ACID-TREATED, HIGH-MOISTURE MILO FOR SWINE

by

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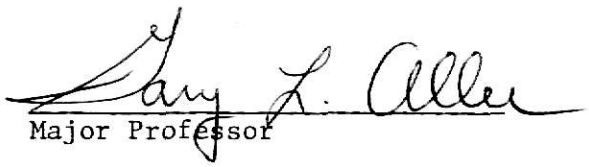

Major Professor

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INTRODUCTION

The oxygen limiting structure has been the conventional method of storing high-moisture grain. The exclusion of oxygen decreases aerobic microbial activity. Recently interest has developed in using certain fungicidal organic compounds to preserve high-moisture grain.

Acid treatment is an alternative to oxygen limiting structures for the preservation of high-moisture grain. The acid lowers the pH of the grain which inhibits microbial growth. Thomke-Tiden (1973) reported satisfactory preservation of high-moisture barley with propionic acid. Lynch et al. (1975) evaluated the effects of different chemical preservatives on the feeding value of high-moisture corn fed to growing and finishing swine. He found that pigs readily consumed the high-moisture corn regardless of the preservative used. Rates of gain and feed efficiency were similar on all high-moisture, acid-treated diets and equal to or better than dry corn diets.

There was no significant difference in average daily gain or feed efficiency in a comparison of high-moisture, acid-treated milo diets by Knabe et al. (1972). Young et al. (1970) reported that pigs fed high-moisture, acid-treated corn gained at a faster rate and had an improved feed efficiency when compared to pigs fed dry corn. Perez-Aleman et al. (1971) found no significant differences in growth rate or feed efficiency in a study comparing high-moisture, acid-treated barley with dry barley in swine diets. Pigs fed acid-treated corn gained significantly faster in a comparison of high-moisture, propionic acid-treated corn with ensiled high-moisture corn Jones et al. (1970).

Knabe et al. (1973) compared a high-moisture, acid-treated ground complete milo ration with a high-moisture, acid-treated whole milo ration in which the supplement was fed free-choice. The free-choice ration supported lower, but statistically nonsignificant, average daily gain and feed efficiency. In a trial where high-moisture, acid-treated corn was offered free-choice with a supplement or in a mixed diet, Lynch et al. (1975) found no significant differences in average daily gain or feed efficiency. Forsythe (1975) compared high-moisture, propionic acid-treated corn in free-choice feeding and complete mixed diets for swine. Pigs fed high-moisture, acid-treated corn free-choice gained less efficiently due to a low intake of supplement.

Bayley and Holmes (1972) reported that the digestability of high-moisture, acid-preserved corn was greater than the digestability of dry corn.

The objective of these studies was to evaluate the effects of propionic acid and ammonium isobutyrate on acceptance and utilization of high-moisture milo in swine rations. Method of processing (whole vs. ground) and method of feeding (complete vs. free-choice) were also evaluated.

EXPERIMENTAL PROCEDURES

High-moisture milo for the trials was harvested at 22-23% moisture, treated with 0.6% propionic acid, 1.2% propionic acid, or 1.75% ammonium isobutyrate (AIB) and stored in metal bins. All grain treatments were applied on a weight basis. The control (dry milo) was harvested at 14% moisture. Trials 1 and 3 were conducted in the Fall of 1974. Trials 2, 4, and 5 were conducted in the Fall of 1975. The growing pigs in each trial were housed in an environmentally controlled nursery. Each pen (1.5m x 3.4m) had totally slatted floors and contained a two-hole feeder with an automatic watering cup. The finishing trials were conducted in a modified open-front building with concrete, slatted floors. Each pen (1.8m x 4.9m) contained a two-hole feeder with an automatic watering cup. Compositions of the protein supplements and the dry control rations for growing and finishing are shown in tables 1 and 2 respectively. All complete mixed rations provided the same amount of milo on a dry matter basis. The protein supplement was fed as a 4.8mm pellet in a separate two-hole feeder when offered free-choice.

Trial 1. Fifty-five pigs averaging 12.7 kg initially were randomly assigned to dietary treatment by weight and sex. The treatments used were 1) dry, ground, complete mixed 2) high-moisture, propionic acid, ground, complete mixed 3) high-moisture, AIB, ground, complete mixed 4) high-moisture, propionic acid, ground, free-choice supplement 5) high-moisture, propionic acid, whole, free-choice supplement. Propionic

acid was applied at the rate of 0.6% by weight. The trial was conducted for 35 days.

Trial 2. One hundred forty-four pigs of 10.7 kg average weight were randomly assigned to dietary treatment by weight and sex. The treatments used were the same as trial 1 with the exception of treatment 3 (AIB) which was not used. Propionic acid was applied at the rate of 1.2% by weight. The trial was conducted for 35 days.

Trial 3. One hundred-five Yorkshire finishing pigs weighing 56.8 kg initially were randomly assigned to dietary treatments by sex and weight. The treatments used were: 1) dry, ground, complete mixed 2) high-moisture, propionic acid, ground, complete mixed 3) high-moisture, AIB, ground, complete mixed 4) high-moisture, propionic acid, ground, free-choice supplement 5) high-moisture, AIB, ground, free-choice supplement 6) high-moisture, propionic acid, whole, free-choice supplement 7) high-moisture, AIB, whole, free-choice supplement. Propionic acid was applied at the rate of 0.6% by weight. The trial was terminated when each pen of pigs averaged approximately 100 kg.

Trial 4. Ninety-six Yorkshire finishing pigs weighing 49.4 kg were randomly assigned to dietary treatment by weight and sex. The treatments were the same as trial 3 with the exception that the AIB treatments were not used. Propionic acid was applied at the rate of 1.2% by weight. The trial was terminated when the pigs averaged 100 kg in weight.

Trial 5. The objective of this trial was to determine if growing pigs prefer high-moisture, acid-treated milo over dry milo. Two feeders, one containing a dry, ground, complete mixed diet and the other a high-

moisture, propionic acid (1.2%) treated, complete mixed diet, were placed in a pen of 22 growing pigs averaging 6.8 kg. The trial was conducted for 35 days.

In all trials the data were treated statistically using analysis of variance and Duncan's New Multiple Range Test (Snedecor and Cochran, 1971).

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

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TABLE 1. COMPOSITIONS OF PROTEIN SUPPLEMENT AND CONTROL RATION FOR GROWING PIGS.

INGREDIENT, %	DRY-CONTROL[a]	SUPPLEMENT
Milo	69.4	
Soybean Meal (44%)	26.6	86.94
Dicalcium Phosphate	1.4	4.57
Limestone	1.2	3.92
Salt	0.5	1.63
Trace-Mineral	0.1[b]	0.33
Vitamin Premix	0.5[c]	1.63
Antibiotic Premix	0.3[d]	0.98
	100.0	100.00

[a]All complete mixed rations provided the same amount of dry matter from milo.

[b]Provided in the complete diet (ppm): zinc, 100; iron, 100; manganese, 100; copper, 10.0; iodine, 1.0.

[c]Provided per ton of complete diet: vitamin A, 4,000,000 IU; vitamin D_3, 300,000 IU; vitamin E, 20,000 IU; riboflavin, 45 g; niacin, 25 g; pantothenic acid, 12 g; vitamin B_{12}, 22 milligrams.

[d]Provided 100 g chlortetracycline, 100 g sulfamethazine, and 50 g procaine penicillin per ton of complete diet.

TABLE 2. COMPOSITIONS OF PROTEIN SUPPLEMENT AND CONTROL RATION FOR FINISHING PIGS.

INGREDIENT, %	DRY-CONTROL[a]	SUPPLEMENT
Milo	81.55	
Soybean Meal (44%)	15.30	82.99
Dicalcium Phosphate	1.00	5.40
Limestone	1.00	5.40
Salt	0.50	2.70
Trace-Mineral Mix[b]	0.05[b]	0.27
Vitamin Premix[c]	0.50[c]	2.70
Antibiotic Premix[d]	0.10[d]	0.54
	100.00	100.00

[a]All complete mixed rations provided the same amount of dry matter from milo.

[b]Provided in the complete diet (ppm): zinc, 50; iron, 50; manganese, 50; copper, 5.0; iodine, 0.5.

[c]Provided per ton of complete diet: Vitamin A, 4,000,000 IU; vitamin D_3, 300,000 IU; vitamin E, 20,000 IU; riboflavin, 45 g; niacin, 25 g; pantothenic acid, 12 g; vitamin B_{12}, 22 milligrams.

[d]Provided 20 grams Tylosin.

RESULTS

Growing Pigs. Rate of gain and feed efficiency among pigs fed the dry, propionic acid, or AIB treated, ground, complete mixed diets did not differ significantly ($P<.05$) (Tables 3 and 4). Physical form (ground vs. whole) did not significantly ($P<.05$) affect performance of pigs fed high-moisture, acid-treated milo with a free-choice supplement. Daily gain was significantly ($P<.05$) improved when high-moisture, acid-treated milo was fed in a complete mixed diet as compared with offering the supplement free-choice.

Finishing Pigs. As in the growing pig trials, rate of gain and feed efficiency of pigs fed the ground, complete mixed diets did not differ significantly ($P<.05$) (Tables 5 and 6). Pigs fed whole, high-moisture, acid-treated milo with supplement offered free-choice required significantly ($P<.05$) more feed per unit of gain than pigs fed ground milo. Data were not included for pigs fed high-moisture, AIB treated milo that was ground with supplement offered free-choice, because one replicate of pigs consumed an abnormally small amount of protein supplement.

Growing Pig Preference. Results of the preference trial are shown in table 7. The growing pigs consumed 7% more high-moisture, acid-treated milo than the dry control.

TABLE 3. PERFORMANCE OF GROWING PIGS FED HIGH-MOISTURE OR DRY MILO (TRIAL 1).[abc]

Treatment	Daily Gain, Kg	Daily Intake, Kg			Feed/ Gain
		Milo	Supplement	Total	
Dry, Ground, Complete	.68[d]	.94	.41	1.35	2.00[d]
H-M P.A. Ground, Complete	.68[d]	.87	.39	1.26	1.86[d]
H-M AIB Ground, Complete	.69[d]	.91	.40	1.31	1.89[d]
H-M P.A. Ground, Free-Choice	.59[e]	.82	.32	1.13	1.92[d]
H-M P.A. Whole, Free-Choice	.59[e]	.85	.29	1.14	1.92[d]

[a]All feed data expressed on a dry matter basis.

[b]Each value is the mean of 11 pigs with an initial weight of 12.7 kg.

[c]Duration of the trial was 35 days.

[d,e]Means with different superscripts differ significantly ($P<.05$).

TABLE 4. PERFORMANCE OF GROWING PIGS FED HIGH-MOISTURE OR DRY MILO (TRIAL 2).[abc]

Treatment	Daily Gain, Kg	Daily Intake, Kg			Feed/ Gain
		Milo	Supplement	Total	
Dry, Ground, Complete	.59[d]	.72	.32	1.04	1.77[d]
H-M P.A. Ground, Complete	.60[d]	.75	.34	1.09	1.79[d,e]
H-M P.A. Ground, Free-Choice	.49[e]	.68	.25	.93	1.89[e]
H-M P.A. Whole, Free-Choice	.52[e]	.77	.27	1.04	2.00[e]

[a]All feed data expressed on a dry matter basis.

[b]Each value is the mean of 36 pigs with an initial weight of 10.7 kg.

[c]Duration of the trial was 35 days.

[d,e]Means with different superscripts differ significantly ($P<.05$).

TABLE 5. PERFORMANCE OF FINISHING PIGS FED HIGH-MOISTURE OR DRY MILO (TRIAL 3).[abc]

Treatment	Daily Gain, Kg	Daily Intake, Kg			Feed/ Gain
		Milo	Supplement	Total	
Dry, Ground, Complete	.66[d,e]	1.86	.42	2.28	3.45[d]
H-M P.A. Ground, Complete	.71[d]	1.95	.44	2.39	3.36[d]
H-M AIB Ground, Complete	.67[d,e]	1.81	.41	2.22	3.32[d]
H-M P.A. Ground, Free-Choice	.67[d,e]	1.91	.36	2.27	3.39[d]
H-M P.A. Whole, Free-Choice	.63[e]	2.39	.35	2.74	4.35[e]
H-M P.A. Whole, Free-Choice	.63[e]	2.19	.36	2.55	4.05[e]

[a]All feed data expressed on a dry matter basis.

[b]Each value is the mean of 19 pigs with an initial weight of 56.8 kg.

[c]Trial was terminated when each pen of pigs averaged approximately 100 kg in weight.

[d,e]Means with different superscripts differ significantly ($P<.05$).

TABLE 6. PERFORMANCE OF FINISHING PIGS FED HIGH-MOISTURE OR DRY MILO (TRIAL 4).[abc]

Treatment	Daily Gain, Kg	Daily Intake, Kg			Feed/ Gain
		Milo	Supplement	Total	
Dry, Ground, Complete	.69[d]	1.84	.43	2.27	3.30[d]
H-M P.A. Ground, Complete	.69[d]	1.87	.44	2.31	3.36[d]
H-M P.A. Ground, Free-Choice	.65[d,e]	1.85	.35	2.20	3.43[d]
H-M P.A. Whole, Free-Choice	.63[e]	2.21	.34	2.55	4.04[e]

[a]All feed data expressed on a dry matter basis.

[b]Each value is the mean of 24 pigs with an initial weight of 49.4 kg.

[c]The trial was terminated when each pen of pigs averaged approximately 100 kg in weight.

[d,e]Means with different superscripts differ significantly ($P<.05$).

TABLE 7. CONSUMPTION OF FEED BY GROWING PIGS IN PREFERENCE TRIAL (TRIAL 5).[bc]

	H-M (Kg)	Control (Kg)
Feed Consumed[a]	377.3	353.4

[a]Expressed on a dry matter basis.

[b]The trial was conducted for 35 days.

[c]The trial was conducted with 22 growing pigs (6.8 kg).

DISCUSSION

There has been little published concerning the feeding value of high-moisture, acid-treated milo for the growing pig (11-30kg). When fed in ground, complete mixed rations, average daily gain and feed/gain were equal or slightly superior for growing (11-30kg) and finishing (55-100kg) pigs fed high-moisture, acid-treated milo as compared to dry milo. Similar results were reported by Lynch et al. (1975) and Forsyth (1975) with pigs fed high-moisture, acid-treated corn.

Finishing pigs fed whole, high-moisture, acid-treated milo with supplement offered free-choice gained less efficiently and at a slower rate than pigs fed a complete mixed diet. Whole kernels of milo were prominent in the feces of the finishing pigs fed whole, high-moisture, acid-treated milo.

Free-choice feeding of growing pigs significantly ($P<.05$) reduced daily gain, but did not affect feed efficiency. There was no difference in feed efficiency of growing pigs fed high-moisture, ground milo or high-moisture, whole milo when supplement was offered free-choice. The difference in utilization of whole milo by growing pigs as compared to finishing pigs may be due to more efficient mastication by the growing pigs.

The free-choice feeding system resulted in increased intake of grain and decreased consumption of supplement. In all trials, pigs fed free-choice consumed the least amount of supplement. This occurred

even though the only protein source was soybean meal, which is very palatable to pigs. The reduced consumption of supplement is a possible explanation of the reduced performance of pigs fed free-choice.

In the preference trial acid treatment did not adversely effect feed consumption. The growing pigs consumed 7% more high-moisture, acid-treated milo than the dry control. This suggests that feed intake is not a problem with growing pigs fed high-moisture, acid-treated milo.

SUMMARY

Five trials involving 221 growing pigs and 201 finishing pigs were conducted to investigate the effect of feeding high-moisture, acid-treated milo to swine. High-moisture milo (23%) was preserved by adding 0.6% propionic acid, 1.2% propionic acid, or 1.75% ammonium isobutyrate. Complete mixed rations and free-choice feeding were compared. Feeding high-moisture, acid-treated milo in either whole or ground form was also evaluated.

Rate of gain and feed efficiency was similar for all complete mixed diets (both high-moisture, acid-treated and dry) in the growing trials and the finishing trials. Growing pigs gained at a slower rate when fed supplement free-choice. There was no difference in the performance of growing pigs fed ground or whole, high-moisture, acid-treated milo when supplement was offered free-choice. Finishing pigs fed whole, high-moisture, acid-treated milo required more feed per unit of gain than pigs fed the ground milo. In a preference trial involving growing pigs, acid treatment of high-moisture milo had no adverse effect on consumption when compared to dry milo.

High-moisture, acid-treated milo can be fed to growing or finishing pigs resulting in performance equal to pigs fed dry milo. High-moisture, acid-treated milo and dry milo are of similar nutritional value.

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Rate of gain and feed efficiency was similar for all complete mixed diets (both high-moisture, acid-treated and dry) in the growing trials and the finishing trials. Growing pigs gained at a slower rate when fed supplement free-choice. There was no difference in the performance of growing pigs fed ground or whole, high-moisture, acid-treated milo when supplement was offered free-choice. Finishing pigs fed whole, high-moisture, acid-treated milo required more feed per unit of gain than pigs fed the ground milo. In a preference trial involving growing pigs, acid treatment of high-moisture milo had no adverse effect on consumption when compared to dry milo.

High-moisture, acid-treated milo can be fed to growing or finishing pigs resulting in performance equal to pigs fed dry milo. High-moisture, acid-treated milo and dry milo are of similar nutritional value.