Cement Kiln Dust Trials

**R. A. Zinn, D. R. Gill,
F. N. Owens and K. B. Poling**

Story in Brief

The influence of kiln dust on animal performance and nutrient availability was evaluated. Kiln dust was found ineffective in enhancing performance of finishing cattle or laboratory rats. While kiln dust supplementation may improve fiber digestibility and retention of nitrogen and calcium, higher levels may reduce feed intake and increase liver abscesses.

Introduction

Cattle feeders in Georgia first supplemented cattle feed with the waste kiln dust from cement manufacturing. Wheeler and Oltjen (1977) substituted 3.5 percent kiln dust for the protein and mineral supplement in a 50 percent roughage ration for finishing steers. They obtained increased rates (28 percent) and efficiencies of gain (21 percent) from addition of 3.5 percent kiln dust.

Similar results were obtained in a second study with steers and lambs (Wheeler and Oltjen, 1979). In the latter study, steers receiving kiln dust with an 8.4 percent crude protein ration gained 67 percent faster while with a 12.3 percent crude protein ration, gains were increased by 25 percent. Similarly, lambs receiving an 8.4 percent protein diet supplemented with kiln dust gained 352 percent faster while supplementation of a 13.6 percent crude protein ration increased gain by 20 percent. Other work with kiln dust has not looked so promising.

Some studies have even indicated a possible negative response (Personal communications - G. M. Ward, Colorado; W. B. Anthony, Alabama). Certainly the response could vary with source and type of kiln dust. The objective of this research was to determine the influence of various sources and types of supplemental cement kiln dust on (1) growth and performance of nonruminants (rats) and ruminants (steers) and (2) nutrient digestibility of high concentrate and high forage diets.

Materials and Methods

Experiment 1

Seventy-five 635 lb steers were used in a feedlot trial. Treatments consisted of two protein levels, 9.3 and 11.5 percent, and four levels of added cement kiln dust (0, 0.87, 1.75, 3.48 percent). Ingredient composition of experimental diets as well as allocation of animals to treatments is shown in Table 1. After 41 days, the low protein and 3.48 percent kiln dust treatments were discontinued because of reduced rates of gain.

Experiment 2

Three laboratory rat growth trials were conducted. In the first trial, 1 percent added cement dust from three locations (Pryor, Oklahoma, Ada, Oklahoma and Rome, Georgia) were compared to a 0 control and an ashed salt mix for ability to stimulate growth and performance. In addition, four different stages and byproducts of cement manufacturing (Baghouse, Buell, Clinker or cement) obtained from Pryor, Oklahoma, were compared. Rations contained 80 percent ground corn, 11 percent casein, 3.8 percent cellulose, 0.24 percent salt, methionine and choline chloride.

In the second trial, four different kiln dust samples obtained from Rome, Georgia were added at the 1 percent level to a low protein ration consisting of 31 percent ground

Table 1. Experimental diets and animal allocations[a].

Item	Protein levels					
	9.3%	9.3%	11.5%	11.5%	11.5%	11.5%
Steers, no.	13	12	12	13	12	13
Kiln dust	0	3.34	0	0.87	1.75	3.48
Cracked corn	79.2	75.4	73.7	73.5	72.4	70.2
Cottonseed hulls	12.7	13.0	12.7	12.7	12.7	12.7
Soybean meal	.8	1.5	6.4	6.5	6.7	7.1
Dical	.30	.33	.16	.16	.17	.19
Lime	.73	0	.75	0	0	0

[a]Alfalfa hay (1.5%), salt (0.3%), Monensin (30 g/ton) and vitamin A were added to all rations.

Table 2. Ingredient composition (digestion trials).

Ingredient	Concentrate[a]	Roughage[b]
	%	
Corn, cracked	60.9	- - - -
Corn silage	- - - -	97.4
Cottonseed hulls	13.6	- - - -
Soybean meal	9.7	- - - -
Molasses	6.9	- - - -
Alfalfa hay, ground	5.8	- - - -
Salt, mineralized	.5	0.25
Limestone	.5	- - - -
Dicalcium phosphate	.5	0.26
Urea	.1	1.05
Water	2.0	- - - -

[a]To form the test ration, 3.5% kiln dust was added.
[b]To form the test ration, 1% kiln dust from either Oklahoma Cement or Martin Marietta Cement Company were added.

corn, 6 percent casein, 4.5 percent minerals, 4 percent corn oil, 4 percent cellulose, 0.25 percent salt, methionine and choline chloride.

In the third trial, influence of cellulose on response to supplemental cement dust was investigated. Rations consisted of 93 or 54 percent ground corn, 4 or 40 percent cellulose, 2 percent corn oil, 1 percent kiln dust and trace mineralized salt.

Experiment 3

Two metabolism trials were conducted to investigate influence of cement dust on nutrient utilization. In the first trial, four 650 lb steers were used in switchback design experiment to determine influence of cement dust on digestibility of a high concentrate diet. Ingredient composition of experimental diet is shown in Table 2. Kiln dust was added at 3.5 percent to form the test ration.

In the second trial, eight 665 lb steers were used in a completely random design to determine the influence of 1 percent added cement kiln dust on digestibility of an all corn silage ration. Steers were limit fed 9 lb of corn silage dry matter per day. Ingredient composition of experimental diets is shown in Table 2. Steers were allowed 14 days adaptation to silage treatments followed by five-day fecal collection period.

Results and Discussion

Experiment 1

The influence of cement kiln dust on cattle performance, fecal pH and fecal starch is shown in Table 3. Added cement kiln dust at the higher protein level tended to depress feed intake and rate of gain with little effect on efficiency of feed use. Added dust did not improve performance at the low protein level, but higher kiln dust supplementation appeared to decrease fecal starch and increase fecal pH. Carcass characteristics were similar for all treatments; however, kidney-heart-pelvic fat appeared to decrease and liver abscess scores to increase markedly with added kiln dust.

Experiment 2

The influence of source and type of cement dust on rat growth and performance is shown in Table 4. Differences between treatments were small although the first three weeks, added dust increased gains slightly. A comparison of four different Rome, Georgia samples of cement kiln dust on rat growth and feed efficiency is shown in Table 5. Again treatment differences were small with no advantage for added kiln dust. Performance of rats fed high and low cellulose diets with and without added kiln dust is shown in Table 6. With both the high and low cellulose diets, added kiln dust depressed daily gain and feed efficiency.

Table 3. Influence of cement kiln dust of feedlot steers.

Protein	9.3		11.5			
Kiln dust	0	3.44	0	0.87	1.75	3.48
Ca	.45	1.11	.45	.40	.64	1.11
Steers, no.	13	12	12	13	12	13
Initial weight	631	633	636	635	644	633
Daily gain, lb						
0-41	3.64[a]	3.66[a]	4.77[c]	4.87[c]	4.40[bc]	3.90[ab]
41-134	- - -	- - -	2.83	3.03	3.14	- - -
0-134	- - -	- - -	3.48	3.36	3.33	- - -
Daily feed, lb dry matter						
0-41	16.4	17.7	20.0	19.2	17.6	16.3
41-134	- - -	- - -	22.2	22.5	22.4	- - -
0-134	- - -	- - -	21.5	21.5	20.9	- - -
Feed/gain						
0-41	4.50	4.83	4.19	3.95	4.00	4.17
41-134	- - -	- - -	7.84	7.44	7.16	- - -
0-134	- - -	- - -	6.20	6.41	6.30	- - -
NE_g						
0-41	1.49	1.43	1.57	1.65	1.64	1.58
0-134	- - -	- - -	1.26	1.20	1.20	- - -
Fecal pH, day 41	5.09[a]	5.78[bc]	5.42[ab]	5.16[a]	6.38[d]	6.15[cd]
Fecal starch, day 41	23.9	23.4	24.9	23.4	14.1	15.5
KHP fat, %	- - -	- - -	3.00	2.84	2.83	- - -
Liver abscesses, %	- - -	- - -	8.3	23.1	41.7	53.8
Abscess severity	- - -	- - -	1.0	1.7	1.6	2.1

[abcd]Mean values in the same row not followed by same superscript differs significantly (P<.05).

Table 4. Source and type of cement dust and rat growth (Trial 1).

Source	Level %	Daily gain, G 21 days	Daily gain, G 34 days	Gain/feed 17 days
None	0	4.02[a]	4.81	.40
Pryor				
Baghouse	1.0	3.92	- - - -	.40
Buell	1.0	3.86	- - - -	.39
Clinker	1.0	3.82	- - - -	.37
Cement	1.0	3.99	- - - -	.36
Ada dust	1.0	3.86	- - - -	.39
Georgia dust	0.5	4.11	4.91	.39
	1.0	4.16	4.86	.38
Salt mix	1.0	4.04	- - - -	.36
(ashed)	1.6	3.98	- - - -	.39

[a]Three rats per treatment.

Table 5. Comparison of four types of georgia cement kiln dust (Trial 2).

Source	%	Daily gain, grams 13 days	Gain/feed 13 days
None	0	6.09[a]	.298
Georgia #1	1.0	6.08	.272
Georgia "hot"	1.0	5.90	.275
Georgia #3	1.0	5.77	.275
Georgia #4	1.0	6.10	.277

[a]Four rats per treatment.

Table 6. Cement kiln dust and performance of rats (Trial 3).

Treatment: Cellulose	Treatment: Dust	Daily gain, grams 12 days	Gain/feed 12 days
−	−	4.66[a]	.102
−	+	4.01	.090
+	−	1.73	.031
+	+	.13	.002

[a]Seven rats per treatment.

Table 7. Digestibilities and retentions (by steers).

Item	Ration: Control	Ration: Dust
Intake, lb	11.7	10.5
Digestibility, %		
Dry matter	74.1	77.3
Organic matter	75.1	79.9
Protein	66.8	71.4
Starch	91.2	96.8
Calcium	20.3	35.5
Retention, g/day		
Nitrogen	24.8[a]	33.1[b]
Calcium	6.4[a]	24.8[b]

[ab]Treatment in the same row not having similar superscripts differ significantly ($P<.05$).

Table 8. Cement kiln dust and digestibility of corn silage (Digestion Trial 2).

Item	Treatment		
	Control	Martin Marietta	Oklahoma cement
Digestibility, %			
Dry matter	68.2	69.5	69.4
Organic matter	73.4	73.9	73.3
Acid detergent fiber	46.2[a]	50.9[b]	53.2[b]
Nitrogen	52.4	56.7	56.6

[ab]Treatment means in the same row with different superscripts differ statistically ($P<.06$).

Experiment 3

The influence of cement kiln dust on feed digestibility and nutrient metabolism was evaluated in two trials. The 80 percent concentrate ration provided 11.3 percent protein and 0.63 or 1.49 percent calcium. Supplemented kiln dust caused a slight depression in dry matter intake (Table 7). While differences were small, apparent digestibility of all constituents tended to be greater for the kiln dust supplemented ration. Nitrogen and calcium retention were increased markedly when steers were fed the cement dust.

In the second trial, digestibility of nutrients from the corn silage ration was increased slightly (Table 8). Protein digestibility was improved by 9 percent and fiber digestibility by 13 percent when corn silage was supplemented with 1 percent cement kiln dust.

Results of the trials conducted to date are inconclusive; occasional benefits noted have been small. While producing no stimulating effects in terms of animal performance, our results indicate that kiln dust may have some potential for improving digestibility of fiber in high fiber rations. The high calcium digestion and retention also indicate that cement dust is a usable supplemental source of calcium. Potential problems, such as reduced feed intake, increased liver abscess incidence and contamination with fluorine and heavy metals may limit use of kiln dust. It is as yet unapproved as a feed additive.

Literature Cited

Wheeler, W. E. and R. R. Oltjen. 1977. USDA, ARS-NE-88.

Wheeler, W. E. and R. R. Oltjen. 1979. J. Anim. Sci. (In Press).