Total Sulfur Amino Acids: Lysine Ratios and Low Protein Diets Effects on Laying Hens Performance During Early Stage of Production

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INTRODUCTION

In practical poultry diets, methionine is the first limiting amino acid, followed by lysine. Supplementation of methionine and lysine to poultry diets provides a means of improving the efficiency of protein utilization. Recently, more attention has been given to the ideal amino acid profile in poultry diets. In the ideal amino acid concept for poultry, lysine is used as a standard, while the requirements for other amino acids are expressed as a percentage of the need for lysine.

Feeding strategies for poultry production have been given some new priorities with the advent of environmental problems related to nitrogen (N) excretion from animal waste. Previously, dietary adjustments to poultry requirements were aimed to maximize production performance without special concern for nutrient oversupply, especially protein and amino acids. Recent environmental constraints have forced nutritionists to base protein/amino acid levels not only on terms of N retained in animal products, but also in terms of non-utilized fraction of N excreted.

With this in mind, the objective of the current study was to test the effects of lowering dietary protein, combined with variable total sulfur amino acids (TSAA) to lysine ratios on hen performance during early egg production, from 20-40 weeks of age.

EXPERIMENTAL DESIGN AND MEASUREMENTS

Four hundred and thirty two Single Comb White Leghorn hens (Hy-LineW98®) were used in this experiment. Hens were randomly assigned to nine dietary treatments within a factorial arrangement of three levels of crude protein (18, 16 and 14% CP), and three TSAA:lysine ratios of (0.71, 0.81 and 0.91), respectively, throughout the experiment.

Experimental diets (Table 1) were formulated to be isocaloric (2,885 kcal ME/kg) and only differ in crude protein content. TSAA:lysine ratio calculations were based on lysine intake of 900 and three levels of TSAA intake (640, 730 and 820 mg/kg). Diets were formulated on a digestible amino acid basis, utilizing the Degussa prediction model[2].

Feed consumption and hen-day egg production were recorded on a daily basis. Hens were individually weighed once each month. One day's egg production weekly was used to measure egg weight. Two eggs per pen were used either for specific gravity or egg component measurements biweekly.

RESULTS

Lowering dietary protein from 18 to 14% resulted in a significant decrease in feed consumption ($P< 0.01$) (Table 2). TSAA:lysine ratios did not affect consumption. However, hens fed 0.71 ratio had the best feed efficiency (1.72 g. feed/ g. egg) compared to those fed the other two ratios. Lowering dietary crude protein significantly improved egg production ($P< 0.02$) with the highest egg production of 90.22% at 16% CP compared to 87.88 and 89.13% at 18% and 14% respectively. TSAA:lysine ratio did not significantly affect rate of egg production in this trial.

A significant crude protein X ratio interaction ($P<0.07$) was observed for hen weight; such that the lower TSAA:lysine ratio 0.71 combined with 16% protein improved the body weight by (4.03%) compared to the same ratio with 14 or 16% protein. This increase in body weight might be a difference between hens in lipid stores. Egg weight (Table 2) was not significantly affected by any of the dietary treatments. Egg mass increased with increasing TSAA:lysine ratios, but it did not reach significance at the P=0.05 level, as the 0.91 ratio increased egg mass by (2.11%) compared to the other ratios.

Increasing TSAA:lysine ratio significantly increased specific gravity ($P<0.03$), and percent wet shell ($P<0.01$) with the highest value at the higher ratio 0.91. These findings could be a direct response to the effect of TSAA on the shell matrix. Calcium binding ability of the shell matrix is enhanced by the presence of sulfate groups, which may positively increase calcium binding in the shell leading to an increase in both percent shell and specific gravity. Percent albumen and yolk were not affected by dietary treatments.

Percent yolk solids were significantly improved ($P<0.08$) by 0.61% with lowering dietary crude protein levels from 18-14% (Table 3). Ratio did not affect % yolk solids but a significant ($P<0.3$) interaction affect occurred such that within the .81 ratio diet, % solids increased largely as dietary protein decreased.

In conclusion, results reported herein suggest that, lowering dietary protein levels in the range of 18 to 14%, seemed to have no adverse effects on production performance parameters including egg production, egg mass and egg components yield. A high TSAA:lysine ratio is recommended for high protein diets. Using these representative diets, this study has demonstrated that a reduction of crude protein using supplemental lysine and methionine, threonine and trypophan can sustain egg production and subsequently reduce N excretion into the environment.

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[2]Degussa prediction model, *Degussa Laboratories,* Allendale, NJ 07401.

Table 1. Basal diets.

	TSAA:Lysine Ratio								
	0.71			0.81			0.91		
Crude Protein (%)	18	16	14	18	16	14	18	16	14
Ingredients	(%)								
Corn, yellow, %	59.20	64.34	70.54	59.29	64.41	70.62	59.37	64.49	70.70
Soybean meal, %	22.70	19.42	13.67	22.46	19.21	13.44	22.21	18.98	13.21
Corn gluten meal, %	5.00	3.00	3.00	5.00	3.00	3.00	5.00	3.00	3.00
Tallow, %	2.370	2.150	1.290	2.140	2.190	1.330	2.450	2.230	1.360
Cal. Carbonate, %	7.98	7.98	7.99	7.98	7.98	7.99	7.98	7.98	7.99
Dical. Phosphate, %	2.120	2.160	2.210	2.120	2.150	2.210	2.130	2.170	2.210
Salt, %	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
DL-Methionine, %	0.075	0.143	0.199	0.170	0.237	0.294	0.265	0.322	0.388
Lysine, %	---	0.286	0.464	0.164	0.294	0.472	0.172	0.035	0.479
Threonine, %	---	0.085	0.175	---	0.085	0.180	0.012	0.090	0.185
Tryptophan, %	---	0.035	0.065	0.010	0.035	0.065	0.010	0.035	0.065
Mineral premix[1], %	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Vitamin premix[2], %	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
Nutrient Composition									
M.E., kcal/kg	2885	2885	2885	2885	2885	2885	2885	2885	2885
Protein, %	18.00	16.00	14.00	18.00	16.00	14.00	18.00	16.00	14.00
Ca, %	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55
Total P, %	0.69	0.68	0.67	0.69	0.68	0.66	0.69	0.68	0.66
Lysine (calculated), %	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Lysine (analyzed)[3], %	0.90	0.93	0.90	1.03	0.99	0.98	0.99	0.96	1.03
Methionine (calculated), %	0.36	0.39	0.42	0.44	0.48	0.51	0.55	0.57	0.60
Methionine (analyzed)[3], %	0.38	0.37	0.42	0.50	0.52	0.54	0.65	0.65	0.68
TSAA (calculated), %	0.64	0.64	0.70	0.73	0.73	0.73	0.82	0.82	0.82
TSAA (analyzed)[3], %	0.72	0.71	0.70	0.87	0.85	0.84	0.90	1.02	0.97
TSAA:Lysine Ratio (actual)	0.80	0.76	0.77	0.84	0.86	0.86	0.91	1.06	0.94

[1]Mineral premix provided Mn, 88 mg; Cu, 6.6 mg; Fe, 8.5 mg; Zn, 88 mg; Se, 0.30 mg.
[2]Vitamin premix provided vitamin A, 6,600 IU; cholecalciferol 2,805 IU; vitamin E, 10 IU; vitamin K, 2.0 mg; riboflavin, 4.4 mg; pantothenic acid, 6.6 mg; niacin, 24.2 mg; choline, 110 mg; vitamin B_{12}, 8.8 mg; ethoxyquin, 1.1 mg/kg.
[3]Amino acids were analyzed at Degussa Laboratories, Allendale, NJ 07401.

Table 2. Effects of detary protein and TSAA:lysine ratio on egg production parameters.

Crude Protein	Ratio	Feed Consumption	Egg Production	Feed Efficiency	Body Weight	Egg Weight	Egg Mass
(%)		(g/day)	(%)	(g feed:g egg)	(kg)	(g)	(g/hen/day)
18	0.71	95.57	87.70	1.74	1.542[b]	56.14	49.22
18	0.81	96.67	87.02	1.76	1.534	55.92	48.64
18	0.91	96.89	88.92	1.75	1.551	56.56	50.30
16	0.71	94.26	90.80	1.70	1.585[a]	55.55	50.27
16	0.81	96.39	88.29	1.77	1.503	55.67	49.17
16	0.91	95.40	91.55	1.74	1.532	56.13	51.37
14	0.71	94.63	88.65	1.73	1.521[b]	55.79	49.41
14	0.81	94.77	89.62	1.74	1.529	55.62	49.84
14	0.91	92.34	90.13	1.70	1.514	55.14	49.12
SEM		1.01	1.01	0.02	0.01	0.45	0.68
Crude Protein, %							
18		96.38[a]	87.88[b]	1.75	1.542	56.21	49.38
16		95.35[ab]	90.22[a]	1.74	1.540	56.12	50.27
14		93.91[b]	89.13[ab]	1.76	1.521	55.51	49.45
Ratio							
0.71		94.82	89.05	1.72[b]	1.549	56.16	49.63
0.81		95.94	88.31	1.76[a]	1.522	55.74	49.22
0.91		94.88	89.87	1.73[ab]	1.532	55.94	50.26
Statistical Probabilities							
Crude protein		0.01	0.02	NS	NS	NS	NS
Ratio		NS	NS	0.09	NS	NS	NS
Crude protein x ratio		NS	NS	NS	0.07	NS	NS

[abc]Means within a column with no common superscripts differ significantly *P*=0.05 or *P*=0.01 based on least significance difference (LSD) test.

Table 3. Effects of dietary protein and TSAA:Lysine ratio on egg size and quality.

Crude Protein	Ratio	Specific gravity	Albumen	Albumen solids	Yolk	Yolk solids	Wet shell
			(%)	(%)	(%)	(%)	(%)
18	0.71	1.085	61.62	13.11	25.45	55.94	12.69
18	0.81	1.085	61.07	13.31	24.97	55.16[b]	12.58
18	0.91	1.085	61.76	13.02	25.09	55.65	12.94
16	0.71	1.084	61.95	13.42	25.24	55.90	12.58
16	0.81	1.083	61.88	13.12	25.42	55.68[ab]	12.48
16	0.91	1.085	61.39	12.93	25.55	56.08	12.84
14	0.71	1.084	61.81	12.86	25.17	55.61	12.70
14	0.81	1.084	61.17	13.08	25.42	56.15[a]	12.76
14	0.91	1.084	61.11	12.71	25.34	56.00	12.90
SEM		0.0004	0.45	0.28	0.21	0.20	0.12
Crude protein, %							
18		1.085	61.48	13.15	25.17	55.58[b]	12.73
16		1.085	61.74	13.16	25.40	55.89[ab]	12.63
14		1.084	61.36	12.88	25.31	55.92[a]	12.80
Ratio							
0.71		1.084[ab]	61.79	13.13	25.29	55.82	12.66[ab]
0.81		1.084[b]	61.37	13.17	25.27	55.66	12.61[b]
0.91		1.085[a]	61.42	12.89	25.32	55.91	12.89[a]
Statistical Probabilities							
Crude protein		NS	NS	NS	NS	0.08	NS
Ratio		0.03	NS	NS	NS	NS	0.01
Crude protein x ratio		NS	NS	NS	NS	0.03	NS

[abc]Means within a column with no common superscripts differ significantly *P*=0.05 or *P*=0.01 based on least significant difference (LSD) test.