postpartum nutrition of the cow. Calves weaned at 285 days were 73.5 and 93.5 lb heavier for the Moderate and Low levels, respectively, than calves weaned at 210 days and grazed on native pasture for 75 days and fed a high roughage ration during the initial 14 days of the grazing period. The 20-lb advantage to the Low level group is unclear.

Effect of Yeast Culture[1] on Nitrate Toxicity of Lambs and Steers Fed High-Nitrate Sorghum-Sudan Hay

G. W. Horn, G. E. Burrows and K. S. Lusby

Story in Brief

Lambs and steers were fed low-nitrate hay and supplements that supplied 0 or .1 lb (lambs) or .25 lb (steers) of Yeast Culture per head per day for 14 and 12 days, respectively, before being fed high-nitrate sorghum-sudan hay. The effect of Yeast Culture on blood methemoglobin concentrations was evaluated. Nitrate consumption by lambs 6 hr after being fed the high-nitrate hay was similar among treatments and ranged from about .3 to .5 g/kg body weight during 3 challenge days. Similar rates of nitrate consumption were observed for steers. Blood methemoglobin concentrations of lambs and steers fed Yeast Culture were not lower than those of control animals. Results of the study do not indicate that Yeast Culture will decrease the toxicity of high-nitrate forages consumed by sheep or cattle.

Introduction

In previous studies conducted at the University of Missouri by Grebing (1974 and 1976), the feeding of about 0.1 pound per day of Diamond V Yeast Culture markedly decreased death losses of lambs that received a ruminal drench of potassium nitrate and sodium nitrate. In these studies the nitrate dosage was about 0.8 g nitrate per kg of lamb body weight. In the 1976 study lambs were fed a cottonseed hull, cracked corn, soybean meal based ration that contained 24.5 percent corn.

Sapiro et al. (1949) reported that very severe blood methemoglobin concentrations were produced in sheep fed a poor quality grass hay and dosed with 0.4 g

[1]Diamond V Yeast Culture, Diamond V Mills, Inc., Cedar Rapids, Iowa.

nitrate per kg of body weight. One of four sheep died. In the studies of Lewis (1951), 0.3 g nitrate per kg of body weight resulted in methemoglobin concentrations of 60 percent in wethers fed meadow hay.

Nitrate toxicity remains a very significant animal health problem. Feed ingredients that would reduce the incidence of nitrate toxicity in ruminants fed and(or) grazing forages which tend to accumulate nitrates would be welcomed aids.

Diamond V Yeast Culture is very palatable and, when mixed with a self-fed mineral mixture at levels of 33 and 50 percent, increased consumption of the mineral mixture from .08 to .14 and .24 lb per head per day, respectively, by stocker cattle on wheat pasture (Streeter et al., 1981). The effect of Yeast Culture on blood methemoglobin concentrations of lambs and steers challenged with a high-nitrate hay was evaluated in this study.

Experimental Procedure

Lamb Trial

The trial consisted of a 14-day preliminary period and a 5-day experimental period. Twenty-four (24) yearling wethers that weighed 78.0 ± 7.8 lb were housed in individual pens and randomly allotted to two treatment groups. The lambs were fed .5 lb of supplement per head per day that supplied .1 lb of wheat middlings (control) or Yeast Culture (Table 1). Time was allowed for complete consumption of the supplements before hay was fed. During the preliminary period, all lambs had free choice access for 1 ½ hours each day to 2 lb of a control (i.e., low-nitrate) sorghum-sudan hay. Hay that was not consumed during the 1 ½ hour period of each day was removed in an attempt to encourage rapid hay consumption. Mean hay consumption of all lambs during the last 6 days of the preliminary period was 1.7 percent of body weight. If the hay had contained 29,300 ppm nitrate, it would have supplied .50 g nitrate per kg of body weight, which was the desired nitrate dosage.

Table 1. Composition of supplements fed to lambs[a]

Item	Control	Yeast culture
Dehydrated alfalfa meal, %	74.7	74.7
Wheat middlings, %	20.0	—
Diamond V Yeast Culture, %	—	20.0
Dicalcium phosphate, %	4.4	4.4
Trace-mineralized salt, %	.9	.9
Vitamin A*	+	+
Vitamin D*	+	+

[a] Supplements fed at level of .5 lb/head/day to supply .10 lb of yeast culture/head/day.
* Vitamin A and D added to furnish 2000 and 250 IU per head per day.

On day 1 of the 5-day experimental period, all lambs were fed a high-nitrate (i.e., 29,300 ppm nitrate) sorghum-sudan hay in place of the control hay. Because of previous difficulties with rate of consumption of the high-nitrate hay, the lambs were not fed any hay for 43 hours prior to feeding the high-nitrate hay. Supplements were fed daily during the 43-hour period. The lambs had ad libitum access to the high-nitrate hay during the 5-day experimental period. Blood samples were collected from the jugular vein for methemoglobin analysis at 6 hr after feeding the high-nitrate hay on days 1, 2 and 5 of the experimental period. Blood methomoglobin analyses were conducted by a modification of the procedure of

Table 2. Composition of supplements fed to steers[a]

Item	Control	Yeast culture
Soybean meal, %	81.4	81.4
Wheat middlings, %	12.5	—
Yeast culture, %	—	12.5
Molasses, %	2.6	2.6
Dicalcium phosphate, %	1.75	1.75
Trace-mineralized salt, %	1.75	1.75
Vitamin A, IU/lb	11,918	11,918

[a] Supplements fed at level of 2 lb/head/day to supply 0.25 lb yeast culture/head/day.

Table 3. Composition of hays fed in lamb and steer trials

Trial	Crude protein (% of DM)	IVDMD, %	Nitrate (% as-fed)
Lamb			
Control sorghum-sudan[a]	7.8	52.7	<1,000
High-nitrate sorghum-sudan	14.7	58.0	29,300
Steer			
Period I			
Prairie hay[a]	5.6	41.9	NA[b]
High-nitrate sorghum-sudan	13.7	59.0	32,000
Period II			
Control sorghum-sudan[a]	6.4	55.7	1,330
High-nitrate sorghum-sudan	15.4	56.8	29,900

[a] Fed during preliminary period only.
[b] Not analyzed.

Leahy et al., 1960. Number of lambs that were bled per treatment are shown in Table 4.

Hay fed during the preliminary and challenge periods of both the lamb and steer trials was ground in a hammermill through a ¾ inch screen to minimize sorting by the animals. Because of bale-to-bale variation in nitrate concentration, the high-nitrate hay was mixed in an Oswalt mixer-feeder wagon before feedings of individual animals were weighed out. The hay was sampled during mixing for crude protein, in vitro dry matter digestibility (IVDMD) and nitrate analyses. Results of these analyses are shown in Table 3.

Steer Trial

Ten yearling Hereford steers that weighed 561 ± 82 lb were paired by weight, placed in individual pens and randomly assigned within pairs to two treatments. A crossover design that consisted of two 14-day periods was used. Periods consisted of a 12-day preliminary period and a 2-day challenge period during which high-nitrate hay was fed. During the first 10 days of the preliminary periods, steers were fed prairie hay (Period I) and a control (i.e., low-nitrate) sorghum-sudan hay (Period II) at a level of about 2.2 percent of body weight and 2 lb of supplement per head per day that contained 0.25 lb of wheat middlings (control) or Yeast Culture. Composition of the supplements is shown in Table 2. On days 11 and 12 of the preliminary periods, steers were fed prairie hay at a level of 1

Table 4. Effect of yeast culture on blood methemoglobin concentrations of sheep

Item	Control	Yeast culture	Observed significance level
Number of wethers	11	12	
Weight, lb	76.8	79.1	
Day 1 (6 hr post-feeding)			
Number of wethers	6	6	
Hay intake, % of body wt	1.73	1.95	.09
Nitrate intake, g/kg body wt	.51	.57	.09
Methemoglobin, %	28.7	29.2	.98
Day 2 (6 hr post-feeding)			
Number of wethers	11	12	
Hay intake, % of body wt	.95	1.08	.33
Nitrate intake, g/kg body wt	.28	.32	.33
Methemoglobin, %	6.4	8.2	.55
Day 3 (24 hr post-feeding)			
Number of wethers	11	12	
Hay intake, % of body wt	2.87	2.71	.33
Nitrate intake, g/kg body wt	.84	.79	.33
Day 4 (24 hr post-feeding)			
Number of wethers	11	12	
Hay intake, % of body wt	2.74	2.77	.77
Nitrate intake, g/kg body wt	.80	.81	.77
Day 5 (6 hr post-feeding)			
Number of wethers	8	7	
Hay intake, % of body wt	1.52	1.80	.20
Nitrate intake, g/kg body wt	.44	.53	.20
Methemoglobin, %	6.4	14.4	.20

percent of body weight (Period I) and 2 lb per head per day of the control sorghum-sudan hay (Period II). Supplements were fed as usual.

A high-nitrate sorghum-sudan hay was fed at levels to supply 0.5 g nitrate per kg of body weight on each of the 2 days of the challenge period. Blood samples were obtained from jugular vein catheters, by crowding the steers into a corner of the pens at various times after feeding the high-nitrate hay, for methemoglobin analysis. The times in which blood samples were taken are shown in Tables 5 and 6.

Results and Discussion

Lamb Trial

Intake of hay (percent of body wt) and nitrate (g/kg body wt) by the lambs during the 5-day period in which high-nitrate hay was fed is shown in Table 4. The lambs did not consume the high-nitrate hay as rapidly as hoped. Nitrate intake of six lambs per treatment, which had consumed the most hay at 6 hours post-feeding on day 1, was .51 and .57 g/kg body weight, respectively, for lambs fed the control and Yeast Culture supplements. Blood methemoglobin concentra-

Table 5. Hay and nitrate intake and blood methemoglobin concentrations of steers fed high-nitrate sorghum-sudan hay (period I)[a]

Item		Supplement					
		Control			Yeast Culture		
		Hay intake (% of body wt)	Nitrate intake (g/kg body wt)	Methemoglobin (%)	Hay intake (% of body wt)	Nitrate intake (g/kg body wt)	Methemoglobin (%)
Challenge day	Hr post-feeding						
1	0	—	—	0	—	—	0
1	4	0.78	0.25	—	0.76	0.24	—
1	6	0.92	0.29	13.1	0.93	0.30	25.8***
1	12	1.55	0.50	—	1.57	0.50	—
1	24	—	—	2.5	—	—	0.7
2	4	0.83	0.27	26.1	0.65	0.21	40.1*
2	7	1.28	0.41	19.3	1.07	0.34	31.9*
2	12	1.55	0.50	5.5	1.57	0.50	18.2*
2	24	—	—	0.6	—	—	0.6

[a]Four and five steers (561 ± 82 lb) fed control and yeast culture supplements, respectively. Sorghum-sudan hay contained 32,000 ppm nitrate.
Significantly greater (***$P<.01$, *$P<.10$) than methemoglobin concentrations of control steers.

Table 6. Hay and nitrate intake and blood methemoglobin concentrations of steers fed high-nitrate sorghum-sudan hay (period II)[a]

Item		Supplement					
		Control			Yeast culture		
		Hay intake (% of body wt)	Nitrate intake (g/kg body wt)	Methemoglobin (%)	Hay intake (% of body wt)	Nitrate intake (g/kg body wt)	Methemoglobin (%)
Challenge Day	Hr post-feeding						
1	4	0.93	0.28	14.1	1.01	0.30	21.8
1	7	1.17	0.35	52.3	1.11	0.33	34.4
1	12	1.49	0.45	29.7	1.69	0.50	23.3
2	4	0.81	0.24	22.1	0.82	0.25	38.7
2	7	1.34	0.40	27.0	1.32	0.39	37.1
2	12	1.67	0.50	14.4	1.69	0.50	19.7
2	24	—	—	0.7	—	—	1.1

[a] Five steers (551 ± 87 lb) per treatment. Sorghum-sudan hay contained 29,900 ppm nitrate.

tions of lambs on the two treatments were very similar (i.e., 28.7 vs 29.2 percent) at this time. Nitrate intake of all lambs by 6 hours post-feeding on day 2 was .28 and .32 g/kg body weight for the two treatments and was less than that of day 1. Data of one control lamb was deleted because he pulled large amounts of hay out of the feeder, and accurate measurements of hay consumption were not possible. Blood methemoglobin concentrations were low at 6 hours post-feeding on day 2 and were not significantly different between treatments.

By day 5 there was enough high-nitrate hay remaining for only 15 lambs. Nitrate intake of lambs fed the control and Yeast Culture supplements was .44 and .53 g/kg body weight, respectively, at 6 hours post-feeding. Mean blood methemoglobin concentrations were 6.4 and 14.4 percent, respectively, and were not significantly different.

Steer Trial

Intake of high-nitrate hay (percent of body weight), nitrate intake (g/kg of body weight) and blood methemoglobin concentrations of steers during Periods I and II are shown in Tables 5 and 6, respectively. Data of one control steer during period I was deleted because of low hay intake. Blood methemoglobin concentrations are also shown graphically in Figures 1 and 2. Nitrate intakes of steers fed the control and Yeast Culture supplements were similar at the various time intervals after feeding of both Periods I and II. The steers consumed enough hay during the first 4 hours post-feeding to supply about .25 g nitrate/kg body weight. The remainder of the high-nitrate hay was generally consumed by 12 hours post-feeding.

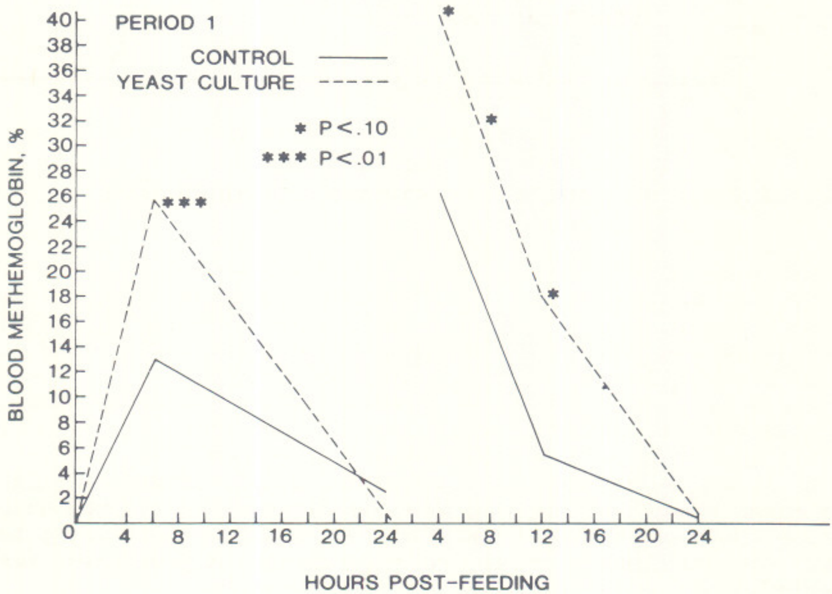

Figure 1. Blood methemoglobin concentration of steers (Period 1)

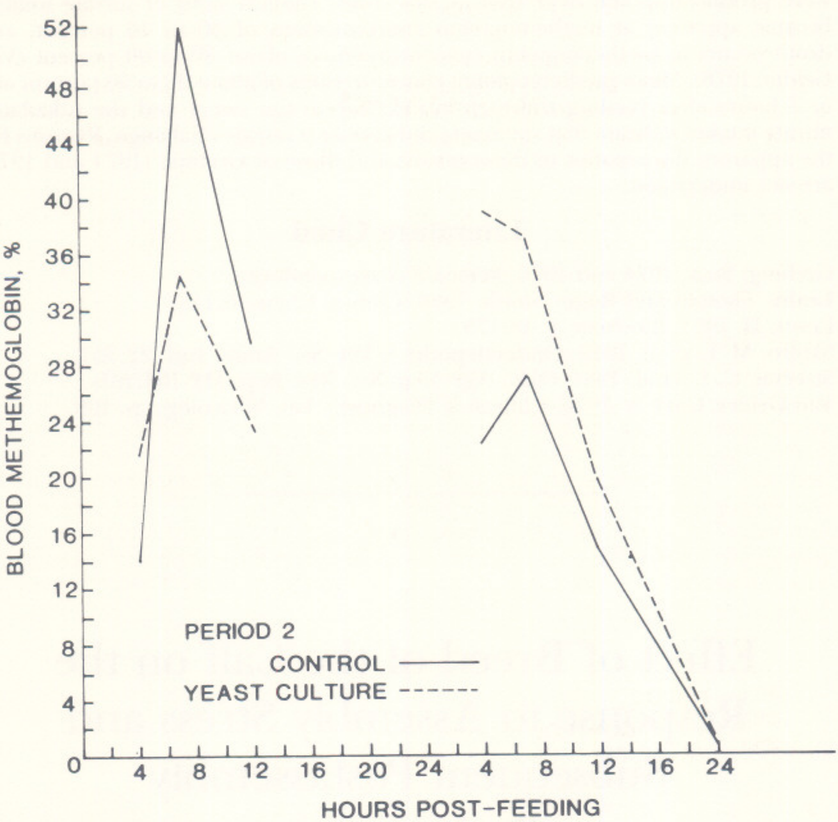

Figure 2. Blood methemoglobin concentration of steers (Period 2)

Blood methemoglobin concentrations at 6 hours post-feeding on day 1 (Period I) were 13.1 and 25.8 percent ($P<.01$), respectively, for steers fed the control and Yeast Culture supplements. Blood methmoglobin concentrations at 4, 7 and 12 hours post-feeding on day 2 (Period I) were higher ($P<.10$) for steers fed the Yeast Culture supplement.

None of the differences among blood methemoglobin concentrations of steers fed the control or Yeast Culture supplements during Period II were significant ($P>.10$). Methemoglobin concentrations of control steers were, however, higher at 7 and 12 hours post-feeding on day 1. Definite clinical signs of nitrate toxicity (i.e., depression, cyanosis and staggering) were observed in one steer of each treatment at 7 hours post-feeding of day 1 (Period II). At 12 hours post-feeding, the steers were much more alert and were not staggering. A pinkish color had returned to the nose and skin around the eyes of the steers.

Results of this study do not indicate that Yeast Culture will decrease the toxicity of high-nitrate forages. While the nitrate challenge was not nearly as acute as in the studies of Grebing (1974 and 1976), definite clinical signs of nitrate toxicity were produced in the steer trial of this study. Clinical signs of nitrate toxicity become apparent at methemoglobin concentrations of 30 to 40 percent, and death occurs at methemoglobin concentrations of about 80 to 90 percent (Van Gelder, 1976). Mean methemoglobin concentrations of about 20 to 50 percent at 4 to 7 hours after feeding the high-nitrate hay to the steers and the calculated nitrate intakes indicate that the steers did receive a nitrate challenge. Reasons for the apparent discrepancy in these results and those of Grebing (1974 and 1976) are not understood.

Literature Cited

Grebing, Stan. 1974 and 1976. Personal correspondence.
Leahy, Thomas and Roger Smith. 1960. Clinical Chem. 6:148.
Lewis, D. 1951. Biochem. J. 48:175.
Sapiro, M. L. et al. 1949. Onderstepoort J. Vet. Sci. Anim. Ind. 22:357.
Streeter, C. L. et al. 1981. Okla. Agr. Exp. Sta. Res. Rep. MP-108:101.
Van Gelder, Gary A. 1976. Clinical & Diagnostic Vet. Toxicology. p. 109.

Effect of Breed of the Calf on the Response to Assembly Stress and Subsequent Postassembly Performance

W. A. Phillips and R. R. Frahm

Story in Brief

Steer calves representing four crossbred groups were used to determine the effect of calf breed on the amount of weight lost during assembly and the subsequent postassembly performance. All breed groups were raised under the same environmental and managerial conditions and subjected to two periods of fasting and one period of refeeding to simulate the stress of assembly and transit. Calf breed had no effect on the amount of weight lost during the first period of fasting in the assembly process. There were differences among breeds in the amount of weight regained during a refeeding period following the first fast and in the amount of weight lost during the second period of fasting, which simulated

USDA, Agricultural Research Service, Southern Region in cooperation with the Oklahoma Agricultural Experiment Station.