

Vitamin A and its association with inflammatory disease from dry off through the fresh period

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Introduction

Vitamin A is an essential nutrient and is well established to be crucial for regulating hematopoiesis, epithelial integrity, vision, and embryogenesis. In humans, vitamin A deficiency is associated with increased risk of morbidity, mortality, and a decreased immune response to vaccines. However, despite being the first vitamin discovered, little is known about its role in these outcomes in dairy cows. Dairy cows experience a significant decrease in serum vitamin A concentrations at the time of calving when cows are most at risk for disease. Previous study findings show conflicting results as to the effects of vitamin A and diseases such as mastitis in dairy cows. However, many studies with negative results are limited by their small sample size and short study period. The objective of this study was to investigate the associations between vitamin A and known disease biomarkers for fresh cow diseases as well as incidents of disease.

Materials and Methods

The Animal Use and Care Committee at Michigan State University (East Lansing) approved this study and all animal protocols. A total of 353 cows from 5 commercial dairy herds in Michigan were enrolled over a 3-year period. Cohorts were made up of 15 cows/cohort and stratified by lactation. Blood samples were collected at dry off (DO; -48±12d pre-calving), close-up (CU; -17±7d pre-calving), and fresh (C+7; 7±3d post-calving) and analyzed for serum vitamin A, beta-hydroxybutyrate (BHB), nonesterified fatty acids (NEFA), and albumin. The health status of each cow was monitored from dry off through 30 days post parturition. Negative health outcomes included milk fever, mastitis, metritis, retained placenta, lameness, displaced abomasum, ketosis, abortion, and pneumonia. A Pearson correlation analyses was performed to assess the correlation between vitamin A and albumin, BHB, and NEFA) at each sample point (dry-off, close-up, and C+7). A linear mixed model was built to describe changes in vitamin A over time. The explanatory candidate variables for entry into the models included parity (1st, 2nd, or 3rd and greater

lactation), season, time point, NEFA, BHB and a parity and time point interaction term. Mixed logistic regression models were built for each disease outcome: ketosis, lameness, mastitis, uterine diseases (RP and/or metritis).

Results

Vitamin A was significantly inversely related to both NEFA ($P<0.01$) and BHB ($P=0.02$). Vitamin A concentrations were significantly higher among cows in the 2nd parity group compared with the 1st and 3+ groups ($P=0.02$ and $P<0.01$, respectively). Vitamin A concentrations remained relatively steady from DO to CU and from CU to C+7 among 1st parity cows. Vitamin A concentrations decreased from DO to CU and from CU to C+7 among 2nd and 3+ parity cows. Vitamin A had a significant association with occurrence of mastitis and the protective effect of vitamin A against mastitis risk increased with parity. Additionally, increased serum vitamin A was associated with uterine disease. This negative association was strongest at the C+7 time point.

Significance

In this 3 year study on commercial dairy farms, vitamin A was found to be negatively associated with mastitis, uterine disease, and NEFA and BHB concentrations. Despite feeding NRC recommended vitamin A concentrations, more than half of the cows were deficient in serum vitamin A in the fresh period. National Research Council recommendations for vitamin A supplementation do not factor in the importance of vitamin A for protection against disease and have not been updated since 2001. Further research is needed to investigate the relationship between vitamin A and mastitis, uterine disease, and negative energy balance. Future research is also needed to investigate how best to supplement vitamin A to cows during the dry and fresh periods in order to prevent vitamin A deficiency.