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

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Species: Poultry (Layers)
Use Area: Animal Housing
Technology Category: Diet Modification
Air Mitigated Pollutants: Ammonia

Description:

Ammonia (NH_3) generation from poultry production is a result of microbial decomposition of uric acid and undigested nitrogen (N) in bird feces. Ammonia emission is associated with 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. A dietary manipulation experiment with hens fed properly formulated lower CP diets was conducted for a full year to evaluate NH_3 emission from commercial layer houses.

Mitigation Mechanism:

The lower CP diet (LCP) was tested against an industry standard or control (Ctrl) diet in four high-rise (HR) laying-hen (Hy-Line W-36) houses at a commercial layer facility in Iowa to study the effect of diet manipulation on NH_3 emissions. Two of the HR houses received a standard CP ration (Ctrl) and the other two received a LCP ration supplemented with amino acids (AA). Hence, the experiment had two dietary regimens with two replicates each.

In general, the LCP diet had 0.4 to 1.2% lower CP than the Ctrl diet during various feeding phases. Soy content was reduced in the LCP 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 LCP diet were slightly lower than those in the Ctrl diet (difference ranged from 0.02% to 0.06%).

Daily NH_3 emission rate (ER) for houses with the LCP diet averaged 0.80 g d^{-1} hen^{-1} (annual ER: 292 g hen^{-1}), as compared with 0.90 g d^{-1} hen^{-1} (Annual ER: 329 g hen^{-1}) for the Ctrl diet houses (Table 1). Hence, NH_3 ER decreased by 11% with up to 1.2% reduction in dietary CP. No significant difference was found between the two diets in weekly hen-day egg production (80.3% for Ctrl vs. 80.2% for LCP) (Fig. 1) or case weight (47.7 lb $case^{-1}$ for Ctrl vs. 48.3 lb $case^{-1}$ for LCP). Therefore, the results indicate that dietary manipulation provides a viable means to reduce NH_3 emission from laying hen operations.

Applicability:

This mitigation technology was tested with Hy-Line W-36 laying hen birds from 20 to 108 weeks of age.

Limitations:

Crude protein (amino acids) in the diet can only be reduced to the level where the next essential amino acids becomes limiting, otherwise it will adversely affect bird performance. The discussed study utilized diets ranging from 0.4 to 1.2% lower CP than the standard or Ctrl diet during various feeding phases to achieve approximately 11% of ammonia emission reduction.

Table 1. Effect of lower crude protein (LCP) diet on ammonia emission rate (ER) from HR layer houses in Iowa

NH_3 ER in g/d-hen (range)		NH_3 ER reduction by the LCP diet
Standard (Ctrl) diet	Lower CP (LCP) diet	
0.90 (0.24 – 1.60)	0.80 (0.19 – 1.37)	11%

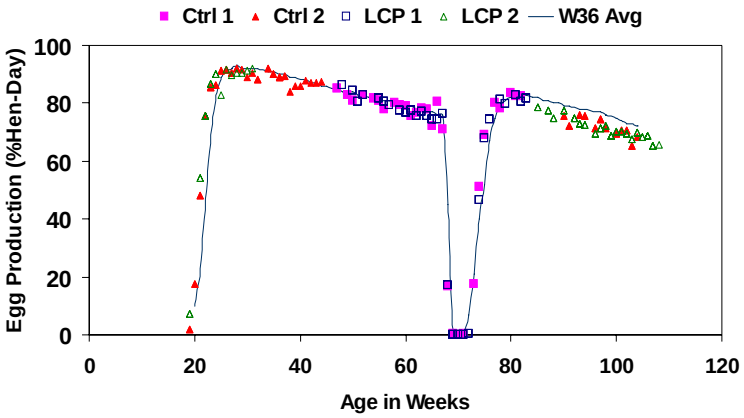

Figure 1. Egg production of birds receiving Standard (Ctrl) or lower CP (LCP) diets. Solid line represents average production performance of Hy-Line W-36 birds.

Cost:

Table 2 lists the cost comparison of a sample dietary formulation of the LCP and Ctrl diets. When the study was conducted in 2003, the costs of 1000 kg of feed were $115.75 and $116.22 for the LCP and Ctrl rations, respectively, based on an estimated corn and soybean prices of $116 and $210 /1000kg. The cost of the same LCP dietary formulation is 1.2% less (2008 prices) than that of the standard dietary formulation due to reduced grain portions, which is especially relevant with the current higher grain costs (corn, soybean, etc.). The costs of 1000 kg of feed are $235.44 and $238.47 for the sample LCP and Ctrl rations based on the 2008 prices, respectively.

Implementation:

Sample dietary formulation of the LCP and Ctrl diets and their nutrient compositions are provided in Tables 2 and 3.

Table 2. Sample dietary formulations of the lower crude protein (LCP) and standard (Ctrl) diets and cost comparison (February 2008 cost basis).

Ingredient	Weight (kg)		Unit price ($/1000kg)	Formulated Cost ($)	
	LCP	Ctrl		LCP	Ctrl
Corn	581.787	552.333	195.00	113.45	107.70
Soybean 48	248.262	275.039	380.00	94.34	104.51
Feed fat	40.840	45.153	255.00	10.41	11.51
Alimet	2.155	1.941	1,820.00	3.92	3.53
Limestone	98.997	98.973	19.00	1.88	1.88
Dicalcium phosphate	21.086	20.850	225.00	4.74	4.69
Salt	4.116	4.111	40.00	0.16	0.16
Vit+min premix	1.100	1.100	3,098.79	3.41	3.41
Choline chloride	0.250	0.250	648.79	0.16	0.16
Natuphos	0.250	0.250	3,578.79	0.89	0.89
L-lysine HCl	0.727		1,600.00	1.16	
L-threonine	0.429		2,100.00	0.90	
Total weight (kg)	1,000.000	1,000.000			
Total Cost of 1000kg of feed ($)				235.44	238.47

Table 3. Dietary nutrient composition of the sample formula for the lower CP (LCP) and standard or control (Ctrl) diets (%, unless otherwise noted)

Nutrient	LCP	Ctrl
Dry matter	89.952	90.038
Crude protein	16.666	17.610
Fat	6.966	7.340
Ash	14.571	14.662
Crude fibre	2.405	2.480
Nitrogen	2.714	2.863
AMEn (kCal/kg)	2,925.000	2,925.000
TMEn (kCal/kg)	3,047.290	3,048.971
Lysine	0.950	0.966
Methionine	0.466	0.460
Methionine+cystine	0.750	0.757
Cystine	0.284	0.297
Threonine	0.680	0.680
Isoleucine	0.700	0.749
Tryptophan	0.191	0.206
Arginine	1.084	1.164
Valine	0.785	0.832
Glycine	0.698	0.743
Glycine+serine	1.538	1.635
Histidine	0.467	0.493
Leucine	1.524	1.592
Phenylalanine	0.845	0.898
Phenyl.+tyrosine	1.488	1.580
Serine	0.839	0.892
Tyrosine	0.643	0.683
TEAA	10.907	11.413
Calcium	4.250	4.250
Phosphorous	0.703	0.709
Avail. phosphorous	0.480	0.480
Sodium	0.190	0.190

Technology Summary:

Utilization of lower crude protein with supplemented essential amino acids is a source reduction method to mitigate ammonia emission from laying hen production facilities. Lower N excretion in the bird feces due to lower total N intake can result in lower NH_3 emission from the production system. The 0.4 to 1.2% lower CP than the Standard diet during various feeding phases used in the above study resulted in about 11% ammonia emission reduction. Formulation based on nutritional requirement at different feeding phases is required to achieve emission reduction without affecting bird performance, i.e. egg production and case weight. The cost of using the lower CP diet is about 1% lower than that of using the standard diet.

Additional Resources:

Y. Liang, H. Xin, E. F. Wheeler, R. S. Gates, H. Li, J. S. Zajaczkowski, P. A. Topper, K. D. Casey, B. R. Behrends, D. J. Burnham, F. J. Zajaczkowski 2005. Ammonia emissions from U.S. laying hen houses in Iowa and Pennsylvania. Trans. ASABE. 48(5):1927-1941.

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