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Effects of Added Chromium and Space Allocation on Finishing Pig Performance

A. Santos
Federal University of Mato Grosso do Sul, Brazil

M. D. Tokach
Kansas State University, Manhattan, mtokach@k-state.edu

S. S. Dritz
Kansas State University, Manhattan, dritz@k-state.edu

See next page for additional authors

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Effects of Added Chromium and Space Allocation on Finishing Pig Performance

Abstract

A total of 256 pigs (Line 600 × 241, DNA Columbus, NE) were used in a 72-d trial to determine the effect of dietary chromium (chromium propionate; Kemin Industries, Des Moines, IA) and space allowance on performance and carcass characteristics of finishing pigs. Pens were blocked by initial weight and randomly assigned to treatments with 8 pigs per pen and 8 pens per treatment. Treatments were arranged in a 2 × 2 factorial with main effects of diet (control or added chromium, 200 ppb) and 2 space allowances (9.8 ft^2 - normal and 6.8 ft^2 – restricted). Adding chromium to the diet decreased ($P = 0.044$) ADG from d 56 to 72 and resulted in poorer ($P = 0.021$) F/G for the overall period. Space restriction decreased ($P < 0.001$) ADG and ADFI for all periods within the study and final BW, and HCW, but increased ($P = 0.009$) carcass yield and decreased ($P = 0.003$) backfat depth. These results indicate that chromium propionate did not improve performance when pigs were restricted in space.

Keywords

chromium propionate, finishing pig, stocking density

Cover Page Footnote

Appreciation is expressed to Kemin Industries (Des Moines, IA) for providing the chromium used in the study.

Authors

A. Santos, M. D. Tokach, S. S. Dritz, J. C. Woodworth, R. D. Goodband, and J. M. DeRouchey

Effects of Added Chromium and Space Allocation on Finishing Pig Performance[1]

A.P. Santos,[2] M.D. Tokach, S.S. Dritz,[3] J.C. Woodworth, R.D. Goodband, and J.M. DeRouchey

Summary
A total of 256 pigs (Line 600 × 241, DNA Columbus, NE) were used in a 72-d trial to determine the effect of dietary chromium (chromium propionate; Kemin Industries, Des Moines, IA) and space allowance on performance and carcass characteristics of finishing pigs. Pens were blocked by initial weight and randomly assigned to treatments with 8 pigs per pen and 8 pens per treatment. Treatments were arranged in a 2 × 2 factorial with main effects of diet (control or added chromium, 200 ppb) and 2 space allowances (9.8 ft^2 - normal and 6.8 ft^2 – restricted). Adding chromium to the diet decreased ($P = 0.044$) ADG from d 56 to 72 and resulted in poorer ($P = 0.021$) F/G for the overall period. Space restriction decreased ($P < 0.001$) ADG and ADFI for all periods within the study and final BW, and HCW, but increased ($P = 0.009$) carcass yield and decreased ($P = 0.003$) backfat depth. These results indicate that chromium propionate did not improve performance when pigs were restricted in space.

Key words: chromium propionate, finishing pig, stocking density

Introduction
Inadequate space allocation can have detrimental effects on performance, economics, and welfare of pigs. The mechanism by which performance is impaired when space allowance is reduced is not well elucidated; however, changes in stress-related hormones (e.g., cortisol, ACTH), cytokines (e.g., TNF-α, IL-6), and behavioral responses may lead to the decreased performance.

Chromium is an essential nutrient in human and animal nutrition. In the body, chromodulin binds chromium and is theorized as having a role in insulin signaling, prolonging kinase activity, and potentiating the effect of insulin in glucose absorption in many tissues, such as liver, spleen, and kidney. The biological mode of action of insulin is interlaced with those of GH and IGF-I, both with activities related to growth and increased lean tissue deposition in pigs. Chromium supplementation has also been

[1] Appreciation is expressed to Kemin Industries (Des Moines, IA) for providing the chromium used in the study.
[2] Visiting scholar. Animal Science Graduate Program, College of Veterinary Medicine and Animal Science, Federal University of Mato Grosso do Sul, Brazil.
[3] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

hypothesized to alleviate stress-related responses and improve performance and carcass characteristics of finishing pigs. The objective of this work was to evaluate the effects of chromium supplementation (from chromium propionate) on the performance and carcass characteristics of finishing pigs under two different space allocations.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. The facility was totally enclosed and environmentally regulated. The experiment was designed with 4 treatments arranged as a factorial with main effects of diet (control vs. chromium) and two different space allowances (9.8 or 6.8 ft^2/pig) with 8 pigs/pen (4 barrows and 4 gilts).

The pens were equipped with adjustable gates to allow different space allowances per pig. If a pig died or was removed from a pen during the experiment, pen size was adjusted to maintain the correct space allocation per pig. Each pen was equipped with a dry, single-sided feeder (Farmweld, Teutopolis, IL) with two 14 × 4.5 in. (length × width) feeder spaces and a 1-cup waterer. Pigs were provided ad libitum access to feed and water. Pens were located over a completely slatted concrete floor with a 4-ft pit underneath for manure storage. A robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) was used to deliver and record daily feed additions to each individual pen.

A total of 256 pigs (Line 600 × 241 DNA, Columbus, NE) initially 129 ± 5.5 lb were used. Pigs were allotted randomly to pens upon entry into the finisher, and the experiment lasted 72 d. Pens of pigs were balanced by initial BW and randomly allotted to 1 of 4 treatments with 8 replications per treatment. Feed was manufactured at the Kansas State University O. H. Kruse Feed Technology Innovation Center, Manhattan, KS. All pigs were fed the same corn-soybean meal-based diet in meal form (Table 1). Diets were fed in 3 phases. Chromium propionate (Kemin Industries, Des Moines, IA) was added at 1 lb/ton replacing corn in the control diets for each phase. Feed samples were taken upon manufacturing during each phase. Pigs and feeders were weighed approximately every 2 wk to calculate ADG, ADFI, and F/G. An adjusted F/G was calculated to account for the different ending BW using the following equation: $F/G_{adj} = (274 - BW \text{ on d } 72) \times 0.005 + \text{actual } F/G$, where 274 is the mean ending BW of the space restricted pigs.

Prior to marketing, all pigs were individually weighed and tattooed for carcass data collection. They were transported approximately 2.5 h to a commercial packing plant (Triumph Foods LLC, St. Joseph, MO). Standard carcass characteristics were measured.

Data were analyzed as a generalized blocked design with diets and space allowance as fixed effects and block as a random effect using PROC GLIMMIX in SAS (SAS Institute, Inc., Cary, NC), with pen serving as the experimental unit. Response criteria were tested for main affects and potential interactions between chromium and space allowance.

Results and Discussion

There were relatively few interactions between dietary chromium and space allowance for growth performance (Table 2). From d 28 to 42, adding chromium to the diet reduced ADG (interaction, $P = 0.014$) for restricted pigs while numerically increasing ADG for pigs housed with adequate space (9.8 ft^2). This led to a tendency ($P = 0.066$) for a similar interaction for F/G. From d 56 to 72, adding chromium to the diet reduced ADFI for pigs restricted in space, but did not influence ADFI for pigs housed at 9.8 ft^2/pig (interaction, $P = 0.033$).

During every 2-wk period in the experiment and for the overall trial, pigs housed at 6.8 ft^2/pig had decreased ($P < 0.01$) ADG and ADFI compared with pigs housed at 9.8 ft^2/pig. Feed efficiency was not influenced by space allowance except when F/G was adjusted to a common BW of 274 lb. After adjustment for the difference in final BW, pigs restricted in space had poorer ($P = 0.020$) F/G than pigs with 9.8 ft^2/pig.

Adding chromium to the diet did not influence growth performance from d 0 to 28. Besides the interactive effects, dietary chromium also reduced ($P = 0.044$) ADG during the last phase of the experiment (d 56 to 72) and tended ($P = 0.079$) to reduce overall ADG resulting in poorer ($P = 0.021$) overall F/G.

The effects of space on ADG and ADFI were reflected in the BW of the animals for all periods within the study. Body weight of pigs provided with 9.8 ft^2/pig were 1.41% ($P = 0.013$), 4.04% ($P < 0.001$), and 5.26% ($P < 0.001$) greater on d 14, 42, and 72, respectively, than for pigs housed at 6.8 ft^2/pig. Altogether, space restriction caused a 16 lb decrease in final BW. Except for a tendency ($P = 0.056$) for a reduction in final BW at day 72, no effects of dietary chromium were observed for BW.

The addition of dietary chromium did not affect carcass criteria, except for a tendency ($P = 0.069$) to increase backfat depth. The effects of space were more pronounced, where pigs restricted in space had decreased ($P < 0.001$) HCW and backfat depth ($P = 0.003$), but had increased ($P = 0.009$) carcass yield and a tendency ($P = 0.060$) for increased percentage lean.

Restricting space from 9.8 to 6.8 ft^2/pig caused a detrimental effect on performance of finishing pigs throughout the experiment. Using broken line analysis to identify a critical k value at which production starts to decline due to space restriction, Street and Gonyou (2008)[4] reported a break point of $k = 0.036$ and Gonyou et al. (2006)[5] reported a k of 0.034. Using these k values as a reference, for the weight range of the animals in this experiment, the k value for the first 14 d of trial was 0.0365 with 6.8 ft^2/pig, which is just above the break point reported by the Street and Gonyou (2008) and Gonyou et al. (2006). Growth rate was reduced during the first 14 d prior to when pigs should not

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[4] Street, B. R. and Gonyou, H. W, 2008. Effects of housing finishing pigs in two group sizes and at two floor space allocations on production, health, behavior, and physiological variables. J. Anim. Sci. 86: 982–991.

[5] Gonyou, H. W., M. C. Brumm, E. Bush, J. Deen, S. A. Edwards, T. Fangman, J. J. McGlone, M. Meunier-Salaun, R. B. Morrison, H. Spoolder, P. L. Sundberg, and A. K. Johnson. 2006. Application of broken-line analysis to assess floor space requirements of nursery and grower-finisher pigs expressed on an allometric basis. J. Anim. Sci. 84: 229-235.

have had their growth restricted due to space. For all the other periods, the *k* values are all below 0.036, with values reaching as low as 0.0246 when pigs were between 245 and 280 lb. Pigs provided 9.8 ft^2/pig on the other hand, just barely reach the 0.036 mark at the end of the last period (0.0352).

Dietary chromium was not able to attenuate the negative effects of the stress caused by restricted space. In fact, it seems chromium further decreased performance of the pigs when they were restricted in space, as final BW of chromium/restricted-space pigs was reduced by 4 lb (271.8 lb) when compared to control pigs that were restricted in space (276.1 lb).

Table 1. Composition of experimental diets (as-fed basis)

	Control diet		
Ingredient %	Phase 1	Phase 2	Phase 3
Corn	77.85	80.55	83.85
Soybean meal, (46.5% CP)	19.70	17.25	13.95
Monocalcium P, (21% P)	0.40	0.30	0.30
Limestone	1.00	1.00	1.00
Sodium chloride	0.35	0.35	0.35
L-Lys-HCl	0.30	0.25	0.23
DL-Met	0.06	0.02	0.01
L-Thr	0.08	0.06	0.06
L-Trp	0.02	0.01	0.01
Trace mineral premix	0.10	0.10	0.10
Vitamin premix	0.10	0.10	0.10
HiPhos 2700	0.02	0.02	0.02
Chromium propionate[1]	---	---	---
Total	100.00	100.00	100.00
Calculated analysis			
Standardized ileal digestible AA, %			
Lys	0.90	0.80	0.70
Ile:Lys	62	64	65
Leu:Lys	142	153	164
Met:Lys	32	30	31
Met and Cys:Lys	58	58	61
Thr:Lys	62	63	66
Trp:Lys	19	19	19
ME, kcal/lb	1,503	1,506	1,507
Ca, %	0.51	0.48	0.47
P, %	0.43	0.40	0.38
Available P, %	0.25	0.23	0.22

[1]Chromium propionate, (Kemin Industries, Des Moines, IA) replaced corn in the control diets in each phase at an inclusion rate of 1 lb/ton to provide 200 ppb of chromium.

Table 2. Effects of chromium supplementation and space allocation on performance and carcass traits of finishing pigs[1,2]

	9.8 ft^2		6.8 ft^2			Probability, P <		
Item	Control	Chromium[3]	Control	Chromium[3]	SEM	Diet × space	Diet	Space
d 0 to 14								
ADG, lb	2.16	2.09	1.96	1.96	0.042	0.535	0.498	0.007
ADFI, lb	5.30	5.17	4.85	5.02	0.078	0.109	0.825	0.002
F/G	2.46	2.48	2.48	2.57	0.029	0.419	0.218	0.201
d 14 to 28								
ADG, lb	2.21	2.26	2.04	2.04	0.028	0.488	0.505	0.001
ADFI, lb	6.27	6.53	5.86	5.87	0.081	0.173	0.151	0.001
F/G	2.84	2.89	2.88	2.87	0.052	0.654	0.737	0.848
d 28 to 42								
ADG, lb	2.22	2.32	2.10	1.96	0.047	0.014	0.683	0.001
ADFI, lb	6.74	6.75	6.26	6.10	0.076	0.396	0.457	0.001
F/G	3.04	2.91	3.00	3.12	0.049	0.066	0.911	0.205
d 42 to 56								
ADG, lb	2.33	2.21	2.04	2.01	0.032	0.287	0.115	0.001
ADFI, lb	7.04	7.07	6.28	6.28	0.056	0.863	0.850	0.001
F/G	3.02	3.21	3.10	3.12	0.047	0.190	0.123	0.943
d 56 to 72								
ADG, lb	2.24	2.17	2.09	1.98	0.041	0.593	0.044	0.001
ADFI, lb	6.94	7.04	6.28	6.02	0.082	0.033	0.305	0.001
F/G	3.11	3.25	3.01	3.06	0.050	0.527	0.204	0.056
d 0 to 72								
ADG, lb	2.23	2.21	2.05	1.99	0.016	0.410	0.079	0.001
ADFI, lb	6.46	6.52	5.91	5.86	0.042	0.385	0.991	0.001
F/G	2.90	2.95	2.89	2.95	0.021	0.931	0.021	0.689
F/G_{adj},[4]	2.82	2.88	2.88	2.96	0.021	0.826	0.014	0.020
BW, lb								
d 0	128.6	128.6	128.6	128.6	1.43	1.000	0.881	0.940
d 14	158.8	157.8	156.2	156.0	1.82	0.607	0.476	0.013
d 28	191.0	189.7	184.8	184.6	1.62	0.637	0.531	0.001
d 42	222.0	222.2	214.2	212.1	1.49	0.412	0.468	0.001
d 56	254.6	253.0	242.7	240.3	1.49	0.795	0.235	0.001
d 72	290.5	287.8	276.1	271.8	1.50	0.649	0.056	0.001

continued

Table 2. Effects of chromium supplementation and space allocation on performance and carcass traits of finishing pigs[1,2]

	9.8 ft^2		6.8 ft^2			Probability, *P* <		
Item	Control	Chromium[3]	Control	Chromium[3]	SEM	Diet × space	Diet	Space
HCW, lb	213.7	213.2	205.3	201.2	1.18	0.231	0.126	0.001
Yield, %	72.08	72.38	72.69	72.48	0.121	0.054	0.728	0.009
BF, mm	22.05	23.39	20.14	20.53	0.324	0.301	0.069	0.003
LD, mm	55.44	56.26	55.31	54.52	0.538	0.301	0.983	0.441
Lean, %	50.92	50.55	51.54	51.25	0.164	0.849	0.131	0.060

[1] A total of 256 finishing pigs (DNA line 600 × 241, initially 128.6 lb) were used in a 72-d study.

[2] Each pen contained 8 pigs, and different space allocations (9.8 and 6.8 ft^2) were obtained by adjusting gates.

[3] Chromium propionate 0.04% (Kemin Industries, Des Moines, IA) replaced corn in the control diets in each phase to obtain the chromium diets (1 lb/ton to provide 200 ppb of chromium).

[4] F/G_{adj} = (274 - BW on d 72) × 0.005 + actual F/G to adjust to a common ending BW.