EFFECT OF DIETARY INTAKE ON OVARIAN FUNCTION IN HEIFERS

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Story in Brief

To determine if alterations in dietary intake of heifers can influence follicular growth and(or) steroid concentrations in follicular fluid, cyclic heifers (n=23) were individually fed for 10 weeks either: a) 1.8% of body weight (BW) in dry matter (DM) per day (GAIN; n=7), b) 1.1% of BW in DM per day (MAINT; n=8) or c) 0.7% of BW in DM per day (LOSE; n=8). After 10 weeks of treatment, heifers were ovariectomized 36-40 hours after prostaglandin $F_{2\alpha}$ synchronization. Heifers weighed 979, 853 and 769 lbs in the GAIN, MAINT and LOSE groups, respectively, at time of ovariectomy. Mean diameter of follicles $\geq$ 10 mm was greater for GAIN than for MAINT or LOSE heifers. Numbers of follicles did not differ between LOSE, MAINT and GAIN heifers. Progesterone concentrations were greater in small and medium follicles of GAIN than MAINT or LOSE heifers, but were unaffected by diet in large follicles. Estradiol concentrations in estrogen-active follicles were two-fold greater in GAIN heifers than either MAINT or LOSE heifers. In conclusion, reduced dietary intake inhibits preovulatory follicular growth and steroidogenesis in heifers.

(Key Words: Estradiol, Follicular Fluid, Heifers)

Introduction

Ovarian follicular development is controlled by numerous systemic and local intraovarian factors (Spicer and Echternkamp, 1986). One of these factors is insulin-like growth factor-I (IGF-I)(Hammond et al., 1988). Previous studies have shown that concentrations of IGF-I in peripheral blood are altered by feed restriction and energy balance in cattle (Houseknecht et al., 1988; Spicer et al., 1990). Because poor nutrition has been associated with decreased reproductive efficiency in cattle (Dunn et al., 1980), it is possible

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that reduced IGF-I secretion is one of the mediators of reduced reproductive efficiency. However, no direct link between decreased feed intake and decreased ovarian follicular function has been reported. Thus, the objectives of the present study were to determine if alterations in dietary intake of heifers can influence concentrations of estradiol and(or) progesterone in follicular fluid (FFL)(as an indicator of steroidogenic capacity), and(or) follicular growth.

Materials and Methods

Cyclic Hereford x Friesian heifers (n=23, mean ± SE, BW = 822 ± 15 lbs) were synchronized before the start of the study using two intramuscular injections of a synthetic prostaglandin (PG) $F_{2\alpha}$ analog given 11 days apart (cloprostenol; Estrumate, Coopers Animal Health, Berks, UK). The heifers had an average body condition score of 3.4 at the start of the study (range 2.5 to 4.0, scale = 1 to 5), were housed individually, and fed a diet of 50% grass silage (17.5% crude protein) and 50% concentrates (barley and soybean meal; 14% crude protein) on dry matter (DM) basis. The study was carried out during June and July.

The heifers were separated into four blocks by body weight and allocated to: a) 0.7% of BW in DM per day (LOSE; n=8), b) 1.1% of BW in DM per day (MAINT; n=8) or c) 1.8% of BW in DM per day (GAIN; n=7) in a randomized complete block design. The heifers were maintained on the diets for 10 weeks, and observed for signs of estrous behavior once daily for a 2-hour period. All cows continued to cycle throughout the study. Before ovariectomy after 10 weeks of treatment, estrous cycles were again synchronized (two injections 11 days apart) with $PGF_{2\alpha}$.

Ovaries were removed per vagina 36-40 hours following the second injection of $PGF_{2\alpha}$ after heifers were sedated epidurally with xylazine (25 mg intramuscular injection). The surface diameter of all follicles ≥ 6 mm was recorded and their FFL collected individually. The FFL from follicles 1-5.9 mm in diameter was collected and pooled within each ovary. FFL was stored at -20°C until analyzed for concentrations of progesterone and estradiol by radioimmunoassay.

Results and Discussion

Mean body weights of LOSE, MAINT and GAIN heifers were 769 ± 20, 853 ± 18 and 979 ± 29 lbs, respectively, at time of ovariectomy; these differences were significant ($P < .05$).

Mean ovarian weights of LOSE, MAINT and GAIN heifers were 14.7 ± 1.6, 11.8 ± 1.6 and 13.3 ± 1.8 g, respectively; these values did not differ (P>.10). Similarly, previous studies have shown that underfeeding of dairy heifers did not affect ovarian weight (Spicer et al., 1984).

Mean numbers of small (1-5.9 mm) and medium plus large (≥ 6.0 mm) follicles per heifer were not affected (P>.10) by dietary treatments. Numbers of small follicles for LOSE, MAINT and GAIN heifers were 17.8, 18.8 and 20.9, respectively (pooled SE = 2.5). Numbers of medium plus large follicles for LOSE, MAINT and GAIN heifers were 2.8, 2.6 and 2.1, respectively (pooled SE=0.7).

Mean diameter of large follicles (≥ 10 mm) was greater (P<.05) for GAIN than for MAINT or LOSE heifers (Figure 1). This suggests dietary restriction may inhibit preovulatory follicular growth in heifers. However, mean diameter of medium follicles (6.0 - 9.9 mm) did not differ (P>.10) between dietary treatments (Figure 1).

Mean concentrations of progesterone in FFL of small and medium follicles increased (P<.05) with level of dietary intake (Figure 2) such that

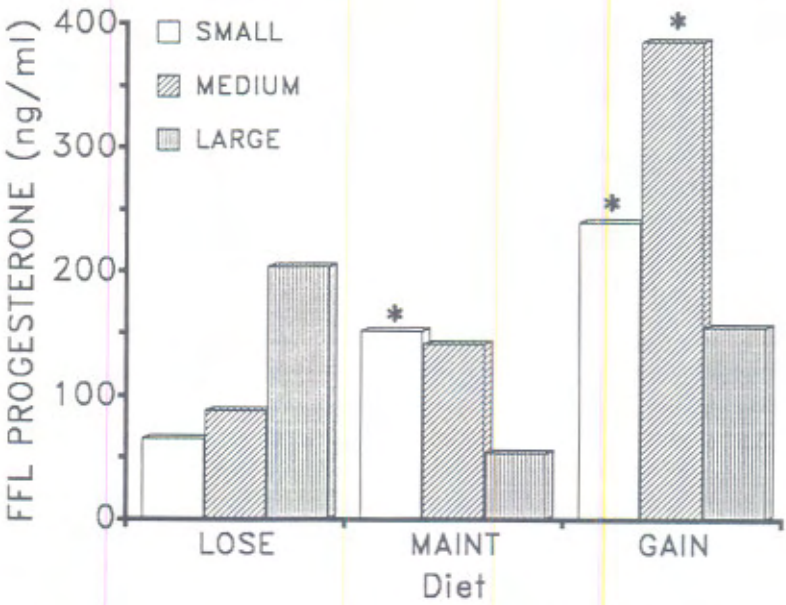

Figure 1. Least-squares means of diameter of medium (6.0 - 9.9 mm) and large (≥ 10 mm) follicles collected during the preovulatory period of heifers fed either LOSE, MAINT and GAIN diets. Asterisk indicate mean differs (P<.05) from respective LOSE and MAINT mean. Pooled SE = 0.6 mm for medium and 0.7 mm for large follicles.

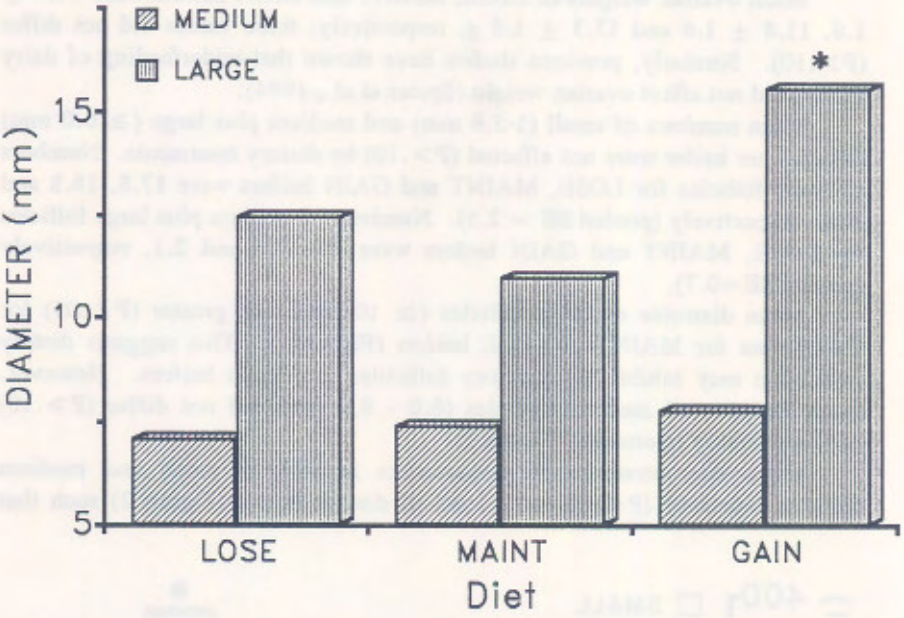

Figure 2. Least-squares means of concentrations of progesterone in follicular fluid (FFL) of small, medium and large follicles collected during the preovulatory period of heifers fed either LOSE, MAINT or GAIN diets. Asterisks indicate mean differs ($P<.05$) from respective LOSE mean. Pooled SE = 69, 91 and 104 ng/ml for small, medium and large follicles respectively.

GAIN heifers had 4-fold greater concentrations than LOSE heifers. However, concentrations of progesterone in large follicles were not affected ($P>.10$) by dietary treatment. These results suggest that dietary restriction may inhibit production of progesterone by small and medium follicles.

Mean concentrations of estradiol in small, medium or large follicles were not affected ($P>.20$) by level of dietary intake. Large follicles (559 ng/ml) had 25- to 85-fold greater ($P<.01$) concentrations of estradiol than small (6.8 ng/ml) or medium (21.6 ng/ml) follicles. FFL data also were analyzed as estrogen-active (E-A; concentrations of estradiol > progesterone in FFL) or estrogen-inactive (E-I; concentrations of progesterone > estradiol in FFL), since E-A follicles in cattle are predominantly healthy (nonatretic) follicles (Spicer and Echternkamp, 1986). Progesterone concentrations (97 vs 183 ng/ml) in FFL of E-A and E-I follicles did not differ ($P>.10$) between LOSE,

MAINT and GAIN heifers. However, estradiol concentrations were greater ($P<.05$) in E-A follicles of GAIN (1232 $\pm$ 87 ng/ml) than LOSE (511 $\pm$ 66 ng/ml) or MAINT (544 $\pm$ 71 ng/ml) heifers. Estradiol concentrations in E-I follicles were not affected ($P>.10$) by diet.

In summary, results of the present study demonstrated that decreased dietary intake in cyclic heifers is associated with: 1) decreased concentrations of progesterone in FFL of small and medium follicles, and 2) decreased size of large follicles.

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