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Comparison of camelina meal and distiller's dried grains with solubles in diet of beef replacement heifers[1]

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SUMMARY

Biofuel production from different crops yields by-product meals that are available for use as protein sources for ruminant livestock. Variation in nutrient composition among meals may result in different inclusion rates to meet nutrient needs of livestock. In this study we compared distiller's dried grains with solubles (DDGS), a by-product of ethanol production, and camelina meal, a by-product of biodiesel production, as a protein source in hay-based diets for beef heifers before breeding. Diets were formulated to be similar in energy and protein content by altering the amount of protein source and corn in the diet. Heifers fed the two protein supplements performed similarly in both weight gain and reproductive performance. Both gain and reproduction were at very acceptable levels for beef heifers, indicating that both by-product meals are satisfactory protein sources in beef heifer diets.

INTRODUCTION

Feed costs affect profitability of a beef heifer development program. Use of locally available by-product feeds should be considered when prices are favorable. Distiller's dried grains with solubles are a corn by-product of the ethanol industry and have been readily available in the Northern Plains at very competitive prices to other protein sources. Camelina (*Camelina sativa*) is a drought tolerant crop that produces oil with potential as a biofuel, leaving behind a by-product meal that has potential for use as a ruminant protein source. Researchers in Wyoming fed beef heifers camelina meal at 0.33% of BW (2.1 lbs DM/d) along with bromegrass hay for 60-d before breeding and observed similar pregnancy rates to heifers fed either soybean-corn or a soybean-corn + glycerin supplement (Moriel et al., 2011). However, in this same study, when heifers not previously observed exhibiting estrus were synchronized and bred by timed AI, heifers fed camelina meal had increased conception rates. To further evaluate diets containing biofuel by-products for replacement heifers, we compared camelina meal and DDGS in diets fed for approximately 2-3 months before breeding on growth and reproductive performance of beef heifers.

MATERIALS AND METHODS

These studies were conducted at the Cottonwood Research and Extension Center near Phillip, SD. All studies were approved by the SDSU Institutional Animal Care Committee and followed guidelines in Guide for the Care and Use of Agricultural Animals in Research and Teaching.

Before the study each year, a composite sample of corn, camelina meal and DDGS were collected and

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analyzed for DM, ash, CP, soluble CP, ADF, NDF, acid detergent soluble CP, neutral detergent soluble CP, lignin, starch, simple sugars, ether extract (fat), and total and individual fatty acids at a commercial laboratory (Dairy One Forage Testing Laboratory, Ithaca, NY; Table 1; ash, acid detergent soluble CP, neutral detergent soluble CP, lignin, starch, and simple sugars not reported). A representative hay sample was analyzed for DM, ash, CP, ADF, and NDF. Laboratory analysis of the initial feed sample was used to balance diets to similar energy and protein content using the Large Ruminant Nutrition System (available at http://nutrition models.tamu.edu/lrns.html).

Year 1

Beginning March 19, 2013, 110 heifers were blocked by weight (BW = 661 ± 28 lbs) into 5 pens per treatment. Heifers were fed a diet consisting of millet hay, corn and either distiller's grains with solubles or cold-pressed camelina meal (Table 2) for 78-d. Heifers were fed once daily in concrete feed bunks, with the concentrate mix fed in the morning and hay provided after the concentrate mix was consumed. Hay was fed at a level to maintain a consistent proportion of dietary ingredients. The quantity of concentrate and hay offered was adjusted to a level to allow daily cleanup of feed in the bunk. A mineral-vitamin mix was provided free-choice in each pen.

Heifers were weighed after an overnight shrink on d 1 and 72 of the study. Final weight was determined on d 72, but heifers remained on their treatment diets through d 79, the day of artificial insemination. Body condition score was determined on d 72 and at fall pregnancy check using a 1 to 9 scale (1 = emaciated to 9 = obese) by a single technician.

On d 1, 62, and 72, blood was collected by jugular venipuncture, centrifuged and serum stored for later analysis of progesterone to determine attainment of puberty. Heifers with serum progesterone concentrations of greater than 1 ng/mL at any of three bleeding dates were considered to have reached puberty.

On d 72, heifers began a 5-d CO-Synch + CIDR® fixed time AI protocol. Heifers received 100μg as 2 mL GnRH and a CIDR was inserted. Five days later, CIDRs were removed and heifers received 25 mg as 5 mL of prostaglandin F2α with a second dose 8 h later. Heifers were bred by AI 72 h after the first prostaglandin injection. One day after breeding heifers were transported to the Fort Meade grazing allotment near Sturgis, SD. Fourteen days later, three bulls were placed in the pasture with the heifers and remained for the next 46-d. Conception to AI or natural service was determined by crown-rump length using transrectal ultrasonography 96-d after AI.

During the study, feed samples were collected once per week and composited monthly for chemical analysis at the SDSU Ruminant Nutrition Laboratory. Samples were ground to pass a 1 mm screen in a Wiley mill and analyzed for DM, ash, ADF, NDF, and CP.

Year 2

Beginning April 8, 2014, 88 heifers were blocked by weight (BW = 719 ± 29 lbs) into 4 pens per treatment. Heifers were fed a diet consisting of grass hay, corn and either distiller's grains with solubles or cold-pressed camelina meal (Table 2). For 59-d, heifers were fed once daily in concrete feed bunks, with the hay fed in the morning and concentrate provided in the afternoon. Hay was fed at a level to maintain a consistent proportion of dietary ingredients. The quantity of concentrate and hay offered was adjusted to a level to allow daily cleanup of feed in the bunk.

Heifers were weighed after an overnight shrink on d 1 and 51 of the study. Final weight was determined on d 51, but heifers remained on their treatment diets through d 59, the day of artificial insemination. Body condition score was determined on d 51 and at fall pregnancy check using a 1 to 9 scale by a single technician.

On d 1, 41 and 51, blood was collected by jugular venipuncture, centrifuged and serum stored for later analysis of progesterone to determine attainment of puberty. Heifers with serum progesterone concentrations of greater than 1 ng/mL at any of three bleeding dates were considered to have reached puberty.

On d 51, heifers began a 5-d CO-Synch + CIDR® fixed time AI protocol that was the same as year 1. One day after breeding heifers were transported to the Fort Meade grazing allotment. Thirteen days later, three bulls were placed in the pasture with the heifers and remained for the next 46-d. Conception to AI or natural service was determined by crown-rump length using transrectal ultrasonography 123-d after AI.

Feed sampling and laboratory analysis was similar to Year 1.

Statistical analysis

Due to differences in diet composition and length of feeding, data from the two years were analyzed separately. Weight data was analyzed as a completely random design with pen as the experimental unit using the mixed model procedure in SAS (SAS Inst. Inc., Cary, NC). Puberty and pregnancy data were analyzed using the GLIMMIX procedure. Treatments were considered significantly different at a value of $P < 0.05$.

RESULTS AND DISCUSSION

The cold-pressed camelina meal used in this study contained greater concentrations of CP and EE than the DDGS (Table 1). Solubility of CP was also greater in the camelina meal than DDGS. In addition to slightly greater total fatty acids, the fatty acid profile of camelina meal differed from DDGS, with a greater proportion of linolenic acid and lower proportion of oleic and linoleic acids. Difference in nutritional content of the protein sources required that camelina meal-based diets have less of the test protein source and greater amount of corn to balance for energy and protein (Tables 2 and 3).

Year 1

Dry matter intake averaged 15.9 lbs per day, which was 2.24% of BW (Table 3). Because pens were offered feed at a similar proportion of average body weight, dry matter intake was not considered a response variable. Heifer weight gains averaged 1.21 ± 0.05 lbs/d (Table 4) and final BW was 749 ± 28.1 lbs (Table 4); neither differed between dietary treatments. Additionally, no difference was detected for BCS (5.2 ± 0.06) at breeding or at fall pregnancy check between treatments.

None of the reproductive measures differed between heifers fed camelina meal or DDGS (Table 5). Ninety percent of the heifers were pubertal before breeding, 59% conceived to artificial insemination and 88% were pregnant at the fall pregnancy check.

Year 2

Heifers consumed an average of 19.3 lbs of feed per day, which was 2.54% of BW. Final BW averaged 804 ± 31.2 lbs and was not affected by dietary treatment (Table 4). Average daily gain (1.66 ± 0.09 lbs/d) did not differ with dietary treatment.

The number of heifers that had reached puberty before breeding, conception to AI, and overall pregnancy rates did not differ between treatments (Table 5). Eighty-eight percent of the heifers were pubertal at breeding, 53% conceived to AI, and 86% became pregnant during the breeding season.

Our data suggests that camelina meal has the potential to serve as a feed resource for beef replacement heifers with no adverse effect on weight gain or pregnancy rates when compared to the use of DDGS as a protein source. Heifers fed both diets had high reproductive performance and diets are acceptable for use in a heifer development program.

LITERATURE CITED

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Table 1. Nutrient composition of camelina meal and dried distiller's grains with solubles (DDGS) used in diets fed to beef heifers before breeding.

	Camelina meal	DDGS
YEAR 1		
CP, % of DM	40.9	30.8
Soluble CP, % of CP	74.5	20.2
NDF, % of DM	31.1	21.7
ADF, % of DM	17.8	9.2
EE, % of DM	12.1	9.0
Total fatty acids (TFA), % of DM	10.8	9.4
Oleic acid, % of TFA	16.8	27.1
Linoleic acid, % of TFA	22.6	53.1
Linolenic acid, % of TFA	28.0	1.7
YEAR 2		
CP, % of DM	41.4	33.8
Soluble CP, % of CP	60.0	15.2
NDF, % of DM	24.5	24.9
ADF, % of DM	11.9	13.2
EE, % of DM	14.9	9.3
Total fatty acids (TFA), % of DM	11.6	8.6
Oleic acid, % of TFA	18.8	25.8
Linoleic acid, % of TFA	22.7	53.2
Linolenic acid, % of TFA	22.0	2.2

Table 2. Ingredient composition of diet containing either camelina meal or dried distiller's grains with solubles (DDGS) offered during the study.

	-------------------Diet------------------------	
	Camelina meal	**DDGS**
YEAR 1	--------% of DM-------------	
Millet hay	73.2	73.4
DDGS	-	14.6
Camelina meal	9.4	-
Corn	17.4	12.0
YEAR 2		
Grass hay	65.0	65.7
DDGS	-	13.0
Camelina meal	10.4	-
Corn	24.6	21.3

Table 3. Nutrient composition and DM intake of diets containing either camelina meal or dried distiller's grains with solubles (DDGS) fed to beef heifers before breeding

	Camelina meal	**DDGS**
YEAR 1	-----------------------------% DM--------------------------------	
CP	9.3	9.6
NDF	52.6	54.7
ADF	29.5	29.3
DMI, lbs/d	16.0	15.8
DMI, % of BW	2.27	2.24
YEAR 2		
CP	10.2	10.4
NDF	49.7	50.1
ADF	27.1	27.0
DMI, lbs/d	19.3	19.3
DMI, % of BW	2.54	2.54

Table 4. Performance of heifers receiving diets containing camelina meal or dried distiller's grains with solubles (DDGS) before breeding.

	Protein source			
	Camelina meal	DDGS	SE	P-value
YEAR 1				
Number of heifers	55	55		
BW, lbs				
Day 0	661.3	660.5	28.1	0.99
Day 72	746.1	752.3	28.1	0.88
ADG, lbs/d	1.17	1.26	0.05	0.24
BCS				
Day 72	5.2	5.2	0.06	1.00
At fall pregnancy check	5.3	5.2	0.08	0.41
YEAR 2				
Number of heifers	44	44		
BW, lbs				
Day 0	719.9	718.8	29.2	0.98
Day 51	798.3	809.7	31.2	0.80
ADG, lbs/d	1.54	1.78	0.09	0.11
BCS				
Day 51	5.0	5.1	0.13	0.73
At fall pregnancy check	5.3	5.3	0.08	0.85

Table 5. Reproductive performance of heifers fed diets containing camelina meal or dried distiller's grains with solubles (DDGS) before breeding.

	Protein source			
	Camelina meal	DDGS	SE	P-value
YEAR 1	----------------------%----------------------			
Pubertal before synchronization	87.3	92.7	3.9	0.33
Conception to AI	61.8	56.4	6.7	0.57
Overall pregnancy rate	90.9	85.4	4.2	0.35
YEAR 2				
Pubertal before synchronization	90.9	84.1	4.9	0.33
Conception to AI	54.6	50.7	7.4	0.71
Overall pregnancy rate	86.4	86.1	5.2	0.98