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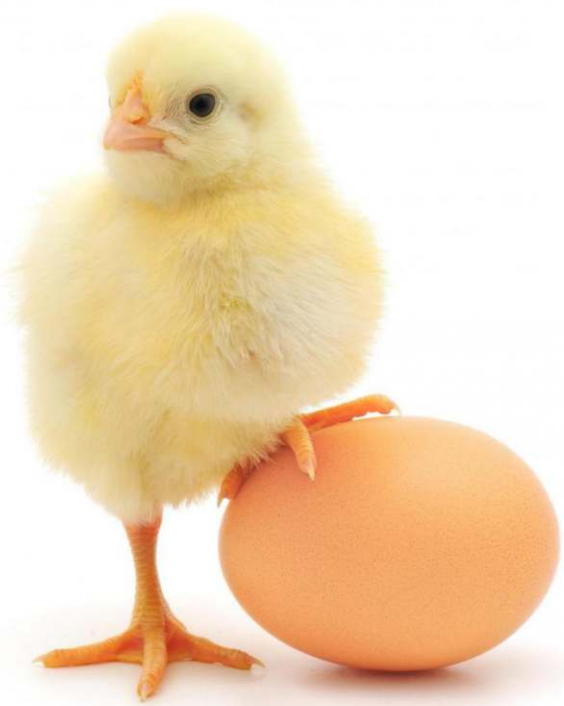

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Influence of Added Synthetic Lysine for First Phase Second Cycle Commercial Leghorns with the Methionine+Cysteine/Lysine Ratio Maintained at 0.75

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Abstract: A 3 × 4 factorial experiment with three protein levels (17.52, 16.24 and 15.22%) and four added synthetic lysine levels (0.0000, 0.0295, 0.0590 and 0.0884%) was conducted to determine the influence of adding synthetic lysine in er diets while maintaining a 0.75 Met+Cys/Lys ratio. In this experiment, a total of 1,440 Hy-Line W-36 hens (first phase of second cycle) were randomly divided into 480 cages with 3 birds per cage. Five adjoining cages consisted of a group and then the ninety-six groups were randomly assigned to 12 dietary treatments. The results showed there were no interactions ($P > 0.05$) between protein level and added synthetic lysine on feed intake, egg production, egg mass, egg weight or feed conversion. Protein effects were observed for feed intake ($P < 0.01$), egg production ($P < 0.01$), egg mass ($P < 0.01$), egg weight ($P < 0.05$) and feed conversion ($P < 0.05$). There was no difference ($P > 0.05$) obtained among the four supplemental synthetic lysine levels, indicating the influences of adding synthetic lysine on performances was not significant ($P > 0.05$) for hens fed diets containing a low protein level up to 15.22% and with feed intake at approximate 100 g/hen/day.

Key words: Layers, lysine, methionine, protein, ratio

Introduction

In practical poultry diets, methionine is the first limiting amino acid, followed by lysine. When synthetic methionine became commercially available in 1951, Supplementation of methionine to poultry diets provides a way of improving the efficiency of protein utilization. However, although lysine is also commercially available, little, if any, synthetic lysine is typically added in practical corn-soybean layer diets.

It is believed that the quality of protein in low protein corn-soybean diets is not as good as that in high protein diets, since the amino acid mixture in high protein corn-soybean diets is closer to the ideal protein than that in lower protein diets. For example, hens consuming 15.2 g proteins/day from a 24 lb/100h/day low protein (14%) diet will not be as efficient in conversion of protein to egg as a hen consuming 15.2 g protein/day from a 19 lb/100h/day high protein (17.6%) diet. The reason may be due to deficiencies of more than one amino acid and lysine may be largely responsible. For example, when decreasing protein from 19.0 to 14.2% in a corn-soybean diet the methionine content decreases only 0.04% (from 0.28 to 0.24%), while, the lysine content decreases 0.23% (from 0.92 to 0.69%). Thus it is believed that added synthetic lysine may be needed in low protein diets to optimize protein utilization.

Low protein diets are used for three major reasons. First, for hens consuming high quantity of feed due to environmental temperature, the same quantity of protein intake can be maintained as feed intake increases with a low protein level. Harms (1981) realized that although hens eat more feed as temperature decreases, what hens really need was just more energy not more protein. Second, as hen's age increases, egg mass decreases, which reduces the hen's need for protein. Third, low protein diets give a way to reduce nitrogen excretion (Jais and Kirchgessner, 1993; Summers, 1993; Blair *et al.*, 1999; Saitoh, 2001). With people becoming increasingly aware of the environmental problems related to nitrogen excretion from animal waste, nutritionists were forced to base protein/amino acid levels not only in terms of nitrogen retained in animal products, but also in terms of non-utilized fraction of nitrogen excreted. Therefore, interest is growing in studying minimum dietary protein and amino acid levels to optimize poultry production and maximize efficiency of protein utilization.

From previous studies in our lab (Bateman *et al.*, 2000; Yadalam *et al.*, 2000; Yadalam, 2001), we believe the optimal Met+Cys/Lys ratio for laying hens is 0.75, which is lower than the value suggested in NRC (1994). The purpose of this experiment was to determine the influence of added synthetic lysine in low protein diets for first phase second cycle commercial leghorns with the Met+Cys/Lys ratio maintained at 0.75.

Materials and Methods

The basal diet was formulated to meet the Commercial Management Guide (Anonymous, 2000) nutrient requirements for Hy-Line Variety W-36, with exception of total protein (Table 1). The metabolic energy content for the basal diet was 2809kcal/kg, which was adequate for the requirement. The diets were formulated based on lysine but not protein. It would be desirable to hold lysine

Table 1: Ingredient (%) of the diets

Ingredient	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8	Diet 9	Diet 10	Diet 11	Diet 12
Corn	617.51	616.87	616.21	615.61	657.91	657.26	656.61	656.01	690.13	689.39	688.66	687.92
SBOM	253.15	253.21	253.28	253.31	219.65	219.72	219.78	219.81	192.99	193.12	193.26	193.40
Limestone	70.50	70.50	70.50	70.50	70.61	70.60	70.60	70.60	70.69	70.69	70.6	87.068
Hard shell	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Dical-phos	16.02	16.02	16.02	16.03	16.17	16.17	16.17	16.17	16.28	16.28	16.29	16.29
Poultry oil	12.22	12.20	12.19	12.16	5.41	5.40	5.38	5.36	0.00	0.00	0.00	0.00
NaCl	4.54	4.54	4.54	4.55	4.55	4.55	4.55	4.55	4.56	4.56	4.56	4.56
Vit. Premix	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Min. premix	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
DL-Met	1.06	1.28	1.51	1.73	0.70	0.93	1.15	1.38	0.35	0.58	0.80	1.03
Lys	0.00	0.37	0.75	1.12	0.00	0.37	0.75	1.12	0.00	0.37	0.75	1.12
Price	118.48	119.68	120.87	122.06	113.08	114.27	115.47	116.66	108.63	109.84	111.04	112.24
Analysis												
CP	17.52	17.57	17.62	17.66	16.24	16.29	16.33	16.38	15.22	15.27	15.32	15.37
ME, kcal/kg	2809	2809	2809	2809	2809	2809	2809	2809	2809	2809	2809	2809
Ca	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
AP	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Methionine	0.39	0.41	0.43	0.45	0.34	0.36	0.38	0.40	0.29	0.31	0.34	0.36
Met+Cys	0.69	0.71	0.73	0.76	0.62	0.64	0.67	0.69	0.56	0.58	0.61	0.63
Lysine	0.92	0.95	0.98	1.01	0.83	0.86	0.89	0.92	0.75	0.78	0.81	0.84
Tryptophan	0.21	0.21	0.21	0.21	0.19	0.19	0.19	0.19	0.17	0.17	0.17	0.17

[1]Provided per kilogram of diet: vitamin A (as retinyl acetate), 8,000 IU; cholecalciferol, 2,200 ICU; vitamin E (as dl-α-tocopheryl acetate), 8IU;vitamin B_{12}, 0.02mg; riboflavin, 5.5mg; D-calcium pantothenic acid, 13mg; niacin, 36mg; choline, 50mg; folic acid, 0.5mg; vitamin B_1 (thiamin mononitrate), 1mg; pyridoxine, 2.2mg; d-biotin, 0.05mg; vitamin K (menadione sodium bisulfate complex), 2mg. [2]Provided per kilogram of diet: manganous oxide, 65mg; iodine (ethylene diamine dihydriodide), 1mg; ferrous carbonate, 55mg; copper oxide, 6mg; zinc oxide, 55mg; sodium selenite, 0.3mg.
[3]DL-methionine calculated as 99.7%. [4]L_lysince calculated as 78.6%.

Table 2: Experiment design

Protein[1] (%)	Total M+C%	Natural M+C%	Added Met%	Added Met (lbs/ton)	Total Lys (%)	Natural Lys (%)	Added Lys (%)	Added Lys[2] (lbs/ton)
17.52	0.6900	0.58	0.1100	2.2000	0.9200	0.92	0.0000	0.0000
17.52	0.7121	0.58	0.1321	2.6421	0.9495	0.92	0.0295	0.7500
17.52	0.7342	0.58	0.1542	3.0843	0.9790	0.92	0.0590	1.5000
17.52	0.7563	0.58	0.1763	3.5264	1.0084	0.92	0.0884	2.2500
16.24	0.6225	0.55	0.0725	1.4500	0.8300	0.83	0.0000	0.0000
16.24	0.6446	0.55	0.0946	1.8921	0.8595	0.83	0.0295	0.7500
16.24	0.6667	0.55	0.1167	2.3343	0.8890	0.83	0.0590	1.5000
16.24	0.6888	0.55	0.1388	2.7764	0.9184	0.83	0.0884	2.2500
15.22	0.5625	0.52	0.0425	0.8500	0.7500	0.75	0.0000	0.0000
15.22	0.5846	0.52	0.0646	1.2921	0.7795	0.75	0.0295	0.7500
15.22	0.6067	0.52	0.0867	1.7343	0.8090	0.75	0.0590	1.5000
15.22	0.6288	0.52	0.1088	2.1764	0.8384	0.75	0.0884	2.2500

[1]Means the protein level in the basal diet without added synthetic lysine. [2]Lysine = 78.6% Lysine.

Table 3: Influence of added synthetic lysine on feed intake (g/hen/day)

	Factor	Week 2[1]	Week 4	Week 6	Week 8	Week 10	Overall
Protein	15.22%	95.3	100.5	99.7	100.2	99.4	99.0
	16.24%	97.8	102.6	102.1	102.3	100.9	101.1
	17.52%	99.4	103.6	103.5	104.4	102.7	102.7
Lys[2]	0.000%	96.6	103.3	102.0	101.8	100.5	100.9
	0.030%	97.4	102.1	102.8	103.3	101.8	101.5
	0.059%	98.4	102.1	101.5	102.2	100.7	101.0
	0.088%	97.6	101.4	100.6	101.8	100.9	100.5
15.22% Protein	0.000% Lys	92.0	92.0	99.4	101.2	100.5	98.8
	0.030% Lys	93.6	93.6	101.3	100.9	99.1	99.2
	0.059% Lys	98.1	98.1	97.9	98.1	98.0	98.4
	0.088% Lys	97.6	100.3	100.2	100.5	100.0	99.7
16.24% Protein	0.000% Lys	98.3	103.8	101.9	100.3	98.8	100.6
	0.030% Lys	98.1	103.1	104.1	104.8	103.8	102.8
	0.059% Lys	98.6	103.1	102.7	103.2	102.4	102.0
	0.088% Lys	96.0	100.3	99.5	100.8	98.5	99.0
17.52% Protein	0.000% Lys	99.4	105.4	104.8	104.0	102.2	103.2
	0.030% Lys	100.6	101.9	103.1	104.3	102.7	102.5
	0.059% Lys	98.4	103.4	103.9	105.3	101.8	102.5
	0.088% Lys	99.2	103.6	102.2	104.0	104.2	102.6
SEM		2.2	1.5	1.8	1.7	1.6	1.5
		----------------------	----------------------	---------------------- Probability	----------------------	----------------------	----------------------
ANOVA							
Protein		0.0422	0.0254	0.0145	0.0052	0.0225	0.0053
Lysine		0.7981	0.4850	0.4918	0.6544	0.7632	0.8609
Protein × Lysine		0.4510	0.7373	0.6406	0.4928	0.1962	0.7505

[1]Means the average of previous two experimental weeks (week 1 and week 2). The followings are the same and the overall means the average of the whole 10 experimental weeks. [2]Means the supplemental lysine level.

and protein from natural ingredients constant but this could not be accomplished with only corn and soybean. Therefore, the protein level is allowed to float while holding lysine from corn and soybean constant. This was a 3×4 factorial experiment with three low protein levels (15.22, 16.24 and 17.52%) and four added synthetic lysine levels (0.000, 0.0295, 0.0590 and 0.884%). The experimental design is shown in Table 2.
In this experiment, 1,440 Hy-Line W-36 hens in the first phase of the second cycle (70 weeks old) were used for each treatment. Three hens were housed in a 40.6 cm × 45.7 cm cage and five adjoining cages consisted of a group. Then ninety-six groups were randomly assigned to the twelve treatments. Replicates were equally distributed into upper and low cage level to minimize cage level effect. All hens were housed in an environmentally controlled house with temperature maintained at approximately 25.6 °C (21.1 °C during the night and 28.9 °C during the day). The house has controlled ventilation and lighting (16 hr/day), but no control on relative humidity. All hens were supplied with feed and water *ad libitum*. Feed consumption was recorded weekly; egg production was recorded daily; egg weight was recorded bi-weekly; and egg specific gravity was recorded monthly. Egg weight and egg specific gravity were measured using all eggs produced during two consecutive days. Egg specific gravity was determined by the floatation method as described by Holder and Bradford (1979). Mortality was determined daily and the feed consumption was adjusted accordingly. Body weight was obtained by weighing 3 hens per group at the end of the experiment. Egg mass and feed conversion (g feed/g egg) were calculated from egg production, egg weight and feed consumption.
Data was analyzed using general linear model procedure (PROC GLM) in SAS/STAT (2000). The statistical model was:

$$Y_{ijk}=\mu+P_i+S_j+PS_{ij}+e_{ijk}$$

where Y_{ijk} is the k-th response for the treatment combination P_iS_j, μ is the overall mean, P_i is protein level effect, S_j is added synthetic lysine effect, PS_{ij} is the interaction of protein level and added synthetic lysine, e_{ijk} is the random error.

Results

During the 70-d experimental period, the total mortality was 1.25% (18 hens out of 1,440). Mortality was not affected (P > 0.05) by treatment (Data not shown). Feed intake was adjusted for mortality.
There was no interaction (P > 0.05) between protein and added synthetic lysine on feed intake (Table 3), egg production (Table 4), egg mass (Table 5), egg weight

Table 4: Influence of added synthetic lysine on egg production (%)

	Factor	Week 2[1]	Week 4	Week 6	Week 8	Week 10	Overall
Protein	15.22%	76.4	80.0	83.1	83.1	81.9	80.9
	16.24%	77.8	81.8	85.1	83.0	82.6	82.1
	17.52%	81.3	85.3	86.3	85.8	84.6	84.7
Lys[2]	0.000%	77.4	81.9	83.8	83.0	83.0	81.8
	0.030%	77.2	82.5	85.0	84.1	82.5	82.3
	0.059%	80.7	82.7	85.0	84.6	84.0	83.4
	0.088%	78.6	82.5	85.5	84.3	82.6	82.7
15.22% Protein	0.000% Lys	73.7	79.7	81.8	82.7	83.1	80.2
	0.030% Lys	75.5	79.3	82.3	83.2	80.7	80.2
	0.059% Lys	79.3	80.1	83.5	82.8	82.5	81.6
	0.088% Lys	77.0	81.1	84.7	83.7	81.2	81.5
16.24% Protein	0.000% Lys	76.8	81.1	83.0	80.7	81.0	80.5
	0.030% Lys	75.1	80.7	86.0	83.4	83.5	81.7
	0.059% Lys	80.1	82.7	84.6	83.2	82.2	82.6
	0.088% Lys	79.0	82.8	87.0	84.6	83.7	83.4
17.52% Protein	0.000% Lys	81.7	84.8	86.5	85.6	84.8	84.7
	0.030% Lys	81.0	87.6	86.9	85.7	83.3	84.9
	0.059% Lys	82.7	85.3	87.1	87.6	87.4	86.0
	0.088% Lys	79.8	83.7	84.9	84.5	82.9	83.1
SEM		2.4	1.6	1.6	1.4	1.3	1.3
ANOVA		-- Probability--					
Protein		0.0127	<0.0001	0.0164	0.0052	0.0133	0.0005
Lysine		0.2591	0.9218	0.5672	0.5424	0.4720	0.5173
Protein × Lysine		0.8801	0.5683	0.5976	0.5320	0.1736	0.7330

[1]Means the average of previous two experimental weeks (week 1 and week 2). The followings are the same and the overall means the average of the whole 10 experimental weeks. [2]Means the supplemental lysine level.

Table 5: Influence of added synthetic lysine on egg mass (g/hen/day)

	Factor	Week 2	Week 4	Week 6	Week 8	Week 10	Overall
Protein	15.22%	47.86	51.31	52.74	52.95	52.57	51.49
	16.24%	50.61	52.86	54.47	53.22	53.16	52.86
	17.52%	53.20	55.84	55.76	55.68	55.24	55.14
Lys[1]	0.000%	49.83	52.96	53.22	52.81	53.27	52.42
	0.030%	49.73	53.67	54.44	53.83	53.02	52.94
	0.059%	52.07	53.42	54.64	54.58	54.31	53.80
	0.088%	50.59	53.29	55.01	54.58	54.03	53.50
15.22% Protein	0.000% Lys	46.58	46.58	51.07	51.45	52.66	50.59
	0.030% Lys	45.96	45.96	52.41	53.27	51.56	50.82
	0.059% Lys	49.83	49.83	53.76	53.04	52.56	51.95
	0.088% Lys	49.06	52.58	53.72	54.06	53.51	52.59
16.24% Protein	0.000% Lys	49.76	52.71	52.56	52.11	52.39	51.91
	0.030% Lys	49.37	52.41	54.90	52.90	53.35	52.59
	0.059% Lys	52.18	53.77	54.27	53.67	52.64	53.31
	0.088% Lys	51.13	52.55	56.15	54.20	54.25	53.66
17.52% Protein	0.000% Lys	53.16	54.99	56.02	54.86	54.75	54.76
	0.030% Lys	53.87	57.72	55.99	55.32	54.16	55.41
	0.059% Lys	54.20	55.91	55.88	57.04	57.73	56.15
	0.088% Lys	51.59	54.73	55.17	55.49	54.32	54.26
SEM		2.68	1.70	1.73	1.74	1.74	1.56
ANOVA		-- Probability --					
Protein		0.0007	<.0001	0.0033	0.0037	0.0074	<.0001
Lysine		0.4108	0.9101	0.3129	0.2468	0.5321	0.4280
Protein × Lysine		0.8626	0.4636	0.6201	0.9510	0.4296	0.8567

[1]Means the supplemental lysine level.

Table 6: Influence of added synthetic lysine on egg weight (g)

	Factor	Week 2	Week 4	Week 6	Week 8	Week 10	Overall
Protein	15.22%	63.25	63.62	63.55	63.80	64.45	63.73
	16.24%	63.97	64.40	63.90	64.54	64.63	64.29
	17.52%	64.49	65.16	64.87	65.30	65.33	65.03
Lys[1]	0.000%	63.88	64.08	63.90	64.21	64.57	64.13
	0.030%	63.89	64.44	64.18	64.49	64.76	64.35
	0.059%	63.98	64.57	64.24	64.75	64.91	64.49
	0.088%	63.87	64.49	64.12	64.74	64.97	64.44
15.22% Protein	0.000% Lys	62.70	62.84	62.84	62.87	63.91	63.03
	0.030% Lys	63.11	63.63	63.53	63.50	64.00	63.55
	0.059% Lys	63.60	64.09	64.08	64.34	64.97	64.21
	0.088% Lys	63.58	63.93	63.77	64.51	64.92	64.14
16.24% Protein	0.000% Lys	64.30	64.46	63.60	64.71	64.72	64.36
	0.030% Lys	63.75	64.29	63.87	64.37	64.33	64.12
	0.059% Lys	64.17	64.72	64.21	64.38	64.45	64.39
	0.088% Lys	63.69	64.14	63.93	64.72	65.01	64.30
17.52% Protein	0.000% Lys	64.66	64.95	65.24	65.07	65.09	65.00
	0.030% Lys	64.80	65.40	65.13	65.61	65.97	65.38
	0.059% Lys	64.16	64.91	64.43	65.53	65.31	64.87
	0.088% Lys	64.34	65.39	64.67	64.99	64.97	64.87
SEM		0.71	0.69	0.69	0.59	0.63	0.62
ANOVA		--Probability--					
Protein		0.0521	0.0086	0.0237	0.0028	0.1139	0.0154
Lysine		0.9978	0.8271	0.9350	0.6532	0.8721	0.8990
Protein × Lysine		0.9114	0.9223	0.8523	0.6100	0.6723	0.8806

[1]Means the supplemental lysine level.

Table 7: Influence of added synthetic lysine on feed conversion (g feed/g egg)

	Factor	Week 2	Week 4	Week 6	Week 8	Week 10	Overall
Protein	15.22%	2.07	1.94	1.92	1.91	1.90	1.95
	16.24%	2.01	1.94	1.91	1.94	1.89	1.94
	17.52%	1.94	1.85	1.89	1.88	1.88	1.89
Lys[1]	0.000%	2.03	1.94	1.95	1.94	1.89	1.95
	0.030%	2.05	1.91	1.93	1.94	1.93	1.95
	0.059%	1.94	1.90	1.89	1.89	1.86	1.90
	0.088%	1.99	1.90	1.86	1.88	1.87	1.90
15.22% Protein	0.000% Lys	2.09	1.96	1.98	2.00	1.91	1.99
	0.030% Lys	2.13	1.96	1.97	1.91	1.92	1.98
	0.059% Lys	2.00	1.95	1.86	1.87	1.86	1.91
	0.088% Lys	2.05	1.91	1.89	1.87	1.90	1.92
16.24% Protein	0.000% Lys	2.07	1.96	1.98	1.94	1.89	1.97
	0.030% Lys	2.07	1.98	1.93	1.99	1.94	1.98
	0.059% Lys	1.95	1.92	1.93	1.95	1.96	1.94
	0.088% Lys	1.94	1.90	1.82	1.87	1.79	1.86
17.52% Protein	0.000% Lys	1.94	1.89	1.90	1.88	1.88	1.90
	0.030% Lys	1.95	1.80	1.88	1.92	1.93	1.89
	0.059% Lys	1.88	1.83	1.89	1.85	1.77	1.84
	0.088% Lys	1.99	1.89	1.88	1.89	1.93	1.92
SEM		0.07	0.03	0.04	0.05	0.05	0.03
ANOVA		-- Probability ----------------------------------					
Protein		0.0324	0.0007	0.5025	0.2623	0.7783	0.0425
Lysine		0.2181	0.5144	0.0864	0.2219	0.3072	0.1046
Protein × Lysine		0.8535	0.2886	0.3992	0.4914	0.0515	0.3681

[1]Means the supplemental lysine level.

Table 8: Influence of added synthetic lysine on egg specific gravity and body weight (kg)

	Factors	Egg Specific gravity			Body Weight
		Month 1	Month 2	Overall	
Protein	15.22%	1.0827	1.0766	1.0796	1.57
	16.24%	1.0824	1.0764	1.0794	1.61
	17.52%	1.0822	1.0760	1.0791	1.62
Lys[1]	0.000%	1.0824	1.0767	1.0796	1.58
	0.030%	1.0823	1.0766	1.0794	1.60
	0.059%	1.0824	1.0756	1.0790	1.62
	0.088%	1.0825	1.0764	1.0795	1.60
15.22% Protein	0.000% Lys	1.0833	1.0783	1.0808	1.56
	0.030% Lys	1.0823	1.0762	1.0793	1.55
	0.059% Lys	1.0822	1.0751	1.0786	1.59
	0.088% Lys	1.0830	1.0766	1.0798	1.57
16.24% Protein	0.000% Lys	1.0821	1.0760	1.0791	1.60
	0.030% Lys	1.0822	1.0765	1.0793	1.58
	0.059% Lys	1.0824	1.0763	1.0794	1.67
	0.088% Lys	1.0830	1.0769	1.0799	1.56
17.52% Protein	0.000% Lys	1.0820	1.0759	1.0789	1.57
	0.030% Lys	1.0825	1.0770	1.0797	1.66
	0.059% Lys	1.0827	1.0753	1.0790	1.60
	0.088% Lys	1.0817	1.0759	1.0788	1.66
SEM		0.0004	0.0006	0.0004	0.06
ANOVA		Probability			
Protein		0.2454	0.4426	0.2390	0.4382
Lysine		0.9343	0.1245	0.3393	0.8593
Protein × Lysine		0.0822	0.0883	0.0270	0.7800

[1]Means the supplemental lysine level.

Table 9: Influence of protein level and added synthetic lysine on profits[1]

Protein (%)		Added synthetic lysine level (%)			
		0.000	0.0295	0.0590	0.0884
17.52	Egg production (%)	84.7	84.9	86.0	83.1
	Egg weight (g)	65.00	65.38	64.87	64.87
	Profit (cents/doz)	20.0	20.1	20.0	19.2
16.24	Egg production (%)	80.5	81.7	82.6	83.4
	Egg weight (g)	64.36	64.12	64.39	64.30
	Profit (cents/doz)	20.3	20.0	20.2	20.7
15.22	Egg production (%)	80.2	80.2	81.6	81.5
	Egg weight (g)	63.03	63.55	64.21	64.14
	Profit (cents/doz)	21.3	21.0	21.3	20.9

[1]The egg price spread between medium and large eggs was 13 cents

(Table 6), or feed conversion (Table 7). Feed intake, egg mass, egg weight did not increase ($P > 0.05$) and feed conversion was not improved ($P > 0.05$) by adding the synthetic lysine.

Protein effects ($P < 0.05$) were obtained for feed intake ($P < 0.01$), egg production ($P < 0.01$), egg mass ($P < 0.01$), egg weight ($P < 0.05$) and feed conversion ($P < 0.05$). Average feed intake, egg production, egg mass, egg weight and feed conversion were 102.7 g/hen/day, 84.7%, 55.14 g/hen/day, 65.03g and 1.89 respectively at 17.52% protein level, but was only 99.0 g/hen/day, 80.9%, 51.49 g/hen/day, 63.73 g and 1.95 respectively at 15.22% protein level. There was no effect of adding synthetic lysine on feed intake in any of the protein levels. Although there was some trends for lysine to improve performances of hens, no significant improvements were observed.

There was an interaction ($P < 0.05$) between protein and added synthetic lysine for egg specific gravity (Table 8). However, there was no added synthetic lysine effect (P

> 0.05). There was also no interaction, protein or added lysine effect (P > 0.05) on body weight (Table 8).

Discussion

Methionine usually is the first limiting amino acid, followed by lysine. Many researchers have reported that adding synthetic methionine to low protein diets was economical (Johnson and Fisher, 1958; Combs, 1962; Harms and Miles, 1988; Waldroup and Hellwig, 1995), but typically little or no synthetic lysine is added in corn-soybean layer diets. More recently, feeding based on the ideal amino acid concept has been given more attention. When diets are formulated based on amino acid, lysine is used as the standard with the requirements for other amino acids expressed as a percentage of lysine. Little attention has been given to the possibility that more synthetic lysine may be needed in corn-soybean layer diets (Latshaw, 1981; Keshavarz and Jackson, 1992; Blair *et al.*, 1999).

A previous study in our lab showed that the quality of low protein diets could be improved by adding synthetic lysine while maintaining the Met+Cys/Lys ratio at 0.75. However, the protein levels (14.3 and 13.6%) used in that experiment was lower than the protein used in this experiment. In this experiment, a typically used protein level (17.52%) for hens in the first phase of the second cycle along with two lower protein levels (16.24 and 15.22%) were used to determine the influence of adding synthetic lysine while maintaining the Met+Cys/Lys ratio at 0.75, which was shown to be a correct ratio in previous studies (Bateman *et al.*, 2000; Yadalam *et al.*, 2000).

The results showed that there were no significant differences (P > 0.05) among the added synthetic lysine levels for egg production, egg mass, egg weight, feed conversion, or body weight. This indicated that adding synthetic lysine on performances had no significant influence on these criteria. In our previous study, using lower protein (14.3 and 13.6%) levels, those performances were significantly improved by adding synthetic lysine. The reason adding synthetic lysine had no influence on hen performances in this study may be due to higher feed intake and the diets were not low enough in protein. In this experiment, feed intake (approximate 100 g/hen/day) was higher than normal feed intake (approximate 90 g/hen/day) of Hy-Line W-36 hens in first phase second cycle.

An economic analysis (Roland *et al.*, 1998, 2000) was also conducted using feed and egg prices at the time of this study. Results showed that, although higher profit (due to lower feed cost) per dozen eggs was obtained from hens fed the 15.22% protein diet compared to hens fed the 17.52% protein diet, the egg production and egg weight of hens fed 16.24 or 15.22% protein diets could not be improved by adding lysine equal to the egg production and egg weight of hens fed 17.52% protein diets without added lysine (Table 9). Therefore, more research is needed to determine the economic feasibility of using synthetic lysine in low protein corn-soybean layer diets.

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