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Heifers with Low Antral Follicle Counts Have Low Birth Weights and Produce Progeny with Low Birth Weights

Adam F. Summers
Meat Animal Research Center

Robert A. Cushman
USDA-ARS, Bob.Cushman@ars.usda.gov

Karl Moline
University of Nebraska–Lincoln, kmoline1@unl.edu

Jeff Bergman
University of Nebraska–Lincoln, jbergman1@unl.edu

Andrea S. Cupp
University of Nebraska–Lincoln, acupp2@unl.edu

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Summary

To determine the relationship of antral follicle count and heifer BW, reproductive tract characteristics, and first-calf performance, Red Angus-composite heifers were used over three years. High antral follicle count heifers had greater BW from birth through pre-breeding. Progeny birth BW was greater for calves born to high antral follicle count heifers compared to low antral follicle count heifers. Taken together these data indicate a relationship between antral follicle counts and BW through the first breeding season and corresponding progeny, and continues to support a possible link between genes that influence growth and development and establishment of ovarian reserve.

Introduction

At birth, heifer ovaries contain 10,000 to 350,000 healthy follicles, and the number decreases approximately 20% within the first year of life (*Journal of Animal Science,* 1966, 25:800-805). Longevity of a beef cow is related to reproductive success (*Journal of Animal Science*, 2009, 87: 1971-1980) and thus cows with a smaller ovarian reserve may deplete their reserve sooner, resulting in earlier removal from the herd.

Size of the ovarian reserve has been predicted via ultrasonography and recorded as antral follicle count (AFC; *Biology of Reproduction*, 2008, 79:1219-1225). The size of the ovarian reserve has been correlated to fertility, with low AFC heifers having reduced pregnancy rates compared to high AFC heifers (*Journal of Animal Science*, 2009, 87: 1971-1980). Furthermore, maternal diet can impact progeny ovarian reserve. Initial reports indicated a correlation between birth BW and ovarian reserve in sheep (*Reproduction*, 2002, 123:769-777; *Placenta*, 2003, 24:248-257); however, recent reports demonstrate maternal diet can influence ovarian reserve without affecting birth BW in heifers (*Reproduction, Fertility, Development*, 2009, 21:773-784). The objective of this study was to determine the relationship between AFC and heifer BW, reproductive characteristics, and first-calf performance.

Procedure

The University of Nebraska–Lincoln Institutional Animal Care and Use Committee approved the procedures and facilities used in this experiment.

Weaned MARC III (1/4 Angus, 1/4 Hereford, 1/4 Red Poll, 1/4 Pinzgauer) × Red Angus composite heifers (n = 264; year 1 = 91, year 2 = 90, year 3 = 83) were utilized in this experiment. Heifers grazed a common fall pasture and were offered 4.4 lb/day (10.5% CP, DM basis) supplement for 30 days prior to the initiation of winter development treatment. In year 1, heifers were randomly assigned to either graze corn residue (CR) or dormant winter range from mid-November through mid-February. Heifers were offered 1 to 2 lb/day (31% CP, DM basis) supplement while grazing corn residue or dormant winter range. After the 119-day treatment period, heifers were placed in a common group on dormant forage pastures and grazed for approximately 100 days until the initiation of the breeding season. Heifers were offered 1 lb/day protein supplement during the 100-day grazing period. If weather impeded grazing, heifers were offered free-choice brome hay with CR heifers consuming 9.3 lb/day and WR heifers consuming 7.7 lb/day.

In years 2 and 3, heifers were randomly assigned to one of two groups and received either a dried distillers grain-based or corn gluten feed-based supplement offered at 0.59% (27% CP, DM) and 0.78% BW (20% CP, DM), respectively, from mid-November through May. Supplements were formulated to be isocaloric but differed in rumen undegradable protein. All heifers were fed *ad libitum* meadow hay through winter while grazing dormant pasture.

Prior to breeding, heifers underwent transrectal ultrasonography. One technician scanned each ovary using an Aloka-500 linear array transrectal probe (7.5-MHZ transducer) and counted small (3-5 mm), medium (6-10 mm), and large (> 10 mm) follicles. Follicles counted on each ovary were summed to determine AFC. Heifers were assigned a categorical score based on AFC and were considered low (≤ 15 follicles; LOW), moderate (16-25 follicles; MOD), or high (≥ 26 follicles, HIGH). Uterine horn diameter, presence of CL, and ovarian length and height were also determined. Each heifer received a reproductive tract score (RTS) based on the methods reported by Martin et al. (*Journal of Animal Science*, 1992, 70:4006-4017).

Estrus was synchronized with two injections of prostaglandin $F_{2\alpha}$ (PGF) administered 14 days apart. Estrus detection was performed five days following the second injection. Heifers observed in estrus were artificially inseminated approximately 12 hours after initial estrus detection. Approximately 10 days after AI heifers were placed with fertile bulls for 45 days. In year 1, due to poor response of synchronization, all heifers not artificially inseminated were injected with PGF 10 days after the second injection was administered to resynchronize estrus. Conception rates for both AI and total pregnancy rates were determined via rectal palpation approximately 45 days following AI and bull removal, respectively.

Statistical Analysis

A mixed linear model that included the fixed effects of categorical AFC

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score and development treatment with year and heifer age fitted as random effects was used. The AFC classification x development treatment interaction was not significant and was removed from the model. Heifer progeny data model included maternal AFC classification as the fixed effect and calf sex and year as random effects.

Results

Data for the effect of heifer AFC classification on BW, ADG, and reproductive characteristics and performance are reported in Table 1. High AFC heifers had greater ($P = 0.04$) birth BW compared to LOW heifers (79.8 vs. 75.9 ± 1.4 lb). These data agree with Cushman et al. (*Journal of Animal Science*, 2009, 87: 1971-1980) reporting an approximate 7 lb increase in birth BW for HIGH compared to LOW heifers. Weaning BW was 30 lb (± 11 lb) greater ($P < 0.01$) for HIGH compared to LOW heifers. Furthermore, when using 205-day adjusted BW, BW remained greater ($P = 0.02$) for HIGH compared to LOW heifers. Body weight was greater ($P < 0.01$) at pre-breeding for HIGH compared to MOD and LOW heifers; however, at pregnancy diagnosis after summer grazing, BW was similar ($P = 0.77$) between AFC classifications. Previous literature regarding the relationship of birth weight and ovarian reserve has been reported for sheep and cattle (*Reproduction*, 2002, 123:769-777; *Placenta*, 2003, 24:248-257; *Journal of Animal Science*, 2009, 87: 1971-1980). However, these studies did not demonstrate a relationship between ovarian reserve and BW at weaning or pre-breeding as is reported in the current study. Although not correlating ovarian reserve and BW, Silva et al. (*Livestock Science*, 2006, 99:51-59) did report a genetic correlation of 0.15 for cow stayability and 550-day BW in Nelore cows.

Table 1. Effect of antral follicle count[1] (AFC) classification on heifer BW, ADG, and reproductive performance.

Item	HIGH	MOD	LOW	SEM	*P*-value
n	103	113	48		
Birth BW, lb	80 [a]	77[a,b]	76[b]	1	0.04
Weaning BW, lb	523[a]	518[a,b]	493[b]	10	< 0.01
Adjusted 205-day BW, lb	565[a]	553[a,b]	542[b]	17	0.02
Initial development BW, lb	562[a]	544[a,b]	524[b]	8	< 0.01
Pre-breeding BW, lb	852[a]	809[b]	800[b]	16	< 0.01
Preweaning ADG, lb/day	2.27[a]	2.21[a,b]	2.16[b]	0.07	0.02
Adjusted preweaning ADG, lb/day	2.37[a]	2.32[a,b]	2.27[b]	0.08	0.04
Post-weaning ADG, lb/day	1.38	1.29	1.32	0.04	0.08
AFC	32.5[a]	20.4[b]	12.3[c]	0.9	< 0.01
RTS[2]	4.27	4.29	4.12	0.17	0.24
Pregnancy diagnosis BW, lb	995	985	982	38	0.77
CL present, %	20	29	25	17	0.30
Mature BW at breeding, %	66[a]	63[b]	62[b]	0.1	< 0.01
AI conception rate, %	63	69	68	11	0.78
Pregnancy rate, %	96	89	89	4	0.15
Calving results					
Calf birth BW, lb	79[a]	78[a,b]	75[b]	3.1	0.02
Calving date, Julian	84	82	83	3.4	0.74
Calved first 21-day, %	77.9	75.9	67.8	8.6	0.57
Calf weaning BW, lb	476	478	458	25	0.30
Calf adjusted 205-day BW, lb	537	537	521	24	0.29

[a-b]Means with different superscripts differ $P \leq 0.05$.
[1]Heifer AFC determined via ultrasonography one month prior to breeding season; HIGH ≥ 26 follicles; MOD 16-25 follicles; LOW ≤ 15 follicles (Adapted from *Biology of Reproduction*, 2008, 79:1219-1225).
[2]RTS= reproductive tract score (*Journal of Animal Science*, 1992, 70:4006-4017).

Average daily gain, based on 205-day adjusted weaning BW was greater ($P = 0.04$) for HIGH heifers compared to LOW heifers prior to weaning (2.37 vs. 2.27 ± 0.08 lb/day). Furthermore, post-weaning ADG to pre-breeding tended ($P = 0.08$) to be greater for HIGH compared to LOW heifers. Reproductive tract score, proportion of heifers with a CL present at AFC, and AI pregnancy rates did not differ ($P > 0.30$) among AFC classifications. Overall pregnancy rates, although not significant, had a tendency ($P = 0.15$) to be approximately 9% greater for HIGH compared to MOD and LOW heifers. Our data are similar to previous reports of a significant increase in overall pregnancy rates for HIGH compared to LOW heifers (*Journal of Animal Science*, 2009, 87: 1971-1980) and cows (*Journal of Dairy Science*, 2012, 95: 2355- 2361).

At calving, HIGH heifers gave birth to larger ($P = 0.02$) calves compared to LOW heifers (Table 1). However, the effect of maternal AFC on calf birth BW appears to be sex specific. Heifer calves born to HIGH heifers had a 7 lb (±2 lb) increase ($P < 0.01$) in birth BW compared to heifers born to MOD and LOW heifers; however, there was no difference in bull calf birth BW due to maternal AFC (not reported). Birth weight has been reported to impact survivability in several species, with reduced birth BW causing increased mortality rates (*Australian Veterinary Journal*, 1956, 32:289-298; *Theriogenology*, 1987, 28:573-586). Too great an increase in birth BW, potentially causing dystocia, has more commonly been the cause of early death in beef calves than reduced birth BW (*Theriogenology*, 1987, 28:573-586).

Profitability of a beef cow-calf producer is related to longevity of cows, with most cows leaving the herd due to reproductive failure. Selecting heifers with high AFC has been reported to increase pregnancy rates. We report high AFC heifers have increased BW through pre-breeding, improved ADG prior to development, and give birth to larger heifer calves compared to low AFC heifers. Taken together these data indicate a relationship between AFC and BW through the first breeding season and progeny calf BW. The low birth BW in heifers with low AFC and in their progeny continues to support a possible link between genes that influence growth, development, and establishment of the ovarian reserve.

[1]Adam Summers, graduate student; Robert Cushman, Meat Animal Research Center, Clay Center, Neb.; Karl Moline, cow/calf unit manager; Jeff Bergman, cow-calf unit research technician, Mead, Neb.; Andrea Cupp, professor, University of Nebraska–Lincoln Department of Animal Science, Lincoln, Neb.