Poultry No. 1580

Effects of Reduced Crude Protein, Amino Acid Balanced Diets on Performance and Economics in a Large-scale Commercial Laying Hen Flock

Conclusions

- Reducing dietary CP did not significantly impact hen body weight or egg quality
- Reducing dietary CP by 0.85 or 1.40 % lowered feed costs by an average of $7.40 and $9.20 per 1,000 hens per week compared with the typical high CP diet.
- As a result, the egg income minus feed costs for hens fed the low or mid CP diets were $6.80 and $7.20 greater per 1,000 hens per week than those fed the high CP diet.
- Reducing CP by using supplemental amino acids can maintain egg production and quality as well as being economically beneficial, thus increasing producer revenue.

Objective

In 2004, the United States Environmental Protection Agency estimated that poultry were the highest producers of ammonia gas (NH_3) emissions of all domesticated species. As a result, governmental policies have been enacted that regulate the quantity of NH_3 that can be within and released from commercial hen houses. These regulations are intended to protect not only the environment, but also the laying hen. One potential strategy for reducing NH_3 emissions is by formulating diets to precisely meet the nutrient needs, especially the amino acids needs, of a laying hen. By using supplemental amino acids to meet the hen's needs, the need for intact protein sources, such as soybean meal can be reduced. Currently, most commercial laying-hen diets are already supplemented with the first-limiting amino acid, methionine, but there is potential to reduce nitrogen excretion even further by supplementing lysine and threonine in the diets. In addition to reducing the environmental and animal welfare impacts of excess dietary nitrogen, diet costs can often be lowered by including supplemental amino acids.

The objective of this trial was to determine if reduced CP, AA balanced laying hen diets could maintain hen performance, reduce feed cost, and increase farmer revenue. This commercial-scale trial was conducted in cooperation with **The Pennsylvania State University, A & E Nutrition Services,** and **Wenger Feeds.**

Experimental design

A total of 50,760 Lohmann LSL Lite laying hens were divided into 3 groups, and each group was fed one of three dietary treatments. The treatments were: 1) typical commercial laying hen diet supplemented with DL-Met (**high CP**); 2) intermediate CP diet supplemented with DL-Met and Lys (**mid CP**); and 3) low CP diet supplemented with DL-Met, Lys, and Thr (**low CP**). All diets primarily contained corn and soybean meal, but poultry by-product, corn DDGS, canola meal, bakery by-product, and wheat middlings also were offered to the diets as opportunity ingredients and included when price effective. Diets were formulated on a standardised ileal digestible (**SID**) amino acid basis and balanced for Lys, Met, Met+Cys, and Thr (Table 1). All diets also were formulated to be isocaloric and to meet or exceed current nutrient recommendations of the Lohmann LSL Lite laying hens.

Table 1: Average Composition of Experimental Diets, as-is basis.

Ingredient, %	High CP (+Met)	Mid CP (+Met and Lys)	Low CP (+Met, Lys, and Thr)
Corn	48.68	51.31	51.68
Soybean meal, 48% CP	19.70	13.43	11.04
Poultry by-product meal	4.55	6.90	6.88
Corn DDGS	4.60	6.50	6.51
Canola meal	2.50	4.70	3.97
Bakery by-product meal	1.36	1.13	1.00
Wheat middlings	3.00	3.10	3.00
Fat	2.66	3.00	3.00
DL-Methionine	0.28	0.32	0.36
L-Lysine HCl	--	0.12	0.16
L-Threonine	--	--	0.02
Other	12.67	9.49	12.38
Nutrient composition:			
Energy, kcal ME/kg	2,866	2,866	2,866
Energy, MJ ME/kg	12.0	12.0	12.0
Crude protein, %	19.16	18.31	17.76
SID Lys, %	0.87	0.86	0.87
SID Met, %	0.40	0.40	0.41
SID Met+Cys, %	0.71	0.70	0.71
SID Thr, %	0.65	0.61	0.60
SID Arg, %	1.10	1.02	0.97
SID Ile, %	0.70	0.65	0.62
SID Trp, %	0.19	0.17	0.16

The experimental diets were fed from 18 to 51 weeks of age, and diets were reformulated on a weekly basis based on current ingredient prices and nutrient concentrations. The average calculated compositions of these experimental diets are reported in Table 1. The feeding program was a 2-phase peak lay feeding program. Hens were fed Phase 1 Peak from 18 to 35 weeks and Phase 2 Peak from 35 to 51 weeks of age. The nutrient density was adjusted based on average weekly feed consumption and level of production as needed. Diets were fed as mash, and water was provided *ad libitum* throughout the trial.

Birds were housed in 6 rows of 8.460 birds each, and then each treatment was randomly assigned to 2 rows of birds (16,920 hens per treatment). Cage density, temperature and lighting were in accordance with U.S. commercial laying hen production conditions.

Hens from 3 cages per row were weighed and eggs were collected from 3 locations per row every 4 weeks to determine egg weight, albumen height, Haugh units, yolk color, shell strength, and shell thickness. Egg income, feed consumption and prices during the 33-week experimental period (February to September 2008) were used to calculate weekly feed cost and egg income minus feed costs. Data were analyzed by PROC MIXED procedure of SAS and mean comparisons were made using Tukey's procedure with p-values < 0.05 considered significant.

Table 2: **Average Analyzed Crude Protein and Amino Acid Levels of Experimental Diets, as-is basis.**

Ingredient, %	High CP (+Met)	Mid CP (+Met and Lys)	Low CP (+Met, Lys, and Thr)
Crude protein, %	21.88	20.35	19.90
Total Lys, %	1.06	1.04	1.05
Total Met, %	0.44	0.43	0.45
Total Met+Cys, %	0.85	0.83	0.84
Total Thr, %	0.83	0.76	0.75
Total Arg, %	1.42	1.28	1.23
Total Ile, %	0.87	0.77	0.75
Total Leu, %	1.80	1.67	1.62
Total Val, %	1.07	0.99	0.96
Total Trp, %	0.21	0.19	0.19

Results

Diet analyses confirmed that these diets were balanced for amino acids (Table 2). The mid and low CP diets contained 0.85 and 1.40 % less CP on average than the high CP diet, which was close to planned differences of 0.75 and 1.50 %. While body and egg weights were numerically lower for the hens fed the low CP diet, egg production was numerically higher than for those hens fed the high or mid CP diets, respectively. While not significantly different, this slight reduction in egg weight and body weight when hens were fed the low CP diet may be due to a marginal deficiency in one of other essential amino acids. When the analyzed amino acid levels in these diets are compared with our recommendations for laying hens (Lemme, 2009), it seems possible that the low CP diet was marginally deficient in Trp and/or Arg (based also on an average diet SID of 82 %). There were no differences (P > 0.05) in albumin height, Haugh units, yolk color, shell strength, and shell thickness across treatments.

Table 3: Overall effects of feeding reduced CP diets to Lohmann LSL Lite hens from 18 to 51 weeks of age on layer production parameters.

Treatment	High CP (+Met)	Mid CP (+Met and Lys)	Low CP (+Met, Lys, and Thr)	PSEM
Body weight (kg)	1.58	1.58	1.55	0.01
Egg production (%)	87.1	87.4	87.9	
Egg weight (g)	60.51	60.48	60.02	0.30
Egg mass (g/d)	52.70	52.86	52.76	
Albumen height (mm)	8.95	9.09	8.98	0.07
Haugh unit	93.57	94.30	94.05	0.39
Yolk color (Roche scale)	7.73	7.85	7.81	0.06
Shell strength (kg)	4.30	4.32	4.37	0.06
Shell thickness (mm)	0.36	0.37	0.37	0.01

The low CP diet average weekly egg income was $2.20 and $2.40 per 1,000 hens less than for the mid or high CP diets, respectively, and this difference was due to the difference in egg weight. However, the average feed cost for the low and mid CP diets were $9.20 and $7.40 less per 1,000 hens than for the high CP diet. As a result, the egg income minus feed costs for 1,000 hens fed the low or mid CP diets were $6.80 and $7.20 greater than those fed the high CP diet. For a 100,000 hen operation, this represents an additional $30,680 - $35,360 per year in income

Table 3: Average weekly egg income, feed cost, and egg income minus feed cost when feeding reduced CP diets to Lohmann LSL Lite hens from 18 to 51 weeks of age.

Treatment	High CP (+Met)	Mid CP (+Met and Lys)	Low CP (+Met, Lys, and Thr)
Egg income ($/hen/week)[1]	0.4772	0.4770	0.4748
Feed cost ($/hen/week)	0.2147	0.2077	0.2064
Egg income minus feed cost ($/hen/week)	0.2625	0.2693	0.2684

[1]Egg income calculated as weekly treatment egg income/n; n = 16,920 hens per treatment.

In conclusion, the results of this trial indicate that reducing CP when maintaining amino acid levels by using supplemental amino acids can maintain egg production and quality as well as being economically beneficial.

References:

Lemme, A. 2009. Amino Acid Recommendations for Laying Hens. AminoNews. Vol. 13-2.

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