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Effects of Supplemental Dried Distillers Grains or Soybean Hulls on Growth and Internal Parasite Status of Grazing Lambs[1]

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Summary

The objectives of this study were to determine the effects of supplementation of grazing lambs with dried distillers grains with solubles (DDGS) or soybean hulls (SBH) on growth rate and nematode-parasite status. Over the course of four experiments in consecutive years, 312 lambs were grazed on the same four or six paddocks. Grazing lambs were allotted to one of three supplementation treatments: 1) control, no supplementation (CONT), 2) DDGS, or 3) SBH (Exp. 3 and 4 only). Supplemental DDGS improved ($P < 0.01$) ADG when compared to CONT, and SBH supplemented lambs were intermediate. An analysis comparing CONT vs. DDGS supplementation across all four experiments revealed a reduction in anthelmintic-treatment rate required when DDGS were supplemented (81.2 percent vs. 30.1 percent for CONT and DDGS, respectively; $P < 0.01$). Measures of FAMACHA© score, packed-cell volume (PCV), and fecal-egg count (FEC) were recorded in weeks 3, 5, and 10. An analysis comparing just CONT and DDGS supplementation across all four experiments revealed that DDGS supplementation reduced ($P < 0.01$) FAMACHA score in weeks 3, 5, and 10, but only reduced FEC in week 3 compared to CONT lambs. Supplementation of grazing lambs with DDGS in this study allowed for increased growth, reduced anthelmintic-treatment rate, and reduced risk of becoming anemic as a result of internal parasites.

Key Words: Distillers Grains, Grazing, Lambs, Parasite, Soybean Hulls, Supplementation

Introduction

Grazing weaned lambs on pasture results in slow growth rates and high susceptibility to *Haemonchuscontortus* parasitism (Murphy et al., 1994; McClure et al., 1995; Vanimisetti et al., 2004). Increased resistance of *Haemonchuscontortus* to anthelmintics is also problematic for pasture rearing of weaned lambs (Vanimisetti, et al., 2004). Supplementation of grazing lambs has resulted in increased growth rate (Freer et al., 1988) and may affect resistance or resilience to *Haemonchuscontortus* infection (Shaw et al., 1995; Coop and Kyriazakis, 2001). In their review of the effects of nutrition on nematode parasitism in ruminants, Coop and Kyriazakis (2001) concluded that prevalence and degree of infection have been reduced in grazing lambs fed supplements that provide increased energy, protein, or phosphorus. According to NRC (2000), dried distillers grains with solubles (DDGS) contain 1.50 Mcal of NE_g/kg, 29.5 percent protein, and 0.83 percent P. However, research suggests the actual energy value of DDGS is at least 15 percent greater than corn grain when fed at a restricted intake to beef cows (Radunz et al., 2010) or to feedlot cattle (Stock et al., 2000). With increased production of ethanol, DDGS has become competitively priced with other sources of protein and energy; however, little information is available on the effects of DDGS supplementation to grazing lambs on growth rate and nematode parasite status. Soybean hulls may also be a cost-effective strategy to provide fiber-based, supplemental energy to grazing lambs. The objectives of this study were to determine the effects of supplementation of grazing lambs with DDGS or soybean hulls on growth rate and nematode-parasite status.

Materials and Methods

All animal procedures were approved by the Agricultural Animal Care and Use Committee of The Ohio State University and followed guidelines recommended in the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (FASS, 1998). The experiments conducted were performed in four consecutive years (2007 to 2010).

Experiment 1

The objectives were to determine effects of DDGS supplementation to grazing lambs on growth rate, efficiency of feed utilization, and nematode-parasite status.

Animals, Sampling and Management

One week prior to weaning, 62 Dorset × Hampshire cross-bred ewe lambs (24.5 kg ± 0.5 kg) and their dams were allotted to four outcome groups to equalize lamb BW and rearing status (singles or twins). Sheep in each outcome group were placed in separate paddocks with 15 or 16 ewe lambs per paddock and were randomly assigned to one of two experimental treatments: 1) grazed pasture with no supplementation (**CONT**), or 2) grazed pasture with DDGS supplementation. During the 7-d pre-weaning period, dams and their progeny were fed 0.41 kg of DDGS DM per dam as a method to expose lambs to DDGS supplementation prior to weaning. At weaning (average age = 56 d), the four groups of lambs were weighed at 0800, treated with anthelmintics (Prohibit, Agri Laboratories LTD, St. Joseph, Mo.), and randomly allotted to four orchardgrass pasture paddocks (0.65 ha each). Each paddock was equipped with a water tank and water was available ad libitum. A trace-mineral salt block fortified with selenium (Morton Salt, Chicago, Ill.) was also present in each paddock. Initially, DDGS was offered at 0.41 kg DM/lamb and the DDGS supplementation was increased by 81 g DM/lamb every other day until refusal occurred or until supplementation reached 2.5 percent of lamb BW. This amount of supplement would have provided approximately half of expected DM intake for lambs of this size (NRC, 1985). Weight and anemia status of lambs were determined weekly during the 69-d grazing experiment. Weights were measured at 0800 without withholding from feed or water. A single, trained individual determined lamb anemia status by using FAMACHA eye score and blood hematocrit (Kaplan et al., 2004). Fecal samples (5 g) were collected by rectal palpation to determine fecal nematode egg counts (**FEC**; Kaplan et al., 2004). At each weekly weighing, jugular blood samples (8 mL) to determine hematocrit and fecal samples to determine FEC were collected from lambs with a FAMACHA score of ≥ 3 (scale is 1 to 5, with 1 indicating no anemia and 5 indicating severe anemia). Lambs with a FAMACHA score of ≥ 3 were treated with anthelmintic (Cydectin, Fort Dodge Animal Health, Fort Dodge, Iowa). Treated lambs were not re-treated within 21 d unless their FAMACHA score remained the same or increased after anthelmintic treatment. Hematocrit and FEC were determined on all lambs during weeks 3, 7, and 10. On d 0 and 69, forage in each paddock was sampled for analysis of ADF and NDF (using Ankom Technology Method 5 and 6, respectively; Ankom^{200} Fiber Analyzer, Ankom Technology, Fairport, N.Y.), and CP (macro Kjeldahl N x 6.25). Six samples (0.37 m^2 each) per paddock were clipped to a height of approximately 1 cm and composited. The DDGS was sampled weekly and composited for analysis of ADF and NDF (using Ankom Technology Method 5 and 6, respectively; Ankom^{200} Fiber Analyzer, Ankom Technology, Fairport, N.Y.), CP (macro Kjeldahl N x 6.25), fat (using ether extract method; Ankom Technology, Fairport, N.Y.),and S (AOAC Method 975.03).

Experiment 2

The objectives were to determine effects of DDGS supplementation to grazing lambs on growth rate, efficiency of feed utilization, and nematode-parasite status.

Animals, Sampling, and Management

One week prior to weaning, 62 Dorset × Hampshire cross-bred ewe lambs (26.3 kg ± 0.1 kg) and their dams were allotted to four outcome groups to equalize lamb BW and rearing status (singles or twins). Sheep in each outcome group were placed in separate paddocks with 15 or 16 ewe lambs per paddock and were randomly assigned to one of two experimental treatments: 1) grazed pasture with no supplementation (**CONT**), or 2) grazed pasture with DDGS supplementation. All management and sampling procedures during the 70-d grazing experiment were as described above for Exp. 1 except that anthelmintic treatment was based on anemia measurement, packed-cell volume (**PCV**), in Exp. 2 rather than FAMACHA score, as was done in Exp. 1. This procedural adjustment was made in Exp. 2 because anthelmintic treatment based on FAMACHA score in Exp. 1 resulted in excessive anthelmintic use (treatment of lambs that did not have PCV below 20). In Exp. 2, if a lamb had a FAMACHA score of greater than 2, a blood sample was collected and blood hematocrit was determined (Kaplan et al., 2004). Lambs were treated with anthelmintic (Cydectin, Fort Dodge Animal Health, Fort Dodge, Iowa) if their blood hematocrit was 20 or less.

Experiment 3

The objectives were to determine effects of soybean hull (SBH) or DDGS supplementation to grazing lambs on growth rate, efficiency of feed utilization, and nematode parasite status.

Animals, Sampling and Management

One week prior to weaning, 96 Dorset × Hampshire cross-bred lambs (24.9 kg ± 0.4 kg) and their dams were allotted to six outcome groups to equalize lamb sex, BW, and rearing status (singles or twins). Sheep in each outcome group were placed in six separate paddocks (with 16 lambs per paddock) and were randomly assigned to one of three experimental treatments: 1) grazed pasture with no supplementation (**CONT**), 2) grazed pasture with pelleted SBH supplementation, or 3) grazed pasture with DDGS supplementation. During the 7-d pre-weaning period, dams and their progeny were fed 0.41 kg of SBH DM or 0.41 kg of DDGS DM per dam, as a method to expose lambs to SBH or DDGS supplementation prior to weaning and being fed their respective supplement source. At weaning, the six groups of lambs were randomly allotted to six orchardgrass pasture paddocks (0.65 ha each). Initially, SBH or DDGS was offered at 0.41 kg DM/lamb and supplementation was increased by 81 g DM/lamb every other day until refusal occurred or until supplementation reached 2.5 percent of lamb BW. All management, sampling, and anthelmintic-treatment procedures during the 72-d grazing experiment were as described above for Exp. 2.

Experiment 4

The objectives were to determine effects of SBH fortified with P or DDGS supplementation to grazing lambs on growth rate, efficiency of feed utilization, and nematode-parasite status.

Animals, Sampling and Management

One week prior to weaning, 92 Dorset × Hampshire cross-bred lambs (21.0 kg ± 0.5 kg) and their dams were allotted to six outcome groups to equalize lamb sex, BW, and rearing status (singles or twins). Sheep in each outcome group were placed in six separate paddocks (with 14 to 16 lambs per paddock) and were randomly assigned to one of three experimental treatments: 1) grazed pasture with no supplementation (**CONT**), 2) grazed pasture with pelleted soybean hull supplementation with added P to match the P in DDGS (**SBH+P**), or 3) grazed pasture with DDGS supplementation. The SBH+P supplement was pelleted and consisted of 95.3 percent SBH, 2.7 percent monosodium phosphate, and 2 percent animal-vegetable fat (DM basis). During the 7-d pre-weaning period, dams and their progeny were fed (on a DM basis) 0.41 kg of SBH+P or 0.41 kg of DDGS per dam as a method to expose lambs to SBH+P or DDGS supplementation prior to weaning and being fed their respective supplement source. At weaning, the six groups of lambs were randomly allotted to six orchardgrass pasture paddocks (0.65 ha each). Initially, SBH+P or DDGS was offered at 0.41 kg DM/lamb and supplementation was increased by 81 g DM/lamb every other day until refusal occurred or until supplementa-

Table 1. Effect of dried distillers grains with solubles (DDGS) supplementation on pasture performance and parasite status of grazing lambs in Exp. 1.

Item	CONT[1]	DDGS[2]	SEM	*P-value*
No. replicates	2	2	-	-
No. animals	32	30	-	-
BW, kg				
Initial	24.9	24.0	0.5	0.33
Final	35.0	41.3	1.4	0.09
Days	69	69	-	-
DDGS DMI, g/d	-	476	-	-
ADG, g/d	147	252	23	0.08
DDGS efficiency[3]	-	0.219	-	-
Treated, % [4]	65.6	40.0	5.2	0.07
No. treatments/lamb treated	1.5	1.6	0.2	0.61
ADG treated lambs, g/d	150	259	32.0	0.13
ADG non-treated lambs, g/d	132	249	14	0.03
FAMACHA© Score[5]				
d 21	1.8	1.7	0.1	0.54
d 49	1.9	1.7	0.1	0.42
d 69	1.9	1.7	0.1	0.13
Packed cell volume				
d 21	36.7	36.5	0.5	0.68
d 49	31.5	33.3	0.9	0.30
d 69	30.3	32.5	0.8	0.17
Fecal egg count				
d 21	253	71	53	0.14
d 49	1,147	1,532	352	0.52
d 69	2,989	2,462	988	0.74

[1] CONT = no supplement.
[2] DDGS = supplemented with DDGS (27.4% NDF, 13.3% ADF, 27.2% CP, 12.0% EE, and 1.27% S).
[3] Gain above CONT lambs/g of supplemented feed.
[4] Treated with anthelmintic based on a FAMACHA score greater than 2.
[5] Scale of 1 = darkest to 5 = palest.

Table 2. Effect of dried distillers grains with solubles (DDGS) supplementation on pasture performance and parasite status of grazing lambs in Exp.2.

Item	CONT[1]	DDGS[2]	SEM	*P-value*
No. replicates	2	2	-	-
No. animals	30	32	-	-
BW, kg				
Initial	26.3	26.3	0.1	1.00
Final	33.2	41.9	0.9	0.02
Days	70	70	-	-
DDGS DMI, g/hd/d	-	531	-	-
ADG, g/d	100	224	11	0.02
DDGS efficiency[3]	-	0.235	-	-
Treated, %[4]	90.2	18.7	4.8	0.01
No. treatments/lamb treated	1.3	1.0	0.1	0.03
Avg day of first treatment	27.5	35.5	4.9	0.37
ADG treated lambs, g/d	98	190	12	0.03
ADG non-treated lambs, g/d	118	227	3	0.01
FAMACHA© Score[5]				
d 21	3.5	1.9	0.3	0.07
d 49	2.3	2.3	0.1	0.59
d 70	1.8	1.3	0.1	0.04
Packed cell volume				
d 21	20.9	30.2	1.5	0.05
d 49	32.6	30.5	1.0	0.27
d 70	29.3	33.2	0.9	0.09
Fecal egg count				
d 21	1,171	43	225	0.07
d 49	169	274	170	0.71
d 70	3,275	342	980	0.17

[1] CONT = no supplement.
[2] DDGS = supplemented with DDGS (27.4% NDF, 13.3% ADF, 27.2% CP, 12.0% EE, and 1.27% S).
[3] Gain above CONT lambs/g of supplemented feed.
[4] Treatment with anthelmintic based on a packed cell volume less than 20.
[5] Scale of 1 = darkest to 5 = palest.

tion reached 2.5 percent of lamb BW. All management, sampling, and anthelmintic-treatment procedures during the 68-d grazing experiment were as described above for Exp. 2.

Statistical Analysis

Each of these four studies was analyzed as a completely randomized design. Statistical data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, N.C.). The model used for ADG, GF, DMI, weights on and off test, and supplementation treatment was:

$Y_{ijk} = \mu + p_i + S_j + e_{ij}$

Where Y_{ijk} = response variable; = mean; p_i = the random effect of paddock; S_j = the fixed effect of supplementation treatment; and e_{ij} = the experimental error. Paddock was the experimental unit and n = 2 for all four trials. Significance was declared at $P < 0.05$ and trends were discussed at $P < 0.10$. In Exp. 3 and 4, means were separated by PDIFF, FAMACHA, PCV, and FEC were analyzed as repeated measures and the model was:

$Y_{ijk} = \mu + p_i + S_j + W_k + e_{ijk}$

Where Y_{ijk} = response variable; = mean; p_i = the random effect of paddock; S_j = the fixed effect of supplementation treatment; W_k= the fixed effect of repeated week of sampling; and e_{ijk} = the experimental error. Paddock was the experimental unit. Significance was declared at $P < 0.05$ and trends were discussed at $P < 0.10$.

An analysis was conducted with the CONT and DDGS data across all four experiments. For this analysis, experiment number was included as a block effect in the models above.

Results

Experiment 1

Weekly pasture samples collected during the experiment (mid-July to mid-September) averaged 62.0 percent NDF, 38.2 percent ADF, and 15.6 percent CP. Lambs fed supplemental DDGS consumed 476 g of DDGS DM/d (Table 1). Supplementation tended ($P < 0.09$) to increase ADG and final BW at the end of the 70-d grazing study. Efficiency of DDGS to promote ADG was 0.219 g of gain above the non-supplemented lambs per g of DDGS supplemented. When the decision to treat lambs to control parasite infection was based on a FAMACHA score of greater than 2, there was a trend ($P = 0.07$) for DDGS-supplemented lambs to have a fewer anthelmintic treatments than CONT lambs. Supplemental DDGS did not affect ($P = 0.13$) ADG of lambs treated with anthelmintic compared to CONT lambs. However, for those lambs never treated (FAMACHA score was never greater than 2), DDGS supplementation nearly doubled ADG when compared to CONT lambs ($P = 0.03$). When all lambs were measured on d 21, d 49 and d 69, supplementation with DDGS did not affect ($P \geq 0.13$) FAMACHA scores, PCV, or FEC.

Experiment 2

Weekly pasture samples collected during the experiment (mid-July to mid-September) averaged 64.7 percent NDF, 41.0 percent ADF, and 13.5 percent CP. Average intake of supplemental DDGS was 531 g of DM/d during the 70-d grazing experiment (Table 2). Supplementation more than doubled ADG and increased ($P = 0.02$) final BW at the end of the 70-d grazing study. Efficiency of DDGS to promote ADG was 0.235 g of gain above the CONT lambs per g of DDGS supplemented. When the decision to treat lambs for nematode parasitism was based on FAMACHA score followed by a confirmed anemia (PCV ≤ 20), supplementation with DDGS greatly reduced ($P = 0.01$) the proportion of lambs requiring treatment with anthelmintic (90.2 percent vs. 18.7 per-

Table 3. Effect of dried distillers grains with solubles (DDGS) or soybean hull (SBH) supplementation on pasture performance and parasite status of grazing lambs in Exp. 3.

Item	CONT[1]	SBH[2]	DDGS[3]	SEM	*P-value*
No. replicates	2	2	2	-	-
No. animals	32	32	32	-	-
BW, kg					
Initial	24.85	25.26	24.58	0.36	0.45
Final	31.79[b]	38.82[a]	40.73[a]	0.73	0.01
Days	72	72	72	-	-
Supplement DMI, g/hd/d	-	611	631	10	0.31
ADG, g/d	95[a]	188[b]	224[c]	7	0.01
Supplement efficiency[4]	-	0.152	0.205	0.015	0.13
Treated, %[5]	81.3[a]	31.2[b]	9.4[b]	7.4	0.01
No. treatments/lamb treated	1.27[a]	1.00[b]	1.00[b]	0.02	0.01
Avg day of first treatment	42.0	42.5	55.5	5.0	0.25
ADG treated lambs, g/d	95[b]	177[a]	200[a]	15	0.03
ADG non-treated lambs, g/d	86[c]	195[b]	227[a]	1	0.01
FAMACHA© Score[6]					
d 22	2.1[a]	1.7[b]	1.5[c]	0.04	0.01
d 43	3.3[a]	2.1[b]	1.7[b]	0.2	0.02
d 72	2.7[a]	1.9[b]	1.6[b]	0.1	0.01
Packed cell volume					
d 22	31.5	30.5	33.2	1.4	0.49
d 43	22.7[b]	26.9[a]	29.5[a]	0.7	0.02
d 72	28.1	29.5	31.4	1.2	0.29
Fecal egg count					
d 22	1,616	1,675	765	648	0.60
d 43	2,743	5,173	3,185	1,221.000	0.43
d 72	1,070	4,232	1,567	589	0.06

[1] CONT = no supplement.
[2] SBH = supplemented with SBH (66.4% NDF, 50.6% ADF, 11.2% CP).
[3] DDGS = supplemented with DDGS (24.8% NDF, 11.5% ADF, 26.8% CP, 11.8% EE, and 0.77% S).
[4] Gain above CONT lambs/g of supplemented feed.
[5] Treatment with anthelmintic based on a packed cell volume less than 20.
[6] Scale of 1 = darkest to 5 = palest.
[ab] Means within a row with different superscripts differ *($P<0.05$)*.

cent for CONT vs. DDGS-supplemented lambs, respectively). Supplementation with DDGS reduced ($P = 0.03$) the number of anthelmintic treatments per lamb treated and increased ($P \leq 0.03$) the ADG of both treated lambs and those never treated with anthelmintic during the trial. When all lambs were assessed on d 21, supplementation with DDGS tended to reduce FAMACHA score ($P = 0.07$), increased PCV ($P = 0.05$), and tended to reduce FEC ($P = 0.07$) compared to CONT lambs. Supplementation with DDGS did not affect ($P \geq 0.27$) these variables when lambs were sampled on d 49, but did reduce ($P = 0.04$) FAMACHA score and tended to reduce ($P = 0.09$) PCV on d 70.

Experiment 3

Weekly pasture samples collected during the experiment (mid-July to mid-September) averaged 64.1 percent NDF, 38.9 percent ADF, and 14.9 percent CP. Supplement intake averaged 611 g/d for lambs supplemented with SBH and 631 g/d for lambs supplemented with DDGS (Table 3). Lambs supplemented with DDGS had greater ($P< 0.01$) ADG than CONT lambs while those supplemented with SBH were intermediate. Final BW followed the same trend. Supplementation with SBH or DDGS reduced ($P = 0.01$) the percentage of lambs requiring treatment for internal parasites (31.2 percent for SBH and 9.4 percent for DDGS vs. 81.3 percent for CONT lambs). A similar response was observed for the number of treatments per lamb treated ($P = 0.01$) and the effect of supplementation on the ADG of those lambs that were treated ($P = 0.03$) and those that were not treated ($P = 0.01$). When all lambs were assessed on d 22, DDGS supplementation reduced ($P = 0.01$) average FAMACHA score compared to CONT lambs, while SBH-supplemented lambs were intermediate. Average PCV and FEC on d 22 were not affected ($P \geq 0.49$) by supplementation. On d 43, average FAMACHA score was decreased and PCV were greater ($P = 0.02$) for lambs supplemented with SBH or DDGS compared with CONT lambs.

Table 4. Effect of dried distillers grains with solubles (DDGS) or P fortified soybean hull (SBH+P) supplementation on pasture performance and parasite status of grazing lambs in Exp.4.

Item	CONT[1]	SBH+P[2]	DDGS[3]	SEM	*P-value*
No. replicates	2	2	2	-	-
No. animals	30	32	28	-	-
BW, kg					
Initial	20.8	21.0	21.3	0.5	0.73
Final	27.9[b]	35.1[a]	36.7[a]	0.6	0.01
Days	68	68	68	-	-
Supplement DMI, g/hd/d	-	589a	544b	10	0.05
ADG, g/d	104[b]	206[a]	227[a]	16	0.03
Supplement efficiency[4]	-	0.173	0.225	0.032	0.37
Treated, %[5]	87.5	71.9	52.1	13.0	0.30
No. treatments/lamb treated	1.2[a]	1.1[ab]	1.0[b]	0.04	0.05
Avg day of first treatment	33.5	33.0	34.5	1.5	0.78
ADG treated lambs, g/d	104[b]	197[a]	236[a]	10	0.01
ADG not treated lambs, g/d	122	229	218	31	0.19
FAMACHA© Score[6]					
d 21	2.7	2.1	2.1	0.3	0.28
d 42	2.7	1.7	2.2	0.4	0.26
d 68	2.9[a]	1.5[b]	1.7[b]	0.1	0.01
Packed cell volume					
d 21	27.4	29.1	29.5	1.5	0.64
d 42	23.3	25.5	26.7	1.1	0.22
d 68	26.4	29.5	29.5	0.9	0.17
Fecal egg count					
d 21	1,059	2,869	652	551	0.12
d 42	3,007	4,684	3,321	718	0.35
d 68	3,257	3,091	2,928	599	0.93

[1] CONT = no supplement.
[2] SBH+P = supplemented with P fortified SBH (59.7% NDF, 43.7% ADF, 10.5% CP, 0.91% P).
[3] DDGS = supplemented with DDGS (27.6% NDF, 12.6% ADF, 25.1% CP, 0.73% S, 0.83% P).
[4] Gain above CONT lambs/g of supplemented feed.
[5] Treatment with anthelmintic based on a packed cell volume less than 20.
[6] Scale of 1 = darkest to 5 = palest.
[ab] Means within a row with different superscripts differ *($P<0.05$)*.

Likewise, on d 72, supplementation reduced FAMACHA scores ($P = 0.02$) and tended to reduce FEC ($P = 0.06$) for SBH- and DDGS-supplemented lambs compared with the CONT lambs.

Experiment 4

Weekly pasture samples collected during the experiment (mid-July to mid-September) averaged 62.0 percent NDF, 39.2 percent ADF, and 15.6 percent CP. Lambs consumed 589 g of SBH+P/d and 544 g of DDGS DM /d on average (Table 4). Lambs fed supplemental SBH+P or DDGS had more than double ($P = 0.03$) the ADG of CONT lambs and this response was reflected in increased final BW. Supplemental-feed efficiency was 0.173 for SBH+P and 0.225 for DDGS lambs. Regardless of source, supplementation did not reduce ($P = 0.30$) the percentage of lambs requiring anthelmintic treatment. However, supplementation with DDGS did reduce ($P = 0.05$) the number of anthelmintic treatments per lamb treated compared with the CONT lambs, while the SBH+P lambs were intermediate. For the treated lambs, supplementation increased ($P < 0.01$) ADG compared with CONT lambs. Supplementation did not affect ($P \geq 0.12$) FEC, PCV, or FAMACHA scores, except on d 68 where FAMACHA scores were greater ($P = 0.01$) for CONT lambs than for those supplemented with DDGS or SBH+P.

Discussion

Lambs grazing orchardgrass pastures had increased ADG and final BW when supplemented with DDGS. Many reports confirm the positive effects on ADG of grain supplementation of grazing lambs (Freer, et al., 1988; Daura and Reid, 1991; Karnezos, 1994). However, we found no reports on efficacy of DDGS supplementation for grazing lambs. In the current study, CONT lambs gained an average of 112g/d while lambs supplemented with DDGS gained an average of 232g/d. Supplementation with SBH or SBH+P also resulted in greater ADG compared to CONT lambs. Efficient use of a protein-energy supplement to increase growth rate is an important economic consideration. The efficacy of supplemental DDGS to increase growth above CONT lambs was consistent across experiments and averaged 0.221g of gain above CONT for each g of supplement consumed. In other words, lambs required 4.5g of DDGS for each g of BW gain above the CONT lambs. Efficiency of SBH to increase gains above CONT lambs averaged 0.152 in Exp. 3 and 0.173 in Exp. 4. Trends for decreased ADG and efficiency for SBH vs. DDGS could be due to the difference in energy and/or protein content of these two byproducts. The NRC (2000) indicates DDGS has 1.50 Mcal of NE_g/kg, while SBH contain 1.30 Mcal of NE_g/kg. The DDGS used in these experiments was 26 percent CP while the SBH contained only 11 percent CP.

For Exp.1, the decision to treat lambs for internal parasites was based on the weekly assessment of FAMACHA score. Based on comparison of the PCV data with individual FAMACHA scores, this procedure resulted in anthelmintic treatment of lambs before they were considered anemic (The Merck Veterinary Manual, 2005). In Exp. 2, 3, and 4, lambs did not receive anthelmintic therapy unless a PCV of ≤ 20 confirmed the anemic status of the lambs. Despite these different criteria for therapy decisions, DDGS supplementation decreased required anthelmintic treatment in three of the four experiments when compared to the CONT lambs. An analysis comparing CONT vs. DDGS supplementation across all four experiments revealed a reduction in anthelmintic treatment rate when DDGS were supplemented (81.2 percent for CONT vs. 30.1 percent for DDGS, $P < 0.01$). The mechanism of action for this response could not be determined in this study. However, DDGS supplementation more than doubled ADG of grazing lambs (232 g of gain/d for DDGS vs. 112 g of gain/d for CONT, $P < 0.01$) and lambs in a more positive-energy balance may have been more resistant or resilient when faced with a parasite challenge. Protein supplementation, and a general increase in energy balance, has been shown to improve ability of lambs to withstand a nematode infection (Coop and Kyriazakis, 1999 and 2001). Supplemental SBH were investigated as a strategy to increase fiber-based energy intake without providing a large amount of supplemental protein. Lambs fed SBH had growth rate and anthelmintic treatment rates that were intermediate between CONT lambs and those supplemented with DDGS. As with DDGS, resilience or resistance to internal-parasite infection was likely related to the increased growth rate of the lambs supplemented with SBH.

Additionally, supplemental P has been shown to reduce parasite infection in grazing lambs (Coop and Holmes, 1996). The NRC (2000) indicates that DDGS contains 0.83 percent P whereas SBH contains only 0.18 percent P. In Exp.4, we investigated SBH+P to determine if added P intake that occurs with DDGS supplementation contributed to the reduced anthelmintic treatment rate observed when lambs were supplemented with DDGS. In Exp. 4, SBH+P resulted in increased ADG but did not affect anthelmintic treatment rate compared to the CONT. Lambs supplemented with SBH+P had numerically decreased ADG and numerically greater anthelmintic-treatment rate compared to DDGS-supplemented lambs but these differences were not significant.

All lambs in these four experiments were assessed for FAMACHA score, FEC, and PCV at the end of weeks 3, 5, and 10 of the grazing period. Data collected from lambs later in the grazing period (especially weeks 5 and 10) would be affected by timing and treatment with anthelmintic. Because, in general, more CONT lambs were treated, the data assessing parasite-infection status at the end of weeks 3, 5, and 10 would be confounded by the response of these lambs to the anthelmintic. Because few lambs were treated before d 21, the confounding effect of anthelmintic treatment would be less at this time point. The average FAMACHA score, FEC, and PCV data provide an indication of the severity of the infection in lambs identified as requiring anthelmintic treatment. Lambs supplemented with DDGS had a decreased anthelmintic treatment rate and fewer treatments per lamb treated (except for Exp. 1). An analysis comparing just CONT and DDGS supplementation across all four experiments revealed that DDGS supplementation reduced ($P < 0.01$) FAMACHA score in weeks 3, 5, and 10, but only reduced FEC in week 3.

Conclusions

Supplementing grazing lambs with DDGS at 2.5 percent of their BW increased growth, reduced anthelmintic treatment rate, and reduced risk of becoming anemic as a result of internal parasites. Responses to supplemental SBH were intermediate between no supplementation and supplementation with DDGS. These byproducts provide the sheep industry with an economical strategy to increase performance and reduce anthelmintic treatment rate of grazing lambs.

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