The Professional Animal Scientist 34:261–268
https://doi.org/10.15232/pas.2017-01701

ARPAS
AMERICAN REGISTRY OF PROFESSIONAL ANIMAL SCIENTISTS

Effect of protein restriction of Angus cows during late gestation: Subsequent reproductive performance and milk yield

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ABSTRACT

The effect of level of CP fed during late gestation on reproductive performance and milk production was studied in multiparous cows. Sixty-eight pregnant Angus cows were used. At 121 d prepartum, cows were blocked by BW (409 ± 57 kg) and expected calving date, randomly assigned to a low-protein (LP = 6% CP) or high-protein diet (HP = 12% CP), and allocated to 12 pens per treatment. After parturition, all cows were managed in a single group until weaning. Body weight and BCS were determined at the start of the experiment, at calving, and at weaning. Nonesterified fatty acids, insulin, IGF-1, and glucose were determined every 24 d prepartum and nonesterified fatty acids and glucose every 38 d postpartum. Progesterone was quantified weekly to indicate luteal activity and estimate interval to first estrus. Milk production was measured until weaning. The HP cows had greater BW gain during the prepartum period ($P < 0.01$) and tended to gain more BCS ($P = 0.06$) than LP cows. The prepartum diet did not affect gestation length ($P = 0.44$) or interval from calving to the onset of luteal activity ($P = 0.35$). Pregnancy rates, milk quality, and production were not influenced by dietary treatments. Cows in the HP treatment had greater prepartum serum urea concentrations than LP treatment ($P < 0.05$). In conclusion, protein level prepartum in multiparous beef cows affected the BW change at calving, without consequences on reproductive performance and milk quality and yield.

Key words: multiparous cow, protein restriction, late gestation, milk yield, postpartum reproductive performance

INTRODUCTION

Cow-calf operations in Argentina are managed under extensive conditions on grazing systems. The quality of forages and roughages is often poor (Sala et al., 1981), particularly in winter, leading to many spring-calving cows having periods of undernutrition during the second half of gestation. Protein supplementation during late gestation has been shown to lead to positive BW and BCS changes in cows and heifers (Stalker et al., 2006; Wilson et al., 2015a,b). Nutrition during the prepartum period is one of the most important factors affecting postpartum anestrous length and subsequent pregnancy rates in beef cows (Wettemann et al., 2003). For instance, diets low in CP from 150 d prepartum to 40 d postpartum negatively affected reproductive performance in heifers (Sasser et al., 1988).

Previous studies in dairy cattle have shown that BCS at calving and during early lactation are associated with milk quality (Roche et al., 2007), but this response does not appear to be similar in beef cows, although there is little research in beef cattle (Corah et al., 1975). Lake et al. (2005) supported the concept that the milk response in beef cows is different from that in dairy cows. The prepartum nutrition also affects some metabolites such as urea and nonesterified fatty acid (**NEFA**) concentrations (Konigsson et al., 2008). There are few studies on the effect of prepartum nutrition on milk quality and production in beef cattle and on its relationship with metabolites and hormonal concentrations, particularly when the level of dietary protein has been altered. The objective of this experiment was to determine the effect of protein nutrition level during the last 120 d before calving on BW and BCS, milk production and composition, reproductive performance, and blood metabolites and hormonal concentrations in mature Angus cows during the last 4 mo of gestation until 6 mo after calving. The hypothesis of this experiment was that a reduction of 35% of the CP require-

The authors declare no conflict of interest.

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ment in the prepartum diet of cows will decrease maternal BW and BCS and lead to alterations in milk production and postnatal reproduction compared with nonrestricted cows.

MATERIALS AND METHODS

Animals

The experiment was conducted at Experimental Farm Cuenca del Salado INTA (Buenos Aires, Argentina: 37°05′S 57°52′W) during 2013 to 2014. All procedures were approved by CICUAE INTA- CERBAS nº 87 (Institutional Committee for Care and Use of Experimental Animals of South Buenos Aires region) Buenos Aires, Argentina.

Sixty-eight multiparous Angus cows (initial BW of 409 ± 57 kg) that had just calved in late winter or early spring were synchronized for estrus using a controlled internal drug-releasing device (Cronipres, Biogenesis-Bago, Buenos Aires, Argentina) for 7 d, and upon removal of the device, 500 μg of cloprostenol (Ciclase DL, Syntex, Buenos Aires, Argentina) and 1 mg of oestradiol benzoate (Benzoate de oestradiol Syntex) was administrated intramuscularly. Timed AI was conducted 48 h after oestradiol injection, using semen from a single Angus sire. Fifteen days after AI, a single Angus bull was used for a 15-d natural breeding period. Thirty days after the end of the natural breeding period, pregnancy and fetal age were determined by transrectal ultrasonography. Cows were managed on fescue pastures during early to mid-gestation (62.7% IVDMD, 14.1% CP). At 121 d prepartum, cows were blocked into 4 blocks by BW and expected calving date and randomly assigned to 1 of 2 treatments: a low-protein (6% CP on DM basis; **LP**) or high-protein diet (12% CP on DM basis; **HP**) (Table 1). Cows were allocated to 24 pens (12 pens per treatment) at a rate of 2 or 3 cows per pen. Cows were fed to meet 100% of their ME requirements (NRC, 2000). Rations were fed in plastic feeders as a TMR daily at 0900 h. After parturition all cows were managed in a single group and grazed oats grass (81.4% IVDMD, 16.3% CP) and mixed grass pasture (51.7% IVDMD, 10.3% CP) until weaning.

Ninety-two days after calving, 51 cycling cows were subjected to AI using the synchronization protocol as previously described. Fifteen days after the end of AI, all the cows were exposed to fertile bulls at a ratio of approximately 1 bull per 30 cows for 90 d. The pregnancy rate to timed AI and to natural service was determined by transrectal ultrasonography 28 d after the end of natural service.

BW, BCS, and Gestation Length

The BW and BCS (1 = emaciated to 9 = obese; Wagner et al., 1988) were recorded at the time of group assignment, at calving (less than 12 h after calving), and at weaning. The gestation length was determined only in AI pregnant cows because date of breeding was accurately recorded (LP: 18 cows, HP: 17 cows).

Milk Production and Composition

Milk production was recorded on the same cow per pen on d 20, 34, 47, 75, 103, 135, 165, and 221 (±10.9) postpartum. At 1200 h, cows were separated from calves and each cow was injected intramuscularly with 10 international units of oxytocin (Over, San Vicente, Santa Fe State, Argentina) to facilitate milk letdown. Cows were milked using a portable milking machine 5 min after injection. Calves were fitted with nose plates to prevent suckling (San Miguel, Bahia Blanca, Argentina) and remained with their dams in the same paddock. The following day, at approximately 0600 h, cows were milked again using the protocol described by Quintans et al. (2010). Milk yield was measured throughout lactation using an in-line milk meter (TrueTest, Auckland, New Zealand), and samples were collected to evaluate protein, fat, lactose, total solids (IDF 141C:2000 Bentley Instruments, Chaska, MN), and urea (Chemspec 150, Bentley Instruments). The equation used to estimate milk yield over a 24-h period was proposed by Restle et al. (2004):

$$MY = MMY \times 60/IM \times 24,$$

Table 1. Nutrient content of low-protein and high-protein dietary treatment rations fed to multiparous cows for 120 d before expected parturition

	Prepartum treatment[1]	
Item	**LP**	**HP**
Ingredient (% DM)		
Maize silage	98.5	87.5
Sunflower pellet	—	10.0
Urea	—	1.0
Mineral mix	1.5	1.5
DM (%)	22.1	29.6
Diet composition		
IVDMD (% of DM)	68.1	68.2
NDF (% of DM)	63.2	60.1
ADF (% of DM)	32.7	31.9
Ash (% of DM)	6.5	6.5
CP (% of DM)	6.2	11.7
CP[2] (% NRC)	64.0	121.0
RDP[3] (% CP)	69.0	74.5
RUP (% CP)	31.0	25.5
DMI (kg/d)	7.47	7.53
ME (Mcal/kg)	2.38	2.36

[1]LP = low protein (6% CP); HP = high protein (12% CP).

[2]Ration as a percentage of NRC recommended nutrient requirements of beef cattle (NRC, 2000).

[3]Ration as a percentage of RDP of total CP.