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The Relationship of Metabolic Hormones, Nutrition, and Postpartum Anestrus in Different Biological Types of Cattle

Andrew J. Roberts, Russell A. Nugent III, Thomas G. Jenkins, and John M. Klindt[1]

Introduction

Restricted energy intake can suppress the overall productivity of cattle. Restricted energy intake can decrease overall productivity of beef cows through, among other traits, decreased milk production, calf performance, and reproduction. However, failure of a cow to conceive is the major component affecting the overall production efficiency of the cow herd. In a companion report included in this publication ("Postpartum Interval Is Influenced by Nutritional Environment and Biological Type"), we demonstrated that the postpartum intervals for breeds of cattle with different genetic potentials for growth and milk production were differentially affected by restricted energy availability. This report, along with numerous other studies, confirms the fact that limited availability of energy can increase the time it takes cows to resume estrous cycle activity after calving. However, the mechanism(s) by which limited energy intake influences resumption of estrous activity after calving is not known. The objective of this study was to identify how changes in metabolic hormones correspond to the time from calving to resumption of cyclicity. In addition, results from this study may explain why diverse biological types of cattle respond differently to restricted energy availability.

Procedure

Cattle used in this study were purebred Angus, Braunvieh, Charolais, Gelbvieh, Hereford, Limousin, Pinzgauer, Red Poll, and Simmental. Four cows from each breed were fed daily rations of ground alfalfa hay and shelled corn containing 130, 170, 210, and 250 kcal of metabolizable energy x body weight$^{-.75}$ (i.e., metabolic weight) for four years. Rations were increased by 25% after calving to account for the increased demand of lactation. Additional information on the treatment, feeding and handling of these cows is included in the companion report entitled "Postpartum Interval Is Influenced by Nutritional Environment and Biological Type" found elsewhere in this publication.

In 1991, 121 of 144 cows calved. Beginning at approximately 3 weeks after calving, cows were bled once per week for at least 15 weeks. In addition, a subset of cows that included the Red Poll, Hereford, Charolais, and Braunvieh cows on the 2 lowest energy levels (i.e., 130 and 170 kcal ME/wt$^{-.75}$/day) were bled every 15 minutes for 6 hours on weeks 2, 3, 4, 6, 8, and 10 after calving. These intensive blood-sampling periods were conducted because levels of some hormones fluctuate in pulsatile fashions, thereby making it difficult to draw conclusions from a single sample at any one time. Serum from all of the blood samples was frozen for future analysis of several metabolic hormones.

Results

To date, two hormones have been analyzed, growth hormone (GH) and insulin-like growth factor-I (IGF-I). Results indicate that maintenance of cattle on the lower levels of energy intake suppresses levels of IGF-I. In contrast, GH appears to be increased in cows maintained on low levels of energy. Thus, chronic (i.e., 4 years) restriction of energy intake affects IGF-I and GH in opposite fashions. It was of interest to determine whether the levels of these hormones would be useful indicators of when cows would resume cycling. The fact that GH is secreted in a pulsatile fashion makes this hormone less desirable as a possible indicator of reproductive status because several blood samples would be required. Levels of IGF-I, however, were relatively consistent from one week to another. Therefore, IGF-I concentrations in serum at three weeks after calving were evaluated as an indicator of length of time it took cows to resume cycling. Analysis indicated that postpartum interval was negatively associated with IGF-I for cows maintained on the two lowest levels of energy. In simplistic terms, these results indicate that when energy intake is low, cows with high levels of IGF-I will likely resume cycling sooner than most of the cows with low levels of IGF-I. However, some cows with low levels of IGF-I did resume cycling at similar times as cows with high levels of IGF-I. These results indicate that low levels of IGF-I are not as consistent for predicting postpartum intervals as high levels are. Because of this observation, measuring circulating IGF-I levels will probably not be acceptable as a management tool for predicting length of postpartum interval.

Ongoing research will focus on evaluating other metabolic factors, including insulin, glucose, and thyroid hormones. Our future objective is to determine whether these factors may be involved in mediating nutritional effects on reproduction. In addition, research is underway to determine if low levels of IGF-I may be perceived differently by tissues involved in regulating ovarian function (i.e., the hypothalamic-pituitary-ovarian axis), thereby resulting in the wide range of differences in length of postpartum interval observed in cows with low IGF-I levels.

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