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NOTE

EFFECTS OF DIETARY PROTEIN LEVELS AND SUPPLEMENTAL LYSINE ON PERFORMANCE OF LAYING HENS

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ABSTRACT

An experiment was conducted to assess the effects of supplemental L-Lysine HCl at two dietary protein levels (13 and 14%), which contained lysine at 80% (0.56% lysine) of NRC recommendations. To these diets lysine was added in such a way that other experimental diets at each protein level contained lysine at the rate of 90, 100, 110 and 115% (0.62, 0.69, 0.76 and 0.79% lysine) of NRC recommendations. Two hundred and fourty Hy-line W-36 layers (52 wk of age) were divided into 60 groups (replications), four hen per replicate. Each experimental diet was given to six replicates for a period of 16 wk. Egg production (EP), egg weight (EW), egg output (EO) and feed consumption (FC) were not significantly affected by dietary protein. Feed conversion ratio (FCR) was significantly ($P<0.05$) improved due to increasing dietary protein. Lysine significantly affected EP, EW ($P<0.05$) and FCR ($P<0.001$). FCR was increased due to lysine supplementation. Hens consuming about 520 mg d^{-1} lysine at both protein levels had better EP, EW, EO and FCR.

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اثرهای سطوح پروتئین و لیزین برعملکرد مرغ های تخمگذار

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چکیده

برای ارزیابی اثر مکمل ال-لیزین هیدرو کلراید در دو سطح پروتئینی جیره (۱۳و ۱۴٪) که حاوی ۸۰٪ (۰/۵۶ درصد لیزین) توصیه NRC برای لیزین بودند، آزمایشی به اجرا در آمد. به این جیره ها، لیزین اضافه گردید به نحوی که سایر جیره های آزمایشی در هر سطح پروتئین حاوی لیزین به میزان های ۹۰، ۱۰۰، ۱۱۰و ۱۱۵ درصد توصیه NRC بودند. دویست و چهل مرغ تخمگذار های -لاین W36 در سن ۵۲ هفتگی به ۶۰ گروه (تکرار) که در هر تکرار ۴ مرغ وجود داشت، تقسیم شدند. هر یک از جیره های آزمایشی برای مدت ۱۶ هفته به چهار تکرار داده شد. تولید تخم مرغ ، وزن تخم مرغ، بازده تخم مرغ و مصرف غذا تحت تاثیر معنی دار پروتئین جیره قرار نگرفتند. ضریب تبدیل غذا به طور معنی داری ($P< ۰/۰۵$) به وسیله افزایش پروتئین بهبود یافت. مکمل لیزین به طور معنی داری بر تولید تخم مرغ و وزن تخم مرغ ($P<۰/۰۵$) و ضریب تبدیل غذا ($P<۰/۰۰۱$) اثر داشت . ضریب تبدیل غذا به وسیله مکمل لیزین افزایش یافت. مرغ هایی که روزانه حدود ۵۲۰ میلی گرم لیزین مصرف کرده بودند، در هر دو سطح پروتئین ، تخمگذاری ، وزن تخم مرغ، بازده تخم مرغ و ضریب تبدیل غذایی بهتری داشتند.

INTRODUCTION

There have been limited studies utilizing amino acid less than or in excess of NRC recommendations. Excess or low-protein regimes seem to depend on provision of balanced dietary protein. Practical diets formulated to low levels of dietary protein are likely to have a high proportion of grain and a high proportion of energy relative to protein. They may also be low in lysine, particularly when corn is the primary ingredient (11).

March and Biely (6) utilizing a 15.5% protein diet with supplemental lysine, reported an increase in egg mass as lysine level increased; however, initial levels of lysine were low. In a 15.1% protein layer diet containing 0.5% lysine, supplements of 0.2 and 0.3% lysine increased egg weight (EW), whereas 0.1% additional lysine had no effect (2). Egg weight, egg mass and feed conversion were increased in a sunflower seed basal diet (3).

Feeding excesses of various amino acids, specially with high protein diets to poultry may reduce performance. Koelkebeck *et al.* (5) indicated that excess lysine decreased feed efficiency compared to excess methionine or tryptophan. In their experiment, other production parameters (EP, EW, etc.) were not affected by levels in excess of 1% lysine, methionine or tryptophan.

Addition of lysine to the diets of 23-wk old laying hens increased EW but not EP, whereas EW and EP were increased due to supplemental lysine with older (42 wk of age) hens (10).

The dietary lysine contents of 0.712-0.812% (on the basis of 100 g feed h^{-1} d^{-1}) for producing 45 g^{-1} h^{-1} have been reported by McDonald and Morris (7). The amount of 0.69% is recommended by NRC (9). Improvement in laying hen performance due to increasing dietary protein has been reported by Keshavarz and Nakajama (4). Waldroup *et al.* (13) hypothesized that by limiting dietary excess of amino acids, feed intake may be increased and thus performance improved. In Iran many egg producers do not pay attention to the level of dietary amino acids, particularly lysine and methionine because of low cost of these amino acids. They usually add these two amino acids to the diets of laying hens irrespective of the age and production of the flock. This introduces the possibility of supplementation or feed mixing errors and may cause amino acid imbalance and poor performance. The present study was undertaken to investigate the response of laying hens fed low protein and lysine diets supplemented with graded levels of lysine lower than and in excess of NRC recommendations (9).

MATERIALS AND METHODS

The experimental design was a factorial (2×5) arrangement of 10 dietary treatments and six replications. Each experimental unit (cage) comprised of 4 hens. A total of 240 commercially available laying strain (Hy-Line W-36) at the age of 52 wk was divided into 60 groups. The production rate of selected birds in each experimental group was nearly identical. Before the experiment, hens had been maintained on a practical laying hen diet containing 2900 kcal kg^{-1} ME and 15% protein.

During the 16 weeks of experiment, hens had free access to food and water. The photoperiod was 16 h light d^{-1}. Eggs were collected and mortality was recorded daily for calculation of production parameters. Egg weight was determined by collecting the eggs produced in the 3 consecutive days, biweekly. Feed consumption of each cage was measured at 28- day intervals.

Two basal diets (1 and 6) containing 13 and 14% protein were formulated (Table 1). The lysine content of these diets was 80% of NRC (9)

Table 1. Composition of the basal diets†.

	Diets Number	
	1	6
Ingredients %		
corn	72.37	70.56
Wheat	3.50	2.0
Soybean meal	14.2	17.1
Corn oil	-	0.45
Dicalcium Phosphate	0.75	0.75
Oystershell	8.00	8.00
Salt	0.40	0.40
Vitamin and mineral supplement§	0.50	0.50
DL-Methionine	0.25	0.24
Lysine-HCl	0.03	-
Total	100	100
Calculated composition		
ME (Kcal kg^{-1})	2864	2860
Protein	13.06	14.04
Ca (%)	3.25	3.25
Available P	0.25	0.25
Sulfur amino acids (%)	0.476	0.470
Lysine (%)	0.557	0.560

† Dietary lysine content was 80% of NRC (9) recommendations.

§ The vitamin and mineral supplement supplied per kg of diet: retinol, 2.175 mg; cholecalciferol, 23 µg; dl-α-tocopheryl, 9.1 mg; cyanocobalamin, 10 µg; vitamin K, 1.1 mg; riboflavin, 5.5 mg; calcium pantothenate, 11 mg; niacin, 53 mg; choline chloride, 1000 mg folic acid, 0.7 mg; biotin, 0.25 mg; manganese, 55 mg; zinc, 42 mg; iron, 80 mg; copper, 5 mg; selenium, 0.1 mg; iodine, 0.18 mg.

recommendations (0.56% lysine). Diets 2, 3, 4 and 5 contained, 0.62, 0.69, 0.76 and 0.79% lysine (equal to 90, 100, 110 and 115% of NRC

recommendations), respectively, supplied as lysine-HCl. Dietary lysine contents of diets 7, 8, 9 and 10 were similar to diets 2, 3, 4 and 5 except that they had 14% protein. The TSAA of all diets were 0.85% of their contents, accordingly (9).

Data were subjected to ANOVA regression analysis utilizing the General Linear Models (GLM) Procedure of SAS (12). Mean differences were pair-wise tested by the GLM procedure.

RESULTS AND DISCUSSION

Protein levels did not have any significant effect on egg production (EP), egg weight (EW), egg output (EO), and feed consumption (FC). Feed conversion ratio (FCR) was significantly ($P<0.001$) affected by dietary protein. EP, EO and FCR were significantly ($P<0.05$) affected due to supplemental lysine. Interaction of protein and lysine only affected the FCR significantly ($P<0.05$).

Hens receiving 13 or 14% dietary protein had similar EP and EW (Table 2). FC was reduced slightly due to increasing dietary protein. Hens consuming the diet with 14% protein had significantly ($P<0.001$) better FCR (Table 2). The results indicated that at higher ages, 13% protein would be adequate for layers to produce a 46.8 g h^{-1} egg, which is not in agreement with report of Jensen *et al.* (2)

Table 2. Effect of levels of protein and supplemental lysine on performance of laying hens.

	Egg production (%)	Egg weight (g)	Egg output (g h^{-1})	Feed consumption g h^{-1} d^{-1}	Feed conversion (g feed g egg^{-1})
Dietary protein (%)					
13	77.1	59.6	46.8	98.8	2.13a†
14	77.5	59.6	45.5	94.6	2.07b§
Dietary lysine (%)					
0.55	78.4a	60.2a	47.4a	94.9	2.00b
0.62	77.3a	59.5ab	46.3a	97.3	2.10a
0.69	77.9a	60.1ab	46.6a	96.1	2.07ab
0.76	75.1b	58.8b	44.6b	95.8	2.15a
0.79	77.6a	59.5ab	46.3a	98.9	2.14a
SE	1.07	0.61	0.81	2.72	0.04

† Means in the same column with letter "a" do not differ ($P<0.05$).
§ Means in the same column with letter "b" do not differ($P<0.01$).

There were no singificant effects (except for 0.76% lysine) of lysine supplementations, on EP, EW, and FCR. Hens receiving diet with 0.56% lysine (80% of NRC recommendations) had better EP, EW, EO and FC. These results showed that, it is not necessary to add lysine to the diet of older hens, and that most NRC recommendations would produce satisfactory results. These findings do not agree with those of March and Biely (6) and Jensen *et al.* (2).

Table 3 shows the interaction of protein and lysine level on EP, EW, EO, FC and FCR. At both levels of dietary protein, all parameters except feed conversion were not significantly affected by supplemental lysine. These results confirmed the report of Koelkebeck *et al.* (5) regarding no changes in EP and EW due to increasing dietary lysine. Addition of lysine to 13% protein diet significantly reduced the FCR ($P<0.05$). The results indicated that at both dietary protein levels, lysine intake as low as about 520 mg h^{-1} which is 80% of NRC recommendations, was sufficient for satisfactory

Table 3. Interactions of protein and lysine levels on EP, EW, EO, FC and FCR in laying hens.

Dietary protein (%)	Lysine intake mg h^{-1}	Dietary lysine (%)	Egg production (%)	Egg weight (g)	Egg output (g h^{-1})	Feed consumption (g h^{-1} d^{-1})	Feed conversion (g feed g egg^{-1})
13	519	0.55	78.7a†	60.5a	47.7a	94.4ab	1.97d
	608	0.62	77.4ab	59.5ab	45.8ab	98.1ab	2.11bd
	672	0.69	78.1a	59.3ab	46.3ab	97.4ab	2.10bd
	717	0.76	75.6ab	59.5ab	45.0ab	94.3ab	2.14ab
	798	0.79	76.1ab	59.8ab	45.5ab	101.0a	2.23a
14	524	0.55	78.2a	60.0ab	47.0a	95.3ab	2.02ad
	606	0.62	77.4ab	60.1ab	46.5ab	97.7ab	2.11bd
	654	0.69	77.1ab	60.8a	46.8a	94.8ab	2.03cd
	728	0.76	76.3ab	59.5ab	45.0ab	95.8ab	2.14ac
	754	0.79	79.2a	59.4ab	47.0a	95.5ab	2.04cd
SE	-	-	3.06	1.75	2.30	7.22	0.127

† Means in each column with different letters differ ($P<0.05$).

production. These results are in agreement with the findings of other investigators (1, 4, 8) who reported daily lysine requirements ranging from 662 to 862 mg h^{-1}. Reduced FCR obtained agrees with the results of Koelkebeck *et al.* (5) who showed a reduction in feed conversion with excess lysine.

Feed consumption was not affected by dietary protein and lysine which is not in agreement with hypothesis of Waldroup *et al.* (13) who stated that limiting dietary amino acids may cause an increase in feed intake and consequently better performance.

The following regression equations were estimated for the criteria measured:

Egg production	Y = 82.38X-7.44	R^2 = 0.32
Egg weight	Y = 62.15X-3.72	R^2 = 0.40
Egg output	Y = 51.04X-7.06	R^2 = 0.48
Feed conversion ratio	Y = 1.69X+0.587	R^2 = 0.75

X = dietary lysine

Because the cost of crystalline amino acids continues to decrease, producers use these amino acids in the diet without any precaution and this might produce adverse effects on performance because sometimes amino acid imbalance or antagonism may occur.

In conclusion, the results of this experiment indicated that limiting amino acid intake does not reduce feed intake. Under production conditions of Iran and in older hens (over 50 wk), and taking into consideration the margin of safety, the NRC recommendations for lysine and SAA will produce satisfactory results, and it is not necessary to use any supplemental lysine in the diets of commercial layers in Iran.

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