Sulfur amino acids requirements of laying hens in low protein diets

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An experiment was coducted with White Leghorn hens in early laying stage to determine the influence of dietary crude protein (CP) concentration on the requirement for total sulfur amino acids (TSAA).The experiment was conducted for 8 weeks on 600 commerical layer hens, Hy-Line w-36 (six groups of 4 hens, 30 weeks old).
This experiment arranged to factorial 5×5 in a complete random design with five levels 13.1, 13.6, 14.1, 14.6 and 15.1% of CP and five levels 0.53, 0.57, 0.61, 0.65 and 0.69% of TSAA.
Both CP and TSAA significantly improved feed intake, egg production, egg weight and feed efficiency ($p<0.01$). But these two factors together had significantly improvement effect just on feed intake and egg weight.
So as a result the recommendable levels of CP and TSAA in layer diets to reach the optimum egg weight and feed efficiency, were 14.6% or 15.1% of CP and 0.69% of TSAA. However, higher levels of TSAA in such low protein diets, may have an extra effect on hen`s performance.
Also this experiment showed that TSAA levels had the best influence of hen`s performance in lower levels of protein.

Keywords: laying hen; sulfur; amino acid; protein

Introduction

Egg production is one of the best ways to supply man with animal protein source. To achieve this aim, it is established that we need to add high amounts of protein and essential amino acids into the layer`s diet. But high protein feeds are expensive and make hens excrete extra nitrogen that contaminates the environment.On the other hand, it`s known that supplementation of low protein diets by limiting amino acids may be useful for its cost (1,2,3,4 and 8). As the methionine is the first limiting amino acid in poultry rations, we carried out an experiment to determine the best levels of total sulfur amino acids (TSAA) in low protein diets to achieve the optimum performance in laying hens and minimize the production cost.

Materials and methods

The experiment was conducted in a windowless house with temperature maintained at 20 to 22^{o}C and the photoperiod was 17 hours light per day. The experimented design was a factorial (5×5) arrangement of 25 dietary treatments (cp and TSAA levels) and 6 replications. Each experimental unit (cage) comprised of 4 hens. A total of 600 commerically available laying strain (Hy-Line w-36) at the age of 30 weeks was divided at random into 150 groups. The production rate of selected birds in each experimental group was nearly 85.5% (ranged from 82.5 to 87.5%). During the 8 weeks of experiment, hens had free access to feed and water. Eggs were collected and mortality was recorded daily for calculation of production parameters. Egg weight was determined by collecting the eggs produced in three consecutive days, biweekly. Feed consumption of each cage was measured at 14-days intervals.

All diets were isocaloric, containing 2900 Kcal per kilogram diet. Five basal diets were containing 13.1, 13.6, 14.1, 14.6 and 15.1% crude protein and 0.53% TSAA (table 1), and the other diets were made by adding dl-methionine as much to reach 0.53, 0.57, 0.61, 0.65 and 0.69% TSAA.

Other nutrients contents of rations were formulated and balanced according to NRC (1994) recommendations.

Table1. Composition of the basal diets

	1	2	3	4	5
Ingredients %					
Corn	57.11	55.40	53.67	51.94	50.24
Soyebean meal 44%	8.10	9.48	10.89	12.26	13.65
Wheat grain	15.00	15.00	15.00	15.00	15.00
Anchovy fish meal	2.00	2.00	2.00	2.00	2.00
Alfalfa meal 15%	2.00	2.00	2.00	2.00	2.00
Wheat bran	5.00	5.00	5.00	5.00	5.00
Fatty acids	2.57	2.88	3.21	3.55	3.88
Oyster shell	7.04	7.04	7.03	7.03	7.02
Dicalcium phosphate	0.24	0.23	0.22	0.21	0.20
Salt	0.15	0.15	0.15	0.15	0.15
Vitamin & mineral premix(1)	0.60	0.60	0.60	0.60	0.60
Vitamin K	0.05	0.05	0.05	0.05	0.05
Vitamin E	0.05	0.13	0.16	0.20	0.21
Dl- methionine	0.05	0.04	0.02	0.01	0
Lysine- Hcl	0.04	0	0	0	0
Total	100.00	100.00	100.00	100.00	100.00
Calculated composition					
ME (Kcal kg $^{-1}$)	2900	2900	2900	2900	2900
Crude protein %	13.1	13.6	14.1	14.6	15.1
Calcium %	2.95	2.95	2.95	2.95	2.95
Available Phosphorus %	0.23	0.23	0.23	0.23	0.23
Lysine %	0.63	0.63	0.63	0.63	0.63
TSAA %	0.53	0.53	0.53	0.53	0.53

1.The vitamin and mineral supplement supplied per kilogram of diet: retinol 2.175mg, cholecalciferol 23µg, dl-α-tocopherol 9.1mg, cyanocobalamin 10 µg, vitamin k 1.1mg, riboflavin 5.5mg, calcium pantothenate 11mg, niacin 53mg, choline cloride 1g, folic acid 0.7mg, biotin 0.25mg, manganese 55mg, zinc 42 mg, iron 80mg, copper 5mg, selenium 0.1mg and iodine 0.18mg.

The experimental parameters were feed consumption, egg output, egg weight, egg mass production, feed conversion ratio (FCR), feed dozen egg (FDE) and the mortality.

Data were subjected to ANOVA regression analysis, utilizing the Duncan`s procedure of SAS.

Results and discussion

Except the mortality, the whole parameters were significantly ($p<0.01$) influenced by CP and TSAA concentrations. But just feed consumption and egg weight were significantly ($p<0.01$) influenced by the interaction of both CP and dietary TSAA levels (table 2).

Table2. Analysis of variation of treatments

Parameters(1)	cp	TSAA	cp× TSAA
Egg output (%)	8.7539**	5.8818**	0.7090^{ns}
Egg weight (g)	4.1713**	10.8228**	2.3043**
Feed intake (g)	11.243**	14.5283**	3.2761**
Egg mass (g)	9.9540**	13.4440**	1.4430^{ns}

FCR(2)	7.1822**	2.3496*	1.5478ns
FDE(3)	2.7673*	2.0315ns	1.4866ns

1.per hen-day
2.feed intake per egg mass
3.feed dozen egg

ns. Nonsignificant difference
* Significant difference ($p<0.05$)
**Significant difference ($p<0.01$)

The effects of dietary CP and TSAA levels on layer`s performance are shown in tables 3 and 4, respectively.

Table3. Effects of CP levels on layers

Parameters	CP concentration %				
	13.1	13.6	14.1	14.6	15.1
Egg output (%)	82.33[c]	85.19[bc]	86.40[ab]	87.96[a]	87.92[a]
Egg weight (g)	54.26[c]	54.36[bc]	55.84[a]	55.04[abc]	55.71[ab]
Egg mass(1)	45.24[b]	46.33[b]	48.25[a]	48.47[a]	49.01[a]
Feed intake(1)	101.25[bc]	100.85[c]	104.87[a]	100.46[c]	102.89[b]
Protein consumption(1)	13.26[c]	13.72[c]	14.79[b]	14.67[b]	15.54[a]
FCR(2)	2.243[a]	2.186[ab]	2.180[ab]	2.082[c]	2.109[bc]
FDE(3)	1.426[ab]	1.424[ab]	1.458[a]	1.372[b]	1.406[ab]

1. gram per hen-day
2. feed intake(g) per egg mass(g)
3. feed intake (kg) per 12 egg

a-c. Mean values within a row with no common superscript differ significantly ($p<0.01$)

Table4. Effects of TSAA levels on layers

Parameters	TSAA concentration %				
	0.53	0.57	0.61	0.65	0.69
Egg output (%)	83.45[b]	86.09[a]	86.59[a]	87.35[a]	87.32[a]
Egg weight (g)	53.10[b]	55.05[a]	55.65[a]	55.16[a]	56.25[a]
Egg mass(1)	44.30[b]	47.42[a]	48.22[a]	48.22[a]	49.13[a]
Feed intake(1)	97.44[c]	102.91[b]	101.99[bc]	104.18[a]	103.81[a]
TSAA consumption(1)	516[c]	587[b]	622[b]	677[a]	716[a]
FCR(2)	2.207[a]	2.179[a]	2.125[a]	2.170[a]	2.120[a]
FDE(3)	1.371[a]	1.437[a]	1.416[a]	1.433[a]	1.429[a]

1. milligram per hen-day
2. feed intake(g) per egg mass(g)
3. feed intake (kg) per 12 egg

a-c. Mean values within a row with no common superscript differ significantly ($p<0.01$)

Apparently, high levels of dietary CP, improved the production. Egg output, egg mass and feed efficiency (both FCR and FDE) were optimized at 14.6% dietary CP concentration and the maximum egg weight and feed intake were at 14.1% of dietary CP level.

Increasing TSAA concentration of diets, also had a significant linear positive effect on laying performance, but feed efficiency (both FCR and FDE). In other words, as the TSAA levels raised, the productive features improved to the same degree. However, 0.69% of TSAA had the best effect on egg output, egg weight, egg mass, feed intake and FCR, and the optimum FDE were observed at 0.53% of dietary TSAA.

The results indicated that 14.1% dietary cp was the marginal level and caused hens to consume more feed to supply their needs. But all in all, feed intake increased due to increasing the dietary protein levels that is a confirm on other investigators` findings except Pour-reza (5) who did not find any correlation between dietary cp and feed intake.

The best level of dietary cp to improve laying performance was 14.6%. Taking account of hens feed intake in that level (100.46 g/hen/day) realized that the experimental birds had consumed 14.67 g/day protein which is closed to NRC recommendation (15g/hen/day).

Decreasing FCR and FDE due to increasing of dietary cp concentration showed the negative correlation between them. This findings were not aggrement with some other investigators (1,6 and 7). According to the results, extra amounts of methionine improved hen`s performance.It is mentionable that there was just a little significant difference between 0.57% and higher levels of TSAA on egg output, egg weight and feed efficiency, but appearantly production rate raised as the dietary TSAA levels increased. On the other hand, improvement of FDE at 0.53% TSAA indicated that these amino acids influence egg weight before egg production; that means although the dietary levels of TSAA are low, hens try to continue their layings but lay small eggs.

The effect of TSAA concentrations on production were more appearant in low protein diets. Also in a given level of protein, the laying performance improved due to increasing of dietary TSAA levels.

As a result, although the interaction of CP and TSAA levels were not significant ($p<0.05$) on egg mass and feed efficiency and 14.6% CP and 0.69 % TSAA statistically were the best levels, the recommended levels of CP and TSAA are 15.1% and 0.69% of diet, respectively, to achive the minimum cost and the maximum productive performance (egg mass 50.93 g/hen/ day, feed intake 102.43 g/ hen/ day, FCR 2.013 and FDE 1.398).

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