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BIOLOGICAL AND IMMUNOLOGICAL LUTEINIZING HORMONE ACTIVITY AND BLOOD METABOLITES IN POSTPARTUM BRAHMAN COWS

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SUMMARY

Pluriparous Brahman cows were assigned by order of calving and sex of calf to groups to be fed to maintain a body condition score (BCS) of 6 or greater (M; n=10) or to lose BCS (L; n=10). By day 45 after parturition, 7 of 10 M cows had returned to estrus. Therefore, comparisons between groups were made only on days 15 and 30 after calving. Cows in the M group had a shorter interval to first estrus (46.7 days) than L cows (91.2 days). The concentrations of bioactive (B) and immunoactive (I) luteinizing hormone (LH) were parallel between days 15 and 30 postcalving. However, a day x treatment interaction showed that episodic BLH concentrations (ng/ml) decreased with day after calving in L, but increased in M cows from day 15 to 30 postcalving. Likewise, relative biological activity, as measured by B:I ratios, decreased between day 15 and 30 in L cows, yet increased in M cows during the same period. Serum cholesterol concentrations also were higher on all days in M compared with L cows. Serum NEFA (non-esterified fatty acid) concentrations were greater in L (1.082 mEq/l) cows compared with M cows (.560 mEq/l) on days 7, 21 and 35 postcalving. Results of this study indicate that nutritional status of the animal altered the bioactivity of the LH molecule and that M had an enhanced metabolic state and pituitary function that resulted in a shorter interval to first estrus compared with cows losing body energy reserves.

INTRODUCTION

A prolonged interval from parturition to onset of normal estrous cyclicity is a major cause of decreased reproductive efficiency in the beef cow. A positive relationship exists between weight gain and body condition gain, and fertility in cattle. Cows bred while gaining weight and(or) body condition during the postpartum interval, have a higher pregnancy rate than those bred while losing weight or body condition. Reduced energy intake after calving reduces pregnancy rates and increases the postpartum interval to estrus in beef cows.

Synthesis and secretion of luteinizing hormone (LH) differs with physiological status of the animal. Deficiencies in secretion of LH occur during various states of nutritional and postpartum anestrus. Therefore, insufficient secretion of LH from the anterior pituitary gland may be a reason for anestrus. Gonadotropin releasing

hormone (GnRH) induced release of LH and mean concentrations of LH in peripheral blood are generally lower than those observed just before the first postpartum estrus.

Studies in dairy cows have suggested that the biological quality of LH changes throughout the postpartum period. Bioactive LH changes in the ewe also have been reported during the estrous cycle. It has not been determined, however, if an interaction exists between body weight (BW) and(or) body condition at calving and blood metabolites with either bioactive or immunological LH profiles during the postpartum period in suckled beef females. Therefore, the objectives of this study were to determine: 1) if biological and immunological activities of LH changes in suckled beef females maintaining or losing BW and(or) BCS during the postpartum period; 2) the effect of nutritional restriction on blood metabolites; and 3) calf performance and milk production associated with BW and(or) BCS changes after calving.

PROCEDURES

Twenty fall-calving, pluriparous Brahman cows were assigned by order of calving, calf sex and sire of calf to one of two nutritional schemes. Control (n=10) cows were fed to maintain (M) or gain weight and thus sustain body condition scores of at least 6 (BCS; 1=emaciated, 9=obese) during the first 50 days postcalving. Control cows were fed 8 $lb \cdot head^{-1} \cdot d^{-1}$ of a 1:3 mixture of soybean meal:ground corn with Coastal bermudagrass hay available free choice during the experimental period. Feed-restricted cows (L, n=10) were fed Coastal bermudagrass hay free choice from calving to day 50 postcalving to achieve no less than BCS of 4 during that period. All cows had access to trace mineralized salt during the experimental period. At calving and at 15, 30, 45 and 50 days postcalving, all cows were weighed, and BCS were recorded. Birth weights and average daily gains (ADG) of calves were taken and on day 50 all cows were hand milked to evaluate 4-hour milk production. Milk production was induced by an intravenous injection of oxytocin (30 IU), and the cows were hand milked. Cows were then allowed to stand for 4 hours, and the milking procedure was repeated for determination of weight of milk produced. Sterile marker bulls were maintained with both experimental groups throughout the trial as an aid in detection of estrus.

Blood samples were collected from all cows from an indwelling jugular vein cannula at 15-minute intervals for 6 hours on days 15, 30 and 45 postcalving to determine concentrations of biologically- and immunologically-active LH and

estradiol-17β. All blood samples were immediately chilled and allowed to clot. After 24 hours, serum was separated from cells by centrifugation. Serum samples were frozen and stored until assayed for LH and estradiol-17β. In addition, blood samples for determination of concentrations of progesterone and blood metabolites were collected via tail vessel puncture at weekly intervals from 7 to 50 days postcalving.

Serum LH concentrations were determined via radioimmunoassay (RIA). Sensitivity of the assay was .04 ng. The intra-assay coefficient of variation was 8%. Serum bioactive LH concentrations were measured in selected samples using the rat Leydig cell testosterone (RICT) assay.

Serum progesterone and estradiol concentrations were measured by RIA. The inter- and intra-assay coefficients of variation ranged between 12.4% and 6.8%, respectively. Spectrophotometric techniques were used to determine the metabolite concentrations in serum obtained from five cows on each experimental treatment. Serum glucose, blood urea nitrogen, total cholesterol and non-esterified fatty acids were determined.

Data were subjected to analysis of variance procedures, and treatment differences were determined utilizing the least-squares means method of the Statistical analysis system (SAS, 1985). Pearson's correlations were used to test all possible relationships between immunoactive and bioactive LH concentrations and also to test the relationship between BW and BCS changes on days 15, 30 and 50 after calving with serum LH traits and blood metabolites.

RESULTS

Body weight and BCS for each nutritional management group are shown in Table 1. At calving, BW and BCS were not different between cows assigned to maintain or lose body condition after calving. Similarly, BW on days 15 and 30 postcalving were not different between M and L cows. However, at day 50 postcalving, cows in the L group were 133 lb lighter compared to cows in the M group. Differences in BCS were found at 15, 30 and 50 days after calving between M and L cows. Analysis of BW and BCS changes from calving to 50 days postcalving (Table 2) indicated that BW losses were greater in L (-1.8 lb/day), while M cows gained (.3 lb/day). Likewise, BCS losses at 50 days were greater in L (-2.3) than in M cows (-.2). Postcalving BW and BCS changes were correlated (r = .63).

Calf birth weights were not affected by dam BW or BCS at calving in either

M or L cows (Table 3). Average daily gain to 50 days was affected by sex of the calf and by nutritional management of the dam (Table 3). Calves from M cows had higher ADG (2.2 lb/day) than calves from L cows (1.9 lb/day).

The ability of cows to secrete milk over a 4-hour period was affected by nutritional management (Table 3). Milk production at 50 days postcalving was greater (2.9 lb/4 hours) in M than in L (2.4 lb/4 hours) cows (Table 3). The postpartum interval to first estrus was 45 days shorter in M cows than in L cows. Eighty percent of the females maintaining body condition following parturition had been observed in standing estrus following parturition within 50 days compared with 0% of the females that were losing body condition. Pregnancy rate during a 45-day breeding season, after 45 days postcalving, was 80% (8 of 10) in M cows compared to 30% (3 of 10) in L cows.

Overall, nutritional management group and day after calving had no effect on immunoactive serum concentrations of LH (Table 4). Mean serum LH did not differ between M and L groups. Similarly, basal LH, amplitude of the peaks, peak height and number of episodic peaks (Table 4) did not differ by treatment on days 15, 30 and 45 postcalving. By day 45 postcalving, only 3 cows remained in the M group since 7 of 10 had shown estrus by day 45. Therefore, all comparisons were made between groups on days 15 and 30 after calving. Comparisons of episodic and basal LH concentrations measured by RIA and by bioassay from L and M cows on days 15 and 30 postcalving are shown in Table 5. No significant differences were found in episodic and basal concentrations of immunoactive or bioactive LH between M and L cows on days 15 and 30 postcalving. Concentrations of bioactive and immunoactive LH change in parallel during days 15 and 30 after calving. However, a day x treatment interaction ($P < .05$) was found in both bioactive episodic LH and bioactive to immunoactive (B:I) LH ratios. Bioactive episodic LH concentrations and B:I ratios decreased with day after calving in L cows, but increased in M cows from 15 to 30 days postcalving. Concentrations of LH estimated by bioassay and RIA were highly correlated ($r = .80$; $P < .001$).

Concentrations of serum glucose, blood urea nitrogen (BUN), non-esterified fatty acids (NEFA) and total cholesterol (TCHOL) on days 7, 15 and 35 after calving are shown in Table 6. There were no significant trends with time or nutritional management in serum concentrations of glucose. Serum BUN concentrations were affected ($P < .001$) by nutritional management group but not by day postcalving. Serum mean BUN concentrations were lower (13.1 mg/dl) in L than in M (21.3 mg/dl) cows. Serum NEFA concentrations were affected by

nutritional management and day postcalving ($P < .001$). Higher NEFA concentrations (1.1 mEq/l) were found in L compared with M (.6 mEq/l) cows at all days after calving examined. Likewise, serum NEFA concentrations decreased with time after calving in both L and M cows. Serum TCHOL concentrations were affected by nutritional management group ($P < .001$) and day postcalving ($P < .01$). Lower TECHOL concentrations were found in cows losing (76.1 mg/dl) compared with maintaining (101.9 mg/dl) both BW and BCS postcalving. Total cholesterol concentrations, however, increased ($P < .01$) from 7 through 35 days postcalving in M cows compared with L cows which did not show any significant increase with time after calving.

Dietary feed restriction during the postpartum period, decreased both BW and BCS by day 50 after calving. Calf birth weights were not affected by dam BW or BCS at calving, indicating that birth weight of the calf is not influenced by body energy reserves when cows have BCS between 7 and 8 at parturition. However, calves from M cows had higher ADG at 50 days postcalving compared with calves from L cows. Lower calf ADG from cows losing body condition paralleled lower milk production at 50 days postcalving.

Bioassay and RIA concentrations of LH were highly correlated indicating that the changes in concentrations of LH between 15 and 30 days postcalving observed by RIA are representative of those by bioassay. However, 7 of 10 cows in the M group were detected in standing estrus between 30 and 40 days after calving, when bioactive LH concentrations were increasing, which strongly suggests that changes in the biological activity of LH were responsible for the earlier resumption of ovarian cyclicity in these cows.

It is concluded, therefore, that the level of dietary restriction imposed, although sufficient to cause BW and BCS changes, increased postpartum interval to first estrus and elevated serum NEFA. Dietary restriction did not alter the pattern of pulsatile release of LH or mean concentrations of serum LH. However, cows fed to maintain body condition postcalving had shorter intervals to first estrus and had higher absolute bioactive LH concentrations and B:I ratios as well as greater serum TCHOL concentrations around the time of resumption of ovarian cyclic activity after calving. Therefore, we conclude that nutritional status of the animal may have altered the bioactivity of the LH molecule and that cows maintaining body condition had an enhanced metabolic state and pituitary function that resulted in shorter postpartum intervals to first estrus compared with cows losing body energy reserves after calving.

TABLE 1. BODY WEIGHT (BW) AND BODY CONDITION SCORE (BCS) IN BRAHMAN COWS LOSING OR MAINTAINING BODY CONDITION FROM CALVING TO 50 DAYS AFTER CALVING

	Nutritional management group			
	Maintaining		Losing	
Days	BW (lb)	BCS[a]	BW (lb)	BCS
Calving	1137.0	7.7	1108	7.7
0-15	1152.0	7.8	1094	7.0**
16-30	1147	7.9	1078	6.4**
31-50	1153	7.5	1018**	5.5**
SE[b]	77	.1	77	.1

Values are least-squares means ± SE with 10 cows/group.
**P < 0.001.
[a]BCS scale (1 = emaciated; 9 = obese).
[b]Mean SE.

TABLE 2. BODY WEIGHT (BW) AND BODY CONDITION SCORE (BCS) CHANGES IN BRAHMAN COWS LOSING OR MAINTAING BODY CONDITION FROM CALVING TO 50 DAYS AFTER CALVING

	Nutritional management group			
	Maintaining		Losing	
Days	ADG (lb)	BCS[a]	BW (lb)	BCS
0-15	1.01	No change	-.87	-.7**
16-30	.36	.1	-.99	-.3**
31-45	-.34	1.0	-1.31*	-.7
46-50	.32	-.2	-1.78*	-2.3**
SE[b]	.67	.3	.67	.2

Values are least-squares means ± s.e.m with 10 cows/group.
*P < .05, ** P < .001.
[a]BCS scale (1 = emaciated; 9 = obese).
[b]Mean SE.

TABLE 3. CALF BODY WEIGHT (BW) AND CALF AVERAGE DAILY GAIN (ADG) AT 50 DAYS AND MILK PRODUCTION OF BRAHMAN COWS LOSING OR MAINTAINING BODY CONDITION FROM CALVING TO 50 DAYS AFTER CALVING

Group	BW (lb)	ADG (lb)	Milk production (lb/4 hours)
Losing	71.5	1.93	2.44
Maintaining	75.9	2.33*	2.97*
SE[b]	3.8	.11	.09

Values are least-squares means ± SE with 10 cows/group.
*P < .05.
[b]Mean SE.

TABLE 4. MEAN SERUM IMMUNOACTIVE LH TRAITS OF BRAHMAN COWS LOSING (L) OR MAINTAINING (M) BODY CONDITION FROM CALVING TO 50 DAYS AFTER CALVING

		Characteristics of LH (ng/ml)				
Days	Group	Mean LH	Basal LH	Number of episodes/6 hours	Peak height	Peak amplitude
15	L	.83	.51	2.2	1.2	.7
	M	.77	.45	2.2	1.4	.9
30	L	.85	.47	2.5	1.4	.9
	M	.85	.35	2.5	1.4	1.0
45[a]	L	.77	.40	2.1	1.4	.9
	M	.71	.32	1.7	1.4	1.1
SE[b]		.13	.07	.4	.2	.3

Values are least-squares means ± s.e.m. with 10 cows/group/day.
[a]Three cows remained in M group.
[b]Mean SE.

TABLE 5. IMMUNOACTIVE (I) AND BIOACTIVE (B) EPISODIC AND BASAL SERUM LH CONCENTRATIONS (ng/ml) ON DAYS 15 AND 30 AFTER CALVING IN BRAHMAN COWS LOSING (L) OR MAINTAINING (M) BODY CONDITION

		LH episodes (ng/ml)[a]		Basal LH (ng/ml)[a]	
Days	Group	I	B	I	B
15	L	1.78	.47	.51	.12
	M	1.30	.19	.46	.08
30	L	1.52	.17	.47	.17
	M	1.44	.27	.35	.10
SE[b]		.16	.09	.07	.06

Values are least-squares means ± SE with 10 cows/group/day.
[a]Not significant between treatment groups.
[b]Mean SE.

TABLE 6. BLOOD METABOLITES ON DAYS 7, 21 AND 35 AFTER CALVING IN BRAHMAN COWS LOSING OR MAINTAINING BODY CONDITION

	Nutritional management group					
	Maintaining			Losing		
Metabolite	7	21	35	7	21	35
Glucose (mg/dl)	59.6±3.8	60.2±5.4	58.6±5.4	61.3±5.4	54.0±5.4	55.7±5.4
BUN (mg/dl)[a]	19.5±1.5	23.4±2.1	20.9±2.1	11.5±2.1	16.0±2.1	11.5±2.1
NEFA (mEq/l)[b]*	.7± .1	.6± .1	.4± .1	1.4± .1	1.1± .1	.7± .1
TCHOL (mg/dl)[c]*	87.0±5.5	101.2±5.5	117.6±5.1	69.1±5.5	78.9±5.5	80.4±5.5

Values are least-squares means ± with 5 cows/group/day.
[a]Blood urea nitrogen.
[b]Non-esterified fatty acids.
[c]Total cholesterol.
*Day effect $P < 0.01$.