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ABSTRACT

An experiment was replicated over 2 yr to determine the effect of additional RUP and dietary fat from dried distillers grains plus solubles (DDGS; n = 2) or wet corn gluten feed (WCGF; n = 2) before breeding on primiparous cow reproduction and calf production. Over 2 yr, 134 postpartum, primiparous cows (429 ± 5 kg initial BW) were fed 1 of 2 isocaloric, approximately isonitrogenous diets in 1 pen/yr (n = 4) providing varying levels of RUP and dietary fat. Treatments were initiated 21 (yr 1) and 60 d (yr 2) postpartum and continued for 56 (yr 1) or 16 d (yr 2) until timed AI. Diet type did not affect (P = 0.78) prebreeding BW; however, WCGF-fed cows had a greater (P = 0.03) ADG before breeding compared with DDGS-fed cows. Percentage of cows resuming estrus, becoming pregnant to AI, and becoming pregnant after bull exposure were similar (P > 0.10) between treatments. Male calf weaning BW, adjusted 205-d BW, and calf value were similar (P > 0.10) between treatments. Female calf weaning BW and calf value were also not different (P > 0.10) between treatments. Female calves from DDGS-fed cows tended to have a greater (P = 0.07) adjusted 205-d BW than calves from WCGF dams. In conclusion, WCGF in postpartum, primiparous beef cow diets improved cow ADG before breeding, and DDGS increased 205-d weaning BW of female offspring. Both DDGS and WCGF are acceptable supplements for primiparous cows and may improve beef production sustainability.

Key words: corn gluten feed, distillers grain, primiparous cow, reproduction

INTRODUCTION

Successful rebreeding of primiparous females is perhaps the most challenging aspect of beef cow reproduction. Postpartum anestrus length is controlled by numerous factors, reviewed by Short et al. (1990). Estrous cyclicity is under intricate control by the hypothalamic, pituitary, gonadal axis, which is further regulated by season, parity, suckling, and nutrition (Randel, 1990; Hess et al., 2005). Restriction of energy or CP in the pre- or postpartum period may have deleterious effects on subsequent reproduction. Dietary CP restriction before breeding was found to reduce pregnancy rate significantly in suckled beef cows (Randel, 1990).

Products of wet and dry corn milling, such as wet corn gluten feed (**WCGF**) and dried distillers grain plus solubles (**DDGS**), are good sources of CP. Further, DDGS is an excellent source of RUP as a percentage of CP, compared with WCGF and many other feedstuffs. Postpartum RUP supplementation may reduce the postpartum anestrus interval (Wiley et al., 1991; Triplett et al., 1995). Providing supplemental RUP postpartum improved first-service conception in primiparous cows (Wiley et al., 1991; Triplett et al., 1995) or had no effect on reproduction (Rusche et al., 1993; Alderton et al., 2000). The effect of RUP on early conception appears dependent on the level of RUP supplementation relative to the level of RDP in the diet. Most data indicate RUP supplementation does not affect calf weaning BW (Wiley et al., 1991; Dhuyvetter et al., 1993; Triplett et al., 1995; Strauch et al., 2001). However, recent data

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from our group indicate supplemental postpartum RUP may improve the weaning BW of calves from mature cows. Postpartum fat supplementation has produced mixed results. Research indicates postpartum fat may reduce the postpartum anestrus interval (Webb et al., 2001) and improve pregnancy rate (DeFries et al., 1998). In contrast, research has also indicated no effect of postpartum fat supplementation (Filley et al., 2000; Martin et al., 2005).

Previous experiments have provided CP supplementation for more than 60 d before breeding, which may be economically suboptimal. Current volatility in the commodity markets accentuates the need for research in short-term supplementation strategies before breeding. Thus, an experiment was conducted over 2 yr, providing 2 levels of supplemental RUP and dietary fat from corn coproducts between 16 and 56 d before breeding.

MATERIALS AND METHODS

The University of Nebraska-Lincoln Institutional Animal Care and Use Committee approved the procedures and facilities used in these experiments.

Animals and Treatments

An experiment was replicated over 2 yr to determine the effect of additional RUP and dietary fat from DDGS versus WCGF before breeding on primiparous cow reproduction and calf production. Over 2 yr, 134 postpartum, primiparous cows (429 ± 5 kg initial BW) were fed 1 of 2 isocaloric, approximately isonitrogenous diets providing varying levels of RUP and dietary fat. Dietary nutrient compositions were calculated from tabular values (NRC, 1996). Beginning in mid-November and continuing until mid-February, pregnant, primiparous cows grazed corn residue with 0.45 kg/d supplement (28% CP, DM basis). After grazing corn residue, cows were housed in a drylot and consumed a common diet (11.3 kg/d, yr 1; 12.3 kg/d, yr 2; Table 1) during the calving season and before treatment. Cows were stratified and allotted to treatment by calving date. At the beginning of treatment, cows were approximately 21 d postpartum in yr 1 and 60 d postpartum in yr 2. Treatments were imposed before breeding, beginning in early April and continuing for 56 d in yr 1, or early May and continuing for 16 d in yr 2, ending in late May each year. In yr 1, one pen of primiparous cows consumed a diet containing WCGF (12.3 kg/d; Table 1). The second pen of primiparous cows consumed a diet containing DDGS (11.9 kg/d; Table 1). In yr 2, one pen of primiparous cows consumed the diet containing WCGF (11.9 kg/d; Table 1), and one pen of primiparous cows consumed the DDGS diet (12.1 kg/d; Table 1).

Animal Management and Sampling

Blood samples were collected every other week during the feeding period in yr 1 and before and after feeding in yr 2. Samples were collected via coccygeal venipuncture and cooled immediately on ice; serum was harvested via centrifugation at 1,349 × g and frozen at −20°C until analysis. Serum progesterone concentrations were determined by direct solid-phase RIA (Coat-A-Count, Diagnostics Products Corp., Los Angeles, CA) without extraction as described by Melvin et al. (1999). Intra- and interassay CV were less than 10%. Progesterone concentration greater than 1 ng/mL was interpreted to indicate ovarian luteal activity. At all blood collections, BW was recorded.

In both years, estrus was synchronized using a controlled internal drug-releasing device (Eazi-Breed **CIDR**, Pfizer Animal Health, New York, NY), Co-Synch protocol with timed AI (**TAI**). All cows were administered a single 2-mL i.m. injection of gonadotropin-releasing hormone (Ova-Cyst, Teva Animal Health Inc., St. Joseph, MO), and a CIDR was inserted. The CIDR was removed 7 d after insertion, and all cows then received a single 5-mL i.m. injection of prostaglandin $F_{2\alpha}$ (Prostamate, Teva Animal Health Inc., or Lutalyse, Pfizer Animal Health, New York, NY). All cows received TAI approximately 66 h after CIDR removal and a single 2-mL i.m. injection of gonadotropin-releasing hormone (Ova-Cyst, Teva Animal Health Inc.). Subsequently, all cows were combined on spring pasture without a supplement and exposed to fertile bulls for a period not less than 45 d. Cows remained combined for the remainder of the grazing season until weaning. Approximately 45 d after TAI, first-service conception was assessed via transrectal ultrasonography. Final pregnancy rate was determined via transrectal palpation or ultrasonography. The calves used in this analysis were suckling during the supplementation period; thus, calf BW responses are due to changes in either dam milk production or calves' consuming dietary treatments. Calves were weaned at 187 ± 2 d of age in yr 1 and 221 ± 3 d of age in yr 2. All calves were weighed at weaning and BW was recorded.

Economic Analysis

The sale value of progeny at weaning was calculated from the Nebraska average price reported by the USDA Agricultural Marketing Service for each individual date. A price slide was calculated from historical Nebraska average prices across a range of BW classes (D. Mark, University of Nebraska, Lincoln, personal communication). Because there was a differential effect on weaning BW between sexes, economic analysis was conducted independently for each sex.

Statistical Analysis

Because treatments were applied on a pen basis, pen (n = 4; 2/yr) was considered the experimental unit for the cow performance, reproduction, and calf production data. The data were tested for year × treatment interactions, and because none was found ($P > 0.15$), the data for both years were combined. Continuous data were analyzed using the MIXED

Table 1. Composition and calculated nutrient analysis of postpartum diets fed to primiparous heifers

	DM, %					
	Yr 1			Yr 2		
		Treatment period			Treatment period	
Item	Pretreatment	WCGF	DDGS	Pretreatment	WCGF	DDGS
Corn, dry-rolled	—	12	8	—	—	—
DDGS[1]	—	—	11	—	—	10
WCGF[2]	7	14	—	14	15	—
Corn silage	27	27	27	28	26	27
Bromegrass hay	47	33	40	55	55	60
Wheat straw	—	14	14	—	—	—
Supplement	3	—	—	3	3	3
DMI, % BW	2.65	2.88	2.71	2.80	2.74	2.66
Nutrient composition						
CP, %	12.5	11.9	12.4	13.4	13.8	13.9
RUP, % CP	29.2	33.3	35.6	21.3	21.4	25.0
Crude fat, %	3.0	2.9	3.6	2.6	2.6	3.4
ME, Mcal/kg	2.5	2.5	2.4	2.3	2.3	2.3
MP[3] balance, g/d	268	345	392	270	253	329
RDP balance, g/d	11	−10	−58	273	209	179
RDP, g/d	1,002	982	955	1,302	1,306	1,237
RUP, g/d	413	490	528	353	355	413

[1]DDGS = dried distillers grain plus solubles.

[2]WCGF = wet corn gluten feed.

[3]MP = metabolizable protein.

procedure (SAS Inst. Inc., Cary, NC) and binomial data were analyzed with the GLIMMIX procedure (SAS Inst. Inc.). The statistical model included the fixed effects of treatment and year where it explained significant variation ($P < 0.15$). The model also included the random effect of pen nested within year.

RESULTS AND DISCUSSION

Cow Production and Reproduction

Cow performance and reproduction data are presented in Table 2. Primiparous cows consuming the WCGF diet had a greater ($P = 0.03$) ADG during the supplementation period. However, prebreeding BW was similar ($P = 0.78$) between treatments. The slight difference in initial BW was likely a result of allotting cows to treatment by calving date. These results disagree with most previously published data, which indicated an increase in both BW and BCS for RUP-supplemented cows (Wiley et al., 1991; Forcherio et al., 1995; Alderton et al., 2000). However, the response to RUP in those experiments appeared dependent on the level of RDP in the diet. If metabolizable protein (**MP**) is balanced, without oversupplying RDP, RUP appears to increase BW gain

Table 2. Effect of postpartum supplemental nutrition on performance and reproduction in primiparous beef cows

	Treatment[1]			
Item	DDGS	WCGF	SEM	*P*-value
n	2	2	—	—
BW at initiation, kg	435	424	5	0.11
BW at breeding, kg	451	448	9	0.78
ADG, kg/d	0.81	1.02	0.07	0.03
Cycling before breeding, %	55.5	32.0	17	0.41
Conceived to timed AI, %	72.7	64.2	5	0.48
Pregnant, %	93.9	98.5	3	0.42

[1]DDGS = dried distillers grain plus solubles. Primiparous cows were offered a drylot diet containing 10 to 11% DDGS for either 16 or 56 d before breeding in yr 1 or 2, respectively. WCGF = wet corn gluten feed. Primiparous cows were offered a drylot diet containing 14 to 15% WCGF for either 16 or 56 d before breeding in yr 1 or 2, respectively.

and potentially milk production in cows (Rusche et al., 1993; Triplett et al., 1995; Alderton et al., 2000). However, if the diet contains excess RDP, additional RUP may reduce both milk production and gain (Forcherio et al., 1995). In the current experiment, although there was no year × treatment interaction, there was a year effect on ADG (data not shown). The relative differences in ADG between the 2 yr may be related to RDP balance (Table 1). In yr 1, providing WCGF nearly balanced RDP, without providing excess N, which may explain the increased ADG. In yr 2, RDP was in excess in both diets, negating any effect of CP source in the diet. Previous literature suggests postpartum dietary fat supplementation may increase BW or BCS of cows on a positive plane of nutrition (Webb et al., 2001; Martin et al., 2005). However, additional dietary fat in the current study did not influence BW gain.

Supplementing DDGS postpartum resulted in a seemingly large increase in the percentage of primiparous cows resuming estrus before TAI; however, the difference was not statistically different ($P = 0.41$). Previous data suggest supplemental fat in the postpartum period may hasten the resumption of estrus (Webb et al., 2001). Literature on postpartum RUP supplementation has revealed numeric improvements in the percentage of cows resuming estrus as well (Wiley et al., 1991; Triplett et al., 1995), similar to the current study. Length of the postpartum anestrus interval is a major determinant of the ability of a cow to become pregnant in the subsequent breeding season (Short et al., 1990). Triplett et al. (1995) and Wiley et al. (1991) indicated a numeric reduction in the postpartum anestrus interval, which translated into improvement in the first-service conception rate. However, in the current experiment, the percentage of cows becoming pregnant to TAI was similar ($P = 0.48$) between treatments. In contrast, Dhuyvetter et al. (1993) indicated that more late-calving cows supplemented with RUP calved early in the subsequent season, perhaps indicating an improvement in first-service conception. Similar to previous literature with postpartum fat supplementation (Filley et al., 2000; Webb et al., 2001; Martin et al., 2005) and RUP supplementation (Wiley et al., 1991; Rusche et al., 1993; Alderton et al., 2000), the final pregnancy rate was similar ($P = 0.42$) between treatments.

Table 3. Effect of postpartum supplemental nutrition on performance of offspring from primiparous beef cows

Item	Treatment[1] DDGS	WCGF	SEM	*P*-value
n	2	2	—	—
Bull calves				
Weaning BW, kg	207	208	6	0.94
205-d BW, kg	210	212	4	0.70
Value, $/bull calf	584	587	8	0.73
Heifer calves				
Weaning BW, kg	208	201	13	0.69
205-d BW, kg	211	202	4	0.07
Value, $/heifer calf	539	526	8	0.21

[1]DDGS = dried distillers grain plus solubles. Primiparous cows were offered a drylot diet containing 10 to 11% DDGS for either 16 or 56 d before breeding in yr 1 or 2, respectively. WCGF = wet corn gluten feed. Primiparous cows were offered a drylot diet containing 14 to 15% WCGF for either 16 or 56 d before breeding in yr 1 or 2, respectively.

Calf Production

Calf production data are presented in Table 3. Because maternal dietary treatments affected male and female calves differently, results for each sex were analyzed independently. Male calves weaned from primiparous cows and offered a diet containing either DDGS or WCGF had similar ($P = 0.94$) weaning BW and adjusted 205-d BW ($P = 0.70$). As a result, the value of male calves suckling dams from both treatments was similar ($P = 0.73$). Female calves from DDGS-supplemented dams had similar ($P = 0.69$) weaning BW as calves from WCGF-supplemented dams. However, female calves from DDGS-supplemented dams tended to have heavier ($P = 0.07$) adjusted 205-d BW than calves from WCGF-supplemented dams. Because weaning value was calculated from actual weaning BW, the value of heifer calves suckling dams of both treatments were similar ($P = 0.21$). Previous data regarding postpartum supplementation indicate no effect of postpartum fat supplementation on calf weaning BW (DeFries et al., 1998; Webb et al., 2001; Martin et al., 2005). However, DeFries et al. (1998) found calf ADG was improved only during the postpartum fat supplementation period, indicating a transient effect of dietary fat on dam milk production. The response of calf weaning BW to postpartum dam RUP supplementation is mixed. Data indicate no effect (Wiley et al., 1991; Dhuyvetter et al., 1993; Rusche et al., 1993; Triplett et al., 1995; Alderton et al., 2000; Strauch et al., 2001) or a positive effect (Blasi et al., 1991) of RUP supplementation on calf weaning BW. Many of these studies demonstrated an increase in milk production (Blasi et al., 1991; Rusche et al., 1993; Triplett et al., 1995; Alderton et al., 2000; Strauch et al., 2001) along with a concomitant increase in calf ADG during the supplemented period. However, these responses seemed transient and were lost after the supplemental period. As indicated, only Blasi et al. (1991) showed a benefit of postpartum dam RUP supplementation to calf weaning BW. The supplemental diets in that study were offered for a period of 75 d, beginning shortly before breeding and continuing through breeding. Thus, the length of supplementation after peak lactation may have been responsible for the increase in calf weaning BW. However, diets in the current study were provided only before breeding and around the time of peak lactation. Recent unpublished data from our group indicates DDGS supplementation for approximately 45 d before breeding improves ($P = 0.03$) calf weaning BW by 9 kg compared with supplementation with dried corn gluten feed and whole corn germ. Diets in the unpublished study were formulated to be isonitrogenous and isocaloric and to contain a similar percentage of fat. Thus, the effect of DDGS supplementation on weaning BW remains unclear, but is likely related to the provision of RUP. Similar to maternal ADG, the balance between RUP and RDP (Table 1) may be important to milk production and subsequent calf weaning BW (Forcherio et al., 1995). In the current study, maternal provision of RUP in yr 1 resulted in a greater increase in calf weaning BW than in yr 2. Perhaps the differential response is related to RDP balance in yr 1 compared with the RDP excess in yr 2 or the duration of supplementation. However, the exact mechanisms behind these effects are unclear from these data. Further research is needed to elucidate the mechanisms responsible for differential responses to RUP and the appropriate duration of supplementation.

IMPLICATIONS

These data and others provide evidence that corn coproduct supplementation corrects a nutritional deficit in primiparous postpartum cows. However, the response is linked to total CP in the diet. Because WCGF is widely abundant in Nebraska at a relatively low cost, it is an attractive method to improve postpartum cow ADG. Further, DDGS is abundant, economical, and improves the weaning BW of offspring. The BW gain response noted in this study and subsequent effects on reproduction and profitability may be magnified in nutritionally challenged cows. Research aimed at identifying the appropriate level and duration of supplementation is warranted. Experimental evidence is also needed to determine how the composition of various coproduct feedstuffs is related to effects on reproduction. These data indicate corn coproducts are beneficial for reproducing females and may improve beef production sustainability.

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