Influence of dietary nitrogen content and source on growth performance in finisher pigs

Kwan Ng[1,2], Dan Columbus[1, 2]

Dan Columbus

INSIGHT FOR PRODUCERS

Producers may want to avoid ammonium phosphate in finisher pigs unless supplemental lysine is also included in the diet, as there was a decrease in average daily gain and feed efficiency with ammonium phosphate inclusion.

SUMMARY

Low-protein diets may be nitrogen-deficient for optimal growth in pigs. Previous work showed a benefit in grower pigs when dietary nitrogen, either through protein or non-protein nitrogen, was increased. The objective of this study was to determine the impact of dietary nitrogen content and source on finisher pig performance. Finisher pigs were fed a nitrogen-deficient diet or a diet containing supplemental nitrogen as protein or non-protein nitrogen. Diets included either a standard or supplemented level of lysine. There was no impact of diet on performance. This indicates that finisher pigs may not respond to additional nitrogen as was previously observed in grower pigs.

"The use of ammonium phosphate as a nitrogen source has the potential to further reduce feed costs."

INTRODUCTION

The use of reduced-protein, essential amino acid (EAA)-supplemented diets has become commonplace to reduce feed costs and mitigate nitrogen (N) excretion into the environment. While growth performance can generally be maintained on these diets, there is some indication that reduced-protein diets may become limiting in either non-essential amino acids (NEAA) or N. It has been suggested that after meeting the requirements for the EAA, protein (or N) may become limiting, reducing the production of NEAA and limiting the utilization of EAA. For instance, Rocha et al. (2022) determined a minimum crude protein level required to maintain average daily gain in pigs, with 18.4%, 16.1%, and 11.6% estimated to be required for nursery, grower, and finisher pigs, respectively.

It has been suggested that dietary N sufficiency can be estimated through calculation of the EAA-N:total N ratio (E:T), with a higher ratio indicating potential N-deficiency and lower ratio indicating sufficient N. We have previously demonstrated that when an additional source of N, either as intact protein (Camire et al., 2023) or as non-protein nitrogen (NPN; Buchinski et al., 2024a) was included in N-deficient diets (as indicated by a high E:T), that N-retention was increased, resulting in a higher lysine requirement. Plasma AA analysis demonstrated an increase in EAA utilization (decreased plasma EAA) with NPN inclusion and increased plasma content of glutamine and glutamate (Buchinski et al., 2024a), which are important NEAA for N metabolism and non-waste utilization. We also showed that addition of NPN to diets did not alter pig growth rate, but improved feed efficiency, increased lean gain, and decreased fat gain in growing pigs (Buchinski et al., 2024b). The results of these studies suggest that it may be possible to replace some dietary protein/AA with a source of NPN to maintain growth performance, however, as these studies were based on grower pigs, the impact of dietary N content and source of finisher pigs is not known.

Improved feed efficiency while maintaining similar growth performance will result in reduced feed costs. In addition, use of ammonium phosphate as a nitrogen source has the potential to further reduce feed costs as its inclusion level is lower than intact protein to achieve the same E:T ratio with the added benefit of reducing or eliminating the need for additional sources of phosphorus.

1 Prairie Swine Centre Inc., PO Box 21507, 2105 – 8th Street East, Saskatoon SK S7H 5N9
2 Department of Animal and Poultry Science, University of Saskatchewan, 51 Campus Drive, Saskatoon SK S7N 5AB

EXPERIMENTAL PROCEDURES

A total of 270 mixed-sex finisher pigs with an initial body weight (BW) of 69.8 ± 0.37 kg were housed in groups of 5 pigs/pen and pens randomly assigned to 1 of 6 dietary treatments (n=9 pens/treatment). Dietary treatments consisted of an N-deficient diet (HR; E:T ratio of 0.33) or a low E:T ratio diet (E:T ratio of 0.30) achieved by supplementing intact protein (i.e., soybean meal; LRP) or NPN (i.e., ammonium phosphate; LRA). Each diet contained either a standard amount of Lys based on the requirement as indicated by NRC (2012) or Lys at 120% of the requirement (L), as indicated by our previous studies in pigs fed diets with a low E:T ratio. All diets were formulated to meet or exceed all other nutrient requirements according to NRC (2012), with diets analyzed for dry matter, crude protein, and amino acid content.

The experimental period was 42 d in length and pigs had ad libitum access to feed and water throughout the study. Individual BW and per pen feed intake were measured on d 0, 7, 14, 21, 28, 35, and 42 of the study for determination of average daily gain, average daily feed intake, and feed efficiency (gain:feed). On d 42 of the study, ultrasound was performed on 2 pigs per pen for determination of back fat and lean depth, all pigs were then weighed and shipped to a commercial abattoir (Thunder Creek) for standard carcass measures.

RESULTS

Diets were analyzed to confirm nutrient content. Dietary protein and energy content were within the expected range of formulated values, however, amino acid content was lower than expected based on formulated values. Mixing inclusion of ingredients was confirmed to be accurate, so the lower values were either due to a systemic laboratory analysis issue or variability in ingredients. Results are discussed with the assumption that diets were made properly and contain the expected amount of nutrients, although there is a possibility that, in some cases, a lack of treatment effect may be due to lower amino acid content.

Overall dietary treatment did not influence body weight, except for a reduction in body weight of LRA-fed pigs on d 28 and 35 of the study compared to pigs fed HR, HR-L, and LRP-L ($P < 0.01$). Average daily gain between d21-28 was lower in LRA-fed pigs compared to HR-fed pigs from d 21-28 ($P < 0.05$) and compared to pigs fed HR-L over the entire experimental period (d 0-42; $P < 0.05$). There was no treatment effect on average daily feed intake. Feed efficiency (gain to feed ratio, G;F) was lower in HR-L pigs compared to LRP-fed pigs from d 0-7 ($P < 0.05$), and in LRA-fed pigs compared to HR-L, LRP-L, and LRP over the entire experimental period (d 0-42; $P < 0.01$). Gain:feed was reduced in LRA-fed pigs compared to HR-L from d 14-21 ($P < 0.05$).

There was no effect of dietary treatment on body composition, lean depth, or backfat as determined by ultrasound ($P > 0.05$). Likewise, there were no dietary effects on carcass characteristics determined in market pigs, including carcass weight, yield, backfat, or lean depth ($P > 0.05$).

IMPLICATIONS

[Note: the following conclusions assume that diets contained essential amino acids at requirements/as formulated and the low analyzed values are due to an analytical issue]

The E:T ratios of these studies does not appear to have a significant impact on growth performance of finisher pigs. Dietary lysine had limited effect on growth performance, only having a positive effect in pigs fed diets with added ammonium phosphate (LRA). As there was no impact on feed efficiency, adding ammonium phosphate appears to cause a change (i.e., reduction) in nutrient utilization and the reduced performance does not appear to be due to a decrease in palatability.

Overall, diet had no impact on final body weight or carcass composition, however, there was a decrease in average daily gain and feed efficiency with ammonium phosphate inclusion, indicating that producers may want to avoid ammonium phosphate in finisher pigs unless supplemental lysine is also included in the diet.

The differing results of E:T ratio and nitrogen supplementation in finisher pigs vs. grower pigs (Buchinski et al., 2024) may be due to a change in growth composition in finishers vs. growers, as finisher pigs have lower lean gain and reduced efficiency compared to growers.

Although not an original objective, this study also demonstrates that finisher pigs can grow well on diets containing as low as 12% protein when essential amino acids are fed at requirement. An additional potential benefit shown in this study is that ammonium phosphate can also be a source of phosphorus, with inclusion of ammonium phosphate allowing for removal of other sources of phosphorus (e.g., monocalcium phosphate) from diet formulations. Finally, the results of this study show that there is no economic advantage to providing additional nitrogen or lysine in diets for finisher pigs as formulated in the completed experiment.

ACKNOWLEDGEMENTS

This study was completed with support from the ADOPT program (Agriculture Development of Processes and Technologies). The authors would also like to acknowledge the participation of the cooperating farm in this research project, as well as the strategic program funding provided to Prairie Swine Centre by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund.