WHOLE PLANT GRAIN SORGHUM SILAGE PROCESSING AND LASALOCID EFFECTS ON STOCKER CALF PERFORMANCE AND RUMEN FERMENTATION[1]

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Summary

Experiments were conducted to determine the effects of whole plant grain sorghum silage processing and dietary lasalocid on stocker calf performance, digestibility and rumen fermentation. Two silage treatments and three concentrations of lasalocid (0, 33 and 49 ppm) were examined in a 100 day growth trial. Lasalocid at 33 ppm depressed feed intake of steers without affecting weight gain and, therefore, improved feed efficiency. Lasalocid at 49 ppm did not improve feed conversion over that observed in controls. Both concentrations of lasalocid increased rumen propionic acid and decreased acetic acid levels. Lasalocid did not affect ruminal concentrations of isobutyric, valeric or isovaleric acids. Dry matter intake and animal weight gain in the growth trial were greater for steers fed the non-processed whole plant grain sorghum silage (NPS) with grain in the whole form than for those fed processed silage (PS) with the grain rolled before ensiling. Feed efficiency was similar for steers fed the two silage treatments. Processing treatment did not influence ruminal acetic, propionic, isobutyric or isovaleric acid proportions. In a digestion trial, postensile rolling of the grain and stover of whole plant grain sorghum silage increased ($P<.05$) in vivo starch digestion above levels observed for PS or NPS silages. Digestibilities of dry matter, organic matter, crude protein and acid detergent fiber were similar for all silage treatments.

Key Words: Grain Sorghum Silage, Whole Plant, Digestibility, Lasalocid Sodium, Cattle.

Introduction

Previous research indicated that feeding whole plant grain sorghum silage as compared to harvesting and feeding only the grain, could increase total beef production per ha by almost 28% (Buice et al., 1981). In addition, Suarez (1976) suggested that the accepted practice of harvesting and feeding only the grain portion of the grain sorghum plant should be reconsidered because the stover could be a valuable source of roughage for cattle. Ruff and Schake (1978) proposed that the feeding potential of grain sorghums could be significantly improved through harvesting of the whole plant because it provides a nearly complete diet. One problem in feeding whole plant grain sorghum as silage, however, is the lower apparent digestibility of much of the grain when fed in the whole form. Inconsistent responses have resulted when grain sorghum silage has been fed with the grain processed before ensiling (Boren et al., 1972; Schake et al., 1981) or after ensiling (Newland et al., 1969; Fox et al., 1970; Pund, 1970)

Enhancement of cattle performance through the use of monensin has encouraged the testing of related compounds that may also alter ruminal activity and improve feed efficiency and (or) weight gain. Lasalocid sodium, an ionophore similar to monensin, has improved gain and efficiency of cattle in several studies (Bartley et al., 1979; Brethour, 1979; Herod et al., 1979; Berger and Rike, 1980).

Objectives of this research were to determine the effects of processed whole-plant grain sorghum silage on in vivo digestibility and calf performance, and to evaluate the feedlot performance of, and rumen fermentation by growing calves fed several concentrations of

lasalocid sodium.

Experimental Procedure

A commercial, heteroyellow-type grain sorghum hybrid, WAC715, was harvested as whole plant silage (grain sorghum aerial parts with heads ensiled, IFN-3-07-692) by a grain combine modified such that the grain and stover were harvested and field processed simultaneously and separately. Machine modifications (Ruff and Schake, 1978) were such that combined grain within the silage was either selectively processed through a roller mill (PS) or maintained in the whole form NPS). All stover was processed in a recutter-blower and recombined with the grain. Silage yield was 8,474 kg/ha at 34.1% dry matter and the material was immediately placed in oxygen limited structures where it was stored for six months prior to feeding.

Exp. 1. Two whole plant grain sorghum silages (PS and NPS) and three levels of lasalocid sodium (0, 33 and 49 ppm) were evaluated during a 100-day growth trial. Seventy-two Beefmaster type steers averaging 217 kg were allotted by weight to 12 similar groups. Each group was randomly assigned to a 2 x 3 factorial arrangement of treatments with two replicates per diet.

All steers were fed a diet consisting of 91.2% grain sorghum silage and 8.8% of a granular commercial protein-mineral supplement that contained 34.3% crude protein, 3.40% Ca and .76% P. Lasalocid at desired levels was mixed with the commercial supplement. Steers were

individually weighed (non-shrunk) every 28 days during the trial and on 2 consecutive days at the beginning and at the end of the trial. The steers were fed once daily at ad libitum levels of intake. Feed intake and refusal was recorded daily, and dry matter content of feed and orts was determined on samples collected weekly. All samples were dried in a forced draft oven for 24 hr at 70 C and retained for later analyses. Dried feed and orts samples were ground in a laboratory mill with a 2-mm screen and composited. Composite feed and orts samples were analyzed for dry matter, N, Ca and P.

Ruminal samples, collected between 7 and 9 a.m. on day 84 via esophageal tube from half of the steers in each treatment, were analyzed for VFA and lactate concentrations by the methods outlined by Byers (1980).

Exp. 2. The effects of three whole plant grain sorghum silage processing methods on in vivo nutrient digestibility were compared. Two of the silage treatments were the same as those used in Exp. 1. A third treatment was prepared by rolling both the stover and grain portions of the NPS whole grain whole plant grain sorghum (postensiled rolled silage). These sorghum silages were individually fed to six 204 kg Beefmaster type steers according to a switchback design described by Lucas (1956).

Ytterbium nitrate included in the diet at approximately 50µg of pure Yb/g of dry matter consumed was used as an external marker. The indicator was uniformly added to the protein supplement which was then blended with each silage as fed. The trial included three

periods, each consisting of an 8-day adaptation phase followed by a 6-day fecal collection period. Grab fecal samples were collected twice daily according to an advancing 4-hr schedule designed to minimize any diurnal digestive variation.

Fecal samples were collected in duplicate. One set of samples was frozen at 0 C for pH analyses. The second set was dried in a forced draft oven at 70 C for 48 hours, then ground through a laboratory mill with a 2-mm screen and composited by animal and period for subsequent analyses. Feed samples were obtained in duplicate on the second and fifth days of each fecal collection period. One of the duplicate samples was dried in a forced-draft oven at 70 C for 24 hr and then ground and composited in the same way as the fecal samples. The second dulpicate sample was frozen at 0 C and analyzed for dry matter content using the Karl Fischer moisture procedure (AOAC, 1975). A linear regression was calculated between values obtained by this and the drying procedure in order to establish the actual dry matter content of the diets in both growth and digestion trials. Oven-dried composite feed and fecal samples were analyzed for Yb concentration by methods described by Ellis (1981). Crude protein and organic matter content were determined by AOAC (1975) procedures. Starch content was measured by methods described by MacRae and Armstrong (1968).

Data were statistically analyzed by analysis of variance and Duncan's multiple range test routine's in the Statistical Analysis Software package (Barr et al., 1979).

Results and Discussion

Exp. 1.

Composition of the silage diets is presented in table 1. No significant interactions were observed between silage treatments and lasalocid levels; hence, the results of this experiment are presented and discussed as separate main effects.

Dry matter intake was higher ($P<.05$) for cattle fed the NPS than for those fed the PS (table 2). This difference in silage dry matter consumption agrees with the results obtained by Schake et al. (1981) with similar silages. Feed conversion was not significantly affected by silage treatments, which supports results obtained by Boren et al. (1972), Brethour and Duitsman (1963) and Schake et al. (1981) who reported that grinding of either the grain or the heads of grain sorghum before ensiling had no effect on feed efficiency. Steers fed NPS had higher ($P=.13$) daily gains than steers fed the PS, in agreement with results obtained by Boren et al. (1972) and Schake et al. (1981).

The effects of processed whole plant grain sorghum silage on ruminal fatty acids is given in table 3. No significant differences in ruminal acetic, propionic, isobutyric or isovaleric acid were found between silage treatments. Steers fed PS had lower butyric and valeric acid concentrations than calves fed the whole grain silage. No significant differences in total VFA were found between treatment groups and no measurable amounts of lactic acid were detected in the samples.

The influence of lasalocid upon calf performance is summarized

in table 4. Lasalocid reduced (P<.05) dry matter intake of steers by 12.2% at 33 ppm and by 17.3% at 49 ppm compared to control steers. These results support previous reports (Davis, 1978: Brethour, 1979: Brown et al., 1979) indicating that feed intake was reduced with all levels of lasalocid. Daily gain of control steers and those fed lasalocid at 33 ppm was similar and greater (P<.05) than gain of steers fed 49 ppm lasalocid. Apparently lasalocid at 49 ppm excessively reduced feed intake, thus depressing steer weight gains.

Feed efficiency of steers fed lasalocid at 33 ppm was superior (P<.10) to that of control steers but similar to that of cattle fed 49 ppm lasalocid. The improvement in feed efficiency of the steers fed 33 ppm lasalocid agrees with results obtained by Bartley et al. (1979), Brethour, (1979), Herod et al., (1979) and Berger and Ricke, (1980), who found that efficiency was significantly improved when lasalocid was added. The 49 ppm level reduced intake excessively leaving a smaller proportion of the feed energy consumed available for production.

Effects of lasalocid sodium on rumen fermentation of steers are shown in table 5. With both levels of lasalocid the proportion of acetic acid in the rumen fluid was lower (P<.05) and levels of propionic acid were higher (P<.05) than for control cattle. No significant difference was observed between lasalocid levels. Butyric acid concentration in the control group was similar to that in cattle fed 49 ppm lasalocid, but higher than that in cattle fed 33 ppm. No significant differences in the proportion of butyric acid were found between lasalocid levels. The lasalocid induced shifts to less acetic

acid in rumen fluid, combined with the increases in propionic acid resulted in acetic to propionic acid ratios that were almost 40% narrower ($P<.05$) than those in control steers. These results are in agreement with those of Davis (1978), Bartley et al. (1979), Brown et al. (1979) and Thonney et al. (1981). No significant differences in isobutyric, isovaleric and valeric acid proportions were found among treatments, which agrees with most previous data indicating that the main effect of lasalocid is not on these acids but on propionic, acetic and butyric acids. No measurable concentrations of lactic acid were found in the rumen samples. A significant difference in total VFA concentration was found between the control steers and steers fed lasalocid sodium at 49 ppm. Steers fed lasalocid at 33 ppm were not statistically different from those in the other two treatments in total VFA. These findings disagree with most previous reports which indicate that lasalocid does not affect total VFA concentration in the rumen.

Exp. 2.

No significant differences in apparent organic matter, dry matter and crude protein digestibilities were found among the three silage treatments (table 6). The similarity of nutrient digestibilities between NPS and PS treatments supports the minimal difference observed in performance of steers in Exp. 1. However, when the silage was rolled after ensiling, there was a trend toward higher digestibilities of organic matter, dry matter and crude protein. Furthermore, starch digestibility and fecal pH were higher ($P<.05$) with rolled silage than with the other two treatments. These data indicate that post-

ensile rolling is the preferred approach for processing grain contained within whole plant sorghum. It is possible that similar factors are involved with these whole plant grain silages, as have been observed with reconstitution as ground versus whole grain sorghums (Baker, 1973). Whole grain within silage may undergo partial reconstitution which would not be accomplished successfully for ground or rolled grain.

TABLE 1. COMPOSITION OF SILAGE DIETS FED, EXPERIMENT 1 AND 2

Item	Component[a]							
	Dry matter	Crude protein	Acid detergent fiber	Ether extract	Starch	Ash	Ca	P	Organic matter
Exp. 1									
Whole grain (NPS)[b]	36.7	10.3	29.4	3.4	----	9.2	.56	.29	90.8
Pre-ensiled rolled grain (PS)[c]	34.1	10.3	31.2	3.5	----	9.1	.53	.28	90.9
Exp. 2									
Whole grain (NPS)[b]	38.4	10.7	26.2	---	27.3	9.9	---	---	90.1
Pre-ensiled rolled grain (PS)[c]	35.4	10.5	28.4	---	26.7	9.3	---	---	90.7
Post-ensiled rolled grain	39.3	10.8	26.3	---	28.1	9.0	---	---	91.0

[a]Values given as percentage of dry matter.

[b]NPS = Non-processed silage

[c]PS = Processed silage

TABLE 2. EFFECT OF WHOLE PLANT GRAIN SORGHUM SILAGE PROCESSING ON STOCKER CALF PERFORMANCE

Item	Silage treatment		
	Whole grain (NPS)	Preensiled rolled grain (PS)	SEM
No. of steers	36	36	
No. of replicates	6	6	
Steers per replicate	6	6	
Avg initial weight, kg	216.57	216.38	
Avg final weight, kg[a]	293.58	290.05	.45
Avg daily gain, kg[a]	.77	.74	.03
Daily feed intake, as fed, kg	15.41	15.66	
Dry matter, %[b]	36.48	34.09	.44
Daily dry matter intake, kg[b]	5.62	5.34	.17
Dry matter feed conversion	7.30	7.26	.40

[a] (P = .13)

[b] (P<.05)

NPS = Non-processed silage

PS = Processed silage

TABLE 3. WHOLE PLANT GRAIN SORGHUM SILAGE PROCESSING METHODS AND RUMEN FERMENTATION

Rumen VFA[a]	Silage treatment		
	Whole grain (NPS)	Preensiled rolled grain (PS)	SEM
Total VFA, μmoles/ml	32.00	34.14	4.91
Acetic	65.94	67.87	2.65
Propionic	19.95	20.25	2.51
Butyric[b]	8.05	6.75	.90
Lactic	Traces	Traces	-
Isobutyric	1.55	1.35	.18
Isovaleric	2.50	2.17	.26
Valeric[b]	2.02	1.63	.25
Acetic to propionic ratio	3.62:1	3.62:1	.50

[a] moles/100 moles or μmoles/ml

[b] $P<.05$

NPS = Non-processed silage

PS = Processed silage

TABLE 4. EFFECT OF LASALOCID SODIUM ON STOCKER CALF PERFORMANCE

Item	Lasalocid, ppm			
	0	33	49	SEM
No. of steers	24	24	24	
No. of replicates	4	4	4	
Steers per replicate	6	6	6	
Avg initial weight, kg	216.08	216.70	216.63	
Avg final weight, kg	296.48[a]	293.70[a]	285.25[b]	.45
Avg daily feed intake, kg of dry matter	6.08[a]	5.34[b]	5.02[c]	.17
Avg daily gain, kg	.80[a]	.77[a]	.69[b]	.03
Dry matter feed conversion	7.58[d]	6.95[e]	7.32[d,e]	.40

[a,b,c] Means in the same row with different superscripts differ ($P<.05$).

[d,e] Means in the same row with different superscripts differ ($P<.10$).

TABLE 5. LASALOCID SODIUM EFFECTS ON RUMEN FERMENTATION

Rumen VFA[a]	Lasalocid, ppm			
	0	33	49	SEM
Total VFA, μmoles/ml	26.72[b]	33.94[bc]	38.50[c]	4.91
Acetic	71.99[b]	65.95[c]	62.76[c]	2.65
Propionic	13.96[b]	22.27[c]	24.06[c]	2.51
Butyric	8.22[b]	6.49[c]	7.48[bc]	.90
Lactic	Traces	Traces	Traces	-
Isobutyric	1.51	1.49	1.33	.18
Isovaleric	2.51	2.32	2.16	.26
Valeric	1.80	1.63	2.04	.25
Acetic to propionic ratio	5.19:1[b]	3.03:1[c]	2.63:1[c]	.50

[a]moles/100 moles or μmoles/ml

[b,c]Means in the same row with different superscripts differ (P<.05).

TABLE 6. EFFECT OF WHOLE PLANT GRAIN SORGHUM SILAGE PROCESSING UPON APPARENT NUTRIENT DIGESTIBILITY

Item	Silage treatment			
	Whole grain (NPS)	Preensiled rolled grain (PS)	Postensiled rolled silage	SEM
No. of steers[a]	6	6	6	
Digestibility, %				
Organic matter	55.10	55.39	59.50	4.64
Dry matter	52.83	53.00	56.80	4.36
Crude protein	43.83	43.30	46.57	3.36
Starch	87.21[b]	83.97[b]	93.63[b]	4.19
Fecal pH	6.85[b]	6.97[b]	7.02[c]	.05

[a]The initial weight of steers was 204 kg and their final weight was 217 kilograms.

[b,c] Means in same row with different superscripts are different ($P<.05$).

NPS = Non-processed silage

PS = Processed silage

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