Effects of lasalocid and diet particle size on feedlot performance, carcass traits, and nutrient digestibility in feedlot lambs[1]

A. R. Crane[*†], R. R. Redden[*], P. B. Berg[*], and C. S. Schauer[†]

[*]Department of Animal Sciences, North Dakota State University, Fargo, ND 58108;
[†]Hettinger Research Extension Center, North Dakota State University, Hettinger, ND 58639

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The objective of this research was to determine the influence of diet particle size and lasalocid on growth performance, carcass characteristics, and N balance in feedlot lambs. Lasalocid fed lambs had an increase in HCW. Additionally, there was an interaction of particle size and use of ionophores for ADG, loin eye area, and % boneless closely trimmed retail cuts (%BCTRC). Loin eye area was greatest for WCL and GCNL. A second study was conducted utilizing the same treatments to evaluate N balance in 16 crossbred wethers. Nitrogen balance was not affected by treatment. Our results indicate that HCW in lambs fed lasalocid was increased while particle size had no major impact on feedlot performance, carcass traits, or N digestibility.

INTRODUCTION

In the Northern Great Plains, lambs are commonly fed whole corn accompanied by a market lamb pellet through self-feeders during the growing-finishing phase. However, as evidenced in the cattle industry, when feeding high energy and low roughage diets acidosis can become a health problem resulting in a decrease in performance and an increase in morbidity and mortality (Elam, 1976).

Research in cattle has shown the effectiveness of ionophores for increasing feed efficiency and decreasing the incidence of acidosis in high grain diets (Jacques et al., 1987). Additionally, in sheep, researchers have reported the ability of ionophores to improve rate of gain, organic matter and crude protein digestion, and the absorption of N (Funk et al., 1986; Horton, 1980; Ricke et al., 1984). However, monensin is not currently labeled for use in sheep (FDA, 2005). The ionophore lasalocid is approved for use in sheep (FDA, 2003) and has been shown to increase total tract organic matter digestibility in finishing lambs (80 vs. 76.4%; Funk et al., 1986) fed a 65% concentrate diet. With the exception of the previous trial, little data exists describing the effects of lasalocid in lamb finishing rations.

Grinding the diet can increase digestibility, intake, and performance of livestock (Kerley, et al., 1985). However, in the lamb finishing industry it is generally advised to leave feeds whole, as the cost of grinding usually exceeds the performance benefits of feeding a ground ration (Stanton et al., 2006). Additionally, when feeds are ground lambs tend to select larger particles (Reynolds and Lindahl, 1960), potentially resulting in reduced DM intake and/or failure to eat a complete diet. Grinding feeds can increase the rate of digestion, therefore decreasing total digestibility (Reynolds and Lindahl, 1960) and potentially resulting in more cases of acidosis (Gressley, et al., 2011).

To our knowledge, limited research has evaluated the effects of particle size and ionophores in sheep. Our hypothesis was that lambs fed ground rations and lasalocid would have the greatest performance in the feedlot and improved nutrient digestibility when compared to lambs fed rations that weren't ground or rations without lasalocid. Our specific objectives were to determine the influence of lasalocid and particle size on growth performance, carcass characteristics, and N balance in lambs consuming a finishing ration.

PROCEDURES

All procedures were approved by the Animal Care and Use Committee of North Dakota State University (protocol # A13041). This study was conducted at the NDSU Hettinger Research Extension Center in Hettinger, ND.

Feedlot Study

Animals and Diets. At 2 wk of age, tails were docked, males were castrated, and all lambs were vaccinated for *Clostridium perfringens* types C and D and tetanus (CD-T; Bar Vac CD/T; Boehringer Ingelheim, Ridgefield, CT). Lambs were weaned and vaccinated with CD-T again at approximately 60 d of age and d -1 (4 mo. of age) of the trial. Lambs were allowed free choice access to a commercial lamb creep pellet (16% CP) from birth to weaning. Lambs were adapted to an 80% corn and 20% commercial market lamb pellet diet (DM basis; Table 1) following weaning. One hundred sixty crossbred (Suffolk x Rambouillet) wether and ewe lambs (68 ± 0.2 lb BW; approximate 90 d of age) were stratified by BW and sex (80 wethers and 80 ewes) and randomly assigned to 1 of 16 outdoor pens (10 lambs/pen). Pens were assigned randomly to 1 of 4 treatments, with pen serving as the experimental unit (n = 4 pens/treatment). Treatments were: whole corn with lasalocid (**WCL**), whole corn without lasalocid (**WCNL**), ground corn with lasalocid (**GCL**), or ground corn without lasalocid (**GCNL**; Table 1). Lambs receiving lasalocid (20 g/ton of market lamb pellet, Bovatec, Alpharma Inc., Bridgewater, NJ) received the basal feedlot ration with lasalocid included in the market lamb pellet starting on d 0. A factorial arrangement of treatments was applied in a completely randomized design to evaluate the outlined objectives.

Ground diets were ground through a 1.27 cm screen (Gehl Mix-All, Model 170, Gehl, West Bend, WI). Diets were mixed and provided by the same mixer-grinder and offered ad libitum via bulk feeders (48.6-cm bunk space/lamb). Lambs had continuous access to clean, fresh water and shade. Study diets were balanced to be equal to or great than CP and energy (NE) requirements (NRC, 2007). The rations were formulated to have a minimum Ca:P ratio of 2:1. Feeders were checked daily and cleaned of contaminated feed. Lambs were observed daily to monitor health and treated when necessary.

Data Collection Procedures. The study was divided into four periods. Lambs were weighed on 2 consecutive d at the initiation (d -1 and 0) and end (d 111 and 112) of the trial; single day weights were taken on d 33, 57, and 85 and used to assist in evaluation of morbidity. Ration and feed ingredient samples from the bulk feeders were taken at the beginning of each period and dried at 131°F for 48 h to determine DM and ration nutrient composition.

Trained personnel collected carcass data after a 24-h chill (temperature < 35.6°F and humidity near 100%). Carcass data collected included HCW, leg score, conformation score, fat depth (over the 12^{th} rib), body wall thickness, loin eye area, flank streaking, quality grade, and yield grade, and % boneless closely trimmed retail cuts (**%BCTRC**; Savell and Smith, 2000).

Nitrogen Balance Study

Animals and Treatments. Sixteen Suffolk x Rambouillet wethers (88.2 ± 3.7 lbs BW; approximate age = 90 d) were used in completely random design. Wethers were weighed on d 0 and 1, stratified by weight, and allotted randomly to treatments (n = 4 wethers/treatment) as described in the feedlot trial. Lambs were assigned randomly to individual metabolism crates on d 1. Wethers were housed in an enclosed room with lighting from approximately 0730 to 2000 h. Lambs were adapted to diets (Table 1) and processed as outlined in the previous study, but lambs were also given an injection of vitamins A, D and E on d 1 of the trial. Rations were provided daily at 0830 h at 130% of the average daily intake for the previous 5 d. Feed refusals from the previous day were determined before feeding. Water troughs were cleaned and refilled daily after feeding.

Data Collection Procedures. The experimental period was 21 d. Dry matter intake was determined on d 14 to 20. Additionally, samples of corn, pellets, and ration were collected on d 14 to 20 and dried at 131°F for 48 h. Wethers were fitted with fecal collection bags on d 11. Total fecal and urine output were collected on d 15 to 21. A subsample of each daily fecal sample (7.5% of total, wet basis) was dried at 131°F for 96 h for calculation of fecal DM. Urine was collected via stainless steel funnel beneath the lamb, with total urine output collected. Sufficient 6 N HCL (100 mL) was added daily to urinals to maintain urine pH < 3. Total daily urine output was recorded and urine was composited daily by wether (10% of total; wet basis) and stored at 39°F. Approximately 288 g of urine were collected from each urine subsample and stored at 39°F. On d 15 to 21, 10 mL of blood were collected via jugular venipuncture 4 h after feeding using vaccutainers (VWR International). Blood was cooled at 39°F for 2 h and centrifuged (3,640 × g, 59˚F, 20 min), and serum was harvested and stored (-4°F).

Dried fecal samples were ground through a Wiley mill (2-mm screen) and composited by lamb. Daily samples of corn, pellets and ration were composited for the collection period, and orts were composited by lamb on an equal weight basis (20%; as-fed basis). Feed, orts, and fecal samples were analyzed for DM, ash, NDF, and ADF as described previously in the feedlot study. Feed, orts, fecal, and urine samples were analyzed for N as described previously in the feedlot study. Concentration of N in feed, orts, fecal, and urine samples was used to calculate daily N intake and excretion from feed, ort, feces, and urine weights. Nitrogen excretion (fecal N + urinary N) was subtracted from N intake (feed N – ort N) to calculate N balance (g N/lb BW basis).

RESULTS AND DISCUSSION

Feedlot Study

Feedlot Performance. Results for feedlot lamb growth, carcass characteristics and mortality are reported in Table 2. There were no interactions among treatments for final BW, feed offered, G:F, mortality, HCW, leg score, conformation score, fat depth, body wall thickness, flank streaking, quality or yield grade, and dressing percentage ($P \geq 0.06$). However, there was an interaction of particle size and use of ionophores for ADG (P = 0.05), loin eye area ($P < 0.001$), and BCTRC (P = 0.004). While an interaction was observed for ADG, upon comparison of means no differences were observed among treatments ($P > 0.05$). . Numerically the WCL fed lambs had the highest ADG, and this difference in BW gain could be relevant from a producer standpoint, with a difference of 5.3 lbs over the 120 d finishing period when comparing WCL vs. WCNL or GCL. Lending further evidence to the benefit of whole corn diets including lasalocid, we observed a tendency for an interaction (P = 0.06) between particle size and ionophores for final BW, where WCL fed lambs tended to be heavier than the other lambs by up to 0.33 lbs. Erickson et al. (1988 and 1989) conducted two trials in lambs evaluating particle size in finishing rations. Erickson et al. (1989) reported reducing particle size (whole vs. ground in corn-based diets) had no effect on ADG or G:F in feedlot lambs. However, Erickson et al. (1988) also reported a tendency for lambs fed whole grain diets to have heavier final BW, which is similar to the tendencies we observed for final BW.

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Carcass Characteristics. There were no interactions among treatments for HCW, leg score, conformation score, fat depth, body wall thickness, flank streaking, quality or yield grade, and dressing percentage ($P \geq 0.06$). However, there was an interaction between particle size and ionophores for loin eye area ($P < 0.001$) and % BCTRC ($P = 0.004$). Loin eye area was greatest ($P < 0.05$) for WCL and GCNL, with GCL intermediate. However, GCNL had the greatest ($P < 0.05$) %BCTRC. Additionally, lambs fed lasalocid had heavier HCW (3%; $P = 0.05$) compared to those fed diets without lasalocid. No additional effects were observed for the rest of the carcass traits in relation to particle size or ionophore inclusion ($P \geq 0.06$). The research that has been conducted evaluating particle size in grain based finishing rations in lambs supports our findings that reducing particle size has minimal effects on carcass traits. Erickson et al. (1988) reported that lambs fed whole vs. ground corn had no difference in HCW and leg score, however lambs had higher yield grades and thicker fat depths when fed whole grains vs. ground. Reynolds and Lindahl (1960) reported that lambs tend to not consume finely ground feeds and sort through feed to select larger particles and secondly, that grinding increases the rate of digestion, therefore decreasing total digestibility. Additionally a previous trial at this lab, similar to our research, fed lambs coarse rolled corn with lasalocid had higher dressing percentage when compared to lambs not receiving lasalocid, however lasalocid did not affect any other carcass characteristics (Rupprecht et al., 1992).

While performance and carcass data evaluating particle size and ionophores is limited, research is available addressing the biological affects of ionophores. Ionophores appear to alter the movement of certain ions across biologic membranes, which, in the rumen, results in an alteration of microflora (NRC, 2007). Feeding lasalocid and monensin may also exert a possible N-sparing effect by inhibition of ruminal amino acid deamination (Schelling et al., 1978; Poos et al., 1979). In vitro production of amino-N decreased linearly with increasing levels of monensin in research reported by Whetstone et al. (1981) which suggests a decrease in rate of proteolysis. In a study by Paterson et al. (1983), rumen propionate was increased and the acetate to propionate ratio was decreased when lasalocid was fed to lambs. The addition of lasalocid to a low ruminal N degradable feed resulted in more rapid weight gain than without lasalocid; however, when lambs were fed soybean meal with or without lasalocid, lasalocid actually slowed the rate of gain (Paterson et al., 1983). These results indicate that lasalocid can effectively increase propionate production in the rumen, which explains the tendency for higher growth performance of the lambs fed WCL diets in the current trial. However, GCNL fed lambs had similar growth performance to WCL fed lambs, which is quite interesting. A possible explanation for the similar performance is due to a smaller particle size which led to an increase in overall digestibility for the GCNL fed lambs; although, this is speculation and was not tested in the current trial. The most interesting note in this trial, is WCNL fed lambs numerical reduction in performance compared to the three other treatments. Lasalocid is most likely needed to increase propionate production with this whole grain diet to attain the increased performance seen in the other treatments. In the current trial, GCNL fed lambs did have greater %BCTRC, however these lambs also had increased loin eye area, although statistically similar to WCL, which could have driven the increase in %BCTRC. Interestingly, the current trial showed that particle size also affected loin eye area ($P = 0.008$), while prior research in ground vs. whole grains has shown no effect of diet processing on loin eye area (Erickson et al., 1988; Erickson et al., 1989).

Nitrogen Balance Study

There were no interactions or main affects among treatments for DMI, N intake, N balance, or serum urea-N concentration (Table 3; $P \geq 0.18$), however, there was a day effect ($P = 0.0018$) for serum urea-N concentration. Days 1, 2, and 3 were generally lower than days 4 to 6 ($P < 0.05$; data not shown). There is conflicting research on particle size and its effects on N digestion, N balance, and serum urea-N concentration. Although there was no particle size affect ($P \geq 0.22$) in the current trial, previous research by Kerley et al. (1985) reported that N digestion was increased in lambs fed 6.5, 5.4 and 0.8 mm particle size corncob diets, while the 1.4 mm diet was decreased. The 1.4 mm diet also had higher fecal N loss when compared to the other diets. Other research by Perez-Torres et al. (2011) reports no differences in DM or OM intake or digestibility in diets that differ in particle size, agreeing with results from the current trial. However, the addition of lasalocid did decrease ($P = 0.01$) fecal N excretion. This is similar to findings by Ricke et al. (1984), in which lasalocid treated lambs also had decreased fecal N excretion when compared to lambs fed monensin or no ionophore. Varying results exist on lasalocid's effects on N digestibility, with some reporting it increases N digestibility (Paterson et al., 1983; Ricke et al., 1984), while other report that it remains unaffected (Funk et al., 1986) with N balance also appearing to remain unaffected (Funk et al., 1986). Ricke et al., (1984) also reports that lasalocid-fed lambs had less fecal N loss and therefore higher N retentions, which could be reflective of increased digestibility. The differences in findings could be due to the different types of collection, ranging from N balance trials, to in situ techniques.

IMPLICATIONS

Grinding lamb finishing rations containing 80% corn and 20% market lamb pellet had no beneficial, or negative, impact on lamb growth performance, mortality, or carcass traits. However, including lasalocid in rations containing whole corn and market lamb pellet may result in an increase in average daily gain, final body weight, and carcass weight. Additional research is needed to further quantify the benefits of grinding rations with feed ingredients of differing particle size (i.e. combing corn and dried distillers grains), as well as the impacts of ionophores in non-traditional feedlot rations.

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Table 1. Ingredient and nutritional composition of diets fed to lambs fed differing particle sizes of corn and market lamb pellets with or without lasalocid (DM basis)

	Treatments[1]			
Item	WCNL	WCL	GCNL	GCL
Ingredient, %				
Corn	80	80	80	80
Market lamb pellet[2]	20	20	20	20
Nutrient composition, %				
DM	96.4	96.3	96.0	96.7
CP	19.6	18.7	17.7	17.2
NDF	16.4	15.4	14.4	15.7
ADF	5.3	4.8	4.5	5.3

[1]Treatments: WCNL= whole corn and market lamb pellet without lasalocid (Bovatec, Alpharma Inc., Bridgewater, NJ); WCL= whole corn and market lamb pellet with lasalocid; GCNL= ground corn and market lamb pellet without lasalocid; GCL= ground corn and market lamb pellet with lasalocid.

[2]Market lamb pellet contained 38% CP, 4.25% Ca, 0.6% P, 3.5% salt, 3.0 ppm Se, 24,000 IU/lb vitamin A, 2,400 IU/lb vitamin D, and 60 IU/lb vitamin E with treatments WCNL and GCNL having no lasalocid and WCL and GCL containing 20 g/ton of lasalocid.

Table 2. Effects of lasalocid and particle size on lamb growth performance, carcass characteristics, and mortality

	Treatment[1]					*P*-value[3]		
Item	WCNL	WCL	GCNL	GCL	SEM[2]	PS	ION	PS*ION
Initial BW, lb	68.78	69.00	67.90	69.00	0.22	---	---	---
Final BW, lb	151.46	157.41	153.44	152.34	1.54	0.34	0.17	0.06
ADG, lb/d	0.57[a]	0.62[a]	0.60[a]	0.57[a]	0.02	0.76	0.73	0.05
Feed offered, lb DM • head^{-1} • d^{-1}	5.56	5.89	5.73	5.89	0.15	0.58	0.14	0.57
G:F	0.10	0.10	0.11	0.10	0.004	0.59	0.47	0.23
Mortality, %	0	5	2.5	5	2.39	0.61	0.14	0.61
HCW, lb	74.3	78.0	75.0	75.6	1.06	0.37	0.05	0.16
Leg score[4]	11.5	11.7	11.5	11.6	0.13	0.06	0.14	0.94
Conformation score[4]	11.7	11.9	11.8	11.8	0.10	0.85	0.24	0.51
Fat depth, cm[5]	0.73	0.61	0.66	0.74	0.06	0.60	0.72	0.11
Body wall thickness, cm	2.53	2.55	2.51	2.63	0.08	0.73	0.42	0.54
Loin eye area, cm^2	19.6[a]	21.1[bc]	22.0[c]	20.7[b]	0.31	0.008	0.79	<0.001
Flank streaking[6]	375	389	366	376	9	0.27	0.22	0.89
Quality grade[4]	11.7	11.8	11.6	11.6	0.09	0.10	0.43	0.88
Yield grade[7]	3.28	2.81	3.01	3.30	0.22	0.61	0.70	0.11
BCTRC, %[8]	46[a]	47[a]	47[b]	46[a]	0.18	0.06	0.24	0.004
Dressing, %	49	50	49	50	0.39	0.80	0.10	0.85

[1]Treatments: WCNL= whole corn and market lamb pellet without lasalocid (Bovatec, Alpharma Inc., Bridgewater, NJ); WCL= whole corn and market lamb pellet with lasalocid; GCNL= ground corn and market lamb pellet without lasalocid; GCL= ground corn and market lamb pellet with lasalocid.

[2]$n = 4$.

[3]PS= particle size of diet and ION= ionophores.

[4]Leg score, conformation score and quality grade: 1= cull to 15= high prime.

[5]Fat depth and yield grades.

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

[7]Yield grade= 0.4 + (10 × fat depth).

[8] BCTRC= boneless closely trimmed retail cuts, % = [49.936- (0.0848 × HCW, lb) – (4.376 × 0.3937 × fat depth, cm) – (3.53 × 0.3937 × body wall thickness, cm) + (2.456 × 0.155 × loin eye area, cm^2)].

[a,b,c]Means within a row with different superscripts differ ($P < 0.05$).

Table 3. Effects of lasalocid and particle size of feed on N intake, excretion, balance, and serum urea-N concentration in lambs

	Treatment[1]					*P*-value[3]		
Item	WCNL	WCL	GCNL	GCL	SEM[2]	PS	ION	PS*ION
Daily DMI, g/ kg BW	38.43	36.99	66.16	37.97	12.9	0.29	0.28	0.32
Daily N intake, g/ kg BW	1.06	0.94	1.11	1.04	0.06	0.26	0.18	0.69
Daily N excretion, g/ kg BW								
Fecal	0.23	0.14	0.21	0.16	0.01	0.87	0.01	0.45
Urinary	0.05	0.04	0.05	0.05	0.004	0.23	0.97	0.25
Daily N Balance, g/ kg BW	0.78	0.76	0.84	0.83	0.05	0.22	0.76	0.99
Serum urea-N[4], m*M*	10.29	10.11	10.87	10.37	0.53	0.50	0.65	0.77

[1]Treatments: WCNL= whole corn and market lamb pellet without lasalocid (Bovatec, Alpharma Inc., Bridgewater, NJ); WCL= whole corn and market lamb pellet with lasalocid; GCNL= ground corn and market lamb pellet without lasalocid; GCL= ground corn and market lamb pellet with lasalocid.
[2]$n = 4$.
[3]PS= particle size of the diet and ION= ionophores.
[4]*P*-values for serum urea-N: day ($P = 0.0018$) and treatment × day ($P = 0.33$).