Influence of the level of dried distillers grains with solubles on feedlot performance, carcass characteristics, blood metabolites, and semen quality of growing rams[1]

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The objectives of this research were to determine the influence of dried DDGS on feedlot performance, carcass characteristics, semen quality, and testosterone concentrations of growing rams. Results indicate that semen quality may be affected by increasing concentrations of DDGS in rations fed to growing rams.

INTRODUCTION

In the past 10 years, ethanol production has increased from 1.5 million gallons per year to approximately 9 million gallons per year in the United States (Renewable Fuels Association, 2010). With this expansion brings an affordable and viable feed source for ruminants, dried distillers grains with solubles (DDGS). Anecdotal reports from the feed industry have reported that growing bulls and rams should not be fed DDGS, due to a fear of a negative effect on reproductive performance. To our knowledge, there is no research currently available describing the effect of DDGS feeding on male reproductive performance.

Research involving the feeding of DDGS to ruminants has become more prominent in the past few years due to the rising costs of feedstuffs, particularly corn. Compared with non-supplemented heifers, dried distiller's grains supplemented heifers had increased ADG and reduced forage intake (MacDonald et al., 2007). However, during the growing and finishing phase DDGS fed to steers at 30% of the diet did not affect any performance variable or carcass characteristic (Leupp et al., 2009). Similarly, Schauer et al. (2008) and Neville et al. (2010) observed no negative effects on finishing lamb performance or carcass characteristics when fed DDGS at 60%.

While we are not aware of research evaluating the effects of DDGS feeding on male reproductive performance, there is some research available on feeding increased dietary CP to growing males (an artifact of increasing DDGS in rations, as DDGS is relatively high in CP). Rams fed a high energy and protein diet had increased testosterone concentrations at the beginning of the trial, but as the trial duration increased, the differences in testosterone concentrations were reduced (Martin et al., 1994). Hotzel et al. (1998) observed an increase in testosterone concentrations in Merino rams fed a diet above maintenance requirements.

Therefore, we hypothesized that feeding increasing levels of DDGS would have no deleterious effects on ram feedlot performance, carcass characteristics, and semen quality, but would increase testosterone concentrations.

PROCEDURES

All procedures were approved by the Animal Care and Use Committee of North Dakota State University. This study was conducted at the Hettinger Research Extension Center in Hettinger, North Dakota.

Animals and Diets. One hundred twenty crossbred rams (western whiteface x Suffolk; approximately 90 d of age) were used in a completely randomized design to determine the effects of DDGS on feedlot performance, carcass characteristics, semen quality, and testosterone concentrations of growing rams. Rams were allotted into one of four dietary treatments (n = 4 pens/treatment; 10 rams/pen; Table 1): 1) **CON**: 85% corn and 15% commercial market lamb pellet; 2) **15DDGS**: 15% DDGS substituted for corn (DM basis); and 3) **30DDGS**: 30% DDGS substituted for corn (DM basis). Rams were fed a ground ration (grinder-mixer) ad-libitum via self-feeders. Rams had continuous access to water and shade. Rams were weighed on two consecutive days at the beginning (d 0, 1) and end of the trial (d 96, 97 and d 116, 117), and weighed on a single day every 28 d. Scrotal circumference was measured on d 84, 96, and 116 of the trial. Two slaughter dates were utilized for the trial. The first slaughter date included all rams weighing at least 67 kg except those involved with the semen quality and testosterone portions of the trial. The second slaughter date included all remaining rams on trial. At completion, rams were shipped to Superior Farms in Denver, CO for carcass data collection. One ram was removed from the trial prior to being shipped for slaughter due to non-treatment related purposes (antibiotic withdrawal time).

Semen Quality. Semen was collected on forty-eight rams (a sub-sample of the 120 rams in the feedlot study described above; 4 rams/pen; 16 rams/treatment; n = 4). Semen from each of the rams was collected on d 84, 98, and 112 of the study. Motility, a subjective motility score, and concentration of sperm in the ejaculate via a hemocytometer on the fresh ejaculate sample were used to determine semen quality.

Testosterone. The forty-eight rams (4 rams/pen; 16 rams/treatment; n = 4) utilized in semen collection were used to collect testosterone concentrations. Blood samples were collected via a 20 gauge x 1 inch vacutainer needles into serum separator 16 x 100 mm tubes. Every 14 days throughout the duration of the trial, a 10 mL blood sample was collected via jugular venipuncture of each ram and immediately placed on ice until serum could be harvested post-centrifugation. Serum was frozen at -20ºC until analysis could be accomplished.

Statistical Analysis. Ram feedlot performance, carcass characteristics, and scrotal circumference were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Pen served as the experimental unit. The fixed effect included in the model was dietary treatment. The fixed effect of day was utilized in the REPEATED measures analysis for testosterone concentrations, spermatozoa concentration, and the subjective semen score. The model included the fixed effects of dietary treatment, week, and treatment x week. When a significant *F*-test was observed ($P \leq 0.15$), pre-planned comparisons of linear and quadratic contrasts were utilized to partition treatment effects. Significance was determined at $P \leq 0.05$. All interactions that were not clearly significant ($P \geq 0.20$) were removed from the model. To partition day effects and treatment × day interactions, LS Means was utilized ($P \leq 0.05$).

RESULTS AND DISCUSSION

Feedlot and Carcass Characteristics. Final BW and days on study were not affected ($P \geq 0.50$) by dietary treatment (Table 2). Average daily gain increased linearly ($P = 0.02$) with the addition of DDGS in the diet. Previous research has also suggested that lambs consuming rations containing DDGS have increased ADG compared with those lambs consuming no DDGS (Schauer et al., 2008). Overall, DMI increased linearly ($P < 0.001$) as the amount of DDGS was increased in the ration. These results are similar to those observed by Schauer et al. (2008) when DDGS inclusion was increased to 60% of the ration as a replacement for barley. However, G:F was reduced linearly ($P < 0.001$) with the inclusion of DDGS in the diet. Although there were some significant differences, the DDGS did not cause any overall deleterious effects on feedlot performance. This is indicated by the lack of differences in the amount of days on trial among the dietary treatments.

Hot carcass weight, dressing percentage, ribeye area, 12th rib fat thickness, body wall thickness, leg score, overall conformation, flank streaking, quality grade, yield grade, and percent boneless, closely trimmed retail cuts were not affected ($P = 0.26$; Table 2) by dietary treatment. These results were similar to Schauer et al. (2008) and Neville et al. (2010) in which there were no deleterious effects on carcass characteristics with DDGS inclusion in the diet.

Reproductive Traits. Change in scrotal circumference was not significant ($P = 0.61$) due to dietary treatment (Table 2). Contrary to the results in the current study, Martin et al. (1994) noted an increase in scrotal circumference in the high protein and energy fed rams compared with the low energy and protein fed rams. Hötzel et al. (1998) observed an increase in the change in scrotal circumference throughout the study in the rams fed to have increased rate of gain. Similar results were also observed in bulls, in which bulls fed increased energy diets (Coulter and Kozub, 1984). Although TDN was not different between diets, the CP of the diets increased with the increasing DDGS. Therefore, the results in the current study were not expected. There was a day effect ($P < 0.001$; Figure 1) for testosterone concentrations. This was expected as rams became more mature throughout the study; therefore, the testosterone concentrations would be expected to increase as the rams reached maturity. Testosterone concentrations were decreased in mature Merino rams fed a sub-maintenance diet compared with those fed a supra-maintenance (Hötzel et al., 1998). Martin et al. (1994) observed similar results to Hötzel et al. (1998), in which the high and intermediate energy and protein fed rams had increased testosterone concentrations compared with the low energy and protein fed rams.

Spermatozoa concentration decreased linearly ($P = 0.05$; Table 2) as DDGS increased in the diet. The rams fed the DDGS at both 15 and 30% had numerically reduced spermatozoa numbers compared with the rams that were not fed any DDGS. Coulter and Kozub (1984) observed a reduction in epididymal spermatozoa reserves and motility in bulls fed a high energy diet. The current results as well as previous research (Kozub and Coulter, 1984), may suggest increased protein and/or fat cause a reduction in spermatogenesis. This may be due to increased fat deposits around the seminiferous tubules. The spermatozoa motility score not affected (P = 0.23) by DDGS level (Table 2).

IMPLICATIONS

Much of the previous research with male reproductive performance has occurred in mature rams and bulls. Therefore, much of the data does not include growing rams as they approach and reach puberty. The current research suggests that feedlot rams can be fed up to 30% on DM basis of DDGS without causing deleterious effects to feedlot performance and carcass characteristics. However, care must be taken when feeding DDGS to growing rams due to a possible reduction in spermatozoa concentration, especially when included at 15% of the diet or higher. Further research is needed to elucidate why semen quality may be affected and if actual fertility of rams is compromised by feeding increasing concentrations of DDGS.

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Table 1. Ingredient and nutritional composition of diets fed to feedlot ram lambs (DM basis).

	Dietary Treatment[1]		
Item	CON	15DDGS	30DDGS
Ingredient, %			
Corn	85	70	55
DDGS[2]	—	15	30
Commercial market lamb pellet[3]	14.8	14.3	13.8
Calcium carbonate	0.2	0.7	1.2
Nutritional Composition, % DM			
TDN	84.6	84.6	84.3
CP	13.8	16.0	19.4
Ash	4.7	5.5	6.4
NDF	18	22.2	26.1
ADF	4.6	5.5	5.7
Crude Fat	2.3	3.7	4.6

[1]CON: 85% corn and 15% commercial market lamb pellet; 15DDGS: 15% DDGS substituted for corn on a % DM basis; and 30DDGS: 30% DDGS substituted for corn on a % DM basis.
[2]Dried distiller's grains with solubles.
[3]Commercial Market Lamb Pellet contained: 0.22 g/kg Chlortetracycline; 38.0% CP; 3.75-4.75% Ca; 0.6% P; 3.0-4.0% salt; 1.2 ppm Se; 52,863 IU/lb Vitamin A; 5,286 IU/kg Vitamin D; and 209 IU/kg Vitamin E.

Table 2. Effects of dried distiller's grains with solubles on feedlot performance and carcass characteristics of growing rams.

	Dietary Treatment[1]					*P*-value[4]	
Item	CON	15DDGS	30DDGS	SEM[2]	*P*-value[3]	Linear	Quadratic
Initial BW, lb	91.03	89.56	89.03	3.11	0.89	0.65	0.90
Final BW, lb	184.40	185.17	190.33	3.91	0.50	0.28	0.64
ADG, lb/d	0.96	0.98	1.04	0.02	0.06	0.02	0.52
DMI, lb/head/d	4.53	5.16	5.58	0.14	0.001	< 0.001	0.55
Days on study, d	109	108	107	1.59	0.54	0.27	0.90
G:F, lb of gain/lb of DMI	0.43	0.38	0.38	0.01	< 0.001	< 0.001	0.09
HCW, lb	91.91	93.74	93.82	2.46	0.81	0.57	0.77
Dressing %	49.95	50.41	50.13	0.37	0.67	0.72	0.41
REA, in^2	3.05	3.09	3.08	0.07	0.90	0.74	0.74
12th rib fat thickness, in	0.22	0.22	0.21	0.01	0.88	0.69	0.76
Bodywall thickness, in	1.05	1.11	1.13	0.04	0.26	0.11	0.70
Leg score[5]	11.60	11.98	11.69	0.25	0.54	0.80	0.29
Overall conformation[5]	11.60	11.96	11.80	0.21	0.47	0.49	0.32
Flank streaking[6]	350.79	374.88	356.86	11.57	0.30	0.70	0.14
Quality grade[5]	11.56	11.89	11.82	0.16	0.29	0.24	0.30
Yield grade	2.55	2.56	2.48	0.14	0.88	0.69	0.76
BCTRC,[7] %	44.98	44.73	44.87	0.30	0.84	0.79	0.60
Scrotal circumference change, in	0.59	0.49	0.68	0.74	0.61	0.65	0.39
Spermatozoa concentration[8]	91.8	69.3	63.0	10.17	0.13	0.05	0.52
Spermatozoa motility score[9]	3.3	2.8	2.7	0.23	0.23	0.12	0.52

[1]CON: 85% corn and 15% commercial market lamb pellet; 15DDGS: 15% DDGS substituted for corn (DM basis); and 30DDGS: 30% DDGS substituted for corn (DM basis).

[2]n = 4.

[3]*P* -value for the F test of the mean.

[4]*P*-value for linear and quadratic effects of increasing dried distillers grains with solubles.

[5]Leg score, conformation score, and quality grade: 1 = cull to 15 = High Prime.

[6]Flank streaking: 100-199 = practically devoid; 200-299 = traces; 300-399 = slight; 400-499 = small; 500-599 = modest.

[7]Percent boneless, closely trimmed, retail cuts (% BCTRC) = [49.936 – (0.0848 × 2.204 × Hot Carcass Weight, kg) – (4.376 × 0.393 × 12th rib fat thickness, cm) – (3.53 × 0.393 × body wall thickness, cm) + (2.456 × 0.155 × LM area, cm2)].

[8]Spermatozoa concentrations were measured as hundreds of millions per milliliter. The hemocytometer has a counting chamber volume of 1 cubic millimeter. Five large squares were counted for each ejaculate sample, the four corner squares, and the middle square. To calculate the spermatozoa concentration: Total number of sperm counted x dilution factor x hemocytometer factor x conversion factor. The dilution rate was 1:200, the hemocytometer factor was 50, and the conversion factor (converted units to spermatozoa/cubic centimeter, or ml) was 1,000.

[9]Spermatozoa motility score: 1 = no forward movement to 4 = fast forward movement.

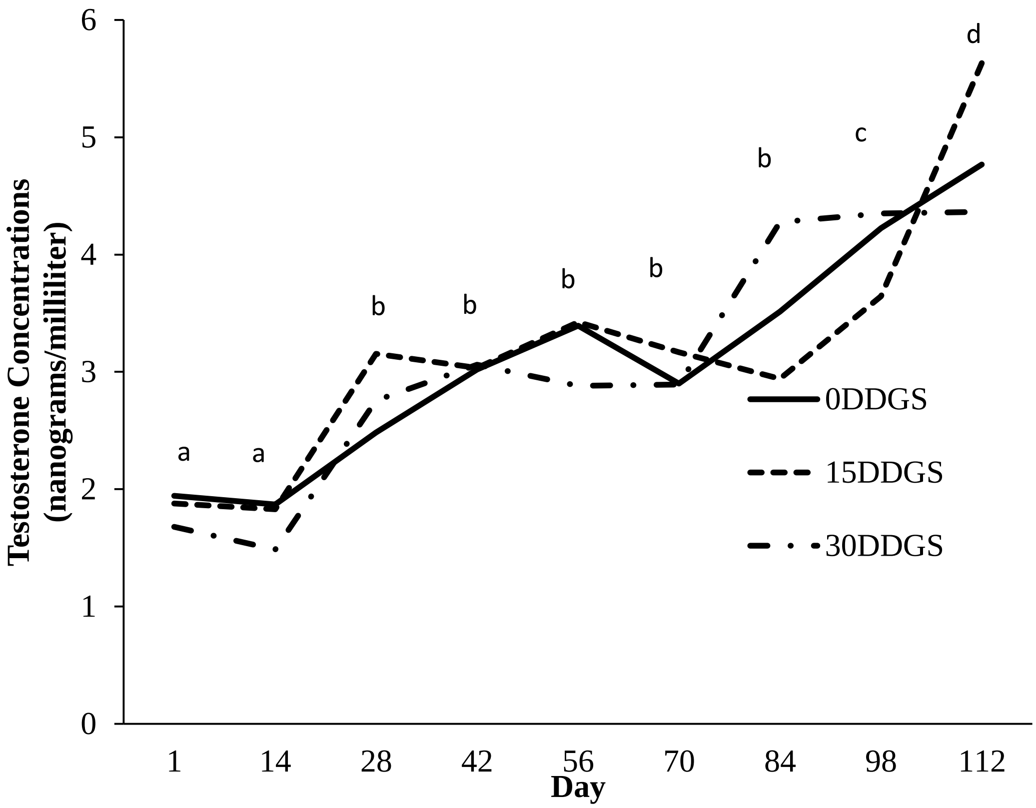

Figure 1. The effects of dried distillers grains with solubles on testosterone concentrations of growing ram lambs. Treatments included CON: 85% corn and 15% commercial market lamb pellet; 15DDGS: 15% DDGS substituted for corn (DM basis); and 30DDGS: 30% DDGS substituted for corn (DM basis). *P*-values: treatment, $P = 0.97$; day, $P < 0.001$; treatment x day, $P = 0.86$.