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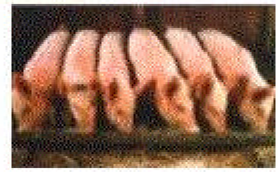

[1]EFFECTS OF SUPPLEMENTAL TRACE MINERAL LEVELS ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS, AND FECAL MINERAL EXCRETION IN GROWING-FINISHING SWINE

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Summary

A total of 6,024 pigs (initial BW = 20.2 kg) was used to determine the impact of reducing supplemental trace mineral (TM) levels during the grower-finisher phase on fecal mineral excretion. Pigs were randomly distributed into 4 blocks of 2 barns, ensuring that each block of barns was filled at the same time. Barns were then allotted within block to receive either diets with low or high TM supplementation. Four diet phases were fed with 135, 125, 105, and 85 ppm added Zn, 13.5, 12.5, 10.5, and 8.5 ppm added Cu, and 113, 104, 87.5, and 70 ppm added Fe for the high TM diets and 30 ppm added Zn, 6 ppm added Cu, and 30 ppm added Fe for all low TM diets. Diets were analyzed to contain 181, 155, 142, and 135 ppm Zn, 17, 21, 19, and 18 ppm Cu, and 506, 477, 352, and 299 ppm Fe for the high TM diets and 80, 75, 79, and 80 ppm Zn, 12, 8, 10, and 10 ppm Cu, and 389, 368, 270, and 271 ppm Fe for the low TM diets. During the period that the second diet phase was fed, fecal samples were obtained randomly, from at least 8 pigs in each barn. Samples were combined within barn and analyzed for Zn, Cu, and Fe. Pigs fed low TM diets had lower levels of Zn (363 vs 1,146 ppm; $P = 0.05$), Cu (94 vs 147 ppm; $P = 0.004$), and Fe (1,683 vs 2,534 ppm; $P = 0.01$) in feces (on a DM basis) than pigs fed the high TM diets. Analysis of individual slaughter records indicated that pigs fed low TM diets had greater carcass weight (89.5 vs 88.3 kg; $P < 0.06$), carcass weight payment ($110.54 vs 108.53; $P < 0.04$), and total payment ($112.98 vs 111.07; $P < 0.02$) compared to pigs fed high TM diets. Backfat thickness, loin depth, % lean, and lean premium payment were not affected ($P > 0.10$) by dietary treatments. Results indicate that reducing trace mineral levels in diets for grower-finisher pigs reduced fecal mineral excretion of Zn, Cu, Fe, and Mn by 68, 36, 34, and 45% respectively, without negatively affecting carcass characteristics.

Introduction

Accumulation of zinc and copper in soils may be of concern in areas where manure from swine facilities is applied extensively (Tucker, 1997). The swine industry typically supplements zinc and copper to diets at greater levels than those suggested by the NRC (1998). Analysis of swine feeds conducted by the North Carolina Feed Testing Laboratory indicated that the zinc concentration ranged from 103 to 205 ppm and the copper concentration ranged from 9 to 281 ppm (Spears, 1996). In comparison to the NRC (1998) requirements, the levels of zinc and copper supplementation in practical diets were 3.0 and 6.7 times greater, respectively. These differences may be due to high mineral concentrations in certain feed ingredients, but are most likely the result of safety margins used in diet formulation to account for any potential increases in requirements due to genetics, environment, or health. Spears et al. (1999) evaluated the effects of lowering trace mineral supplementation from levels typically used in the industry to levels suggested by the NRC (1998). In that study, the levels of zinc and copper in growing-finishing pig diets were reduced from 100 to 25 ppm and 15 to 5 pmm, respectively. In addition, the levels of iron and manganese were reduced from 100 to 25 ppm and 40 to 10 ppm, respectively, to minimize any antagonistic effects of these minerals on the absorption of zinc and copper. Results demonstrated that reducing trace mineral levels reduced zinc and copper excretion in feces of gilts by at least 40% without affecting growth performance (Spears et al., 1999).

The objectives of the present study were to evaluate the effects of lowering supplemental trace-minerals on pig performance and carcass characteristics under commercial conditions and to determine the effect of lowering dietary trace minerals on mineral excretion in swine feces.

Materials and Methods

A total of 6,024 pigs was randomly allotted to 4 sets of 2 barns. Each set of barns was filled at the same time with pigs from the same source. Barns were then assigned to one of two treatments: 1) mineral supplementation typical of industry; or 2) reduced mineral levels (Cu, Zn, and Fe). Pigs were fed a 4-phase diet program typical of the swine industry in North Carolina. The analyzed mineral composition of each of the diets is shown in Table 1. Growth performance data were collected for each barn and carcass measurements were collected for each individual pig at a commercial packing plant at the end of the trial. Information collected at the packing plant included sex of the pig, carcass weight, back fat depth, loin depth, % lean, payment for the carcass (based on weight only), payment premium for leanness (for the whole carcass), and total payment (for the entire carcass including payment for lean). Fecal grab samples were obtained randomly from at least 8 pigs in each barn during diet phase 2 for mineral analysis. Data were analyzed as a randomized complete block design using the GLM procedures of SAS (SAS Inst. Inc., Cary, NC). The model for growth performance and mineral excretion data included block (set of barns) and trace mineral inclusion level. The model for carcass data included block, trace mineral supplementation level, sex, the trace mineral supplementation by sex interaction and the block by trace mineral supplementation level. The latter was used as error term to test the effect of trace mineral supplementation on carcass characteristics.

Table 1. Analyzed composition of the experimental diets

Mineral	Trt	Phase 1	Phase 2	Phase 3	Phase 4
Zn	**High**	181	155	142	135
	Low	80	75	79	80
Cu	**High**	17	21	19	18
	Low	12	8	10	10
Mn	**High**	69	64	49	52
	Low	61	55	39	42
Fe	**High**	506	477	352	299
	Low	389	368	270	271

Results and Discussion

Pigs fed diets containing the low levels of trace minerals were heavier ($P < 0.05$) at the time of marketing and were less efficient than control pigs fed the industry type levels of minerals (Table 2). However, although pigs were randomly assigned within each set of barns, it was noted upon sexing them at the packing plant that the treatment group receiving the low mineral supplementation had relatively fewer gilts (and more barrows) than the group fed the high mineral treatment level. The difference in % gilts was not significant, but may have, in part, confounded the results. In addition, differences in final weight between treatment groups were similar to differences in initial weight resulting in no effect of treatment on daily weight gain.

Table 2. Growth performance of pigs fed different levels of trace-minerals

Item	High	Low	SEM	P-value
Start Wt	19.1	21.2	0.89	0.19
End Wt	113.0	115.0	0.35	0.02
Days	135	136	0.33	0.48
ADG	0.69	0.69	0.01	0.91
ADFI	1.76	1.85	0.03	0.12
Gain/Feed	0.39	0.37	0.002	0.01
% Gilts	62.5	42.0	12.1	0.32

As expected, carcass weight and back fat depth were greater (P < 0.01) and % lean and payment for lean were reduced in barrows as compared to gilts (Table 3). Reducing trace mineral levels from those typically used in the industry resulted in increased carcass weight (P < 0.05), loin depth (P < 0.01), payment for weight (P < 0.05) and total payment (P < 0.05). The greater carcass weight for pigs fed diets with low mineral supplementation is consistent with the increased final live weight reported in Table 2 and may have been largely due to the greater weight at placement. Thus, the increased loin depth, payment for weight and total payment for pigs fed low trace mineral levels appeared to be a result of heavier carcass weights. Analysis of the data using carcass weight as a covariate indicated that final payment for the carcass was greater (P < 0.01) in pigs fed the low mineral diets, but no other differences between treatment were evident (P > 0.13).

Table 3. Effect of mineral supplementation on carcass characteristics

	High Minerals		Low Minerals		
Item	**Gilts**	**Barrows**	**Gilts**	**Barrows**	**SEM**
Carcass Weight, kg[ab]	87.6	89.1	87.9	91.2	0.48
Fat Depth, mm[a]	17.3	19.8	17.4	20.4	0.26
Loin Depth, mm[c]	58.5	58.2	59.5	58.9	0.46
% Lean[a]	55.3	53.8	55.4	53.5	0.18
Payment for Weight, $[bd]	107.93	109.12	109.17	111.91	0.72
Payment for Lean, $[a]	3.50	1.60	3.61	1.40	0.22
Total Payment, $[b]	111.43	110.71	112.70	113.26	0.83

[a] Sex effect (P < 0.01)
[b] Treatment effect (P < 0.05)
[c] Treatment effect (P < 0.01)
[d] Sex effect (P < 0.05)

Feces of pigs fed diets with low levels of trace minerals contained 68% less zinc (P < 0.05), 36% less copper P < 0.10), 34% less iron (P < 0.10), and 45% less manganese (P < 0.10) compared to pigs fed industry levels of trace minerals (Table 4). In agreement with these results, Spears et al. (1999) suggested that zinc and copper excretion could be reduced by at least 40%.

Table 4. Effect of mineral supplementation on mineral concentration (ppm on a DM basis) in feces of pigs

Item	High	Low	% Reduction	SEM	P-value
Zn	1,146	363	68	106	0.03
Cu	147	94	36	12	0.09
Fe	2,534	1,683	34	165	0.07
Mn	473	260	45	44	0.08

Implications

In summary, these results indicate that reducing trace mineral levels in diets for grower-finisher pigs reduced fecal mineral excretion of zinc, copper, iron, and manganese by 68, 36, 34, and 45%, respectively, without negatively affecting carcass characteristics or carcass value.

References

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