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Evaluation of Sodium Bisulfate as a Replacement for Phosphoric Acid in a Conventional Mink Ranch Diet

Steven Bursian, Jane Link and Angelo Napolitano
Department of Animal Science
Michigan State University
East Lansing, MI 48824

Introduction

Phosphoric acid has been used in conventional mink ranch diets and in commercial mink and fox pellet formulations for preservation of feed, for prevention of urinary calculi in mink and fox and to reduce the incidence of "wet belly" disease in mink. The recommended level of inclusion is 1.0% of 75% feed-grade phosphoric acid in conventional ranch diets employing 15 to 20% fortified cereal. Prevention of urinary calculi composed of magnesium ammonium phosphate by addition of phosphoric acid to the diet is accomplished through a reduction in urinary pH.

Inclusion of sodium bisulfate into the diet of cats has been shown to effectively reduce urinary pH, thus reducing the incidence of urinary calculi. It was of interest to determine if sodium bisulfate could be used as a replacement for phosphoric acid in a conventional mink ranch diet. This would benefit the mink rancher in terms of safe material handling (dry product compared to wet product) as well as a reduction in feed costs.

Objectives

The objectives of the study were to: (1) compare the effectiveness of sodium bisulfate and phosphoric acid for lowering urinary pH of mink; (2) compare the phosphorus content of diets containing phosphoric acid or sodium bisulfate; (3) compare the phosphorus content of feces from mink fed diets containing phosphoric acid or sodium bisulfate; (4) compare body weight gain of mink fed diets containing phosphoric acid or sodium bisulfate.

Methods

Sixty-three adult mink (39 females and 24 males) from the Michigan State University Experimental Fur Farm herd were fed a conventional ranch mink diet containing 1% of 75% feed-grade phosphoric acid and 66 adult mink (41 females and 25 males) were fed the same diet with the phosphoric acid replaced by 1% sodium bisulfate (Table 1). Diets were fed from September 10, 2008 until December 2, 2008 (82 days). Animals were housed individually in wire mesh cages within an open-sided pole barn. Feed was provided daily by placing approximately 250 g on

the top of the cage. Unconsumed feed was scraped off the cage the next day and replaced with fresh feed. Water was available *ad libitum*.

Animals were weighed at the beginning of the trial and then on a monthly basis until the end of the trial. Urine samples were collected prior to the beginning of the trial as well as on days 1, 7 and 42 for pH determination. Fecal samples for determination of phosphorus concentrations were collected on day 42 of the trial.

Results

Body weight gains of male and female mink fed diets containing 1% phosphoric acid or 1% sodium bisulfate were comparable (Table 2). This indicates that growth of juvenile mink is adequate in animals fed diets containing sodium bisulfate. The effectiveness of sodium bisulfate to maintain urinary pH within the appropriate range (6.0-6.6) to prevent cystitis and urinary calculi is presented in Table 3. While the pH of urine collected from mink fed the diet containing 1% phosphoric acid was significantly lower than pH of urine collected from mink fed the diet containing 1% sodium bisulfate on days 1 and 7 of the trial, pH in both groups was lower than 6.6. On day 42 of the trial, urinary pH was comparable between the two groups. These data indicate that sodium bisulfate is as effective as phosphoric acid in terms of keeping urinary pH within the appropriate range for prevention of cystitis and urinary calculi. The concentration of phosphorus in the feed containing 1% phosphoric acid was 28% greater when compared to the feed containing 1% sodium bisulfate when expressed on a dry matter basis and 46% greater when expressed on an as fed basis (Table 1). Similarly, fecal phosphorus concentrations were significantly greater (29%) in the phosphoric acid group compared to the sodium bisulfate group when expressed on both a dry weight basis (29%) and a wet weight basis (19%) (Table 4). This could have important environmental implications in that ranchers must limit the amount of phosphorus applied to fields. Interestingly, the moisture content of feces from animals in the sodium bisulfate group was slightly, but significantly, greater than moisture content of feces collected from animals in the phosphoric acid group (74.63% vs 69.28%) (Table 4). The difference in moisture content was not readily apparent upon visual examination of manure beneath the cages. Subjective evaluation of pelts after processing indicated no noticeable differences between the two groups.

Summary

Incorporation of 1% sodium bisulfate in a conventional mink diet as a replacement for phosphoric acid resulted urinary pH values that were comparable to those resulting from use of phosphoric acid. Fecal phosphorus content was lower while moisture content was greater in the sodium bisulfate group. There were no differences in body weight gain and pelt quality between the two groups.

Table 1. Diets for evaluation of sodium bisulfate (SBS) as a replacement for phosphoric acid (PA) in conventional mink ranch diet

Ingredient	**Phosphoric Acid** % of Diet	**Sodium Bisulfate** % of Diet
Cereal - National G'NF-20	17.63	17.63
Whole ground chicken	17.63	17.63
Spray-dried liver	5.29	5.29
Spray-dried egg	5.92	5.92
Spray-dried blood protein	1.69	1.69
Fish meal	5.29	5.29
Soy oil	2.54	2.54
Water	37.03	37.03
MSU vitamin premix	0.36	0.36
MSU mineral premix	0.36	0.36
Biotin	0.02	0.02
Phosphoric acid/	0.93	0.00
Sodium bisulfate	0.00	0.93
Larvadex	5.29	5.29
Total	100.00	100.00
Dry matter (DM)	39.90 %	47.44 %
Diet analysis - phosphorus (DM basis)	12.09 mg/g	9.47 mg/g
Diet analysis - phosphorus (As fed basis)	7.26 mg/g	4.98 mg/g

Table 2. Effect of sodium bisulfate (SBS) as a substitute for dietary phosphoric acid (PA) on mink body weight gain over 82 days

	Females					Males				
	PA (n = 39)	SD*	SBS (n = 41)	SD	*P*-value	PA (n = 24)	SD	SBS (n = 25)	SD	*P*-value
Initial Wt. (g)	1235	178	1229	185	0.8804	2047	227	2027	315	0.8070
Final Wt. (g)	1356	191	1329	196	0.5302	2080	198	2038	287	0.5525
Gain (g)	121	96	100	107	0.3551	33	172	10	138	0.6096
ADG (g/d)	1.48	1.17	1.22	1.31	0.3551	0.41	2.10	0.13	1.69	0.6096

*SD = standard deviation.

Table 3. Effect of sodium bisulfate (SBS) as a substitute for dietary phosphoric acid (PA) on mink urine pH

	PA	SBS	*P*-value
Pretrial	6.38	---	
1 d	5.98	6.46*	0.0006
7 d	5.74	6.19*	<0.0001
42 d	5.65	5.86	0.1426

*Significantly different than phosphoric acid value at $P < 0.01$.

Table 4. Effect of sodium bisulfate (SBS) as a substitute for dietary phosphoric acid (PA) on mink fecal phosphorus concentration*

	PA	SBS	*P*-value
Fecal P concentration (mg/g dry matter)**	22.70	17.66	< 0.0001***
Fecal P concentration (mg/g wet basis)	15.72	13.18	< 0.0014***

*n = 16 samples per treatment.
**% dry matter = 30.72 for phosphoric acid fecal matter and 25.37 for sodium bisulfate fecal matter. The dry matter values are significantly different at $P < 0.01$.
***Significantly different the phosphoric acid value at $P < 0.01$.