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Summary

Crossbred, *AI-pregnant heifers were fed in a Calan Broadbent individual feeding system for 110 days beginning at approximately day 142 of gestation. Heifers were offered ad libitum grass hay and no supplement, hay plus distillers based supplement, or hay plus dried corn gluten based supplement. Supplements were isocaloric, isonitrogenous, and equal in lipid content but differed in rumen undegradable protein. Protein supplementation increased DMI and ADG in pregnant heifers; however, calf birth BW and subsequent pregnancy rates were similar.*

Introduction

The relationship between prepartum nutrition and subsequent breeding season pregnancy rates is well established. This relationship is especially critical for primiparous heifers and young cows due to the added nutrient requirement of their own growth, resulting in a higher risk of reproductive failure compared with mature cows.

Providing supplemental protein to beef cattle grazing low quality forages has been reported to increase forage intake, improve cow BW gain, and may increase pregnancy rate (*Journal of Animal Science*, 2000, 77:1-16). However, results vary based on protein source, degradability, and physiological status of the female. Therefore, objectives of the current study were to determine the effect of supplemental protein source on ADG, feed intake, calf birth BW, and subsequent pregnancy rate in pregnant beef heifers.

Materials and Methods

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

Pregnant Heifer Management

A 3-year study was conducted at the West Central Research and Extension Center (WCREC), North Platte, Neb. Crossbred, AI-pregnant heifers (year 1 n = 38, year 2 n = 40, year 3 n = 36) were stratified by BW (992 ± 22 lb) and placed in a Calan Broadbent individual feeding system at approximately day 142 of gestation. Heifers were allowed approximately 25 days to adapt to the individual feeding system followed by an 84 day feeding trial. Heifers were offered ad libitum grass hay (8 to 11% CP, DM basis) and either no supplement (CON), 1.8 lb/day (DM basis) distillers based supplement (HI), or 1.8 lb/day (DM basis) dried corn gluten feed based supplement (LO, Table 1). Supplements were formulated to be isocaloric and isonitrogenous and equal in lipid content but differ in rumen undegradable protein (RUP). Feed offered was recorded daily and refusals removed and weighed weekly. Residual feed intake (RFI) was calculated as the actual DMI minus predicted DMI, with DMI calculated based on net energy (NE) values of the feed to account for different energy levels of the supplement compared with the control diet.

Table 1. Composition of supplements offered to heifers during feeding trial.

	% DM	
Ingredient, %	High[1]	Low[2]
DDGS[3]	99.0	—
CGF[4]	—	72.4
Corn germ	—	24.5
Urea	—	2.1
Trace minerals and vitamins	1.0	1.0
Nutrient Analysis[5], %		
CP	28.2	28.1
RUP, % CP	59.0	34.0
TDN	79.4	77.3
Crude fat	11.9	11.9

[1]Heifers offered 1.8 lb/d (DM) distillers grain based supplement.
[2]Heifers offered 1.8 lb/d (DM) dried corn gluten feed based supplement.
[3]Dried distillers grains with solubles.
[4]Dried corn gluten feed.
[5]Wet chemistry, Ward Laboratories, Inc., Kearney, Neb.; RUP based on NRC (1996).

Post-Calving Management

After calving, cows and calves remained at WCREC through AI. Prior to the breeding season, blood samples were collected 10 days apart via coccygeal venipuncture to determine plasma progesterone concentration. Plasma progesterone concentration was determined through direct solid phase RIA (Coat-A-Count, Diagnostics Products Corp., Los Angeles, Calif.). Cows with plasma progesterone concentrations >1.0 ng/mL were considered to have resumed estrus.

Estrus was synchronized utilizing a controlled internal drug release (CIDR; Zoetis, Florham Park, N.J.) protocol, with cows receiving 100 µg i.m. GnRH (Fertagyl, Intervet Inc., Millsboro, Del.) and CIDR insert on day 0. Seven days later, the CIDR was removed and a single injection of $PGF_{2\alpha}$ (25 mg; i.m.; Lutalyse, Zoetis, Florham Park, N.J.) administered followed by GnRH administration and AI approximately 60 hours later. Following AI, cows and calves were transported 28 miles to a commercial ranch in the Nebraska Sandhills for summer grazing. A single bull was placed with heifers approximately 10 days after AI for 60 days. Cows and calves were returned to WCREC prior to weaning for final pregnancy diagnosis. Following weaning, all pregnant 2 year old cows grazed corn residue and received 1 lb/day (32% CP, DM basis) distillers based supplement.

(Continued on next page)

Statistical Analysis

Heifers were offered hay and supplement on an individual basis during the experimental period; therefore, heifer was the experimental unit and diet the treatment. The statistical model included treatment as the fixed effect with pen and year as random effects. Calf sire and gender were included in the model for calving data. Data were analyzed using PROC MIXED and PROC GLIMMIX of SAS (SAS Institute, Inc., Cary, N.C.) for categorical and binomial data, respectively. Regression analysis utilizing PROC REG of SAS was used to determine the relationship between DMI, diet, and week of gestation. There was no intake × diet interaction ($P = 0.62$); thus, regression was utilized to determine the relationship of DMI and week of gestation. Data were considered significant if $P \leq 0.05$.

Results and Discussion

Individual Feeding Results

Heifers not receiving supplement tended ($P = 0.09$) to consume less total DM than either supplement treatment (Table 2). Similarly, total energy intake was less ($P < 0.01$) for CON heifers (10.98 lb) compared with HI or LO heifers (11.97 and 11.79 lb, respectively). However, CON heifers consumed more ($P < 0.01$) forage (21.91 lb) compared with HI or LO heifers (18.74 and 18.39 lb, respectively).

Forage intake declines when diet CP values are below 7%. Providing supplemental protein when cattle are grazing or consuming low quality forage may increase forage DMI. In the present study, forage CP content was greater than 7% and subsequently protein supplement replaced forage intake in HI and LO heifers. These data agree with Loy et al. (*2004 Nebraska Beef Cattle Report*, pp. 22-24) who reported heifers provided chopped grass hay (8.2% CP) and 0.4% BW/day of either dry-rolled corn or dried distillers grain supplement had reduced ($P < 0.01$) hay DMI compared to nonsupplemented heifers.

Table 2. Impact of supplemental protein source on ADG, feed intake, and feed efficiency in pregnant beef heifers.

Item	No supplement[1]	High RUP[2]	Low RUP[3]	SEM	P-value
Initial BW, lb	996	994	988	22	0.74
Final BW, lb	1,105[a]	1,144[b]	1,131[a,b]	20	<0.01
DMI[4], lb	21.91	22.75	22.40	0.26	0.09
Forage DMI[5], lb	21.91[a]	18.74[b]	18.39[b]	0.26	<0.01
NE DMI[6], lb	10.98[a]	11.97[b]	11.79[b]	0.51	<0.01
ADG, lb	1.30[a]	1.81[b]	1.72[b]	0.31	<0.01
RFI, DMI, lb	-0.037	0.018	-0.042	0.377	0.98
RFI, NE, lb	-0.465[a]	0.183[b]	0.141[b]	0.650	<0.01
G:F lb gain/lb	0.061[a]	0.085[b]	0.073[c]	0.013	<0.01

[1]Offered ad libitum grass hay (8 to 11% CP, DM basis) and no supplement.
[2]Offered ad libitum grass hay (8 to 11% CP, DM basis) and 1.8 lb/day (DM; 28% CP) distillers grain based supplement.
[3]Offered ad libitum grass hay (8 to 11% CP, DM basis) and 1.8 lb/day (DM; 28% CP) dried corn gluten feed based supplement.
[4]Dry matter intake of total diet.
[5]Dry matter intake of ad libitum grass hay only.
[6]Dry matter intake based on net energy (NE) values of the feed to account for different energy levels of the supplement compared with the control diet.
[a,b]Within each row, means without common superscripts differ ($P < 0.05$).

Table 3. Impact of supplemental protein source on subsequent cow and calf characteristics.

Item	No supplement[1]	High RUP[2]	Low RUP[3]	SEM	P-value
Julian birth date, day	60	60	62	1	0.36
Gestation length, day	276	276	277	1	0.88
1st calf birth BW, lb	73	73	73	2	0.99
Calving ease[4]	1.40	1.39	1.53	0.13	0.70
Calf vigor[5]	1.41	1.46	1.89	0.19	0.14
Resumption of estrus, %	25	27	37	11	0.51
Prebreeding BW, lb	981[a]	1,010[b]	1,014[b]	29	0.03
Pregnancy diagnosis BW, lb	1,065	1,076	1,087	26	0.48
Retention rate, %[6]	92	90	82	5	0.35
AI pregnancy rate, %	59	56	64	10	0.80
Overall pregnancy rate, %	90	91	79	12	0.22
Second calf Julian birth date, day	68	72	64	4	0.19
AI to parturition, day	290	294	286	4	0.20
Calved first 21 days, %	73	65	87	9	0.20

[1]Offered ad libitum grass hay (8 to 11% CP, DM basis) and no supplement.
[2]Offered ad libitum grass hay (8 to 11% CP, DM basis) and 1.8 lb/day (DM; 28% CP) distillers grain based supplement.
[3]Offered ad libitum grass hay (8 to 11% CP, DM basis) and 1.8 lb/day (DM; 28% CP) dried corn gluten feed based supplement.
[4]Calving ease scoring system: 1 = no assistance, 2 = easy pull, 3 = mechanical pull, 4 = hard mechanical pull, 5 = Caesarean section.
[5]Calf vigor scoring system: 1 = nursed immediately; 2 = nursed on own, took some time; 3 = required some assistance to suckle; 4 = died shortly after birth; 5 = dead on arrival.
[6]Proportion of cows remaining at the beginning of the second breeding season.
[a,b]Within each row, means without common superscripts differ ($P < 0.05$).

Heifers receiving no supplement had less ($P < 0.01$) ADG (1.30 lb) than either HI (1.81 lb) or LO (1.72 lb) heifers, resulting in reduced ($P < 0.01$) BW (1,105 lb) compared with HI heifers (1,144 lb) at the end of the trial. The differences in diet nutrient density resulted in a greater ($P < 0.01$) NE intake for the HI and LO heifers compared with the CON heifers. Although DMI tended to be greater for HI compared with CON heifers, G:F was greater ($P < 0.01$) for HI compared with CON heifers. The increase in G:F can be attributed to improved ADG for HI heifers, which was approximately 1.4 times greater than CON heifers. However, CON heifers had increased ($P < 0.01$) RFI based on diet energy compared with HI and LO heifers, whereas RFI between supplement groups was similar.

Dry matter intake was greatest at gestation week 28 (22.18 lb/day) and decreased ($P = 0.01$) as week of gestation increased throughout the remainder of the feeding period (week 38).

Calving and Subsequent Pregnancy Results

Julian birth date and gestation length were similar among treatments. Calf birth BW, calving ease, and calf vigor did not differ among treatments (Table 3). At pre-breeding, CON heifers weighed less ($P < 0.03$) compared with LO heifers. However, prepartum supplementation did not influence the proportion of heifers cycling prior to the breeding season. Cow BW was similar among treatments at pregnancy diagnosis. The proportion of cows pregnant to AI and final pregnancy rate was similar among treatments.

Cows were synchronized utilizing a CIDR estrus synchronization protocol. It has been reported (*Journal of Animal Science*, 2001, 79:982-995) CIDR increased the proportion of anestrous cows detected in estrous within the first three days of the breeding season compared with $PGF_{2\alpha}$-treated or control cows. It is possible the synchronization protocol used in the current study increased synchronization response and subsequent pregnancy rates to AI given the relatively low percentage of cows resuming estrus prior to synchronization. Regardless, prepartum supplement treatment did not affect resumption of estrus prior to CIDR insertion.

The impact of late gestation nutrition on subsequent pregnancy rate has been inconclusive (reviewed in *Journal of Animal Science*, 2000, 77:1-16). Patterson et al. (*2000 Nebraska Beef Cattle Report*, pp. 7-10.) reported increased pregnancy rates for heifers supplemented with RUP during late gestation to balance MP requirements compared to heifers supplemented to balance CP requirements. Also, it was reported (*Journal of Animal Science*, 2008, 86:1697-1708) providing heifers a diet of hay and distillers grains with solubles during late gestation improved pregnancy rate 10 percentage points compared with heifers offered hay and soybean hulls. In both studies, pregnancy rates were decreased in heifers offered diets deficient in MP during late gestation. In the present study, all diets supplied excess MP (CON, + 96 g/day; HI, + 247 g/d; LO, + 168 g/day), which may explain the lack of treatment effects on pregnancy rates.

In the current experiment, protein supplementation increased ADG in pregnant heifers; however, calf birth BW, resumption of estrus, and subsequent pregnancy rates were similar, regardless of supplementation or supplemental protein source. All diets in the current study were balanced for or exceeded MP requirements. Future studies restricting heifer MP intake during mid- to late gestation are warranted to determine the impact protein source and level may have on feed intake, ADG, and reproductive efficiency.

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