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Effects of Increasing Salt Concentration for 15 to 22 lb Nursery Pigs

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Effects of Increasing Salt Concentration for 15 to 22 lb Nursery Pigs

Abstract

A total of 325 maternal line barrows (Line 200 × 400; DNA, Columbus, NE; initially 14.6 lb BW) were used in a 14-d growth trial to determine the optimal inclusion rate of dietary salt for growth performance of nursery pigs weighing approximately 15 to 22 lb. Upon entry of the nursery, pigs were allotted by BW and fed a common starter diet (6 lb/ton added salt and 25% dried whey) for 7 d after weaning. At d 7 after weaning, considered d 0 in the trial, pigs were allotted by pen weight and assigned to 1 of 5 dietary treatments. Treatments included a diet containing 10% dried whey with no added salt, or 4, 8, 12, and 16 lb/ton of added salt. A common Phase 3 diet, containing 7 lb/ton added salt, was then fed from d 14 to d 21.

From d 0 to 14, increasing salt increased (linear, $P < 0.015$) ADG and ADFI. Feed efficiency improved (quadratic, $P < 0.034$) as added salt increased from 0 to 12 lb with no further benefits observed thereafter. From d 14 to 21, when pigs were fed a common Phase 3 diet (7 lb/ton added salt), those previously fed no added salt had 20% greater ADG (linear, $P < 0.013$) than those previously fed 4 to 16 lb added salt. The compensatory ADG observed from d 14 to 21 resulted in no overall differences in ADG, ADFI, or F/G from d 0 to 21. In conclusion, it appears that 12 lb/ton of added salt in a diet containing 10% dried whey optimizes ADG, ADFI, and F/G in 15 to 22 lb nursery pigs.

Keywords

chlorine (Cl), sodium (Na), nursery pig, salt

Authors

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Effects of Increasing Salt Concentration for 15 to 22 lb Nursery Pigs

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Summary

A total of 325 maternal line barrows (Line 200 × 400; DNA, Columbus, NE; initially 14.6 lb BW) were used in a 14-d growth trial to determine the optimal inclusion rate of dietary salt for growth performance of nursery pigs weighing approximately 15 to 22 lb. Upon entry of the nursery, pigs were allotted by BW and fed a common starter diet (6 lb/ton added salt and 25% dried whey) for 7 d after weaning. At d 7 after weaning, considered d 0 in the trial, pigs were allotted by pen weight and assigned to 1 of 5 dietary treatments. Treatments included a diet containing 10% dried whey with no added salt, or 4, 8, 12, and 16 lb/ton of added salt. A common Phase 3 diet, containing 7 lb/ton added salt, was then fed from d 14 to d 21.

From d 0 to 14, increasing salt increased (linear, $P < 0.015$) ADG and ADFI. Feed efficiency improved (quadratic, $P < 0.034$) as added salt increased from 0 to 12 lb with no further benefits observed thereafter. From d 14 to 21, when pigs were fed a common Phase 3 diet (7 lb/ton added salt), those previously fed no added salt had 20% greater ADG (linear, $P < 0.013$) than those previously fed 4 to 16 lb added salt. The compensatory ADG observed from d 14 to 21 resulted in no overall differences in ADG, ADFI, or F/G from d 0 to 21. In conclusion, it appears that 12 lb/ton of added salt in a diet containing 10% dried whey optimizes ADG, ADFI, and F/G in 15 to 22 lb nursery pigs.

Key words: chlorine (Cl), sodium (Na), nursery pig, salt

Introduction

Sodium and chloride are key ions that are involved in metabolic processes and electrolyte balance in the body. Salt levels have been positively correlated to growth, feed

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efficiency, and feed intake (Mahan et al., 1996[2];1999[3]). Monegue et al. (2011)[4] observed that pigs had a preference for a diet with added salt versus no added salt and that increasing added salt up to 16 lb/ton resulted in increased ADG and ADFI. Kerr et al. (1994)[5] reported that in Phase 2 diets formulated with 10% dried whey, 7 lb/ton of added salt resulted in improved ADG and F/G compared to treatments containing 0 and 3.5 lb/ton added salt. The NRC (2012)[6] requirement estimates for Na and Cl are 0.35 and 0.45%, respectively, for 15 to 25 lb pigs. Because dried whey typically contains 2 to 3% salt, most Phase 2 diets contain fixed amounts of 5 to 7 lb/ton added salt to try to meet the requirement estimate. However, despite the Na provided by dried whey and 7 lb/ton added salt, the Na concentration may be deficient in Phase 2 diets based on NRC requirement estimates (0.35% Na). Therefore, the objective of this study was to determine the dietary salt requirements for nursery pigs weighing 15 to 25 lb.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the K-State Segregated Early Weaning Facility in Manhattan, KS. Each pen was equipped with a 4-hole, dry self-feeder and a nipple waterer to provide ad libitum access to feed and water. A total of 325 maternal line barrows (Line 200 × 400; DNA, Columbus, NE) were used in a 14-d growth trial. Pigs were weaned at 21 d of age and placed into the nursery. Initially, pigs were randomly allotted to pens of 5 based on their initial BW. Pigs were fed a common diet for 7 d after weaning (Table 1). At d 7 after weaning, considered d 0 in the trial, pigs were randomly assigned to 1 of 5 dietary treatments with 13 replications per treatment. Dietary treatments were corn-soybean meal-based containing 10% dried whey and no added salt, or diets with either 4, 8, 12, or 16 lb/ton of added salt; this resulted in calculated dietary Na levels of 0.13, 0.21, 0.29, 0.37, and 0.45%, respectively. Pigs were then fed a common diet from d 14 to 21 (7 lb/ton added salt). Pens of pigs were weighed and feed disappearance was recorded on d 0, 7, 14, and 21 to determine ADG, ADFI, and F/G.

All experimental diets were fed in meal form and were manufactured at the Kansas State University O.H. Kruse Feed Technology Innovation Center, Manhattan, KS. To create the intermediate diets, the low (no added salt) and high (16 lb/ton salt) treatment diets were manufactured and then blended at the mill. Experimental diets were achieved by replacing corn with salt.

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[2] Mahan, D. C., E. A. Newton, and K. R. Cera. 1996. Effect of supplemental sodium chloride, sodium phosphate, or hydrochloric acid in starter pig diets containing dried whey. J. Anim. Sci. 74:1217-1222.

[3] Mahan, D. C., T. D. Wiseman, E. Weaver, and L. Russell. 1999. Effect of supplemental sodium chloride and hydrochloric acid added to initial starter diets containing spray-dried blood plasma and lactose on resulting performance and nitrogen digestibility of 3-week-old weaned pigs. J. Anim. Sci. 77:3016-3021.

[4] Monegue, J.S., M.D. Lindemann, H.J. Monegue, and G.L. Cromwell. 2011. Growth performance and diet preference of nursery pigs fed varying levels of salt. J. Anim. Sci. 89 (E-Supplement 2):104.

[5] Kerr, C. A., R. D. Goodband, M. D. Tokach, J. L. Nelssen, S. S. Dritz, B. T. Richert, J. R. Bergstrom, and W. B. Nessmith. 1994. The effects of added salt in the Phase II starter pig diet. Kansas Swine Industry Day Report of Progress 717.

[6] NRC. 2012. Nutrient requirements of swine. 11th rev. ed. Natl. Acad. Press, Washington, DC.

Diet samples were taken from 8 feeders per dietary treatment and subsampled. Subsamples were analyzed for DM, CP, Na, Cl, and salt (Ward Laboratories, Inc., Kearney, NE, Table 2).

Data were analyzed as a randomized complete block design using PROC GLIMMIX in SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Linear and quadratic polynomials were used to evaluate increasing added salt. Results were considered significant at $P \leq 0.05$ and marginally significant between $P > 0.05$ and $P \leq 0.10$.

Results and Discussion

Chemical analysis indicated that calculated values for Na and Cl were similar to analyzed values. Sodium ranged from 0.09 to 0.40% and Cl ranged from 0.23 to 0.72% (Table 2). Salt content ranged from 0.38 to 1.19% across treatment diets. This indicates that the 10% dried whey contributed approximately 7.6 lb salt to the diet.

From d 0 to 14, increasing added salt increased (linear, $P < 0.015$) ADG and ADFI. Feed efficiency improved (quadratic, $P < 0.034$) as added salt increased from 0 to 12 lb with no further benefits observed thereafter (Table 3). From d 7 to 14, increasing salt also increased (linear, $P < 0.050$) ADG, ADFI, and d 14 BW. There was no effect on F/G.

From d 14 to 21, when all pigs were fed a common diet (7 lb salt), those previously fed no added salt had a 20% greater ADG and better F/G than those previously fed 4 to 16 lb added salt (linear, $P < 0.013$). Because of the compensatory ADG observed during d 14 to 21, there were no overall (d 0 to 21) differences in ADG, ADFI, F/G, or final BW.

According to the chemical analysis, the diet with 12 lb/ton added salt contained 0.38% and 0.56%, Na and Cl, respectively (Table 2). The diet with 12 lb/ton added salt would be relatively similar in Na concentration to the NRC (2012)[6] estimate of 0.35%. Dietary Cl concentration was greater than the optimal level suggested by Mahan et al. (1999)[3] of 0.38% or the NRC (2012)[7] recommendation of 0.40%. Kerr et al. (1994)[5] added 3.5 or 7 lb/ton salt to diets containing 10% dried whey and tended to see a linear improvement in ADG and F/G. Monegue et al. (2011)[4] observed that increasing added salt up to approximately 10 lb/ton optimized performance; however, their diets were formulated with only added crystalline lactose, not dried whey as in our study.

In conclusion, 12 lb/ton of added salt, in a diet already containing 10% dried whey, appeared to optimize ADG and F/G in 15 to 22 lb nursery pigs. Further research should be conducted to see if the growth responses were due to an increase in Na or Cl, or both.

[7] NRC. 2012. Nutrient requirements of swine. 11th rev. ed. Natl. Acad. Press, Washington, DC.

Table 1. Diet composition (as-fed basis)

Item	Common Phase 1[1]	Experimental[2]	Common Phase 3[3]
Ingredient %			
Corn	39.28	51.00	63.77
Soybean meal (48% CP)	17.65	29.60	32.86
Corn DDGS (6-9% oil)	5.00	-	-
Fish meal	4.50	-	-
Dried whey	25.00	10.00	-
HP 300 (Hamlet Protein)	2.50	5.00	-
Choice white grease	3.00	1.00	-
Monocalcium P (21% P)	0.40	1.05	1.10
Limestone	0.50	1.05	0.98
Salt	0.30	-	0.35
L-Lys-HCl	0.48	0.30	0.30
DL-Met	0.20	0.18	0.12
L-Thr	0.18	0.15	0.12
L-Trp	0.05	-	-
L-Val	0.10	-	-
Trace mineral premix	0.15	0.15	0.15
Vitamin premix	0.25	0.25	0.25
HiPhos 2700	-	0.02	0.02
Zinc oxide	0.39	0.25	-
Choline chloride	0.04	-	-
Vitamin E, 20,000 IU	0.05	-	-
Total	100.00	100.00	100.00

continued

Table 1. Diet composition (as-fed basis)

Item	Common Phase 1[1]	Experimental[2]	Common Phase 3[3]
Calculated analysis			
Standardized ileal digestible (SID) amino acids, %			
Lys	1.40	1.35	1.35
Ile:Lys	55	63	57
Leu:Lys	111	124	117
Met:Lys	36	35	30
Met and Cys:Lys	56	59	51
Thr:Lys	62	66	57
Tryp:Lys	19	19	17
Val:Lys	67	67	62
Total Lys, %	1.55	1.49	1.37
ME, kcal/lb	1,579	1,517	1,483
NE kcal/lb	1,191	1,053	1,072
SID Lys:ME, g/Mcal	4.02	4.04	4.13
CP, %	21.0	22.8	21.4
Ca, %	0.67	0.78	0.70
P, %	0.67	0.68	0.64
Available P, %	0.57	0.48	0.41
Na, %	0.39	0.13	0.18
Cl, %	0.78	0.40	0.49

[1]Common Phase 1 diet fed to all pigs from d 0 to 7 after weaning.
[2]Experimental diets were fed to pigs from d 7 to 21 after weaning. Corn was removed and replaced with salt to create the treatment diets. Treatment diets containing 0 and 16 lb/ton salt were manufactured and blended at the feed mill to create the intermediate levels of 4, 8, and 12 lb/ton.
[3]Common Phase 3 diet fed to all pigs from d 21 to 28 after weaning.

Table 2. Chemical analysis of experimental diets (as-fed basis)[1]

	Added salt, lb/ton				
Item, %	0	4	8	12	16
DM	90.13	89.94	90.08	90.14	90.93
CP	22.8	22.4	23.2	22.6	22.9
Na	0.09	0.17	0.23	0.38	0.40
Cl	0.23	0.37	0.46	0.56	0.72
Salt	0.38	0.62	0.76	0.92	1.19

[1]Multiple samples were collected from each diet throughout the study, homogenized, and then subsampled for analysis (Ward Laboratories, Inc., Kearney, NE).

Table 3. Effects of increasing salt for 15 to 22 lb nursery pigs[1]

	Added salt, lb/ton[2]						*P* value	
Item	0	4	8	12	16	SEM	Linear	Quadratic
d 0 to 7[3]								
ADG, lb	0.24	0.25	0.33	0.38	0.35	0.016	<0.001	0.106
ADFI, lb	0.43	0.39	0.44	0.46	0.46	0.019	0.026	0.396
F/G	1.78	1.57	1.33	1.24	1.30	0.047	<0.001	<0.001
d 7 to 14								
ADG, lb	0.62	0.70	0.70	0.75	0.76	0.042	0.004	0.478
ADFI, lb	0.93	0.96	0.97	0.98	1.02	0.036	0.050	0.867
F/G	1.54	1.57	1.41	1.33	1.36	0.125	0.117	0.913
d 0 to 14								
ADG, lb	0.43	0.48	0.52	0.56	0.56	0.023	<0.001	0.218
ADFI, lb	0.68	0.67	0.70	0.72	0.74	0.021	0.015	0.609
F/G	1.60	1.45	1.38	1.30	1.33	0.048	<0.001	0.034
d 14 to 21								
ADG, lb	0.95	0.78	0.80	0.84	0.74	0.054	0.013	0.318
ADFI, lb	1.23	1.15	1.21	1.21	1.17	0.054	0.701	0.911
F/G	1.31	1.51	1.57	1.48	1.64	0.065	0.002	0.313
d 0 to 21								
ADG, lb	0.60	0.58	0.61	0.65	0.62	0.024	0.169	0.918
ADFI, lb	0.86	0.83	0.87	0.88	0.88	0.025	0.259	0.768
F/G	1.44	1.45	1.44	1.36	1.44	0.030	0.286	0.528
BW, lb								
d 0	14.6	14.6	14.6	14.6	14.6	0.104	0.630	0.789
d 7	16.3	16.4	17.0	17.3	17.1	0.174	<0.001	0.107
d 14	20.7	21.3	21.9	22.5	22.5	0.330	<0.001	0.297
d 21	27.4	26.8	27.4	28.3	27.6	0.550	0.229	0.982

[1] A total of 325 maternal line barrows (Line 200 × 400; DNA, Columbus, NE) were used in a 14-d study with 5 pigs per pen and 13 pens per treatment. Pigs were weaned at approximately 21 d, fed a common starter diet for 7 d post-weaning, then placed on experimental diets.

[2] Treatment diets with 0 and 16 lb salt/ton were manufactured and blended at the feed mill to create the intermediate levels of 4, 8, and 12 lb salt/ton.

[3] Experimental diets were fed from d 0 to 14 and a common Phase 3 diet was fed from d 14 to 21.