Dietary Manipulation to Reduce Ammonia Emission from High-Rise Layer Houses

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Summary and Implication

Efficacy of dietary manipulation on reduction of ammonia (NH_3) emissions from high-rise (HR) layer houses was evaluated for a full year in Iowa. Two HR houses used diet with standard levels of crude protein (CP), designated as *Standard*, and two comparison houses used an average of 1% lower CP diet supplemented with essential amino acids, designated as *Lower CP*. Annual mean NH_3 emission rate (ER) was 0.81 (±0.21) g d^{-1} hen^{-1} or 296 g yr^{-1} hen^{-1} for houses using the Lower CP diet, as compared with 0.90 g d^{-1} hen^{-1} or 329 g yr^{-1} hen^{-1} for houses using Standard diet. Namely, the 1% reduction in dietary CP led to about 10% reduction in NH_3 ER. Hen performance of both diets was similar, with hen-day egg production of 80.3% vs. 80.2% for Standard and Lower CP and the corresponding case weight of 48.3 vs. 47.7 lb.

Introduction

Ammonia (NH_3) generation is a result of microbial decomposition of uric acid and undigested nitrogen in bird feces. Ammonia emission is associated with nitrogen (N) content of the feces, which is influenced by feed composition and feed conversion efficiency of the bird. To reduce N content in feces, ration may be formulated with reduced dietary crude protein (CP) and supplemented with limiting amino acids (AA) to match bird dietary requirements, thereby improving digestive conversion efficiency. However, data are lacking that link reduced ammonia emission from commercial layer houses with hens fed properly formulated lower CP diets.

Materials and Methods

Four HR laying hen (W-36) houses at a commercial layer facility in Iowa were used to study the effect of diet manipulation on NH_3 emissions. The houses measured 48 ft wide by 432 ft long. They used cross ventilation system that consisted of 24, 48″ diameter exhaust fans and two, 36″ diameter exhaust fans. Number of birds at start ranged from 73938 to 82219.

Two of the HR houses (C-1, C-2) received a standard CP ration (Standard 1 and 2) and the other two (T-1, T-2) received a lower-protein ration supplemented with amino acids (AA) (Lower CP 1 and 2). Hence, the experiment had two dietary regimens with two replicates each. Before the Lower CP flocks received the experimental diet, manure was removed from all experimental houses. Dietary compositions for each flock at onset of the study are listed in Table 1. In general, the Lower CP diet had 0.4 to 1.2% lower CP than the Standard diet during various feeding phases. Soy content was reduced for the Lower CP diet, and crystalline AA DL-methionine, L-lysine.HCL and L-threonine were supplemented so that these essential AA were at the same levels in both diets for each corresponding feeding phase. Tryptophan and isoleucine in the Lower CP diet were slightly lower than those in the Standard diet (difference ranged from 0.02% to 0.06%). During the molting period, a lower calcium ration containing 15% CP was used during restricted feeding for C-1 and T-1 flocks, followed by 15.3% and 14.4% CP, respectively, in post-molt feed. CP content of the diet for the new flocks (18 weeks of age, pair 2) was 16.9% for Standard 2 and 15.7% for Lower CP 2.

Portable monitoring units (PMUs), two per house, were used to measure NH_3 and CO_2 concentrations of intake and exhaust air and building static pressure. The PMU featured purging and sampling cycles to eliminate measurement errors caused by saturation of the electro-chemical NH_3 sensors. This purging-sampling led to 30-min measurements of the gas concentrations. Quality assurance and quality control protocols were strictly followed in instrument calibration, data collection, and data analysis to ensure data integrity. Each data collection trip involved 48-hr or longer continuous measurements, and was performed weekly. Building ventilation rates were determined using calibrated CO_2 balance method. Mass balance on nitrogen intake through feed and output, including measured NH_3emission from manure, was conducted as a way to validate the emission data. The measurement periods were Dec. 2002 to Dec. 2003.

Results and Discussion

Daily NH_3 emission rate (ER) for houses with the Lower CP diet averaged 0.81 (±0.21) g d^{-1} hen^{-1} (an annual ER of 296 g hen^{-1}), as compared with 0.90 g d^{-1} hen^{-1} (an annual ER of 329 g hen^{-1}) for Standard diet houses (Table 2). Hence, NH_3 ER decreased by 10% with 1% reduction in dietary CP.

No significant difference was found between the two diets in weekly hen-day egg production (80.3% vs. 80.2% for Standard and Lower CP) or case weight (48.3 lb $case^{-1}$ for Lower CP, vs. 47.7 lb $case^{-1}$ for

Standard). Therefore, the results indicate that dietary manipulation provides a viable means to reduce NH_3 emission from laying hen operations.

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Table 1. Dietary composition (as analyzed) of the first formula at the beginning of the study for the four high-rise layer houses (%, unless otherwise noted)

Ingredient	Pair 1		Pair 2	
	C-1 (47 wk)	T-1 (48 wk)	C-2 (89 wk)	T-2 (85 wk)
Protein	**16.6**	**15.6**	**15.2**	**14.3**
ME, MJ/kg	11.7	11.8	11.9	11.9
Lysine	0.94	0.94	0.84	0.84
Methionine	0.44	0.44	0.34	0.34
Threonine	0.66	0.66	0.61	0.61
Tryptophan	0.22	0.20	0.18	0.18
Isoleucine	0.85	0.79	0.78	0.72
Calcium	4.25	4.25	4.25	4.25
Available Phosphorus	0.48	0.48	0.43	0.43

C = control, diet with standard crude protein
T = treatment, diet with lower than standard CP
1 or 2=house number

Table 2. Annual ammonia emissions from four high-rise layer houses with different diets (mean ± S.D.)

Building ID	Days of Monitoring	NH_3 Emission Rate, g d^{-1} hen^{-1}
T-1	84	0.81 ± 0.23
T-2	75	0.80 ± 0.24
C-1	84	0.84 ± 0.26
C-2	75	0.95 ± 0.29
Standard diet		0.87 ± 0.29
Lower CP diet		0.81 ± 0.21

C = control, diet with standard crude protein
T = treatment, diet with lower than standard CP
1 or 2=house number