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Abstract

Feeding rumen-escape lipid or soybean oil in a range supplement to beef cow resulted in elevated blood cholesterol and enhanced luteinizing hormone (LH) release compared to a control (milo and soybean meal) supplement. Cholesterol was elevated (P<.01) within 14 d of lipid feeding. The amplitude of each LH pulse and maximal pulse height were greater (P<.05) when cows were fed high-lipid diets. The positive influence of high-lipid diets on reproductive function may be explained in part by enhanced LH release.

Keywords

Cattlemen's Day, 1993; Kansas Agricultural Experiment Station contribution; no. 93-318-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 678; Beef; Beef cows; Lipid; Luteinizing hormone; Cholesterol; Reproduction

LUTEINIZING HORMONE RELEASE AND PLASMA METABOLITES IN MATURE, OVARIECTOMIZED BEEF COWS FED VARIOUS LIPID DIETS[1]

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Summary

Feeding rumen-escape lipid or soybean oil in a range supplement to beef cow resulted in elevated blood cholesterol and enhanced luteinizing hormone (LH) release compared to a control (milo and soybean meal) supplement. Cholesterol was elevated ($P < .01$) within 14 d of lipid feeding. The amplitude of each LH pulse and maximal pulse height were greater ($P < .05$) when cows were fed high-lipid diets. The positive influence of high-lipid diets on reproductive function may be explained in part by enhanced LH release.

(Key Words: Beef Cows, Lipid, Luteinizing Hormone, Cholesterol, Reproduction.)

Introduction

Lengthened postpartum anestrus delays resumption of cyclicity and may increase calving intervals above the goal of 365 d. Incorporating lipid into range supplements fed during the postpartum period has been shown to enhance reproductive function. When cows conceive earlier in the breeding season, calves are heavier at weaning, and yearly calving intervals are achieved. The positive influence of high-lipid diets may be at the level of the ovary (follicular growth, steroid production) or at the level of the hypothalamus and pituitary (gonadotropin release). Our objective was to determine pituitary response, particularly characteristics of luteinizing hormone (LH) release, to high-lipid diets fed to beef cows.

Experimental Procedures

Six ovariectomized, Angus × Hereford, mature cows [avg age = 5 yr; avg wt = 1043 lb; avg body condition score = 5.9 (1 = emaciated, 9 = extremely obese)] served as experimental units in a 6 × 6 Latin square experiment. A 2 × 3 factorial arrangement of treatments was employed consisting of estradiol-17β implanted or nonimplanted cows with three dietary supplements: 1) control (milo + soybean meal); 2) rumen-escape lipid (milo + soybean meal + Megalac®); and 3) soybean oil (milo + soybean meal + soybean oil). Megalac is a rumen-escape lipid composed of calcium salts of palm oil fatty acids. Dietary treatments were designed to compare high-lipid supplements to a control supplement along with comparing rumen-escape lipid (Megalac) to nonescape lipid (soybean oil).

Estradiol produced by the ovary can provide feedback to the hypothalamus and pituitary and alter the release of LH. The purpose of removing the ovaries in this study was to determine the interaction of estrogen and lipid on LH release. By implanting estradiol, we were able to achieve a controlled, constant estradiol level as opposed to the fluctuating levels present in ovary-intact cows. Megalac and soybean oil replaced milo in the control supplement; all supplements were formulated to be isocaloric and isonitrogeneous (20% crude protein), with equivalent levels of calcium and phosphorus. The remainder of the diet consisted of native prairie hay fed according to body weight to meet NRC (1984) requirements. Each period of the Latin square

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was 21 d with a 4 d rest between periods. On d 0 of each period, three cows received four silastic implants containing crystalline estradiol. Implants were placed subcutaneously immediately in front of the shoulder. The remaining three cows received no implants. Jugular blood samples were collected on d 0 and every other day throughout the period. Beginning on d 0, diets were fed once daily for 21 d. On d 20, all cows were fitted with jugular catheters to facilitate blood collection to measure LH. Samples were collected on d 21 for 8 h at 6-min intervals. On d 22, implants were removed and all cows received the control supplement for 4 d, after which the next period began. Body weight and condition scores were determined at the completion of each period. Serum samples were assayed for estradiol and LH and plasma samples were analyzed for cholesterol, triglycerides, blood urea nitrogen, glucose and total protein. Pulsatile characteristics of LH [peak amplitude, maximum peak height, baseline value excluding peaks and pulse frequency (number of pulses during 8 h)] were determined using a computer program called PC-Pulsar, combined with visual graph analysis of individual profiles.

Results and Discussion

Presented in Table 1 are data for body weight and condition score changes. Cows without estradiol implants gained more ($P = .02$) weight during each period; however, condition score changes were not consistent. Estradiol implants elevated ($P < .01$) serum estradiol (.5 vs 15.5 pg/ml), but dietary treatments had no effect.

Detailed in Table 2 are data regarding LH release. Peak amplitude and the maximal height of each LH pulse were enhanced ($P < .05$) by feeding both high-lipid diets. Nonescape lipid tended ($P = .09$) to enhance peak amplitude more than rumen-escape lipid. Pulse frequency of LH was lower ($P < .01$) in cows that received estradiol implants than in nonimplanted controls (see also Figure 1). Figure 2 depicts the enhanced release of LH by cows fed lipid supplements compared to cows fed the control supplement.

As expected, cholesterol was elevated ($P < .01$) in cows receiving either high-lipid diet (Table 3). Nonescape (soybean) lipid produced the highest plasma cholesterol in nonimplanted cows, whereas plasma cholesterol in implanted cows was highest with rumen-escape (Megalac) lipid.

Other researchers have demonstrated ovarian responses to high-lipid diets. Lipid effects on pituitary response have been mixed, primarily as a consequence of differences in animal management or experimental design. Using a controlled system (ovariectomy with or without estradiol implants) showed that high-lipid, isocaloric diets enhance LH release in beef cows. This may help explain the positive influence of high-lipid diets on reproductive function.

Table 1. Effect of Lipid Source and Estradiol on Weight and Body Condition Change and Concentration of Estradiol in Mature, Ovariectomized, Beef Cows

	Nonimplanted[a]			E-implanted[a]				Contrast[c]		
Item	C	R	S	C	R	S	SE	Effect[b]	CvL	RvS
ΔWt, lb	+2	+35	+34	-7	+3	-12	14	E	.17	.56
ΔCondition score	+.2	+.1	+.1	+.0	+.3	+.2	.2	-	.57	.67
Estradiol, pg/ml	.4	.4	.5	13.9	14.3	18.4	2.6	E	.58	.46

[a]C = control; R = rumen-escape lipid; S = soybean oil.
[b]Denotes a significant (P < .05) effect of lipid (L), estradiol (E), or their interaction (LxE).
[c]Probability value associated with the following orthogonal contrasts (CvL = control vs lipid; RvS = rumen-escape vs nonescape lipid).

Table 2. Effect of Lipid Source and Estradiol on Characteristics of Pulsatile Luteinizing Hormone Release in Mature, Ovariectomized, Beef Cows

	Nonimplanted[b]			E-implanted[b]				Contrast[d]		
Item[a]	C	R	S	C	R	S	SE	Effect[c]	CvL	RvS
Luteinizing hormone, ng/ml										
AMP	1.48	2.06	2.14	2.52	2.43	2.95	.18	L,E	.01	.09
MAX	5.03	5.39	5.62	6.09	6.25	6.52	.21	L,E	.04	.23
BASE	3.56	3.29	3.45	3.61	3.82	3.59	.33	-	.87	.90
FREQ	9.5	9.5	10.1	8.3	7.7	7.7	.5	E	.74	.54

[a]AMP = peak amplitude; MAX = maximal pulse height; BASE = baseline excluding peaks; FREQ = pulse frequency.
[b]C = control; R = rumen-escape lipid; S = soybean oil.
[c]Denotes a significant (P < .05) effect of lipid (L), estradiol (E), or their interaction (LxE).
[d]Probability value associated with the following orthongonal contrasts (CvL = control vs lipid; RvS = rumen-escape vs nonescape lipid).

Table 3. Effect of Lipid Source and Estradiol on Plasma Metabolites in Mature, Ovariectomized, Beef Cows

	Nonimplanted[b]			E-implanted[b]				Contrast[d]		
Item[a]	C	R	S	C	R	S	SE	Effect[c]	CvL	RvS
Plasma metabolites, mg/dl										
CHOL	140.7	161.7	228.9	147.7	233.5	161.0	6.3	L,L × E	.01	.68
TG	30.5	23.4	26.5	27.3	25.4	26.6	1.3	L	.01	.09
BUN	10.7	12.2	11.0	8.6	9.9	9.1	.6	L,E	.05	.08
GLU	65.5	61.6	63.2	65.1	63.7	65.6	.8	L,E	.01	.03
TP, g/dl[e]	8.12	7.87	8.08	8.06	7.91	8.22	.06	L	.19	.01

[a]CHOL = cholesterol; TG = triglycerides; BUN = blood urea nitrogen; GLU = glucose.
[b]C = control; R = rumen-escape lipid; S = soybean oil.
[c]Denotes a significant (P < .05) effect of lipid (L), estradiol (E), or their interaction (L × E).
[d]Probability value associated with the following orthogonal contrasts (CvL = control vs lipid; RvS = rumen-escape vs nonescape lipid).
[e]TP = total protein.

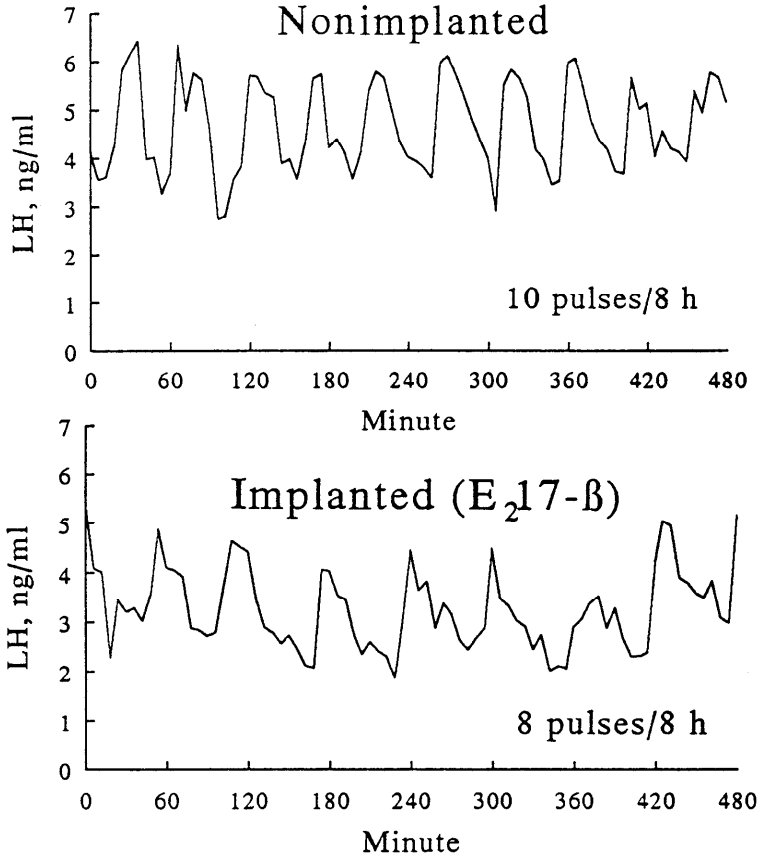

Figure 1. Profiles of Luteinizing Hormone Release in Ovariectomized Beef Cows Receiving Supplemental Estradiol or No Supplemental Estradiol

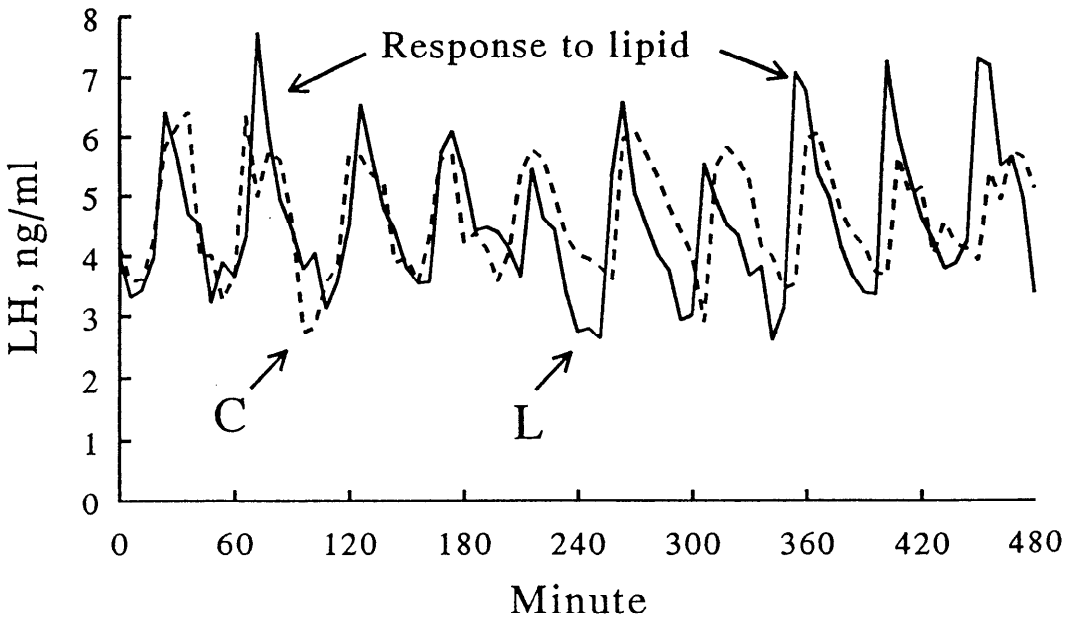

Figure 2. Profiles of Luteinizing Hormone Release in Beef Cows Fed Control (C) or Lipid (L) Supplements