Inclusion of non-protein nitrogen and lysine in grower pig diets on growth performance

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"Ammonium phosphate can improve feed efficiency and increase lean depth in growing pigs while maintaining similar ADG and BW."

SUMMARY

Results from our previous study demonstrated that inclusion of non-protein nitrogen (NPN) in a diet with a high essential amino acid-nitrogen:total nitrogen (E:T) ratio (i.e. limiting in total nitrogen [N]) increased the Lys requirement and maximum N retention in growing pigs. A growth performance study was conducted with grower pigs (20.2 ± 2.18 kg) fed 1 of 6 diets, with factors of NPN inclusion (no ammonium phosphate [NAP; E:T ratio of 0.35] or ammonium phosphate inclusion at 1.7% [AP; E:T ratio of 0.33]) and dietary lysine (Lys; 1.03, 1.15, or 1.27% standardized ileal digestible).

Overall average daily gain and final body weight increased with increasing Lys, but were not impacted by dietary NPN content ($P > 0.05$). Inclusion of NPN reduced feed intake and improved feed efficiency compared to pigs fed NAP diets ($P < 0.05$). Inclusion of NPN increased fecal N output ($P < 0.05$). Pigs fed AP diets had increased lean depth ($P < 0.05$). These results suggest that inclusion of NPN, as ammonium phosphate, can improve feed efficiency and increase lean depth while maintaining similar growth performance.

INTRODUCTION

In recent years, the swine industry has transitioned to feeding lower total protein diets supplemented with essential amino acids (EAA). This shift has allowed for a reduction in dietary protein and subsequently nitrogen (N) content and excretion. While the introduction of these diets has enhanced aspects of the industry by improving the animal's efficiency of N utilization, they may result in reduced growth performance. Pigs require both EAA and non-essential amino acids (NEAA) to ensure proper growth, and LP diets assume pigs can produce the required levels of NEAA even with a lower dietary N content. However, reduced dietary N in low protein diets reduces the animal's ability to endogenously synthesize NEAA and utilize EAA, which may impact growth of the animal. When dietary N is insufficient, the required N for the synthesis of NEAA may be sourced from the catabolism of EAA, impacting efficiency of AA utilization for lean gain. Therefore, both EAA and NEAA, or a source of N, should be provided in the diet in order to ensure adequate N available for the endogenous synthesis of NEAA. In order to maximize growth and EAA utilization, both EAA-N and total N content of the diet should be considered. Previous studies have shown that N retention is affected by the EAA-N:total N (E:T) ratio, with reduced retention observed at extreme ratios. Therefore, the E:T ratio may be used as an indicator of N sufficiency.

It has been demonstrated that non-protein nitrogen (NPN), in the form of ammonia-N, may be used as a direct source of N for the synthesis of NEAA to maintain growth performance of pigs. Results from our previous study indicated that pigs fed high E:T ratio diet had reduced N retention and Lys requirement as a result of N deficiency, and N retention can be improved with NPN supplementation. As a result of increased N retention, the Lys requirement was also increased. The objective of the current study was to determine the effect of dietary NPN inclusion and lysine (Lys) content on growth performance, N digestibility and output, and carcass characteristics of 20-40kg growing pigs. It was hypothesized that growth performance, N digestibility and output, and carcass quality will be improved in pigs fed a diet containing a source of NPN (resulting in a low E:T ratio) and greater Lys content compared to pigs fed a diet deficient in NEAA-N (high E:T ratio).

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EXPERIMENTAL PROCEDURES

Experiment A growth performance study was conducted to determine the impact of NPN inclusion on growth metrics and carcass composition. A total of 240 mixed-sex growing pigs with an initial body weight (BW) of 20.2 ± 2.18 kg were housed in groups of 5 pigs/pen. Pens were randomly assigned to 1 of 6 dietary treatments over 3 blocks (n = 8 pens/treatment) in a 2 × 3 factorial design, with factors of NPN inclusion (no ammonium phosphate [NAP] or ammonium phosphate inclusion at 1.7% [AP]) and dietary lysine (Lys; 1.03%, 1.15% or 1.27% standardized ileal digestible). The lowest Lys level was based on NRC (2012) requirement, the middle level considers the requirement determined in our previous study, and the highest level is equal distance above the middle level. The NAP and AP diets were formulated to have an E:T ratio of 0.35 (considered to be deficient in N) and 0.33, respectively. Pigs had ad libitum access to feed and water for the duration of the experiment (28 d). Individual pig body weight and feed intake were measured weekly to determine average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F). Fresh fecal samples were obtained on d 15 to determine apparent total tract digestibility (ATTD). On d 28, backfat and lean depth were measured on 2 pigs per pen, one male and one female.

RESULTS AND DISCUSSION

Inclusion of NPN reduced ADG from d 15 – 21 ($P < 0.05$), but did not impact daily gain in any other experimental weeks or overall ($P > 0.05$; Table 1). Average daily gain was improved with increasing dietary Lys content from d 15 – 21 and overall ($P < 0.05$). Weekly BW was not impacted by NPN inclusion, except on d 21 where it was reduced ($P < 0.05$). Body weight was increased with increasing Lys on d 14, d 21 and d 28. Average daily feed intake was impacted by NPN inclusion ($P < 0.01$), with AP-fed pigs consuming less feed over the entire experimental period (Table 1). This was reflected in G:F, which was greater in pigs fed NPN for the first 2 experimental weeks ($P < 0.05$) as well as overall ($P < 0.01$), but was not impacted by Lys content or N × Lys interaction.

The ATTD (%) of N was not impacted by NPN inclusion, Lys content or their interaction ($P > 0.05$; Table 1). Fecal N output was increased in AP-fed pigs ($P < 0.05$). Lean depth was impacted by N content, with AP-fed pigs having greater lean depth than NAP-fed pigs ($P < 0.05$; Table 1).

IMPLICATIONS

These results suggest that inclusion of NPN, as ammonium phosphate, can improve feed efficiency and increase lean depth in growing pigs while maintaining similar ADG and final BW. This indicates that NPN, in the form of ammonium phosphate, improves N utilization efficiency and can improve carcass composition in diets deficient in NEAA-N. The present study confirms our previous trial's results, and demonstrates that more research is needed to further our understanding of the impact NPN has on performance measures and carcass characteristics in growing pigs and how the E:T ratio can be used as a tool in diet formulation, particularly in diets that may be limiting in NEAA-N.

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Table 1. Growth performance, carcass traits, and digestibility of nitrogen in pigs fed diets with and without ammonium phosphate at 1.7% inclusion with increasing SID Lys content[1]

	No ammonium phosphate			Ammonium phosphate				P-values		
Lys, % SID	1.03	1.15	1.27	1.03	1.15	1.27	SEM	N	Lys	N × Lys
BW D 28, kg	45.3	46.7	46.5	44.9	45.1	46.9	0.65	0.19	0.01	0.10
Overall ADG, kg/d	0.90	0.93	0.94	0.88	0.90	0.94	0.02	0.24	0.02	0.73
Overall ADFI, kg/d	0.90	0.93	0.94	0.88	0.90	0.94	0.03	< 0.001	0.27	0.51
Overall G:F, kg/kg	0.58	0.59	0.59	0.59	0.61	0.61	0.01	0.002	0.08	0.51
Backfat, mm	6.6	6.7	6.8	6.4	6.4	6.5	0.32	0.15	0.80	0.89
Lean, mm	36.5	37.9	37.3	38.0	40.1	38.9	1.05	0.02	0.13	0.91
Fecal N, g/d	5.61^{B}	6.36^{AB}	5.97^{AB}	7.18^{A}	5.94^{AB}	6.65^{AB}	0.225	0.02	0.72	0.01
ATTD N, %	82.6	82.1	82.7	80.3	83.2	81.8	0.72	0.26	0.30	0.11

ADFI, average daily feed intake; ADG, average daily gain; ATTD, average total tract digestibility; BW, body weight; G:F, gain:feed; Lys, lysine; N, nitrogen; SEM, standard error of the mean; SID, standardized ileal digestible.

1Data presented are least-square means (n=8 pens/treatment).

[A, B] Values within a row without a common superscript differ significantly ($P < 0.05$).