

Feed Efficiency in Nursery Pigs is Maximized When Additional Lys is Supplied by L-Lys·HCl Instead of Intact Protein, but not Affected by Differing NEAA Nitrogen Sources

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Summary and Implications

Two 14-d experiments were conducted using 540 and 450 pigs to determine the Lys requirement for 7 to 16 kg pigs when feeding a variety of synthetic amino acid concentrations, intact protein concentrations, or diets with low protein concentrations. Pigs were weighed 7d after the completion of the experiments (d 21) to determine the carryover effects of treatment diets. Performance data revealed no ($P > 0.17$) protein source \times Lys level interactions. In Exp. 1, ADG increased quadratically ($P = 0.04$) with increasing Lys level and Lys:CP, while G:F increased in a linear ($P < 0.0001$) manner. Break line analyses of all treatments utilizing analyzed SID Lys concentrations revealed optimum ($P = 0.001$) ADG was obtained at 1.26% Lys, while optimum G:F ($P = 0.002$) was obtained at 1.34% Lys. The source of NEAA affected ($P > 0.08$) neither ADG nor G:F. In Exp.2, both ADG and G:F increased linearly ($P < 0.0001$) with increasing Lys level. Optimum ($P = 0.001$) ADG and G:F were both obtained at 1.29% Lys. The source of Lys did not affect ($P = 0.57$) ADG, but tended to affect ($P = 0.07$) G:F. Overall, these data suggest that ADG was improved with increasing Lys levels up to 1.29%. While the source of Lys did not affect ADG, supplying Lys from L-Lys·HCl compared to SBM tended to improve feed efficiency.

Introduction

Numerous experiments have evaluated the optimum amino acid (AA) levels in various growth stages of pigs, but many times these AA requirements can be confounded by the nature of the basal diet. For instance, diets low in crude protein (CP), but high in AA due to synthetic amino acid addition typically result in poorer performance than conventional diets. This phenomenon suggests that some aspect of AA nutrition is not well understood, and may imply that some AA that are typically thought to be non-essential actually become essential when the CP level of the diet is below a certain level. Better understanding these AA requirements may create an opportunity to decrease feed costs, particularly during times of high protein prices. Therefore, the objective of Exp. 1 was to determine if the Lys requirement for pigs is altered when low protein diets

are supplemented with different sources of non-essential amino acid (NEAA) nitrogen.

Moreover, the lysine (Lys) requirement can be confounded by AA source. Theoretically, performance should be similar whether the AA are provided by either synthetic sources or intact protein. However, maximum performance is not always achieved by experiments with high synthetic AA concentrations, which often restricts the use of high L-Lys·HCl in practical diets. Understanding the differences in synthetic and intact protein may allow us to maximize profitability by taking advantage of flexibility in feed ingredients. Thus, the objective of Exp. 2 was to determine if the Lys requirement for pigs is altered when Lys is supplied by synthetic AA instead of intact protein.

Materials and Methods

This study was conducted at the Iowa State University Swine Nutrition Farm under the approval of the Institutional Animal Care and Use Committee (#8-10-7007-S and 11-10-7040-S). A total of 740 or 605 weanling pigs (PIC C22/C29 \times 337) were weighed and tagged individually upon arrival. After a 5-d acclimation period with a common diet, 540 or 450 pigs were placed on test (initial BW = 6.6 or 6.7 kg). There were 6 or 5 pigs per pen and 9 pens per treatment. In each experiment, pigs were blocked by initial weight, and pens were randomly assigned to one of 10 different dietary treatments. Piglet sex was equaled within pen, block, and experiment. Experimental diets were fed for 14 d, and a common diet was fed for 7 d to determine if carryover effects of diets existed. Pigs were weighed on d 0, 14, and 21. Feed disappearance was measured from d 0 to 14.

Experimental diets were based on corn, 30% SBM, 10% whey, 10% lactose, and 6% fish meal. The ME content of all diets was 3.55 or 3.51 Mcal/kg. In Exp. 1, treatments were aligned as a 2×5 factorial: 2 sources of NEAA nitrogen (L-Gln + L-Gly or L-Ala + L-Gly + L-His + L-Pro) and 5 levels of Lys (1.2 to 1.6%). In Exp. 1, treatments were also aligned in a 2×5 factorial: 2 sources of proteins providing additional Lys (L-Lys·HCl: increasing levels of L-Lys·HCl and constant levels of SBM, or SBM: increasing levels of SBM and constant levels of L-Lys·HCl) and 5 levels of Lys (1.2 to 1.6%). Differing level of synthetic AA other than L-Lys·HCl were added to maintain minimum AA:Lys ratios. Analyzed AA levels in Exp. 1 were similar to formulated levels. However, analyzed AA levels in Exp. 2 varied from formulated levels by up to 22%. Due to the complexity of accurate AA analyses, especially in diets containing milk products, data are presented according to formulated levels.

Data were analyzed according to the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) with pen as the experimental unit. Fixed effects included Lys level and source of NEAA nitrogen (Exp. 1) or source of additional Lys (Exp. 2). There were no interactions ($P < 0.17$) for performance variables in either experiment, so the interaction term was removed from the model. Weight block was considered a random effect. Pairwise comparisons, as well as linear and quadratic effects of increasing calculated Lys level were tested whenever the main effect of Lys was significant. Results were considered significant or trends if their P -values were < 0.05 or < 0.10 , respectively. The nutrient requirement was determined using the NLIN procedure of SAS.

Results and Discussion

Experiment 1.

Increasing levels of Lys resulted in heavier weights on both d 14 ($P < 0.0001$) and 21 ($P = 0.002$) due to improved ADG during the treatment period ($P < 0.0001$; Table 1). Although there was no effect ($P = 0.71$) of Lys during the 7-d carryover period, ADG was still improved ($P = 0.001$) over the entire 21 d. Feed intake was not affected ($P = 0.21$); however G:F was improved ($P < 0.0001$) with increasing Lys levels from d 0 to 14. Similar effects were seen with increasing Lys:CP ratio. Source of NEAA did not significantly affect ($P > 0.07$) any performance variables.

Pairwise comparisons utilizing formulated Lys concentrations between sources of NEAA nitrogen at different Lys levels revealed no differences in any measured variables ($P > 0.37$). Weights at d 14 and 21, as well as ADG from d 0 to 14, quadratically increased ($P < 0.04$) with increasing Lys level. Similarly, ADG from d 0 to 21 and G:F increased in a linear ($P < 0.0002$) manner.

The ADG break point of all treatments according to this model was 1.36% Lys. The break point of treatments with NEAA supplied by L-Gln + L-Gly was slightly greater (1.40% vs. 1.33%) than when supplied L-Ala + L-Gly + L-His + L-Pro. The G:F break point of all treatments

according to the 1-slope break line model was 1.45%. The break point of treatments with non-essential AA supplied by L-Gln + L-Gly was again slightly greater (1.48% vs. 1.43%) than when supplied by L-Ala + L-Gly + L-His + L-Pro.

These data suggest that ADG and feed efficiency were improved with increasing Lys levels up to 1.36% or 1.45 % for ADG and G:F, respectively. There was no significant difference in NEAA source, but nursery pig performance was maximized at a slightly higher Lys level when AA were supplied by L-Gln + L-Gly compared to L-Ala + L-Gly + L-His + L-Pro.

Experiment 2.

Increasing levels of Lys resulted in heavier weights on d 14 ($P = 0.0001$) due to improved ($P < 0.0001$) ADG during the treatment period (Table 2). Although there was no effect ($P = 0.91$) during the 7-d carryover period, ADG was still improved ($P < 0.05$) over the entire 21 d. Feed intake was not affected ($P = 0.29$); however, G:F was improved ($P < 0.0001$) with increasing Lys levels. The source of additional Lys did not affect ($P > 0.32$) pig weights, ADG, or ADFI, but did affect ($P = 0.01$) G:F.

Pairwise comparisons between sources of additional Lys at different formulated Lys levels revealed ($P > 0.18$) no differences in weight at d 14 or ADG from d 0 to 14. However, G:F was improved ($P = 0.01$) at 1.5% Lys when the additional Lys was supplied by L-Lys•HCl compared to SBM. All measured variables increased linearly ($P < 0.0001$) with increasing Lys levels.

Break point regression of all treatments according to ADG was 1.47% Lys. The break point of treatments with additional Lys supplied by L-Lys•HCl was lower (1.42% vs. 1.59%) than when supplied by SBM. When analyzed for G:F, there was no apparent break point, suggesting that the Lys level required for optimum G:F was beyond tested levels.

These data suggest that ADG was improved with increasing Lys levels up to 1.36% or 1.47 % for ADG. No requirement could be defined based on G:F. While the

Table 1. Effects of non-essential amino acid (NEAA) nitrogen source or Lys level on pig growth performance (Exp. 1)

NEAA source: Lys level, %:	L-Gln + L-Gly					L-Ala + L-Gly + L-His + L-Pro					SEM
	1.2	1.3	1.4	1.5	1.6	1.2	1.3	1.4	1.5	1.6	
Weight, kg											
d 0	6.65	6.64	6.66	6.65	6.64	6.65	6.67	6.67	6.66	6.66	0.292
d 14	11.27	11.83	12.27	12.20	12.17	11.13	11.90	12.09	12.32	12.38	0.452
d 21	14.32	15.20	15.56	15.62	15.47	14.22	15.09	15.17	15.32	15.55	0.528
ADG, g/d											
d 0 to 14	330	362	401	375	395	320	374	387	385	409	17.1
d 14 to 21	436	481	467	489	472	441	456	440	428	454	23.0
d 0 to 21	365	402	423	413	421	360	401	405	399	424	15.7
ADFI, g/d											
d 0 to 14	451	476	499	469	464	449	486	477	485	477	19.3
G:F, g/g											
d 0 to 14	0.73	0.76	0.80	0.80	0.80	0.71	0.77	0.81	0.80	0.86	0.018

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source of Lys did not affect ADG, supplying Lys from L-Lys•HCl compared to SBM resulted in improved feed efficiency, particularly at 1.5% Lys.

Overall, these experiments have determined that the Lys requirement for 7- to 16-kg pigs is not altered when low protein diets are supplemented with different sources of NEAA nitrogen, and that the Lys requirement is decreased when pigs are fed increasing Lys from L-Lys•HCl instead of intact protein (1.42 vs. 1.59%). We have confirmed that increasing Lys level results in improved growth performance, and that the Lys requirement for optimum ADG is between 1.4 to 1.5%

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Table 2. Effects of additional Lys source or Lys level on pig growth performance (Exp. 2)

Lys source:	L-Lys•HCl					Soybean meal					SEM
Lys level, %	1.2	1.3	1.4	1.5	1.6	1.2	1.3	1.4	1.5	1.6	
Weight, kg											
d 0	6.61	6.60	6.62	6.57	6.60	6.55	6.63	6.64	6.66	6.66	0.292
d 14	10.99	11.44	11.77	11.90	11.73	10.97	11.31	11.50	11.93	11.87	0.495
d 21	14.61	15.00	15.24	15.02	15.05	14.23	14.53	14.86	15.38	15.49	0.602
ADG, g/d											
d 0 to 14	312	338	368	381	367	316	334	347	365	379	16.9
d 14 to 21	518	523	495	446	474	466	461	479	493	484	28.2
d 0 to 21	381	399	410	403	403	366	376	391	408	414	17.3
ADFI, g/d											
d 0 to 14	421	425	452	450	432	440	429	443	460	439	19.6
G:F, g/g											
d 0 to 14	0.74	0.80	0.81	0.85	0.85	0.72	0.78	0.78	0.79	0.86	0.015