Iowa State University
Digital Press
Animal Industry Report

Animal Industry Report

AS 651 ASL R2014

2005

Nitrogen Excretion and Ammonia Emissions from Pigs Fed Reduced Crude Protein Diets or Yucca Extract

D. M. Panetta
Iowa State University

Wendy J. Powers
Iowa State University

Hongwei Xin
Iowa State University, hxin@iastate.edu

Brian J. Kerr
United States Department of Agriculture

Follow this and additional works at: https://lib.dr.iastate.edu/ans_air

Part of the Agriculture Commons, Bioresource and Agricultural Engineering Commons, and the Poultry or Avian Science Commons

Recommended Citation

Panetta, D. M.; Powers, Wendy J.; Xin, Hongwei; and Kerr, Brian J. (2005) "Nitrogen Excretion and Ammonia Emissions from Pigs Fed Reduced Crude Protein Diets or Yucca Extract," *Animal Industry Report*: AS 651, ASL R2014.
DOI: https://doi.org/10.31274/ans_air-180814-1375
Available at: https://lib.dr.iastate.edu/ans_air/vol651/iss1/49

This Poultry is brought to you for free and open access by the Animal Science Research Reports at Iowa State University Digital Repository. It has been accepted for inclusion in Animal Industry Report by an authorized editor of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.

Nitrogen Excretion and Ammonia Emissions from Pigs Fed Reduced Crude Protein Diets or Yucca Extract

A.S. Leaflet R2014

D.M. Panetta, graduate research assistant,
W.J. Powers, associate professor of animal science,
H. Xin, professor of agricultural and biosystems engineering, and
B.J. Kerr, research leader USDA-ARS-SOMMRU

Summary and Implications

Dietary strategies are an important part of management systems designed to reduce ammonia emitted from animal feeding operations. Two potential strategies (reducing dietary crude protein content and adding yucca extract to the diet) were evaluated in two swine feeding trials. Three groups of pigs were housed in environmental chambers in order to allow for direct measurement of ammonia emissions. Emission rates and excreta nitrogen and ammonium concentrations were analyzed. Feeding a diet with four amino acids resulted in large though non-significant reductions in ammonia emissions, and affected excreta nitrogen concentrations; increasing urinary ammonium-N while decreasing urinary and fecal total nitrogen and fecal ammonium-N. The only significant effect of dietary yucca was a decrease in urinary ammonium-N concentration. In both studies, ammonia emission rates increased over time as manure accumulated in the chamber pits.

Introduction

The excretion of excess nitrogen from swine may be reduced by more closely meeting their amino acid requirements. While it has become a common practice to reduce protein content of diets by supplementing with lysine, the potential of further reduced crude protein diets utilizing multiple amino acids to reduce ammonia emissions has not been widely studied.

Yucca extract is a plant product that has been reported to reduce ambient ammonia concentrations in swine buildings, although its effects have not been consistent and its mode of action is still unclear. Two feeding trials were conducted to directly quantify the effects on ammonia emissions and nitrogen excretion of reduced crude protein, amino acid-supplemented diets and the dietary addition of yucca extract.

Materials and Methods

In two experiments, nine grow-finish pigs were housed in environmental chambers and fed experimental diets to measure dietary effects on ammonia emissions and nitrogen excretion. In trial 1, pigs with an average starting bodyweight of 47 kg were fed three diets to determine the effects of reducing dietary crude protein (CP). The diets were: **C**, a 17.4% crude protein corn and soybean meal diet with no additional amino acids; **L**, a 17.0% CP corn-SBM diet with crystalline lysine; and **LMTT**, a 14.5% CP corn-SBM diet with crystalline lysine, methionine, threonine, and tryptophan. In trial 2, pigs with an average starting bodyweight of 41 kg were fed three diets to determine the effects of dietary addition of yucca extract. The diets were: **L + 0**, a corn-SBM and lysine diet with no yucca added; **L + 62.5**, a diet formulated the same as L + 0, but with 62.5 ppm of the yucca product De-Odorase (Alltech, Inc; Nicholasville, KY); and **L + 125**, a diet containing 125 ppm of De-Odorase. In each trial, the three diets were assigned to the three chambers of pigs each of four weeks such that each chamber was fed all three diets at least once and one of the diets twice.

During each week of feeding, the pigs were allowed to adjust to their new diets for the first four days. Continuous automated measurement of ammonia concentration in air exhausted from the chambers occurred on a rotating schedule (20 minutes per chamber) over the final 72 hours using a TEI Model 17C chemiluminescence ammonia analyzer (Thermo Electron Corp.; Beverly, MA). Airflow rates were also measured and used to calculate ammonia emissions. Grab samples of urine and feces were collected from each pig each week and pooled. At the beginning and end of each period, pigs were removed from the chambers and weighed. Manure pits underneath each chamber were emptied and cleaned thoroughly. Feed refusals were weighed to determine weekly intake. Fecal and urine samples were composited by chamber within sampling period and analyzed for concentrations of total Kjeldahl nitrogen (TKN) and ammonium-N.

Ammonia emissions data were analyzed using the MIXED procedure of SAS. The chamber of pigs within a diet -week combination was the experimental unit and the subject of repeated measures. The model evaluated the effects on ammonia emission rates of diet as well as the time that had elapsed since the chambers and manure pits were cleaned out and the time since the pigs had been fed. Animal performance and nitrogen excretion data were analyzed using a general linear model to evaluate the effects of diet and chamber. In trial 1, diet was treated as a fixed effect, while in trial 2 the effect of an increasing dose of yucca was evaluated. Significance was declared at $P \leq 0.05$.

Results and Discussion

Ammonia emission rates were not significantly affected by either of the dietary strategies, although numerical trends of reduced emission rates with reduced CP content and addition of yucca were observed (Figures 1 and 2). A reduction in ammonia emission rate of less than half the rate observed when pigs were fed no crystalline amino acids or lysine, only, was observed when four amino acids were included in the diets. This is equivalent to a 20% reduction in ammonia-N emissions for every percentage unit decrease in dietary CP, much greater than the average of 8.4% observed in other swine studies. The lack of statistical significance may be attributed to the small number of observations (12; three chambers of pigs fed the diets for four feeding periods). As manure accumulated in the collection pits, ammonia emission rates increased in both trials ($P<0.0001$).

Reducing the crude protein content of corn-soybean meal diets using crystalline amino acids had no significant effect on average daily gain or feed efficiency (Table 1). Feeding reduced CP diets resulted in small reductions in urinary and fecal concentrations of TKN and fecal ammonium-N. While one would expect that by feeding pigs less nitrogen, less would be excreted, reductions in nitrogen excretion have been, in other studies, attributed primarily to reductions in urinary urea content. In this study, the concentration of urinary ammonium, a product of urea hydrolysis, was increased in pigs fed the LMTT reduced CP diet. Because total excreta collections were not conducted during these trials, it is unknown how the increase in urinary ammonium concentration affected total nitrogen excretion or whether it represented a shift in the form of nitrogen excreted.

The dietary addition of yucca extract had no significant effects on animal performance. Increased doses of yucca extract reduced the urinary ammonium concentration, but had no effect on the other excretion measurements. Because urinary ammonium is a readily volatilized source of ammonia emitted from manure, feeding yucca extract might promote reduced ammonia emissions. However, in this study, it was not linked with a statistically significant reduction in ammonia emissions.

Acknowledgements

The authors thank the Iowa Pork Producers Association for their support of this project, and Alltech, Inc. for their De-Odorase product. The assistance of Laura Flatow is appreciated.

Figure 1. Mean ammonia-N emission rate per chamber of three grow-finish pigs on reduced crude protein diets ($P = 0.098$, $n = 12$).

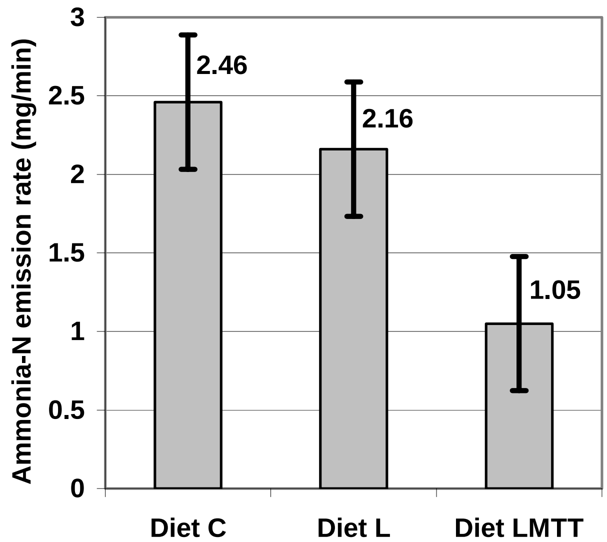

Figure 2. Mean ammonia-N emission rate per chamber of three grow-finish pigs on yucca extract diets ($P = 0.885$, $n = 12$).

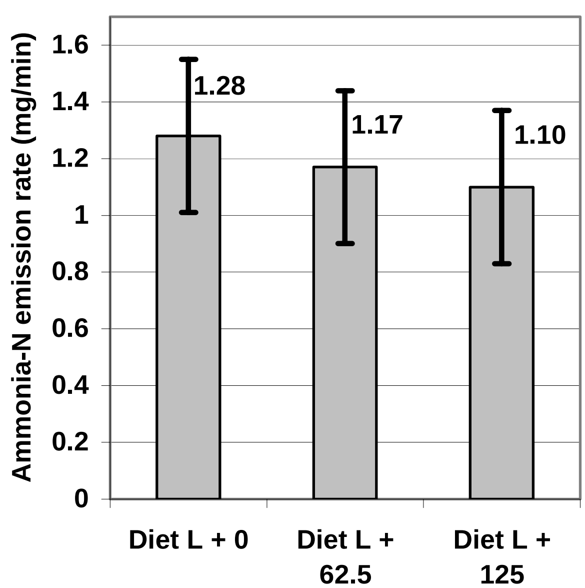

Table 1. Least squares means of pig performance and nitrogen excretion data and effects of dietary crude protein content or dose of yucca.

Diet	Average Daily Gain, kg/pig	Gain: Feed	Urinary Ammonium-N, %	Urinary TKN, %	Fecal Ammonium-N, % DM	Fecal TKN, % DM
C	0.80	0.36	0.10	1.10	0.47	3.97
L	0.88	0.38	0.10	0.94	0.47	3.93
LMTT	0.64	0.27	0.20	0.93	0.42	3.72
Diet P =	0.20	0.09	< 0.0001	0.04	0.01	< 0.001
L + 0	0.79	0.39	0.14	1.05	0.45	3.58
L + 62.5	0.74	0.28	0.13	0.91	0.50	3.60
L +125	0.89	0.38	0.11	0.96	0.50	3.58
Dose P =	0.66	0.94	0.05	0.09	0.20	0.51