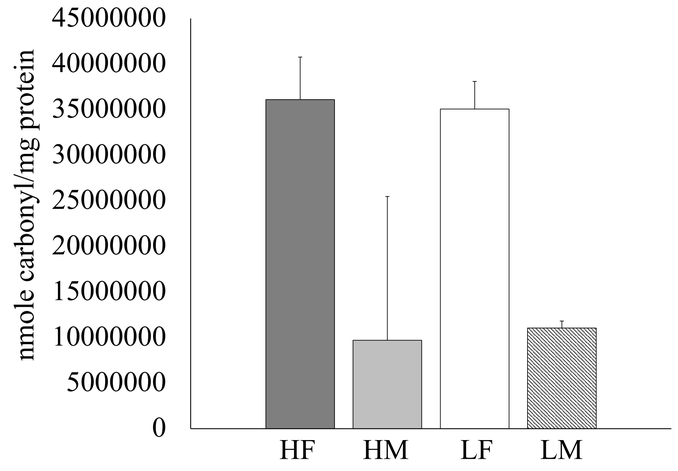


HF: Female calves born to high producing cows, LF: Female calves born to low producing cows, HM: Male calves born to high producing cows, LM: Male calves born to low producing cows.

Interpretation: No effect of maternal milk production by gender was observed for circulating TC concentrations (P = 0.42). Calves were sampled at an early postnatal time point. It is possible that had these animals been sampled at a later, more mature, postnatal time point that differences in TC concentrations may be observed.

RESULTS

Figure 3: Effects of Maternal Milk Production During Gestation on Plasma Protein Carbonyl Concentrations in Neonatal Calves



HF: Female calves born to high producing cows, LF: Female calves born to low producing cows, HM: Male calves born to high producing cows, LM: Male calves born to low producing cows.

Interpretation: No effect of maternal milk production by gender was observed in the present study when evaluating plasma protein carbonyl content (P = 0.66). There are however, gender differences (P < 0.001) observed between the 4 treatment groups, which is likely due interassay variation. This assay will be repeated due to the observed variation so that stronger conclusions can be made from these data.

SUMMARY

- Circulating TG concentrations differ between male and female calves.
- LOW female calves have greater circulating concentrations of TG than HIGH female calves.
- No effect of maternal milk production by gender was observed with plasma protein carbonyl data or TC concentrations.
- A future study will evaluate histological changes in the gastrointestinal tract of calf neonates born to HIGH and LOW producing dams to better understand changes to lipid absorption and passive transfer.

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