ASSOCIATIONS BETWEEN ANESTRUS AND BLOOD GLUCOSE AND INSULIN IN HEREFORD COWS

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Story in Brief

Blood concentrations of glucose and insulin were compared in nonlactating, Hereford cows (n=22) during normal estrous cycles and nutritionally induced anestrus. Cows were fed different amounts of the same diet to maintain or lose weight. When 70% of the lose cows had stopped cycling, they were fed 160% of the maintain diet until estrous cycles resumed. Concentrations of glucose and insulin were determined in blood samples collected weekly, during normal estrous cycles, while cows were initiating anestrus, during anestrus, and when cows were re-initiating estrous cycles. Lose cows had reduced concentrations of glucose and insulin compared with maintain cows during the 45 wk experiment. During normal estrous cycles, disappearance of infused glucose and concentrations of insulin were similar for lose and maintain cows. Disappearance of insulin and infused glucose were prolonged when lose cows were initiating anestrus. Similarly, during anestrus, glucose disappearance was prolonged for lose cows, but mean insulin over time was greater in lose cows when compared with maintain cows. During refeeding, disappearance of infused glucose was similar for both groups. However, mean insulin during refeeding was greater over time in lose cows. These data suggest that reduced concentrations of glucose and insulin in blood are associated with nutritional anestrus.

(Key Words: Anestrus, Beef Cow, Glucose, Insulin, Reproduction)

Introduction

A reduced net calf crop (calves weaned/cows exposed to fertile bulls) is primarily due to failure of cows to become pregnant during the breeding season. Cows cannot become pregnant when they are in anestrus. Anestrus is a period when ovarian activity is decreased and when cows are not receptive to mating. The anestrous condition can result from inadequate nutritional management in prepuberal heifers and in postpartum cows. We found that nonlactating, Hereford cows became anestrus when they reached an average body condition score of 3.5 (Richards et al., 1985).

The presence and availability of metabolic compounds or hormones in blood may influence synthesis and/or secretion of reproductive hormones. The purpose of this study was to determine the influence of reduced nutrient intake on concentrations of glucose and insulin in blood and to examine the association of these blood constituents with anestrus in beef cows.

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Materials and Methods

Mature, nonlactating, Hereford cows (n=22) with good to moderate body condition [BCS=5.5 +.6 (1=emaciated and 9=obese); weight=926 lb], that had previously exhibited normal estrous cycles, were used in this study. Half of the cows were randomly assigned to maintain (M) body weight and condition, while the remaining cows were fed to lose (L) 1% of their body weight weekly until 70% became anestrus. Once the appropriate weight loss had been achieved, L cows were offered approximately 160% of the amount fed to M cows until L cows re-initiated estrous cycles.

During weight loss, regain, and maintenance all cows were kept in a drylot and individually fed daily a complete ration (12% CP and 2.25 Mcal ME/kg) for 41 wk; then all cows were pastured together on dry native range and supplemented with 2 lb/hd/d of a 40% protein cube and exposed to fertile bulls.

Weight and BCS were determined each week independently by two people. Blood samples were collected weekly by venipuncture. Oxalate was added to test tubes prior to sampling to yield plasma. Blood samples were chilled immediately after collection, centrifuged within 4 hr, and plasma was decanted then stored at -20 C. Serum was prepared by allowing blood to stand 10 h at 4 C. Samples were centrifuged, serum was decanted, and stored at -20 C. A colorometric procedure was used to measure plasma glucose. Radioimmunoassays were used determine the concentrations of insulin in serum and progesterone in plasma samples.

At 4 times (TM0=5 wk of restricted nutrient intake; TM1=20 wk of restricted nutrient intake; TM2=25 wk of restricted nutrient intake; and TM3=6 wk of increased nutrient intake after the restricted period) cannulae were placed in both jugular veins of six maintain cows and 5 lose cows at the Nutrition and Physiology Research Center in Stillwater. After 1 d of acclimation, cows were infused (i.v.) with 300 ml of a 40% glucose solution. Serum samples were collected at frequent intervals for 5.5 hr. Concentrations of glucose and insulin were determined.

Results and Discussion

Ovarian activity, body weight, body condition score, and estrous activity were reported previously (Richards et al., 1985). At TM0 all cows had similar weights and BCS (BCS=5.5), whereas at TM1 (BCS=5.7 and 4.4; M and L, respectively), TM2 (BCS=5.8 and 3.7; M and L, respectively), and TM3 (BCS=5.6 and 4.0; M and L, respectively) L cows were significantly lighter and had reduced BCS when compared with M cows. It took approximately 10 wk of refeeding before M and L cows had similar weights and BCS.

Times TM0, TM1, TM2, and TM3 corresponded with normal estrous cycles, initiating anestrus, anestrus, and re-initiation of normal estrous cycles. All cows transported to the NPRC for acute sampling displayed cyclic ovarian activity and normal estrous cycles at TM0. At TM1 20% of the L cows were anestrus whereas, 80% were anestrus at TM2. Forty percent of L cows had resumed cyclic ovarian activity by TM3. Maintain cows exhibited typical estrous cycles at each period.

Concentrations of certain blood metabolites and hormones that influence utilization of these blood components are important indicators of reproductive capacity. Concentrations of glucose (Figure 1)

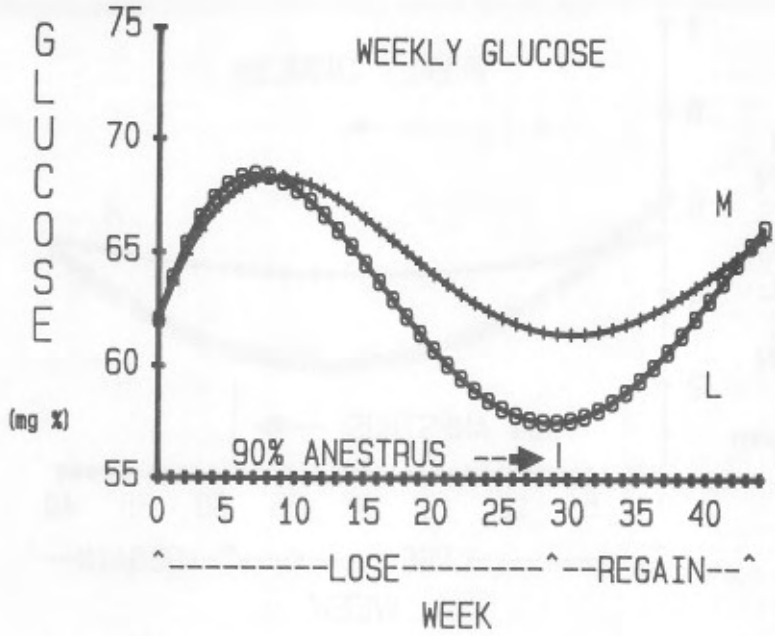

Figure 1. Concentration of glucose (o=Lose; +=Maintain) in weekly blood samples from cows during weight loss and regain.

and insulin (Figure 2) in weekly samples were reduced ($P<.01$) in L cows when they were initiating anestrus and during anestrus when compared with M cows. Rasby et al. (1982) demonstrated that nutrient intake of cows influenced concentrations of plasma glucose.

Disappearance of a compound from blood indicates body utilization and/or breakdown or clearance from the body. Glucose is used for energy by all body cells. Plasma concentration of glucose is the major determinant of insulin production and release by the pancreas. Insulin aids in transport of glucose into most cells.

Disappearance of glucose and insulin from blood after infusion of glucose was similar for L and M cows when cows had similar weights and BCS. However, disappearance of glucose (Figure 3) and insulin (Figure 4) were prolonged after glucose infusion when cows were initiating anestrus. These data suggest that glucose does not enter body cells as effectively in thin anestrous cows when compared with cows in moderate body condition exhibiting normal estrous cycles. Elevated insulin concentrations in thin cows without increased disappearance of glucose indicate that the glucoregulatory effects of insulin may be diminished as anestrus approaches. It is also possible that blood concentrations are greater and disappear less rapidly because the glucose was infused into a smaller blood volume in L cows (Richards et al., unpublished data). However, the pancreas of the L cows may be less responsive to glucose.

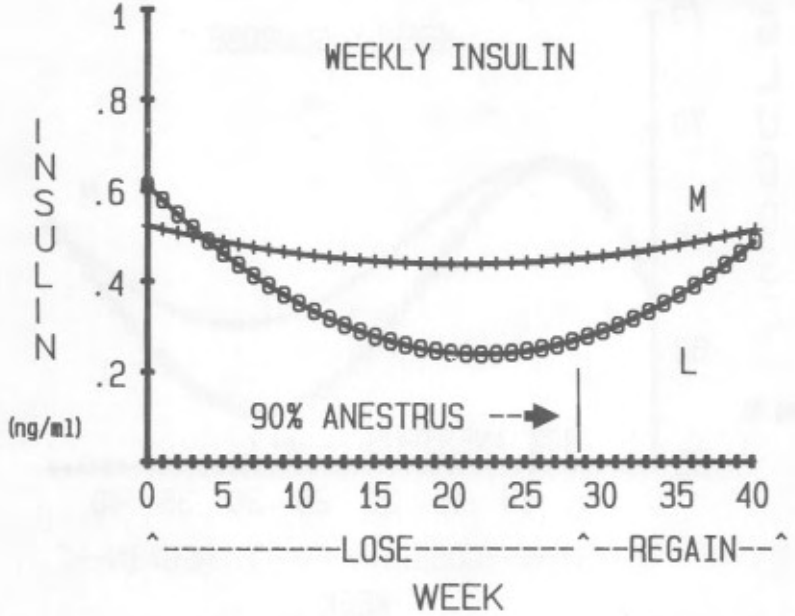

Figure 2. Concentration of insulin (o=Lose; +=Maintain) in weekly blood samples from cows during weight loss and regain.

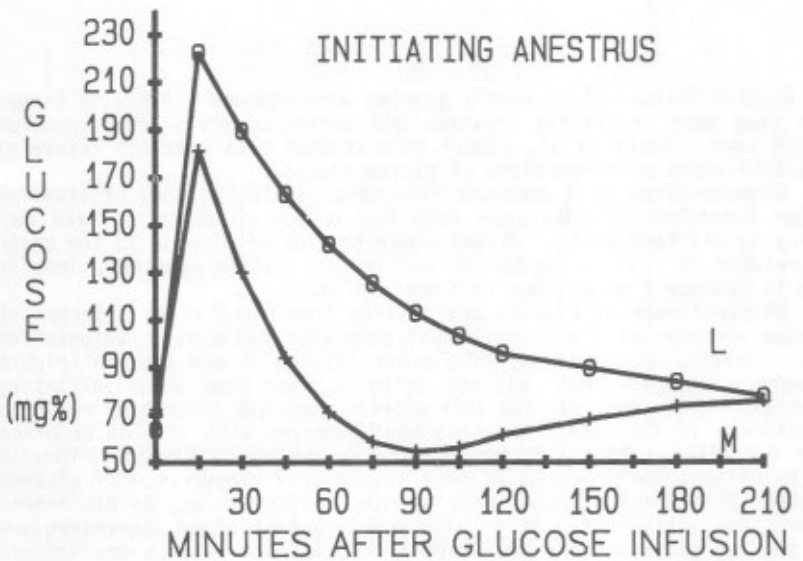

Figure 3. Disappearance of glucose (o=Lose; +=Maintain) from plasma of cows initiating anestrus.

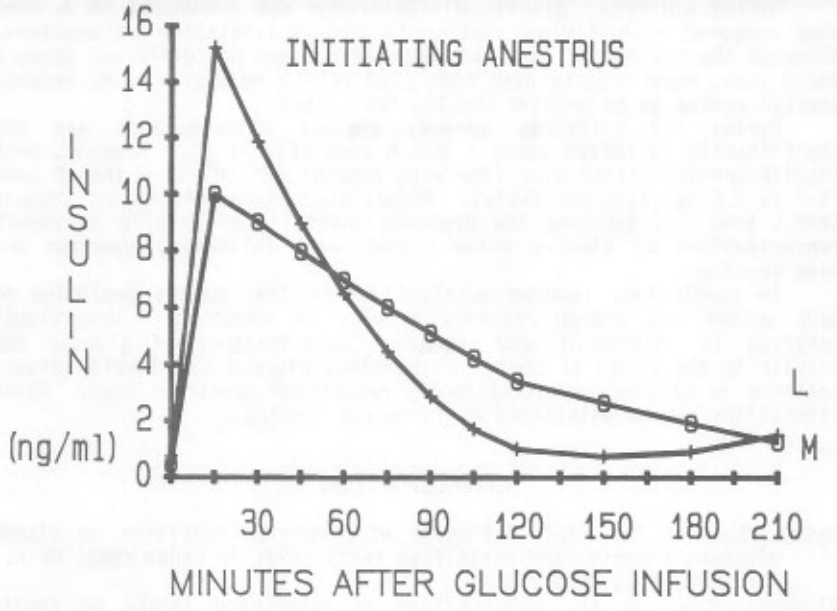

Figure 4. Disappearance of insulin (o=Lose; +=Maintain) from serum of cows initiating anestrus.

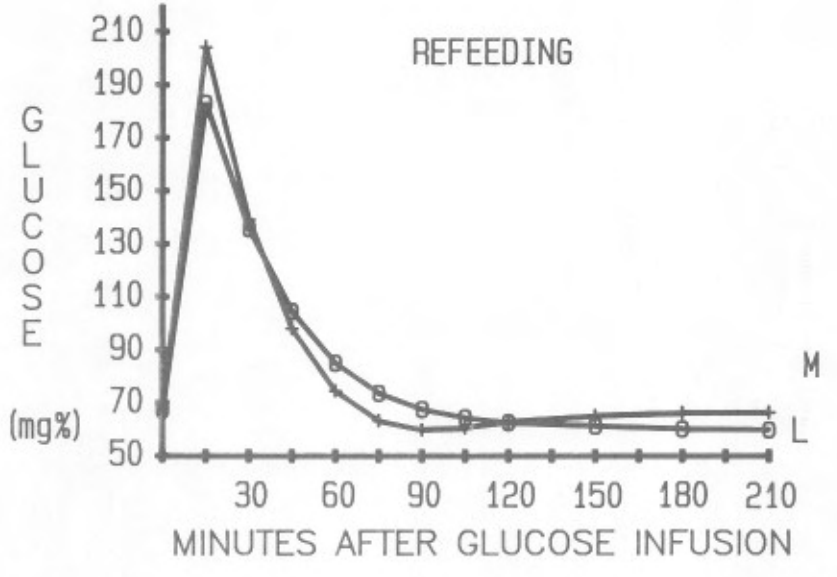

Figure 5. Disappearance of glucose (o=Lose; +=Maintain) from plasma of cows during re-initiation of estrous cycles.

During anestrus, glucose disappearance was prolonged in L cows when compared with M cows similar to during initiation of anestrus. Although the pattern of insulin disappearance was not different among L and M cows, mean insulin over time (7.3 vs 4.3 ng/ml; L vs M, respectively) tended to be greater ($P<.12$) for L cows.

During the refeeding period, glucose disappearance was not significantly different among L and M cows (Figure 5). However, mean insulin concentrations over time were greater ($P<.08$) in L than M cows (6.0 vs 3.8 ng/ml;respectively). Normal glucose concentrations suggest that L cows had overcome the previous inability of insulin to reduce concentrations of glucose while L cows were initiating anestrus and were anestrus.

In conclusion, reduced nutrient intake that causes depletion of body weight and energy reserves results in anestrus. Nutritional anestrus is coincident with reduced concentrations of glucose and insulin in the blood of cows. Futhermore, glucose and insulin disappearance is altered in nutritionally restricted anestrous cows. These alterations can be eliminated by increased feeding.

Literature Cited

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