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Influences of Corn Co-products in Limit-Fed Rations on Cow Performance, Lactation, Nutrient Output, and Subsequent Reproduction

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ABSTRACT

Two experiments were conducted to evaluate the effects of corn gluten feed (CGF) or dry distillers grains with solubles (DDGS) in limit-fed diets on cow performance, lactation, nutrient output, and reproduction. Cows were maintained in concrete lots with open-front sheds and fence-line bunks. In Exp. 1, Simmental cows (n = 100) were blocked by age and calving date and assigned to 12 pens. Cows were fed 4.5 kg/d of alfalfa hay and isocaloric amounts of CGF (5.9 kg/d) or DDGS (5.55 kg/d) to meet requirements. The cows fed DDGS lost 16 kg less (P = 0.008) BW and had 0.9 kg/d less (P = 0.004) milk production, which resulted in a trend (P = 0.06) for slower calf ADG than for cows fed CGF. There was no difference in manure N (P = 0.13), but cows fed CGF did have greater (P = 0.04) manure P than cows fed DDGS. In Exp. 2, Simmental cows (n = 114) were blocked by age and calving date and assigned to 12 pens. Cows were fed 2.3 kg/d of ground cornstalks and isocaloric amounts of CGF (7.7 kg/d) or DDGS (7.2 kg/d) to meet requirements. In contrast to Exp. 1, the DDGS cows tended (P = 0.07) to lose more weight than those fed CGF. In addition, no differences were detected in milk production (P = 0.20) or calf ADG (P = 0.57). In both experiments, no differences were detected in reproductive performance. Corn co-products can be included up to 75% of a limit-fed diet. The higher fat content of DDGS compared with CGF did not improve reproduction.

Key words: limit-feeding, co-product, beef cow, lactation, supplemental fat

INTRODUCTION

Feed costs account for more than 60% of the total costs associated with maintaining a beef cow and are the largest detriment to profitability for beef producers (Miller et al., 2001). The most expensive time to feed a beef cow is during the winter months, when grazing is limited or not available. Providing ad libitum access to large round bales of hay is one of the common ways of winter-feeding cows because of the ease of management. With current hay costs, ad libitum hay could cost as much as $2.50 to $3.00/cow daily or more. Hay waste potentially magnifies the cost. Miller et al. (2007) reported 40% hay waste when cows were offered free-choice access to round bales in a fence-line feeder. When corn prices were lower, researchers reported that feeding corn could reduce costs, minimize waste, and lower manure production (Driedger and Loerch, 1999; Schoonmaker et al., 2003). With higher corn prices, limit-feeding corn may not reduce costs. However, producers located near ethanol plants have the option of feeding corn co-products. Corn co-products provide an excellent source of energy, CP, and P and may provide a less expensive alternative to limit-fed corn rations. Corn gluten feed **(CGF)** has been evaluated in limit-fed cow diets (Willms et al., 1988; Tjardes et al., 1997). Firkins et al. (1985) compared wet and dry gluten feed and wet and dry distillers grains in growing and finishing rations of sheep and cattle. Limited data are available comparing CGF and dry dis-

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tillers grains with solubles (**DDGS**) in limit-fed lactating beef cow diets. One of the differences between CGF and DDGS is the fat content. Distillers grains and CGF are high in PUFA and, in particular, linoleic acid, but DDGS have 2 to 3 times as much fat as CGF (DDGS, 10.7% fat; CGF, 3.91% fat; NRC,1996). Feeding sources that contain high levels of unsaturated fatty acids have resulted in improved reproductive performance (Lammoglia et al., 1997; Bellows et al., 2001; Graham et al., 2001). Because of the similarities in composition with other oilseeds, it is plausible that DDGS could affect reproductive performance similarly to oilseeds and be a less expensive and readily available source for producers located near ethanol plants. The objective of this study was to compare the effects of CGF or DDGS in limit-fed diets on performance, lactation, manure production, and reproduction.

MATERIALS AND METHODS

Animals

Spring-calving (January to March) Simmental cows (n = 100, Exp. 1; n = 114, Exp. 2) nursing calves at the Orr Research Center (Baylis, IL) were used to determine the effects of CGF or DDGS on performance, lactation, reproduction, and manure production. Animals used in this trial were managed according to the guidelines recommended in the Guide for the Care and Use of Agriculture Animals in Agriculture Research and Teaching (Consortium, 1988). All experimental procedures followed those approved by the University of Illinois Laboratory Animal Care Advisory Committee.

Experiment 1

Management and Diets. Diet compositions, nutrient compositions, and daily intakes are shown in Table 1. Cows were fed 4.5 kg DM/d of ground alfalfa hay [81% DM; 19% CP, 3% ether extract (**EE**), 60% TDN, and 0.36% P, all on a DM basis] and either 5.9 kg DM/d of CGF (87% DM, 24% CP, 3% EE, 1.53% P, all on a DM basis) or 5.55 kg DM/d of DDGS (86% DM, 28% CP, 8% EE, 1.28% P, all on a DM basis). All cows were fed 0.45 kg DM/d of supplement (Table 2). Alfalfa hay was fed at this level to represent a moderate level of forage intake and to keep the percentage of fat in the DDGS diet from being excessively high. The CGF or DDGS was added to the diet to meet the energy requirements for maintenance and lactation of Simmental cows (approximately 600 kg) in peak milk production (NRC, 1996). The diets were not isonitrogenous, but both diets did exceed protein requirements (NRC, 1996). Cows were maintained in 11.0 × 10.7-m concrete lots with a 7 × 7-m open-front shed. Each pen had a 7.3-m fence-line bunk. Cows were blocked by parity (primiparous and multiparous) and calving date and randomly assigned within block to 12 pens after calving, resulting in 6 pens per treatment. There were 9 cows in each of the 4 pens in the primiparous blocks and 8 cows in each of the 8 pens in the multiparous blocks.

Performance, Lactation, and Reproduction Data Collection. Within 24 h of calving, cows and calves were weighed and allotted to treatments. Cows were weighed before being fed. Two trained University of Illinois personnel assigned a BCS to each cow. Calf birth weights were used as initial calf BW. Milk production was estimated using the weigh-suckle-weigh (**WSW**) technique at 54 ± 1.0 d postpartum. Using a 12-h WSW technique (Beal et al., 1990), we estimated 24-h milk production. A subsample of 6 cows (1 cow/pen at random) were milked using a commercial portable milk machine (Porta Milker, The Coburn Company Inc., Whitewater, WI) 6 h after the WSW. Cows were administered 20 US Pharmacopeia units of oxytocin (Phoenix Scientific, St. Joseph, MO) intravenously within 2 min of milking to initiate milk letdown. Milk was

Table 1. Diet composition, nutrient compositions, and daily intakes (Exp. 1 and 2)

	Treatment[1]			
	Exp. 1		Exp. 2	
Item	CGF	DDGS	CGF	DDGS
Ingredient, kg DM/d				
Dry corn gluten feed	5.9	—	7.7	—
Dry distillers grains with solubles	—	5.55	—	7.2
Alfalfa hay	4.5	4.5	—	—
Cornstalks	—	—	2.3	2.3
Diet nutrient composition, %				
CP[2]	22.1	23.8	23.1	22.7
RDP[3]	80.2	60.9	77.4	49.5
RUP[3]	19.8	39.1	22.6	50.5
Ether extract[2]	3.0	5.8	4.3	7.4
TDN[4]	73	76	76	80
Daily intake				
NE,[4] Mcal/d	18.0	18.1	18.2	18.3
Metabolizable protein,[2] g/d	997	1,356	1,053	1,464
Ether extract,[2] g/d	316	583	431	702

[1]CGF = corn gluten feed; DDGS = dry distillers grains with solubles.

[2]Calculated values based on laboratory analysis of feed ingredients.

[3]Calculated values based on tabular values of feed ingredients.

[4]Calculated values based on TDN values used for feed ingredients.

sampled and sent to Dairy Lab Services (Dubuque, IA) for compositional analysis. At 74 ± 1.0 d postpartum, dietary treatments ended, and final cow shrunk BW and calf BW were taken and final cow BCS were assigned. Cows (n = 78) were synchronized using the CoSynch+CIDR (controlled internal drug release insert, Pharmacia & Upjohn Company, Kalamazoo, MI) procedure (Bremer et al., 2004) and artificially inseminated at 78 ± 1.3 d postpartum. Twenty-two cows were not synchronized for reasons unrelated to this study. Cows were observed for return to estrus, and the cows returning to estrus were artificially inseminated a second time. After the second AI, cows were exposed for 30 d to bulls. First-service conception rates were determined via transrectal ultrasonography at 41 d after AI. Overall pregnancy rate was determined via rectal palpation 94 d after bulls were removed.

Feed and Manure Samples. The alfalfa hay was analyzed by Rock River Laboratory Inc. (Watertown, WI), and the CGF and DDGS were analyzed by Iowa Testing Labs LLC (Eagle Grove, Iowa). Tabular values of 16, 22, and 52% RUP were assumed for hay, CGF, and DDGS, respectively (NRC, 1996). Nitrogen and P levels in hay, CGF, DDGS, and supplement were used to determine N and P intake for each treatment.

Pens were scraped at the beginning of the trial. Cattle were not bedded and the lots were not covered. Manure was periodically scraped from pens, weighed, and sampled. Manure samples were stored at −20°C until they could be analyzed. Manure was analyzed for DM, N, and P concentrations by Iowa Testing Labs LLC. No corrections were made for volatilization or degradation, and no corrections were made for temperature or precipitation. Manure weights and N and P levels were used to determine manure N and P concentrations and outputs. Nutrient recovery was calculated by dividing nutrient output by nutrient intake.

Statistical Analysis. Using GLM procedures (SAS Inst. Inc., Cary, NC), we analyzed performance data as a randomized complete block design, with parity and calving date as blocking factors and pen as the experimental unit. Treatment effects were considered significant at an α level of 0.05. Only 6 cows per treatment (1 cow/pen at random) were milked to determine the treatment average component percentages; thus, milk composition was analyzed using the GLM procedure, with individual animal as the experimental unit.

Experiment 2

Management and Diets. Diet composition, nutrient compositions, and daily intakes are shown in Table 1. Cows were fed 2.3 kg DM/d of ground cornstalks (92% DM, 3% CP, 2% EE, 55% TDN, and 0.23% P, all on a DM basis) and either 7.7 kg DM/d of CGF (91% DM, 28% CP, 5% EE, 0.89% P, all on a DM basis) or 7.2 kg DM/d of DDGS (91% DM, 28% CP, 9% EE, 0.72% P, all on a DM basis). All cows were fed 0.45 kg DM/d of supplement (Table 2). The ground cornstalks were fed at 20 to 25% of DMI to maintain proper rumen function. The CGF or DDGS were added to the diet to meet energy requirements as in Exp. 1, and cows were managed as indicated for Exp. 1.

Performance, Lactation, and Reproduction Data Collection. Within 24 h of calving, cows and calves were weighed and allotted to treatment. Calf birth weights were used as initial calf BW, and cow BW after calving and before feeding were used as initial cow BW. No BCS evaluation was done in Exp. 2. Milk production was estimated using the WSW technique at 73 ± 1.0 d postpartum. Six cows from each treatment (1 cow/pen at random) were milked using a commercial milking machine (Porta Milker, The Coburn Company Inc.) to determine milk components. Collection and analysis of milk was the same as in Exp. 1. Calf weight at WSW was used to calculate calf ADG. At 77 ± 1.0 d postpartum, dietary treatments ended, and final cow shrunk BW was taken. Cows (n = 109) were synchronized using the CoSynch+CIDR procedure (Bremer et al., 2004) and artificially inseminated at 79 ± 1.0 d postpartum. Cows were observed for return to estrus, and the cows returning to estrus were artificially inseminated a second time. Following the second AI, cows were exposed for 30 d to bulls. First-service conception rates were determined via transrectal ultrasonography at 69 d after AI. Overall pregnancy rate was determined via rectal palpation 95 d after the bulls were removed.

Table 2. Composition of supplement (Exp. 1 and 2)

Item	% as fed
Corn	57.0
Base mineral[1] and Rumensin[2]	25
Limestone	17.5
Thiamine, 8.8%	0.5

[1]Contained 16% Ca, 8.1% P, 19% salt, 2.3% Mg, 2.3% K, 3,000 ppm Zn, 1,485 ppm Cu, 27 ppm Se, 240,000 IU vitamin A, 40,000 vitamin D, and 1,000 IU vitamin E.

[2]Contained 800 mg/0.454 kg of monensin (provided 200 mg/d per head of monensin).

Feed Samples. The CGF and DDGS were analyzed by Rock River Laboratory Inc., and the cornstalks were analyzed by Iowa Testing Labs LLC. Tabular values of 31%, 22%, and 52% RUP were assumed for cornstalks, CGF, and DDGS, respectively (NRC, 1996).

Statistical Analysis. Performance and milk composition data were analyzed as in Exp. 1.

RESULTS AND DISCUSSION

Experiment 1

The performance and milk production data are shown in Table 3. There were no differences in initial BW ($P = 0.79$) or BCS ($P = 0.16$) between treatments. The cows consuming CGF lost 16 kg ($P = 0.008$) more than the cows fed DDGS for the duration of the trial. The CGF cows also tended to lose more ($P = 0.06$) BCS than the DDGS cows. However, this resulted in trends only for lower final BW ($P = 0.16$) and final BCS ($P = 0.17$) for the cows fed CGF compared with the cows fed DDGS. The CGF cows also had 0.9 kg/d greater ($P = 0.004$) milk production than the DDGS cows. The greater milk production by the CGF cows resulted in a trend ($P = 0.06$) for greater calf ADG as compared with the calves nursed by the DDGS cows. The diets were formulated to be isocaloric; however, there appeared to be a shift in energy partitioning. The cows consuming DDGS had less weight loss and milk production than cows fed CGF. Kleinschmidt et al. (2006) reported that DDGS increased milk yield when compared with a control diet. However, Schingoethe et al. (1999) reported that inclusion rates of 31.2% of DDGS had no effect on milk production compared with a corn-soybean meal control diet. Kononoff et al. (2006) reported that 38% CGF diets also resulted in increased milk yield when compared with control diets. These studies evaluated inclusion rates of 5 to 35% of total ration DM. This study had inclusions of more than 55% co-product, which resulted in 5.8% fat in the DDGS diet and 3.0% fat in the CGF diet. This greater level of fat in the DDGS diet could have depressed milk production. However, in dairy cows, feeding vegetable oils at more than 5% often results in poorer fiber digestion, and frequently lower milk fat tests, but usually not in lower milk yield (Coppock and Wilks, 1991). The 2 main differences in CGF and DDGS are the fat content and the CP degradability in the rumen. The percentage of CP as RUP in DDGS is 52% and that in CGF is 22% (NRC, 1996). The apparent energy repartitioning may be related to differences in protein degradability in the rumen rather than to differences in fat. Although this study was not designed to evaluate the effects of RUP and RDP on cow BW gain and milk production, the results are in agreement with previous studies. Hunter and Magner (1988) reported that feeding a diet high in RUP resulted in repartitioning of nutrients to maternal body growth rather than milk production. Hunter and Magner (1988) attributed the repartitioning to changes in plasma insulin and plasma growth hormone. Although the exact mechanism by which RUP repartitions nutrients toward body reserves rather than milk synthesis is not known, it has been observed in multiple trials (Wiley et al., 1991; Forcherio et al., 1992, 1995; Triplett et al., 1995).

The milk composition and milk component production data are presented in Table 4. The cows that consumed CGF had a tendency ($P = 0.10$) to have a greater percentage of protein in the milk and had 0.04 kg/d greater ($P < 0.001$) production of protein than the cows fed DDGS. Schingoethe et al. (1999) reported a smaller milk protein percentage from cows fed DDGS when compared with cows fed a corn-soybean meal control diet. However, the current study compared DDGS to CGF and not to corn-soybean meal. Nichols et al. (1998) found that feeding protected Lys and Met increased milk protein yield and percentage. According to the

Table 3. Effects of type of co-product on cow performance and milk production (Exp. 1)

	Treatment[1]			
Item	CGF	DDGS	SEM	*P*-value
Initial BW, kg	594	598	9.5	0.79
Final BW, kg	575	594	8.9	0.16
BW change, kg	−19	−3	3.2	0.008
Initial BCS	6.0	5.9	0.11	0.69
Final BCS	6.1	6.2	0.08	0.17
BCS change	0.0	0.3	0.07	0.06
Milk production,[2] kg/d	10.2	9.3	0.15	0.004
Calf ADG,[3] kg/d	1.05	0.97	0.024	0.06

[1]CGF = corn gluten feed; DDGS = dry distillers grains with solubles.

[2]24-h milk production determined using the weigh-suckle-weigh technique at 54 ± 1.0 d postpartum.

[3]ADG from birth until 74 ± 1.0 d of age.

Table 4. Effects of type of co-product on milk composition and component production (Exp. 1)

	Treatment[1]			
Item	CGF	DDGS	SEM	*P*-value
Protein, %	2.75	2.59	0.059	0.10
Protein, kg/d	0.28	0.24	0.004	<0.001
Fat, %	6.07	7.56	0.655	0.14
Fat, kg/d	0.62	0.71	0.011	<0.001
Lactose, %	5.00	5.10	0.067	0.32
Lactose, kg/d	0.51	0.48	0.008	0.02
Other solids, %	5.89	5.98	0.066	0.36
Other solids, kg/d	0.60	0.56	0.009	0.01
MUN,[2] mg/dL	28.98	33.13	2.076	0.19

[1]CGF = corn gluten feed; DDGS = dry distillers grains with solubles.

[2]MUN = milk urea N.

Table 5. Effects of type of co-product on manure production and nutrient output (Exp. 1)

	Treatment[1]			
Item	CGF	DDGS	SEM	*P*-value
Manure production,[2] kg DM/d	11.39	10.94	1.010	0.76
N				
Disappearance,[3] kg/d	0.369	0.384	—	—
Manure composition, % N	1.75	1.50	0.106	0.13
N output,[4] kg/d	0.193	0.159	0.0140	0.13
% N recovered[5]	52.2	41.4	3.73	0.07
P				
Disappearance,[3] kg/d	0.116	0.097	—	—
Manure composition, % P	1.25	0.94	0.059	0.006
P output,[4] kg/d	0.142	0.101	0.0116	0.04
% P recovered[5]	122.5	104.7	10.04	0.24

[1]CGF = corn gluten feed; DDGS = dry distillers grains with solubles.

[2]Manure production is the average daily manure DM production per cow-calf pair.

[3]Disappearance calculated using laboratory analysis of N and P for hay, CGF, DDGS, and supplement.

[4]Output calculated using laboratory analysis of N and P of manure and DM weight of manure.

[5]Nutrient recovery rates were calculated by dividing nutrient output by nutrient disappearance.

NRC (1996), CGF has 1.68% of RUP as Met and 1.50% of RUP as Lys, whereas DDGS has 1.20% of RUP as Met and 2.06% of RUP as Lys. The difference in milk protein could be related to the difference in fat between CGF and DDGS. Supplemental fat often decreases the protein percentage of milk (Coppock and Wilks, 1991). Coppock and Wilks (1991) suggested 4 possible causes of smaller milk protein percentages: reduced microbial protein production, restricted availability of glucose, insulin resistance by the mammary gland that impairs amino acid transport and milk protein synthesis, or reduced release of bovine somatotropin from the anterior pituitary reduces mammary gland uptake of amino acids. Reduced microbial protein production seems the most likely because protected Lys and Met supplementation appears to alleviate the milk protein depression (Coppock and Wilks, 1991). There was no statistical difference ($P = 0.14$) in milk fat percentage between treatments; however, the cows fed DDGS had 0.09 kg/d greater ($P < 0.01$) production of fat than the cows fed CGF. One concern of feeding DDGS is the potential milk fat depression that can occur from feeding high-fat diets. In dairy cows, feeding vegetable oils often results in poorer fiber digestion and, frequently, lower milk fat tests (Coppock and Wilks, 1991). Leonardi et al. (2005) reported a linear decrease in milk fat percentage as level of DDGS increased. Kleinschmit et al. (2006) reported no difference in milk fat percentage from DDGS supplementation. There were no differences ($P =$ 0.32 and 0.36, respectively) in lactose or other solids percentages between treatments. However, the cows fed CGF did have 0.03 kg/d greater ($P = 0.02$) production of lactose and 0.04 kg/d greater ($P = 0.01$) production of other solids than the cows fed DDGS. This was primarily due to the greater milk production in the CGF-fed cows. There was no difference ($P = 0.19$) in milk urea N concentration between treatments.

There were no differences ($P = 0.76$) in manure production between treatments (Table 5). Nitrogen intake was 0.369 kg/d for cows fed CGF and 0.384 kg/d for cows fed DDGS. There were no differences in percentage of N in the manure or in kilograms of N output per day between treatments ($P = 0.13$ and 0.13, respectively). There was a trend ($P = 0.07$) for a greater percentage of N recovered in the manure from the cows fed CGF compared with the manure from the cows fed DDGS. Phosphorous intake was 0.116 kg/d for cows fed CGF and 0.097 kg/d for cows fed DDGS. The manure from the CGF-fed cows had a 0.31 percentage unit greater ($P = 0.006$) concentration of P than the manure from the cows fed DDGS. The cows fed CGF also had greater ($P = 0.04$) P output compared with the cows fed DDGS (0.142 vs. 0.101 kg/d, respectively). These are relatively high levels of P and would need to be considered with the nutrient management plan. For many soils, the manure would have increased fertilizer value; however, in some areas, the P level may limit the use of the manure.

Table 6. Effects of type of co-product on reproduction (Exp. 1)

	Treatment[1]			
Item	CGF	DDGS	SEM	*P*-value
n	35	43		
AI conception rate,[2] %	68.6	67.4	5.93	0.92
Overall pregnancy rate,[3] %	97.1	90.7	3.64	0.23

[1]CGF = corn gluten feed; DDGS = dry distillers grains with solubles.

[2]Cows pregnant to AI determined by ultrasound 41 d after AI.

[3]Cows palpating pregnant 94 d after removal of bulls.

Table 7. Effects of type of co-product on cow performance and milk production (Exp. 2)

	Treatment[1]			
Item	**CGF**	**DDGS**	**SEM**	***P*-value**
Initial BW, kg	594	600	6.0	0.47
Final BW, kg	567	563	4.5	0.55
BW change, kg	−27	−38	3.6	0.07
Milk production,[2] kg/d	10.4	9.5	0.43	0.20
Calf ADG,[3] kg/d	0.99	0.98	0.022	0.57

[1]CGF = corn gluten feed; DDGS = dry distillers grains with solubles.

[2]24-h milk production determined using weigh-suckle-weigh technique at 73 ± 1.0 d postpartum.

[3]ADG from birth until 73 ± 1.0 d of age.

Miller et al. (2007), using cows with similar genetics and in the same location as the current trial, reported P outputs of 0.062 kg/d (nearly one-half current study values) when cows were fed good quality alfalfa hay ad libitum.

The reproduction data are presented in Table 6. There was no difference ($P = 0.81$) in first-service conception rate between treatments. Both treatments resulted in approximately 70% first-service conception rates. There was also no difference ($P = 0.21$) in overall pregnancy rate between treatments.

Experiment 2

There was a tendency ($P = 0.07$) for the cows fed DDGS to lose more weight than the cows fed CGF (Table 7). This is in contrast to Exp. 1, in which CGF-fed cows lost more weight. In this study, there were no differences in milk production ($P = 0.20$) or calf ADG ($P = 0.57$). However, the numeric difference in milk production between treatments was similar to Exp. 1. In this study, the SEM for milk production was nearly 3-fold that in Exp. 1. The inclusion of corn co-products in this study was >75% of the diet. This resulted in the DDGS diet being 7.4% fat and the CGF diet being 4.3% fat. These are greater percentages of fat than in Exp. 1.

The milk composition and milk component production data are shown in Table 8. There were no differences in percentages of protein, fat, lactose, or other solids, or in milk urea N concentrations between treatments. There were also no differences in production of protein, fat, lactose, or other solids between treatments. This is a contradiction to Exp. 1, in which CGF-fed cows had greater protein, lactose, and other solids production, as well as less fat production. With no statistical difference in milk production in this study, differences in component production would be unlikely to detect. Similar to milk production, the SEM for protein, lactose, and other solids production in Exp. 2 was 3-fold the SEM in Exp. 1.

There was no difference ($P = 0.87$) in first-service AI conception rate between treatments (Table 9). Both treatments resulted in approximately 65% first-service conception rates. There was also no difference ($P = 0.80$) in overall pregnancy rate. There were also no differences in reproductive performance in Exp. 1. Feed sources containing high levels of unsaturated fatty acids have resulted in improved reproductive performance (Lammoglia et al., 1997; Bellows et al., 2001; Graham et al., 2001). Martin et al. (2007) reported improved AI conception for heifers fed DDGS compared with CGF; however, those diets were formulated to have the same levels of fat. Martin et al. (2007) hypothesized the improved conception could be due to high RUP levels. In the current study, the DDGS treatment had higher fat and RUP, but there were still no differences in reproductive performance. Further work is required to determine the potential effects of fat and RUP in DDGS on reproductive performance.

Table 8. Effects of type of co-product on milk composition and component production (Exp. 2)

	Treatment[1]			
Item	**CGF**	**DDGS**	**SEM**	***P*-value**
Protein, %	3.05	3.14	0.106	0.53
Protein, kg/d	0.32	0.30	0.014	0.38
Fat, %	4.11	4.57	0.449	0.48
Fat, kg/d	0.43	0.44	0.018	0.71
Lactose, %	5.23	5.32	0.082	0.41
Lactose, kg/d	0.54	0.51	0.022	0.30
Other solids, %	6.13	6.24	0.086	0.41
Other solids, kg/d	0.64	0.59	0.027	0.27
MUN,[2] mg/dL	28.51	30.31	1.33	0.36

[1]CGF = corn gluten feed; DDGS = dry distillers grains with solubles.

[2]MUN = milk urea N.

IMPLICATIONS

Based on these experiments, inclusion of corn co-products up to 75% of the diet can be used in limit-fed cow

Table 9. Effects of type of co-product on reproduction (Exp. 2)

	Treatment[1]			
Item	CGF	DDGS	SEM	*P*-value
n	54	55		
AI conception rate,[2] %	64.8	65.5	6.57	0.94
Overall pregnancy rate,[3] %	92.6	90.9	4.57	0.75

[1]CGF = corn gluten feed; DDGS = dry distillers grains with solubles.

[2]Cows pregnant to AI determined by ultrasound 41 d after AI.

[3]Cows palpating pregnant 94 d after removal of bulls.

diets with ground hay or ground cornstalks. The effect of CGF or DDGS on cow BW gain and milk production was variable, although both resulted in acceptable performance and first-service conception rates of >65%. The high level of fat in DDGS did not lower milk fat in cows fed DDGS. In addition, the high fat content of DDGS did not improve reproductive performance compared with cows fed CGF. Depending on the price and availability of corn co-products, utilization of CGF or DDGS in a limit-fed cow diet could be a viable winter feed option for lactating beef cows.

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