Effects of Protein Supplementation of Fall Calving Cows on Cow Performance and Calf Growth

K. J. McLean, B. H. Boehmer, and R. P. Wettemann

STORY IN BRIEF

Fall calving cows were used to determine the effects of protein supplementation on cow performance and calf growth. Cows were individually supplemented (Con; 1.8 kg/d; 38% CP) from November to March, to coincide with early gestation, and with early to mid-lactation the subsequent year. This supplementation program provided extra nutrients for maternal tissues, fetal growth, and growth of suckling calves. Low cows received 0.2 kg/d of an 8% CP supplement. Cows receiving Con supplementation had reduced BW loss from parturition (September- October), through January, and had increased BW and BCS at weaning in May compared with Low cows. Nutrient restriction did not influence birth weights of calves but increased weaning weights, yearling weights, and harvest weights. Nutrient restriction may have programmed the fetus to utilize nutrients more efficiently. This was demonstrated by increases in ADG of calves that were prenatally restricted and suckled cows that were supplemented during lactation. Protein supplementation influenced BW of cows and calves, but did not influence carcass traits of the calves.

Key Words: beef cows, calf growth, nutrition

INTRODUCTION

Profitability depends on maximizing production and minimizing inputs; however, the majority of profit comes from increased BW of calves at weaning (Dickerson, 1970). A cow must produce a calf every 12 mo to maximize production, thus there are only 85 d after parturition for cows to become reproductively fit and rebreed. Supplementation of cows will increase input costs but may be necessary for successful conception rates during times when forage quality is less than adequate (Lusby and Wettemann, 1988).

Cows will frequently be subjected to inadequate forage quality and quantity for the stage of production. When adequate nutrients are not provided to the fetus during gestation, changes may result which will alter productivity of the offspring (Barker et al., 1993). Fetuses deprived of adequate nutrition during early gestation had decreased muscle and increased adipose development (Long et al., 2012). Inadequate prenatal nutrition of calves may cause decreased fertility (Martin et al., 2007) and carcass quality (Stalker et al., 2006).

The major objective of the current study was to determine the effects of protein supplementation of fall calving cows on BW, BCS, reproductive performance, prenatal and postnatal growth of calves, and carcass characteristics of calves. Our hypothesis was that inadequate protein supplementation of fall calving cows will influence prenatal and postnatal growth and carcass characteristics of calves without affecting reproductive efficiency of the cows.

MATERIALS AND METHODS

Animals. Fall calving, multiparous Angus cows were used to determine the effects of protein supplementation on BW, BCS, reproductive performance, calf growth, and carcass characteristics of calves. Cows were maintained in the same pastures, at the Range Cow Research Center west of Stillwater, OK and diets only differed during protein supplementation. Cows were individually supplemented, from mid-November to mid-March during four consecutive years (n = 44, yr 1; n = 51, yr 2; n = 58, yr 3; n = 53, yr 4) with one of two diets. The low diet (L) consisted of an 8% CP supplement fed at 0.2 kg/d, and the control diet (Con) consisted of a 38 % CP supplement fed at 1.82 kg/d. During lactation the subsequent year, half of the cows on Con and L prenatal treatments were assigned to Con and the other half was assigned to L.

Cows were exposed to mature bulls for 60 d commencing on December 1. Cow BW and BCS were obtained before calving in August, monthly during November to March, and at weaning in May. Pregnancy rates were determined at weaning via rectal palpation and the interval from calving to conception was calculated by subtraction of 280 d from calving dates.

Calf Growth and Carcass Traits. Protein supplementation of cows was used to alter prenatal and postnatal nutrient availability of calves. Treatment combinations for calves were: Con prenatal and Con postnatal (ConCon), L prenatal and Con postnatal (LCon), Con prenatal and L postnatal (ConL), and L prenatal and L postnatal (LL). Birth weights were taken within 24 h of birth and bull calves were castrated with rubber bands. Calf BW were recorded in January, February, March, and at weaning in May.

Post-weaning growth was determined from BW obtained 3 to 5 times before calves entered the feedlot and adjusted ADG was calculated for 205 d and 365 d. After weaning each year calves were maintained as a single group at the Range Cow Research Center until entry into the feedlot. Calves received a high concentrate finishing diet comparable to normal diets used in beef production. Calves were fed until it was estimated that back fat was adequate to result in at least 65 % choice carcasses.

Each year calves were harvested on a single day at a commercial abattoir in Arkansas City, KS and carcass characteristics were determined by experienced personnel. Measured traits included HCW, ribeye area, quality grade, yield grade, back fat thickness, dressing percentage, and marbling scores.

Statistical Analysis. The GLM procedure of SAS (SAS Institute Inc., Cary, NC), was used to analyze BW, BCS, and reproductive traits of cows and BW, ADG, and carcass traits of calves. Chi-squared analysis was used to evaluate the effect of treatment on pregnancy rates (PROC FREQ; SAS).

RESULTS AND DISCUSSION

Fall calving cows grazing dormant pastures are usually exposed to inadequate nutrients during the 1st trimester of gestation if supplemental protein is not fed. Supplementing protein to cows grazing dormant, low quality forages will increase DMI and available energy (Fleck et al., 1988). Control cows lost less BW (-29.8 ± 2.8 kg; $P < 0.001$; Table 1) during November to January, compared with L cows (-49.7 ± 2.8 kg). Protein supplementation increased BW ($P = 0.05$) and BCS ($P = 0.03$; Table 1) of Con cows compared with L cows in February. Control cows had greater BW compared with L cows in March (P = 0.03). Control cows had greater BW (P = 0.03) and BCS (P = 0.03) compared with L cows (Table 1) in May. Cow BW and BCS at calving the subsequent fall were not influenced by protein supplementation the previous winter because good quality summer forages were available and cows gained weight. Calving date, pregnancy rate, and postpartum interval to conception were not influenced by protein supplementation (P > 0.22). The interval from parturition to conception and overall pregnancy rates were not influenced by treatments because cows in this study were maintained with the minimal BCS that would allow onset of estrus and pregnancy to occur within a 60 d breeding season (Rakestraw et al., 1986).

Table 1. Influence of protein supplementation (Control) during breeding and the 1st trimester of gestation (mid-November to mid-March) compared with Low supplementation on BW & BCS of fall calving cows

BW, kg	Treatment		SE	*P* value
	Control	Low		
No. of cows	75	75	-	-
August	656.6	660.3	7.1	0.71
November	622.4	629.8	6.9	0.45
November to January	-29.8	-49.7	5.6	< 0.001
January	594.4	580.3	7.4	0.18
February	576.2	556.1	7.0	0.05
March	545.4	522.3	7.6	0.03
May	548.1	529.0	6.0	0.03
BCS [a]				
August	5.3	5.2	0.1	0.37
November	4.8	4.8	0.1	0.56
January	4.4	4.3	0.1	0.49
February	4.2	4.0	0.1	0.03
March	3.9	3.9	0.1	0.30
January to May	-0.29	-0.40	0.05	0.13
May	4.1	3.9	0.1	0.03

[a] BCS: 1 = emaciated; 9 = obese (Wagner et al., 1988)

Birth weight of calves was not influenced by prenatal protein supplementation of cows (P = 0.86, Table 2). The lack of effect of prenatal protein supplementation of cows on birth weight of calves was most likely caused by the stage of gestation that protein and energy were limited. The absence of an effect of nutrient deficiency during early gestation on birth weight of calves has also been observed by Martin et al. (2007) and Long et al. (2009). Even without an influence of prenatal treatment on birth weight, postnatal growth of calves was reduced. There was a prenatal x postnatal treatment effect (P = 0.04) on BW of calves in January; LL calves weighed less than calves on other treatments (Table 2). Adjusted weaning weights (205 d) were less for LL calves (P < 0.003) compared with all other groups. LCon calves weighed more than ConL calves (P = 0.02) and ConCon calves did not differ in BW compared with LCon and ConL calves (Table 2). During the first few months after birth, calves rely more on milk production, thus calves suckling L cows gained less due to decreased milk availability. There were no interactions between prenatal and postnatal treatments after weaning.

Calves grazed forage for approximately 12 mo after weaning and the effects of prenatal and preweaning nutrition on BW were minimal. Postnatal supplementation increased yearling weights (Table 2) of calves regardless of prenatal treatment. Calves that suckled Con cows had greater BW (301.1 ± 8.8 kg) compared with calves which suckled L cows (278.5 ± 8.8 kg, P = 0.01). There was a tendency for ConCon calves to weigh more than LL calves (P = 0.09) at entry to the feed yard (Table 2), at approximately 19 mo of age. Final BW was greater (Table 2; P = 0.02) for ConCon calves compared with LL calves. Hot carcass weight was greater (P = 0.02) for ConCon and LCon compared with LL calves (Table 2).

Table 2. Effects of prenatal [2] and postnatal [3] maternal protein supplementation on BW of calves fall born calves

Trait	Treatment				S.E.
	ConCon [1]	ConL	LCon	LL	
Birth Weight, kg	37.8		38.1		0.6
BW January, kg	126.2^{a}	122.6^{a}	128.3^{a}	111.5^{b}	3.2
Weaning Weight, kg	180.1^{ab}	172.4^{b}	186.1^{a}	154.9^{c}	4.2
Yearling Weight, kg	303.1^{a}	287.7^{ab}	299.0^{a}	269.2^{b}	8.8
Feedlot Entry BW, kg	405.0^{g}	395.1^{gh}	384.4^{gh}	381.4^{h}	10.4
Final BW, kg	642.6^{a}	616.4^{ab}	650.7^{ab}	601.4^{b}	14.7
Hot Carcass Weight, kg	393.6^{a}	376.0^{ab}	398.3^{a}	362.6^{b}	9.0

[a,b,c] Means within row without a common letter differ (*P* < 0.05).
[g,h] Means within row without a common letter differ (*P* < 0.10).
[1] ConCon = prenatal control diet and postnatal control diet
[2] prenatal treatments during conception and the 1st trimester of gestation
[3] postnatal treatments during early to mid-lactation

Reduced availability of nutrients in utero may program the fetus for survival when exposed to nutrient restriction after birth. Animals that are prenatally programmed to survive with limited postnatal nutrients have increased efficiency when adequate nutrients are available after birth. Calves that were LL gained less weight from birth until January (0.69 ± 0.03 kg/d; P = 0.04) compared with ConCon, ConL, and LCon calves (Table 3). Gains of LCon calves were greater from January to weaning compared with ConL calves (P = 0.007); LL calves had the least gain compared with all treatments (P < 0.01, Table 3). Postnatal Con calves tended to have greater ADG from weaning to one year of age compared with L calves (P = 0.10). During the feedlot phase LCon calves had greater ADG than all other treatments (P = 0.03) and ConCon calves had a tendency to gain more compared with LL calves (P = 0.06; Table 3).

Table 3. Effects of prenatal [2] and postnatal [3] maternal protein supplementation on ADG of calves fall born calves					
Trait	Treatment				S.E.
	ConCon [1]	ConL	LCon	LL	
Birth to January	0.83^{a}	0.79^{a}	0.85^{a}	0.69^{b}	0.06
January to Weaning	0.66^{ab}	0.63^{b}	0.69^{a}	0.56^{c}	0.04
Feedlot Period	1.86^{bg}	1.75^{b}	2.10^{c}	1.72^{bh}	0.06

[a,b,c] Means within row without a common letter differ ($P < 0.05$).
[g,h] Means within row without a common letter differ ($P < 0.10$).
[1] ConCon = prenatal control diet and postnatal control diet
[2] prenatal treatments during conception and the 1st trimester of gestation
[3] postnatal treatments during early to mid-lactation

Reduced BW and altered body composition have been reported in humans (Ravelli et al., 1999), sheep (Ford et al., 2007), and cattle (Long et al., 2010) due to prenatal nutrient restriction. Restricted pre-weaning protein supplementation reduced final BW and hot carcass weight of calves, with the greatest effect in calves exposed to low prenatal and low postnatal protein supplementation of cows. However, treatments did not influence dressing percentage (P = 0.17), ribeye area (P = 0.56), yield grade (P = 0.34), or marbling score (P = 0.92).

In conclusion, the Low (inadequate) protein supplementation of fall calving cows during gestation, that was used in this experiment, did not influence reproductive efficiency of cows or birth weight of calves, but increased growth of calves when postnatal nutrition was adequate. Greater protein supplementation of cows during lactation increased ADG and BW of calves, and neither prenatal nor postnatal nutrition influenced the quality of carcasses. Additional research is needed to further evaluate the effect of prenatal nutrition on carcass characteristics.

LITERATURE CITED

Barker, D. J., C. N. Martyn, C. Osmond, C. N. Hales, and C. H. Fall. 1993. Growth in utero and serum cholesterol concentrations in adult life. BMJ 307:1524-1527.

Dickerson, G. 1970. Efficiency of animal production—molding the biological components. J. Anim. Sci. 30:849-859.

Fleck, A. T., K. S. Lusby, F. N. Owens, and F. T. McCollum. 1988. Effects of corn gluten feed on forage intake, digestibility and ruminal parameters of cattle fed native grass hay. J. Anim. Sci. 66:750-757.

Ford, S. P., B. W. Hess, M. M. Schwope, M. J. Nijland, J. S. Gilbert, K. A. Vonnahme, W. J. Means, H. Han, and P. W. Nathanielsz. 2007. Maternal undernutrition during early to mid-gestation in the ewe results in altered growth, adiposity, and glucose tolerance in male offspring. J. Anim. Sci. 85:1285-1294.

Long, N. M., C. B. Tousley, K. R. Underwood, S. I. Paisley, W. J. Means, B. W. Hess, M. Du, and S. P. Ford. 2012. Effects of early- to mid-gestational undernutrition with or without protein supplementation on offspring growth, carcass characteristics, and adipocyte size in beef cattle. J. Anim. Sci. 90:197-206.

Long, N. M., K. A. Vonnahme, B. W. Hess, P. W. Nathanielsz, and S. P. Ford. 2009. Effects of early gestational undernutrition on fetal growth, organ development, and placentomal composition in the bovine. J. Anim. Sci. 87:1950-1959.

Lusby, K. S., and R. P. Wettemann. 1988. Wheat middlings vs soybean meal and corn/soybean meal supplements at two protein levels for wintering spring calving beef cows. Oklahoma Agric. Exp. Sta. MP 125:72-75.

Martin, J. L., K. A. Vonnahme, D. C. Adams, G. P. Lardy, and R. N. Funston. 2007. Effects of dam nutrition on growth and reproductive performance of heifer calves. J. Anim. Sci. 85:841-847.

Rakestraw, J., K. S. Lusby, R. P. Wettemann, and J. J. Wagner. 1986. Postpartum weight and body condition loss and performance of fall-calving cows. Theriogenology 26:461-473.

Stalker, L. A., D. C. Adams, T. J. Klopfenstein, D. M. Feuz, and R. N. Funston. 2006. Effects of pre- and postpartum nutrition on reproduction in spring calving cows and calf feedlot peerformance. J. Anim. Sci. 84:2582-2589.

Wagner, J. J., K. S. Lusby, J. W. Otjen, J. Rakestraw, R. P. Wettemann, and L. E. Walters. 1988. Carcass composition in mature Hereford cows: Estimation and effect on daily metabolizable energy requirement during winter. J. Anim. Sci. 66:603-612.

ACKNOWLEDGEMENTS

The authors of this paper would like to thank Mark Anderson and Randy Jones for their work in managing the animals in this study.