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Influence of prepartum dietary energy on beef cow performance and calf growth and carcass characteristics

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ABSTRACT

Objectives were to evaluate the effects of prepartum dietary energy intake on cow performance as well as performance and carcass characteristics of subsequent progeny. Spring-calving, mature cows ($n=106$ total) were blocked by BW and allotted to 1 of 2 treatments: ground hay and dried distillers grains plus solubles (**REQ**: TDN=61.8%, CP=11.0%, fat=2.1%), or corn bran and ground cornstalks (**HE**: TDN=70.3%, CP=10.0%, fat=5.7%). Treatments were limit-fed as isonitrogenous rations with REQ and HE providing 100% and 125% of TDN requirements, respectively, and were fed from 83 ± 10 d prepartum to calving. All cows were fed a common diet postpartum. Cow BW and BCS were recorded at the beginning of the feeding period, 24 h post-calving, and at breeding. Milk production was estimated via the weigh–suckle–weigh technique 65 ± 9 and 120 ± 9 d postpartum. Calf BW was measured at birth and at weaning (120 ± 9 d of age). Calves ($n=86$) were fed a common feedlot diet beginning 2 d after weaning, and individual feed intake was monitored using GrowSafe. Progeny were slaughtered in 3 groups at an average 12th rib fat thickness of 1.3 cm. From initiation of experiment to breeding, cow BW change was greater ($P<0.01$) and BCS change tended to be greater ($P=0.09$) for HE relative to REQ cows. Birth BW was greater ($P=0.02$) for calves born to cows fed HE with no increase ($P=0.30$) in percentage of unassisted births. There were no effects ($P\geq0.27$) of treatment on calving date, milk production, or subsequent pregnancy rate. Calf weaning BW, initial feedlot BW, final BW, and days on feed were not affected ($P\geq0.20$) by treatment. Feedlot DMI, ADG, and G:F were not different ($P\geq0.35$). There was no effect ($P\geq0.27$) of treatment on progeny morbidity. Although progeny born to HE dams tended ($P=0.10$) to have greater marbling scores at weaning, there was no effect ($P\geq0.60$) of treatment on carcass marbling score or other carcass traits. Feeding cows 125% of TDN requirement during late gestation increased cow BW change and progeny birth body weight. Feeding cows 125% of TDN requirement during late gestation had no effect on pregnancy rate or progeny performance.

1. Introduction

Beef cows may overconsume dietary energy when fed energy-dense rations ad libitum. Another opportunity for overconsumption of energy may be using incorrect energy values of feedstuffs when ration balancing. Late gestation is a critical period during which cow/calf producers have substantial control of the nutrition of spring-calving cows wintered in drylots (Braungardt et al., 2010).

Dietary energy intake impacts body reserves of pregnant cows, but also fetal growth and development. In sheep, maternal overfeeding (150% of NRC [1985] requirement) from 60 d before breeding through parturition resulted in greater adiposity and reduced lean tissue mass of resulting progeny (Long et al., 2010). Few studies, especially those using beef cattle, have attempted to isolate the impact of greater prepartum dietary energy intake on subsequent progeny relative to global overnutrition alone.

There is evidence that dietary energy source has differing effects on both cow performance and of subsequent progeny. When comparing hay and corn coproducts as energy sources in isocaloric late gestation diets, both Radunz et al. (2010) and Wilson et al. (2015) observed greater cow BW and calf birth BW when cows were fed corn coproducts as an energy source relative to hay. Radunz et al. (2012) observed greater marbling scores for progeny born to dams fed dried distillers grains plus solubles (**DDGS**) as an energy source during late gestation relative to those born to dams fed hay. Greater fat of corn coproducts may contribute to greater cow performance relative to when hay is fed as an energy source.

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The current experiment compares a limit-fed hay ration to a more energy-dense, isonitrogenous ration consisting of corn coproducts and ground cornstalks. We hypothesized that greater maternal dietary energy would increase cow BW, progeny birth BW, and increase marbling in subsequent progeny. Objectives were to evaluate the effects of increased dietary energy intake during late gestation on cow performance as well as growth performance and carcass characteristics of subsequent progeny.

2. Materials and methods

2.1. Animals, experimental design, and treatments

Experimental animals were managed according to the guidelines recommended in the Guide for the Care and Use of Agriculture Animals in Agriculture Research and Teaching (FASS, 2010). All experimental procedures followed were approved by the University of Illinois Institutional Animal Care and Use Committee.

Spring-calving, mature, multiparous Angus, Simmental, and Simmental × Angus cows (n=106; BW=688 ± 76 kg; age=4.8 ± 2.4 yr) and their progeny were used to evaluate the effects of increased dietary energy during late gestation on cow performance as well as subsequent progeny pre-weaning and finishing growth and carcass characteristics. Cows were maintained at the Orr Beef Research Center in Baylis, IL. Pregnancy was confirmed, via rectal ultrasonography using an Aloka 500 SV (Hitachi Aloka Medical America, Inc., Wallingford, CT) instrument equipped with a UST 5541 7.5-MHz linear transducer to determine whether cows were bred to either AI or cleanup bulls.

A randomized complete block design was used with cows blocked into light and heavy BW blocks (6 pens per block). Cows were blocked into light and heavy weight blocks of 624 ± 10 kg or 744 ± 9 kg average BW, respectively. Within block, cows were stratified by breed and then allotted to pens (12 total pens, 6 pens total per treatment). Four light block pens contained 9 cows each and 2 pens contained 8 cows each (52 cows total). The 6 heavy block pens contained 9 cows each (54 cows total).

Pens were randomly assigned to 1 of 2 late gestation rations within block (Table 1): Limit-fed ground, mixed, cool-season, grass hay and DDGS (**REQ**, n=6 pens) or limit-fed corn bran and ground cornstalks (**HE**, n=6 pens) 83 ± 10 d prepartum. The REQ and HE treatment rations were formulated to provide 100% and 125% of NRC (1996) energy requirement, respectively. Both treatments were formulated to be isonitrogenous. Rations were formulated using requirements of 636 kg or 727 kg cows with 9.1 kg peak milk production. Using the table generator function of NRC (1996), treatments were balanced using TDN and CP. Dry matter intake of treatments was increased each 30d of the prepartum feeding period to reflect changing nutrient requirements of cows during late gestation. Treatments were evaluated retrospectively with Level 1 of the NRC (1996) model using observed initial BW and BCS, milk production, and calf birth BW, and DMI of each treatment (Table 2). Rations were fed in concrete, fence-line bunks as a total mixed ration daily at 0900 h. Before feeding, hay and cornstalks were ground through a 2.54 cm screen. Cows were provided free choice access to trace-mineral salt (Table 1). Cows remained on treatments until calving. Within 48 h after calving, cows were moved to new pens, comingled among treatment groups, and limit-fed a common diet formulated to meet or exceed NRC (1996) requirements. The common post-calving diet was 50% pelleted corn gluten feed (**CGF**) and 50% ground cornstalks, (Table 1).

2.2. Pre-calving and pre-weaning management of cows and calves

During the prepartum feeding period and early lactation, cows were maintained in 11.0 × 10.7 m^2 or concrete lots with a 7.3 × 7.3 m^2 open-front shed and provided with a minimum of 0.81 m of fence-line bunk space. Cow BW was recorded on 2 consecutive d and BCS was assigned at the start of the prepartum feeding period. Within 48 h after calving, cow BW was recorded and BCS assigned to evaluate cow performance at the end of the treatment period. Thus, post-calving cow BW reflects loss of fetus, placental membranes, and associated fluids. Cow BW, BCS,

Table 1
Diet and nutrient composition of treatment and post-calving diets.

Item	Treatment[a,b,c]		Post-calving[b,c,d]
	REQ	HE[d]	
Ingredient, % DM			
Ground hay	93	–	–
Ground cornstalks	–	50	50
Dried distillers grains plus solubles	7	–	–
Corn bran[e]	–	50	–
Pelleted corn gluten feed[f]	–	–	50
Analyzed nutrient content, %DM			
DM	89.8	93.5	89.8
TDN[g]	61.8	70.3	65.3
CP	11.0	10.0	14.2
RDP, % CP[h]	81.9	72.4	72.0
RUP, % CP[h]	18.1	27.6	28.0
NDF	61.3	57.0	59.2
ADF	40.1	31.6	32.1
Fat	2.1	5.7	2.4

[a] REQ=limit-fed to provide 100% TDN requirement; HE=limit-fed to provide 125% TDN requirement.
[b] Average DMI of treatment diets during treatment period: REQ-Light block=10.6 kg, REQ-Heavy block=11.6 kg, HE-Light block=11.7 kg, HE-Heavy block=12.9 kg. Average DMI of post-calving diet was 11.2 kg.
[c] Given ad libitum access to trace-mineral salt: Salt=20.3%, Ca=16.1%, P=8.2%, Mg=2.3% (MgO), K=2.3% (KCl), S=0.2%, Co=10 mg/kg (CoCO3), I=48 mg/kg (C2H10I2N2), Cu=1498 mg/kg (CuSO4), Fe=8 mg/kg (FeSO4), Mn=2,017 mg/kg (MnSO4), Se=30 mg/kg (Na2SeO3), Zn=3026 mg/kg (ZnO), vitamin A=444.7 IU/kg, vitamin D3=88.9 U/kg, vitamin E=2223.5 IU/kg.
[d] Diet contained 0.14 kg/cow day−1 ground limestone.
[e] Dakota Bran (Dakota Gold Research Association, Sioux Falls, SD).
[f] Values for corn gluten feed from NRC (1996).
[g] Values for ground hay and ground cornstalks from laboratory analysis, TDN value for dried distillers grains plus solubles and corn bran assumed to be 90%.
[h] Values for corn bran provided by Dakota Gold Research Association, other values from NRC (1996).

Table 2
Dry matter, daily nutrient intake, and evaluation of treatment rations.

Item	Treatment[a,b]	
	REQ	HE
DMI, kg/d	11.1	12.2
TDN, kg/d	6.9	8.6
CP, g/d	1237	1220
RDP[c], g/d	1013	883
RUP[c], g/d	224	337
Fat, g/d	237	699
Diet evaluation[d]		
RDP balance, g/d	40	−208
RDP, % requirement	104	81
MP balance, g/d	139	291
MP, % requirement	121	143

[a] REQ=limit-fed to provide 100% TDN requirement; HE=limit-fed to provide 125% TDN requirement.
[b] Average of BW blocks formulated to meet nutrient requirements of 636 kg and 727 kg cows with 9.1 kg peak milk production.
[c] Calculated using NRC (1996) tabular values and values provided by Dakota Gold Research Association (Sioux Falls, SD) as a percentage of CP.
[d] Diet evaluation using Level 1 of NRC (1996) model.