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Effects of Dried Distillers Grains with Solubles on Performance and Carcass Characteristics of Lamb

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Abstract

The effect of including two levels of dried distillers grains plus solubles (DDGS) in formulated diet on performance, and carcass characteristics of lambs was studied. Twenty-four Gulf Coast wether lambs (46.1 ± 1.2 kg initial BW, and 8 to 9 months of age) were divided into two groups based on their live body weight and randomly allocated to dietary treatments (2 per treatment; 4 lambs/pen; 8 lambs per treatment). Treatment diets containing DDGS at 0 (control), 12.7, or 25.4% on a DM basis were fed lambs. Basal diet contained dry-rolled corn, soybean meal, and fescue/bermuda grass hay. Dry Distillers grains with solubles was added to the finishing diets at either 12.7or 25.4% of the dietary DM to replace corn and SBM in basal diet. The concentrate mixes containing DDGS were formulated to be isonitrogenous and isocaloric to meet the NRC requirements of lamb. After 135-d feeding period final BW was recorded, then animals were slaughtered, and carcass parameters collected after a 48-h postmortem. Lamb performance and carcass quality data were analyzed using the GLM procedures. Dry matter intake and final BW of lambs were not different between treatment. Also, no differences were observed between treatments in hot and cold carcass wt, body wall fat, rib eye area, 12th rib fat, and kidney and pelvic fat depots. However a significant decrease ($P \leq 0.05$) in average daily gain was found in lambs fed 0% DDGS diet compared to those fed 12.7 and 25.4% DDGS diets. These results supported the hypothesis that substitute of corn and SBM by up to 25.4% DDGS can be fed to lamb without adverse effect on carcass characteristics.

Keywords: Distillers dried grains with solubles, lamb, growth.

Introduction

Dry Distillers grains with solubles (DDGS) is the major co-product of ethanol production from corn. It contains more than 30% crude protein with approximately 55% ruminally undegradable protein and 2.25 Mcal/kg net energy (Schingoethe et al., 2009). However, it contains high fiber (~ 46% NDF) which negatively affects DDGS digestibility. The composition of DDGS is an ideal supplement for ruminants consuming low-to moderate-quality forages (NRC, 2000; Stock et al., 2000; Spiehs et al., 2002; Archibeque et al., 2008; Jacob et al., 2008; Klopfenstein et al., 2008; Van Emon et al., 2008; Leupp et al., 2009; Koger et al., 2010). However, DDGS are relatively low in rumen-degradable protein (DIP; 27.2% of CP) and relatively high in undegraded intake protein (UIP) (Archibeque et al., 2008; NRC, 2000). Hence, when DDGS are fed at levels of 6 to 15% of diet DM, their primary purpose is to serve as a protein source, and when fed at greater levels, DDGS become a source of energy (Klopfenstein, 2001).

The growth in the biofuel industries and subsequent development of dry-milling production facilities (Renewable Fuels Association, 2009; Gunn et al., 2010; Koger et al., 2010) resulted in volatile futures markets and increased grain costs traditionally used in feedlot diets (Gunn et al., 2010; Schmit et al., 2009). Consequently, to sustain profitability and thrive within their respective industries, livestock producers from all sectors began to seek ways to reduce feed costs, particularly the usage of by-products such as DDGS, which can be used as a substitute for energy and protein sources in beef cattle diets (Stock et al., 2000, Archibeque et al., 2008; Klopfenstein et al., 2008; Vander et al., 2009; Gunn et al., 2010; Whitney and Lupton, 2010a).

Limited data is available on carcass characteristics of livestock fed DDGS (Depenbusch et al., 2008); and to our best

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knowledge, there is no current data available on carcass characteristics of lambs fed DDGS in general, and carcass characteristics when 25% DDGS (DM basis) included in growing wether lambs diets in particular. Therefore, it was hypothesized that up to 25.4% DDGS inclusion would not have an adverse effect on the carcass of finishing lambs. The specific objective was to determine the influence of feeding DDGS on DMI, final BW, ADG, and carcass characteristics of meat sheep including hot and carcass weight, 12th rib fat thickness, body wall fat thickness, kidney and pelvic fat depots, and rib muscle area.

Material and Methods

All animal care and handling procedures followed the farms' written guidelines set forth by FASS (1999) and all procedures involving animals were approved by the Animal Care and Use Committee of Alabama A&M University (AAMU).

Experimental Animals and Facilities

The objective of this study was to evaluate the effects of feeding of three levels DDGS on growth performance and carcass characteristics of wether lambs. The study was conducted at AAMU Winfred Thomas Agricultural Research Station. A total of twenty-four Gulf Coast wether lambs (46.1 ± 1.2 kg initial BW; 7-8 months age) were randomly assigned to three experimental diets. Before initiation of this study, lambs were vaccinated for clostridial disease (Convexin 8, Schering-Plough, Kenilworth, NJ). During the trial, lambs were grouped and housed in pens (4 lambs/pen) equipped with plastic feeders and water buckets. Experimental diets were offered ad libitum once daily with free access to water. Feeders were checked daily and cleaned of contaminated feed (e.g., fecal contamination, wet feed caused by precipitation). Feed refusals were weighed, dried, analyzed for DM, and used to calculate DMI, and animal weights were recorded every 28 d.

Experimental Design and Treatments

Lambs were grouped by weight and randomly allocated within blocks to three experimental diets. Treatments had two replicates of four lambs each (n = 8/dietary treatment). A basal diet containing dry-rolled corn, SBM, and hay was fed as the control diet (Table 1). Dry Distillers grains with solubles was added to the finishing weather diets at either 12.7or 25.4% of the dietary DM to replace corn and soy bean meal (Table 1). The experimental diets were formulated to be isonitrogenous and isocaloric (on a NEg basis) and to meet or exceed the NRC (2007) requirements of a finishing lamb. Lambs were allowed 7-day adjustment period and 7- day transition period to the experimental diets followed by 135 d feeding period.

Data Collection Procedures

Initial and final body weights were the average of two body weights taken on consecutive days. After the 135-d feeding period, lambs were transported (346 km) to Auburn University

Table 1. Ingredient and chemical composition of different concentrates containing fescue/bermuda grass hay and varying levels of dried distillers's grains with solubles (DDGS) fed to finishing lambs[1].

Item	Composition of treatment diets		
	Treatment diets, DDGS (%)		
	0% (control)	12.7%	25.4%
	Amount, %		
Concentrate	63.0	64.4	63.8
Fescue/Bermuda grass hay	37.0	35.6	36.2
Total	100	100	100
Concentrates ingredients, % of DM			
Cracked corn	46.3	40.3	32.5
Soy Bean Meal (48% CP)	12.2	6.9	1.4
DDGS	---	12.7	25.4
Molasses (Black strap)	3.2	3.2	3.2
Sheep Premix2	1.3	1.3	1.3
Nutrient composition of treatment diets, g/100g DM			
Dry Matter	87.0	88.4	89.0
Crude Protein	14.0	14.1	14.0
Ether Extract	2.9	3.0	4.0
Neutral Detergent Fiber	31.8	31.9	31.9
Acid Detergent Fiber	14.0	15.1	15.0
Hemicellulose	17.0	17.0	17.4
Ash	4.0	4.1	4.6
Phosphorus	0.39	0.40	0.42
Sulfur	0.18	0.30	0.30

[1]All values are on dry matter basis except dry matter (unless otherwise indicated).
[2] (%) Ca 9.0, P 8.0, Salt 41.0, K 0.10, Mg 1.0; (ppm) Cu 1,750, Se 25.0, Zn 7,500, and (IU/kg) Vitamin A 308,644, Vitamin D 24,251 and Vitamin E 1,653.

Lambert-Powell Meat Laboratory (Auburn, AL) for slaughtering and subsequent carcass data collection. Carcass quality characteristics collected by trained personnel at 48-h postmortem (temperature <2 C, humidity near 100%), included final hot and cold carcass weight, 12th rib fat thickness, body wall fat thickness, kidney and pelvic fat depots, and rib muscle area.

Statistical Data Analysis

The experiment was arranged as a randomized complete block, with pen as the experimental unit, and data were analyzed according to linear and quadratic orthogonal contrasts. Assumptions of normalitywere tested in the experiment using the UNIVARIATE procedure (SAS Inst. Inc., Cary, NC). The GLM procedure of SAS was used tostatistically analyze performance and carcass characteristicsin the experiment. The effects of treatment and block were included in the model statement for each experiment. In the experiment, least squares means were generated and separated using the PDIFF option of SAS for sig-

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Table 2. The effects of feeding different levels of dried distillers grains with solubles (DDGS) on performance of finishing lambs[1].

Item	Treatment diets, DDGS (%)			SEM	P-value[2]	
	0% (control)	12.7%	25.4%		Linear	Quadratic
Feed intake						
Days on feed	135	135	135	-	-	-
Dry matter intake (kg)	1.66	1.65	1.65	0.015	0.54	0.72
Body Weight						
Average Daily Gain (kg/d)	0.13[a]	0.12[b]	0.12[b]	0.003	0.05	0.34
Initial Body Weight (kg)	45.40	45.47	47.50	0.90	0.20	0.44
Final Body Weight (kg)	62.83	61.5	63.2	1.14	0.82	0.35

[1]Eight lambs were assigned to each treatment (n = 8/dietary treatment).
[2]Based on orthogonal contrasts for equally spaced treatments.
[a,b]Means without common superscript letters differ ($P < 0.05$).

Table 3. The effects of feeding different levels of dried distillers grains with solubles (DDGS) on carcass characteristics of lambs[1].

Item	Treatment Diets, DDGS (%)			SEM	P-value[2]	
	0% (control)	12.7%	25.4%		Linear	Quadratic
Carcass Characteristics						
Hot carcass weight (kg)	30.8	30.1	30.3	0.75	0.71	0.70
Cold carcass weight (kg)	30.7	30.0	30.2	0.74	0.63	0.59
12th Rib fat thickness (cm)	0.91	1.61	0.85	0.34	0.90	0.18
Body wall fat thickness (cm)	1.96	2.15	1.96	0.09	0.99	0.22
Kidney and pelvic fat weight (kg)	2.3	1.9	2.1	0.22	0.61	0.31
Rib Eye Area (cm^2)	6.55	7.00	7.01	0.19	0.19	0.42

[1]Eight lambs were assigned to each treatment (n = 8/dietary treatment).
[2]Based on orthogonal contrasts for equally spaced treatments.

nificant main effects. The protected F-test was used to determine overall significance where P-values of ≤0.05 were considered significant.

Results

DDGS Chemical Composition

In the current experiment, the 25.4% DDGS diet contained a minimal amount of SBM because the CP levels were met by DDGS and corn only. The fescue/bermuda grass mix hay used in the current study was comparable in protein content but lower in neutral detergent fiber and acid detergent fiber values in the literature (NRC, 2001). The different levels of DDGS inclusion resulted in different concentrations of EE in the experimental diets (Table 1). The calculated EE content of diets was 2.9, 3.0, and 4.0 for 0, 12.7, and 25.4% DDGS diets, respectively. As with any other by-product feed supplements, nutrient variability is one of the concerns with DDGS. The nutrient composition of DDGS used in the current study was within the range of reported values. Dry Distillers grains with solubles ranged from 26.6 to 33.9% in CP, from 10 to 15.9% in EE, from 28.6 to 38.4% in NDF, from 2.45 to 9.25% in starch, from 0.77 to 1.06% in P, and 0.46 to 0.83% in S (Janicek et al., 2008). Many factors influence nutrient contents of DDGS such as grain quality, milling process, fermentation process, drying temperatures and the amount of solubles blended back into the wet distiller grain with solubles at the time of drying (Kalscheur et al., 2005). The DDGS used in the current study was received from a single source and single production lot from the Dakota Gold Research Association (Poet Nutrition), Sioux Falls, SD.

Lambs Performance and Carcass Characteristics

Effect of different levels of DDGS on lamb performance and carcass quality characteristics are presented in Tables 2, 3. Lambs on all treatments had similar initial BW as designed (Table 2). Levels of DDGS has significant effect on final body

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weight and dry matter intake (Table 2). Moreover, hot and cold carcass weight, 12th rib fat thickness, body wall fat thickness, kidney and pelvic fat depot weights, and rib eye area were not affected by DDGS (Table 3). However, a decrease ($P \leq 0.05$) in average daily gain was recorded when 12.7 or 25.4 % DDGS was included in the diets (Table 2).

Discussion

According to Archibeque et al. (2008) and Vander et al. (2009) feeding DDGS to ruminants would provide good source of energy compared to corn. Supplementation of DDGS in the diets of ruminants may be limited in their ability to improve dry matter digestibility, but it would provide additional protein sources to lambs consuming moderate-quality forage. Ham et al. (1994); Klopfenstein et al. (2008) and Vander et al. (2009) concluded that the energy value of WDGS was greater than the energy value of DDGS fed to cattle.

The present study is one of few studies provides information on the influence of feeding DDGS on finishing wether lambs carcass characteristics. It investigated the effects of the inclusion of up to 25.4% DDGS (DM basis) on DMI, ADG, and carcass characteristics including final BW, HCW, CCW, 12th rib fat, body wall fat, K&P fat, and REA. Our hypothesis, that including up to 25.4% DDGS in the finishing diets of lambs will have no negative impact on DMI, ADG, and carcass characteristics, was supported by the results of the current experiment, except for ADG when 12.7 or 25.4% DDGS was included in diets.

Feed Intake

There were no differences in feed intake between the experimental diets. The mean DMI were 1.66, 1.65 and 1.66 kg/d for 0, 12.7, or 25.4% DDGS, respectively. The lack of differences in DMI among treatments may be due to similarity of NDF concentrations in the experimental diets The results of the present study agree with previous literature (Powers et al., 1995; Liu et al., 2000; Hippen et al., 2003, Huls et al., 2006; Kleinschmit et al., 2006 ; Van Emon et al., 2008) that including DDGS in finishing diets of lambs have not increase DMI. Kleinschmit et al. (2006) found that included 20% of DDGS in dairy cattle diet did not affect the feed intake. Liu et al. (2000) also compared DDGS versus a blend of other protein sources on lactating cows. They found that DDGS had no effect on dry matter intake. However, results from the present study disagree with the findings of Trenkle (2004); Buckner et al. (2007); Archibeque et al. (2008) and Schauer et al. (2008) that including DDGS in finishing diets of lambs have increased DMI. Archibeque et al. (2008) evaluated the potential of DDGS as a supplement for finishing lambs consuming moderate-quality forages. They noticed a modest increase in average DMI in lambs fed DDGS. Schauer et al. (2008) also evaluated the effect of feeding increasing levels of DDGS in lamb-finishing rations on lamb performance and carcass characteristics. They observed that DMI increased in a linear manner as level of DDGS inclusion increased. Moreover, Trenkle (2004) evaluated the influence of DDGS on finishing Holstein steers. They detected an increase in DMI in growing calves that was fed up to 40% DDGS (DM basis; 90% concentrate diets). Likewise, Buckner et al. (2007) compared a modified dry by-product to dry distillers grains with solubles in growing calf diets by replacing a portion of bromegrass hay and alfalfa haylage with 15 or 30% DDGS. They recorded an increase in DMI in steer calves fed 30% DDGS diets compared with steers consuming 15% DDGS. Leupp et al. (2009) also investigated the effects of increasing levels of DDGS in diets containing 70% concentrate offered to growing steers on DMI, rate and site of digestion, ruminal fermentation, duodenal protein flow, and microbial efficiency. They noticed that DMI responded quadratically with greatest intakes at 15% DDGS and least at 60% DDGS.

Body Weight

Feeding DDGS can increase ADG in growing cattle consuming both low-quality and high-quality forages (Loyet al., 2007; Morris et al., 2005), but the reason for increased gain is not fully elucidated. Dried distillers grains contain 15 to 20% UIP and 8 to 12% fat (MacDonald et al., 2007). Thus, it is possible that UIP and additional energy is responsible for the additional gain.
There were no differences in BW gain between treatments. The mean ADG and final BW were 0.13 kg/d and 62.83 kg for 0% DDGS, 0.12 kg/d and 61.6 kg for 12.7% DDGS, and 0.12 kg/d and 63.2 kg for 25.4% DDGS, respectively (Table 2). In contrast to the present study, Klopfenstein et al. (2008) noticed quadratic response in ADG and a cubic response in G:F as level of DDGS in the diet increased from 0 to 40%. Similarly, previous research (MacDonald et al., 2007; Martin et al., 2007; Depenbusch et al., 2008; Schauer et al., 2008; Van Emon et al. (2008); and McEachern et al., 2009) showed that including DDGS in finishing diets of lambs have not influenced ADG. Also, Depenbusch et al. (2008) compared growth performance and carcass characteristics in yearling heifers fed diets based on steam-flaked corn with or without DDGS. In contrast with the results of the current study, they noticed that ADG and gain efficiencies were not increased when DDGS included in the diets. Furthermore, Martin et al. (2007) investigated the influence of DDGS as an energy source on growth and reproduction of heifers. They reported that ADG was not affected by DDGS supplementation. Moreover, Van Emon et al. (2008) investigated the influence of feeding as much as 50% DDGS on lamb carcass characteristics. Contrary to the present study, they found that supplementation of grazing lambs with DDGS increased ADG.

Carcass Characteristics

There were no significant differences in carcass characteristics between treatments. The mean HCW, CCW, 12th rib fat, body wall fat, kidney and pelvic fat, and REA were 30.8 kg, 30.7kg , 0.91 cm, 1.96 cm, 2.3 kg, and 6.55 cm2 for 0% DDGS, 30.1 kg, 30.0, kg 1.61 cm, 2.15 cm, 1.9 kg, and 7.0 cm for 12.7% DDGS, and 30.3 kg, 30.2 kg, 0.85 cm, 1.96 cm, 2.1 kg, and 7.01 cm for 25.4% .

The results of the present study agree with previous research (Huls et al., 2006; Depenbusch et al., 2008; Schauer et al., 2008; Depenbusch et al., 2009; Neville et al., 2010; Whitney and Braden, 2010b) showed no influence of DDGS on carcass characteristics when DDGS was included in lambs finishing diets. Huls et al. (2006) investigated efficacy of DDGS as a replacement for CSM and a portion of the corn in a finishing lamb diet and reported that lamb BFT decreased, but other carcass characteristics remained similar when DDGS replaced SBM and a portion of the corn in 90-percent concentrate diets. Schauer et al. (2008) also reported no effect on HCW, BFT, and REA when 0, 20, 40, and 60 % DDGS was included in lambs diets. Whitney and Braden (2010b) also investigated the effects of CSM with DDGS on carcass characteristics, meat fatty acid profiles, and sensory panel traits, and reported that partially or totally substituting DDGS for CSM in lamb-finishing diets is acceptable and may enhance sensory traits. The authors concluded that the inclusion of DDG in lamb finishing diets has shown no negative effect on carcass characteristics, thus it could serve as a plausible substitute for CSM in lamb-finishing diets. Likewise, Neville et al. (2010) evaluated the influence of thiamine supplementation on feedlot performance and carcass quality and also noticed that increasing DDGS in diets up to 60 percent did not affect lamb carcass characteristics, except for increased flank streaking and USDA quality grade. Similar results have been reported in cattle (Depenbusch et al., 2008; Depenbusch et al., 2009). Depenbusch et al. (2008) investigated the influence of corn distillers grains with solubles on growth performance and carcass characteristics of finishing feedlot heifers and reported that carcass weight, dress yield, LM area, KPH fat, and 12th-rib fat were not significantly different among treatments.

Conclusion

The growth in the biofuel industries and subsequent development of dry-milling production facilities resulted in volatile futures markets and increased grain costs traditionally used in feedlot diets. Dry Distillers grains with solubles like corn-based ethanol byproducts are an excellent protein and energy source, but are high in fiber which can negatively impact DDGS digestibility. Literature suggested that feeding DDGS to ruminants would provide similar or more amounts of energy compared to corn, and DDGS supplement. The results of this study demonstrated that supplementation of lambs-finishing diet with DDGS did not negatively affect DMI or carcass characteristics. Overall, the current research confirms previous work demonstrating that DDGS can be included in lamb finishing rations at concentrations up to 25% of dietary DM. Further research is needed to examine the efficacy of including DDGS in meat lambs diets.

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