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Efficacy of Dried Distiller's Grains with Solubles as a Replacement for Soybean Meal and a Portion of the Corn in a Finishing Lamb Diet[1]

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Summary

The objective of this experiment was to determine the effects of replacing soybean meal (**SBM**) and a portion of the corn with dried distiller's grains with solubles (**DDGS**) on growth performance, carcass characteristics, and the incidence of acidosis, bloat, or urinary calculi in wethers fed a high-grain finishing diet with soyhulls (**SH**) as the only source of dietary fiber. Wethers (n = 40) were allotted by weight to ten pens (average lamb weight per pen 43.4 kg ± 0.54 kg). Dietary treatments, SH-CORN-DDGS or SH-CORN-SBM, were assigned randomly to five pens. Diets were balanced to have similar CP (14.6 percent), ME (3.4 Mcal/kg), and calcium:phosphorous (2:1) and were pelleted and delivered through self-feeders. Wethers were observed twice daily for symptoms of acidosis, bloat, and urinary calculi. Feed offerings and feeder contents at trial termination were weighed and DMI was calculated. Gain:feed and ADG were calculated based on weights recorded at initiation and termination of the 64-d finishing period. Growth performance, DMI, and carcass data were analyzed statistically in a one-way analysis of variance with pen as the experimental unit. Average daily gain, DMI, gain:feed, and carcass characteristics did not differ ($P > 0.05$) between dietary treatments. Wethers did not exhibit symptoms of acidosis, bloat, or urinary calculi regardless of treatment. Dried distillers grains with solubles is a suitable substitute for SBM and a portion of the corn in a finishing wether diet where SH are the only source of fiber.

Key words: Dried Distiller's Grains with Solubles, Soyhulls, Lambs

Introduction

In the Midwest, the growing ethanol industry has increased the availability of dried distillers grains with solubles (**DDGS**). In 2004, it was estimated that 6.9 metric tons of DDGS was produced in the United States, and this amount of DDGS was expected to increase by 17 percent to 20 percent in both 2005 and 2006 (Markham, 2005). The growing supply of DDGS is likely to lower the cost of the feed ingredient, making it more favorable for use as a protein and energy source in the livestock industry. Large quantities of soybeans are processed in the Midwest resulting in the availability of soyhulls (**SH**). Soyhulls are a highly fermentable fiber source that can be mixed into a total mixed ration and pelleted easily. Increasing the use of DDGS and SH in finishing lamb diets would allow producers to take advantage of these economically priced and regionally available feeds. Currently, the majority of lamb-finishing operations are in the plains states (80 percent), with less than 20 percent of lambs being finished in the Midwest (Jones, 2004). The increasing availability of DDGS and SH could provide a competitive advantage to Midwestern feeders. However, the high phosphorous content of DDGS raises concerns as to its inclusion rate in finishing lamb diets because of environmental impact and potential problems with urinary calculi. Additionally, the inclusion of SH, as the sole source of fiber, is of concern because it is a highly fermentable fiber source with limited effective fiber and may lead to greater incidence of acidosis or bloat (Martin and Hibberd, 1990; Weidner and Grant, 1994; Shriver et al., 2000). This experiment was designed to determine if DDGS can replace SBM as a protein source and a portion of the energy supplied by corn in a high-grain finishing wether diet, where the only fiber source is SH. We hypothesize that when diets are balanced to have similar protein and energy content, wethers will have similar feedlot performance and carcass merit regardless of whether the nutrients are supplied by SH-CORN-SBM or SH-CORN-DDGS.

Table 1. Ingredient composition of diets composed of soyhulls (SH), dried distillers grains (DDGS), soybean meal (SBM) and corn.

	Treatment	
Ingredients[a]	SH-CORN-SBM	SH-CORN-DDGS
SH, %	10.0	10.0
DDGS, %	-	22.9
SBM, %	10.2	-
Corn, %	75.2	62.2
Dehydrated molasses, %	2.5	2.5
Limestone, %	1.5	1.8
Sheep TM salts[b], %	0.1	0.1
Ammonium chloride, %	0.5	0.5
	Calculated Nutrient Composition[c]	
CP, %	14.6	14.6
ME, Mcal/kg	3.4	3.4
Calcium, %	0.70	0.80
Phosphorous, %	0.35	0.40
Calcium : Phosphorous	2 : 1	2 : 1
Sulfur, %	0.143	0.165

[a] DM basis
[b] Sodium chloride 95 ≤ 93%, zinc (zinc oxide) 1.5%, manganese (manganous oxide) 0.80%, iron (ferrous carbonate) 0.46%, iodine (calcium iodate) 0.007%, cobalt (cobalt sulfate) 0.006%, selenium (sodium selinite) 90 ppm
[c] Calculated based on NRC values (NRC, 1985) on a DM basis

Materials and Methods

Animals and Treatments.

This trial was conducted at South Dakota State University in compliance with the regulations of the Institutional Animal Care and Use Committee. Forty crossbred wethers (43.4 kg ± 0.54 kg) of unknown origin were housed in an enclosed livestock facility with cross-flow ventilation, cement flooring and side walls in pens. Pens were bedded with straw and limestone weekly. Wethers were allotted by weight to 10 pens. Dietary treatments were assigned randomly, with each treatment represented by five pens of wethers. Dietary treatments were SH-CORN-DDGS or SH-CORN-SBM in pelleted form (Table 1). Diets were balanced to have similar CP and ME content. A calcium (Ca):phosphorous (P) ratio of 2:1 was maintained in both diets to account for the higher phosphorous content in the SH-CORN-DDGS diet. Ammonium chloride (0.5 percent, DM basis) was added to both diets to prevent urinary calculi. Upon arrival at the facility, wethers were offered fresh water, and water was offered twice daily throughout the experiment. Wethers were observed twice daily for symptoms of bloat (distended abdomen, labored breathing, profuse salivation) or acidosis (diarrhea, unthriftiness), or urinary calculi (frequent urination, distended abdomen, unthriftiness). Wethers were adapted to the facility over a 10-d period prior to trial initiation. During the acclimation period lambs were adapted to their assigned diet and feeding from self-feeders. Once the trial was initiated, self-feeders were filled with the treatment diets and not allowed to empty until the trial was completed. Weight of the initial feed and each subsequent feed addition was recorded. Feeders were checked daily to assure that animals had access to the feed and that bedding and fecal contaminant was removed from the feeder. On a weekly basis, feed fines were cleaned from the trough and their weight was recorded. At trial termination, feed remaining in the self-feeder was removed and weighed. Weight of removed feed fines and feed remaining at trial termination was subtracted from the sum of the feed additions to establish DMI.

Feedlot Performance Data Collection.

Weights were recorded on two consecutive days at trial initiation and averaged to establish average initial weights. Final weights were calculated by averaging two consecutive weights recorded within in a four-hour period on the final day of the 64-d trial. Feed efficiency (gain:feed) was calculated as the ratio of weight gain to DMI. Four intermediate weights were recorded at two-week intervals throughout the trial to monitor growth of the animals and determine when market weights were reached. Wethers, regardless of treatment were marketed at a common time endpoint when the average weight of the wethers reached an acceptable market weight of 60 kg.

Table 2. Growth performance of lambs fed diets composed of soyhulls (SH), dried distillers' grains (DDGS), soybean meal (SBM) and corn.

	Treatment			
	SH-CORN-DDGS	SH-CORN-SBM	SE	*P*-value
Pens per treatment	5	5	-	-
Animals per pen	4	4	-	-
Initial weight (kg)	43.4	43.4	0.54	0.97
Final weight (kg)	62.1	61.9	0.77	0.88
Gain: Feed	0.18	0.18	0.01	0.80
ADG (kg/d)	0.29	0.29	0.02	0.90
Average DMI (kg/d)	1.65	1.59	0.04	0.26

Carcass Data.

Wethers were transported 180 km to be harvested at Iowa Lamb Inc. (Hawarden, Iowa). Hot-carcass weights were recorded on the day of slaughter. Back fat, body wall thickness, longissimus muscle area, USDA quality and yield grades were recorded after carcasses were chilled at 4°C for 24 h. Percent boneless, closely trimmed, retail cuts (%BCTRC) were calculated according to the method of Savell and Smith (1998).

Statistical Analyses.

Growth performance, DMI, and carcass data were analyzed as a completely randomized design using a one-way analysis of variance with pen as the experimental unit.

Results and Discussion

Dry-matter intakes were not different ($P > 0.05$) between the two treatment groups and as hypothesized, ADG and gain:feed were not different ($P > 0.05$) between the two treatment groups (Table 2). Carcass measurements, including hot carcass weight, USDA yield grade, body-wall thickness, longissimus muscle area, and dressing percentage, were not different ($P > 0.05$) as a result of dietary treatment (Table 3). However, back fat was greater for wethers assigned to the SH-CORN-SBM treatment ($P < 0.05$). During the 64-d finishing trial, wethers were not observed to exhibit symptoms of bloat, acidosis, or urinary calculi, regardless of dietary treatment.

Several factors should be considered when feeding diets composed of grain and by-products to ruminants. First, dietary fiber must be an amount that maintains rumen function and minimizes the likelihood of bloat and acidosis. Schauer et al. (2005) reported that when a traditional fiber source (25 percent chopped alfalfa hay) was used in a mixed ingredient diet offered through self-feeders, that DDGS could replace 20 percent of the barley in a finishing diet without adverse effects on feedlot performance or carcass merit. In their research, the hay was adequate to maintain rumen function. Diets containing long-stem forage can be difficult to pellet and deliver via a self-feeder. Delivery of finishing diets via self-feeders minimizes labor expenses associated with finishing lambs. Soyhulls are a fiber source that can be pelleted and therefore conform to a self-feeding management system. Pelleting can be advantageous because it prevents ingredient sorting and enhances flow in self-feeders, but the cost of pelleting adds to the expense of the feed and can decrease the effective fiber content of the diet.

Soyhulls and DDGS have characteristics of fiber that are similar to those found in traditional forages (NDF 45 percent to 70 percent), however, their effective fiber content (2 percent to 4 percent) is considerably lower than that of traditional forages (> 90 percent) (NRC, 2000). Additionally, SH are more fermentable than long-stem forages and therefore have higher energy values than traditional forages. There is, however, concern that SH are not a sufficient source of effective dietary fiber to maintain normal rumen function and prevent the occurrence of bloat and acidosis. Small particle size of SH may result in faster rate of passage through the rumen and more rapid fermentation that decreases rumen pH when compared to traditional dietary fiber sources (Martin and Hibberd, 1990; Weidener and Grant, 1994; Shriver et al., 2000). In the current experiment, no wethers, regardless of dietary treatment, were observed exhibiting symptoms of bloat (distended abdomen, labored breathing,

Table 3. Carcass characteristics of lambs fed diets composed of soyhulls (SH), dried distillers' grains (DDGS), soybean meal (SBM) and corn.

	Treatment			
	SH-CORN-DDGS	SH-CORN-SBM	SE	*P*-value
Pens per treatment	5	5	-	-
Animals per pen	4	4	-	-
Hot carcass weight (kg)	33.3	33.3	0.40	0.97
Back fat (cm)	0.5	0.6	0.03	0.04
Body wall thickness (cm)	2.5	2.5	0.08	1.00
Longissimus muscle area (cm^2)	19.1	18.3	0.38	0.16
Yield grade	2.4	2.4	0.14	0.80
BCTRC (%)[a]	46.7	46.2	0.18	0.10
Dressing percent (%)	53.7	53.9	0.39	0.77

[a] Boneless closely trimmed retail cuts.

profuse salivation) or acidosis (diarrhea, poor condition). These data suggest that SH are a sufficient source of fiber for wethers fed a finishing diet composed primarily of corn. However, without a negative control treatment of traditional long-stem fiber source, it is difficult to determine if wethers were experiencing depressed feed intakes as a result of sub-clinical acidosis. Wethers allowed ad libitum consumption of a high-grain diet can develop sub-clinical acidosis (Merck, 2006). Whereas outwardly apparent symptoms do not occur with sub-clinical acidosis, cyclic feed-intake patterns result in poor feed efficiency (Holcombe et al., 1999). Additional research to evaluate pH decline in the rumen and more precise feeding behavior would be valuable to assure that feeding a non-traditional fiber source, such as SH, is not contributing to sub-clinical acidosis and reduced performance.

A second consideration when feeding diets composed of a high amount of corn and corn by-products, such as DDGS, to finishing wethers, is that phosphorous content of the diet is high. High phosphorous is of concern because when in excess of the wether's requirement, it contributes to environmental pollution generated by livestock feeding operations. Additionally, urinary calculi can result when the ratio of Ca:P is less than 1.5:1 (DelCurto and Cheeke, 2005). However, problems with urinary calculi can be avoided by adding limestone to maintain a Ca:P ratio greater than 1.5:1 and including ammonium chloride in diets where corn and DDGS are included. Grains and by-products generally have a low Ca content, and it may be necessary to add limestone to the diet to ensure that the Ca requirement of the animal is met and that a desirable Ca:P ratio is maintained. Additionally, nutrient composition of DDGS and SH can vary considerably and having load-specific nutrient analyses will aid proper diet formulation (Holt and Pritchard, 2004). A management technique that can be used to prevent the formation of urinary calculi is the inclusion of ammonium chloride in the diet. The recommended inclusion rate of ammonium chloride for the prevention of urinary calculi is 0.5 percent on a DM basis (Jordan, 1990). Ammonium chloride lowers urine pH and prevents the precipitation of phosphates of calcium, magnesium and ammonium (Rush and Grotelueschen, 1996). However, ammonium chloride is not palatable, and feed refusal can result if the intended inclusion rate is exceeded. Using non-traditional fiber sources, such as soyhulls, allows all dietary ingredients to be combined, as opposed to feeding a grain mixture and fiber separately. Mixing ammonium chloride into a total mixed ration rather than the grain portion alone decreases the likelihood of feed refusal (Oetzel et al., 1988). Palatability of diets that include ammonium chloride can be improved by including other dietary ingredients such as molasses and DDGS that have a strong aroma and are palatable to the animal (Oetzel and Barmore, 1993).

Conclusion

Soybean meal and a portion of the corn can be replaced with DDGS in high-grain finishing diets with SH as the only source of fiber with no negative effects on growth performance, DMI and carcass characteristics. Additionally, SH and DDGS can serve as the only source of fiber in the diet and not result in the incidence of clinical acidosis or bloat. When feeding wethers a diet that contains a significant amount of corn and corn by-products, it may be necessary to include limestone and ammonium chloride to prevent the occurrence of urinary calculi.

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