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Effect of Supplemental Lysine to Low Protein Diet on Production Performance, Egg Quality and Serum Biochemical Parameters of Gramapriya Laying Hens

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ABSTRACT

The present study was conducted to evaluate the effect of supplemental lysine to low protein diet on egg production, egg quality and serum biochemical parameters of Gramapriya Laying hens. A basal diet based on maize-soybean meal-deoiled rice bran (14% CP, 0.60% lysine) was formulated, which was adequate in all essential amino acids except lysine. Subsequently, three test diets were formulated by supplementing synthetic lysine at 0.05, 0.10 and 0.15% to obtain 0.65, 0.70 and 0.75% lysine, respectively. Each diet was fed *ad libtum* to 5 replicates of 6 birds in each groups. A lighting regime of 16h was provided and all the layers were kept under uniform management conditions throughout the experimental period (32-44 wks). Increasing dietary level of lysine from 0.60 to 0.65% significantly increased egg production and egg mass, and improved feed conversion ratio. Higher levels of lysine (0.70 or 0.75%) in the diet did not result in further improvement in these parameters. Lowest albumen and highest yolk content in eggs were observed in the dietary group containing 0.60% lysine in the diet. Increasing the lysine levels in the diet to 0.70 or 0.75% significantly increased the albumen content and reduced the yolk content in the eggs of Gramapriya laying hens. It was intermediate in 0.65% lysine containing diet. The serum protein concentration increased marginally by increasing the lysine content of diets from 0.60 to 0.65%. Further increasing the level of lysine to 0.70%, significantly increased the serum protein concentration compared to 0.60% lysine. Considering the overall performance, It is concluded that 0.70% lysine in the diet containing 14% CP is adequate for Gramapriya laying hens.

KEY WORDS: Egg Quality, Gramapriya Laying Hens, Lysine, Production Performance, Serum Biochemical Parameters

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INTRODUCTION

Rural poultry production has been broadly considered as a quickest way to ensure food security, generate employment and income, and promote women's empowerment at a relatively low investment (Panda et al., 2020). Poultry egg and meat are important animal protein sources and essential in providing balanced diets for nutrition and health. The total egg production in India was 138.38 billion numbers during 2022-23 and backyard poultry provided 20.20 billion numbers contributing 14.60% of total production of egg (BAHS, 2023). The higher contribution of eggs from backyard poultry farming in India is due to development and propagation of improved chicken varieties by public funded research organizations with higher production potential (Rajkumar et al., 2021). ICAR-Directorate of Poultry Research, Hyderabad has developed "Gramapriya" an egg type chicken variety suited for backyard poultry production. The greater demand and high market price of egg produced from these birds have encouraged farmers to rear in intensive system of production (Chatterjee and Rajkumar, 2015; Panda et al., 2023). Feed cost accounts for 70-80% of the total cost of production in the intensive system of poultry production. Reducing the cost of production through precision feeding practices in poultry is the need of hour to increase the profit margin.

Among the nutrients needed by the bird, protein is one of the most important nutrients, which has a

major influence on growth, feed utilization, immune function and production performance (NRC 1994; Gumpha et al., 2019; Panda et al., 2024). Amino acids obtained from dietary proteins are used by poultry to fulfill a diversity of functions. Lysine is the second limiting amino acid in laying hen diets and is essential to optimize egg production (Spangler et al., 2018), optimize egg cost (Novak et al., 2004) and reduce nitrogen excretion (Kumari et al., 2018). To our knowledge, no information is available in the literature on the influence of dietary lysine on production performance of Gamapriya laying hens reared in intensive system of production. Therefore, the present study was conducted to evaluate the effect of supplemental lysine to low protein diet on production performance egg quality and serum biochemical parameters of Gramapriya Laying hens

MATERIALS AND METHODS

Experimental birds, management and diet

A total of 120 Gramapriya laying hens (32 wk) were randomly distributed to four dietary treatment groups with 5 replicates of 6 birds in each pen. A lighting regime of 16h was provided and all layers were kept under uniform management conditions throughout the experimental period (32-44 wk). The experiment was conducted following the guidelines of Institute Animal Ethics Committee. A basal diet based on maize-soybean meal-deoiled rice bran was formulated (2600 kcal/kg ME, 14.0 % CP, 0.60% lysine, 0.30% methionine, 3.70% calcium and 0.34% non phytate phosphorus), which was adequate in all essential amino acids except lysine (Table 1). Subsequently, three experimental diets were formulated incorporating lysine (L-lysine HCl) at three graded concentrations (0.05, 0.10 and 0.15%) to obtain 0.65, 0.70 and 0.75% lysine in the diets. A measured quantity of each diet was fed to 5 replicates of 6 birds each.

Table 1. Ingredient and nutrient composition of basal diet (% as such basis)

Ingredients	Parts per quintal
Maize	62.0
Soybean meal	14.4
De-oiled rice bran	12.0
Stone grit	9.67
Dicalcium phosphate	1.10
DL – methionine	0.06
Common salt	0.40
Vitamin premix	0.05
Antibiotics	0.05
Toxin Binder	0.05
Mineral mixture*	0.12
Toxin Binder	0.05
Choline Chloride	0.05
Total	100
Nutrient composition (Calculated value)	
Metabolizable Energy (kcal/kg)	259
Crude Protein (%)	14.0
Lysine (%)	0.60
Methionine (%)	0.30
Calcium (%)	3.24
Non-phytate Phosphorous (%)	0.34

*Trace Min CB (Venky's India Private Limited, Pune). Composition: Each 1 kg Trace Min CB contains Manganese: 90g, Zinc: 80 g, Iron: 90.0g, Copper: 15.0g, Iodine: 2.0g, Selenium: 300mg

Parameters studied

Production performance

Daily egg production was recorded on individual pen basis and percent hen day egg production was calculated. Measured quantity of feed was offered each day and the feed residue was recorded at 28d intervals and feed intake was calculated as g/b/d. Feed conversion ratio was calculated as the quantity of feed consumed per unit of egg mass produced. All the eggs laid during the last three consecutive days of every 28 days period were collected and egg weight was measured. All the birds were individually weighed at the beginning and end of the experimental period.

Egg quality parameters

Twenty eggs (four eggs from each replicate) were randomly chosen from each dietary treatment at the end every 28-d period to measure the albumen weight, yolk weight, eggshell weight, shell thickness and Haugh unit. Yolk and albumen were manually separated. Albumen weight was calculated by deducting the weight of yolk and shell from the whole egg weight. The cleaned egg-shells were dried for 24 h, weighed and expressed as % of whole egg. The shell thickness was measured at three different locations (middle, broad and narrow ends) using a micrometer gauge (Mitutoyo Code, 7027, Japan).

Serum biochemical parameters

At 44th wk, around 3ml of blood was collected from brachial vein from two birds in each pen (10 birds per dietary treatment). Subsequently serum was separated and the concentrations of total protein, albumen, globulin, calcium, phosphorous, cholesterol, triglycerides and uric acid were estimated in the serum by auto-analyzer using diagnostic kits (Coral Clinical Systems, Goa, India).

Statistical analysis

Data were subjected to statistical analysis under completely randomized design employing one-way analysis of variance (Snedecor and Cochran, 1989) and the means of treatments were compared by Duncan multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The effect of supplemental lysine on production performance of Gramapriya laying hen is presented in Table 2. Hen housed egg production, daily egg mass output and feed conversion ratio was influenced by the levels of lysine in the diet. Egg weight was not influenced by the dietary lysine levels in the diet. Increasing lysine level from 0.60 to 0.65% resulted in significantly higher egg production and egg mass. Increasing the levels of lysine to either 0.70 or 0.75% did not results in further improvement on these parameters. The feed conversion ratio was significantly poorer in the dietary group that contained the lowest amount of lysine (0.60%). A significant improvement in feed conversion ratio was observed by increasing the concentration of lysine to 0.65%. However, no significant difference in FCR was observed among dietary groups containing 0.65, 0.70 and 0.75% lysine in the diet. All the birds gained weight during the experimental period, irrespective of the lysine levels in diet. However, no influence of supplemental lysine could be observed on body weight gain of laying hens.

Table 2. Effect of supplemental lysine on production performance of Gramapriya laying hens

Parameters	% lysine in the diet				SEM	P value
	0.60	0.65	0.70	0.75		
Hen housed egg production (%)	68.5^{b}	71.5^{a}	72.05^{a}	71.80^{a}	0.541	0.042
Egg weight (g)	54.1	54.2	54.2	54.28	0.122	0.842
Egg mass/ day (g)	37.1^{b}	38.7^{a}	39.01^{a}	38.87^{a}	0.240	0.048
Feed conversion ratio (g feed/ g egg)	3.23^{a}	3.09^{b}	3.07^{b}	3.086^{b}	0.004	0.051
Body weight gain (g)	48.4	64.5	60.2	72.14	12.44	0.546

$^{a, b,}$ Means with different superscript in a row differs significantly
SEM – Standard Error of Mean

The dietary requirement of proteins are actually the requirement for the amino acids (AAs) content in the dietary protein and amino acids obtained from dietary protein are used to fulfill a diversity of functions including production in poultry (NRC, 1994). The diet containing the lowest level of 0.60% Lys was not adequate for optimum egg production in Gramapriya laying hens. In a study with Matrouh laying hens, El-Maksoud et al. (2011) also reported higher egg production due to supplemental lysine (0.74%) to low CP (12%) diet. In a similar study, Mohapatra et al. (2019) also reported higher egg production and improved FCR in low protein diet (13%) containing 0.65% lysine compared to lower level of lysine in the diet. Blair et al. (1999) reported that laying hen performance could be maintained on low CP (13.5%) diet provided the diet is supplemented with essential amino acids. Amino acid requirements differ among types, breeds, and strains of poultry (NRC, 1994). Genetic differences in amino acid requirements may also occur because of differences in efficiency of digestion, nutrient absorption and metabolism of nutrients. In efficiency of digestion, nutrient absorption. Gramapriya laying hen differs in genetic composition compared to commercial laying hens and 0.65% lysine in the diet containing 14% crude protein is adequate for optimizing the production performance as observed in the present study.

The effect of supplemental lysine on egg quality parameters of Gramapriya laying hen is presented in Table 3. Lowest albumen and highest yolk content in eggs were observed in the dietary group containing 0.60% lysine in the diet. Increasing the lysine levels in the diet to 0.70 or 0.75% significantly increased the albumen content and reduced the yolk content in the eggs of Gramapriya laying hens. It was intermediate in 0.65% lysine containing diet. The egg shell percentage and egg shell thickness were not influenced due to lysine supplementation in the diet of laying hens. The Haugh unit increased significantly due to supplemental lysine in the diets, however, no difference could be observed among the supplemental levels of lysine in diet (0.65, 0.70 and 0.75%).

Table 3. Effect of supplemental lysine on egg quality parameters of Gramapriya laying hens

Parameters	% lysine in the diet				SEM	P value
	0.60	0.65	0.70	0.75		
Albumen (%)	56.7^{b}	57.04^{ab}	57.3^{a}	57.2^{a}	0.12	0.04
Yolk (%)	33.9^{a}	33.5^{ab}	33.3^{b}	33.3^{b}	0.17	0.05
Egg shell (%)	9.40	9.48	9.38	9.44	0.14	0.44
Shell Thickness (mm)	0.36	0.36	0.36	0.36	0.002	0.64
Haugh unit	67.2 ^{b}	68.4^{a}	68.6^{a}	68.3^{a}	0.24	0.05

$^{a, b,}$ Means with different superscript in a row differs significantly
SEM – Standard Error of Mean

In the present study, egg quality parameters like albumen %, yolk % and Haugh unit were significantly influenced due to supplemental lysine in the diet. Prochaska and Carey (1993) and Prochaska et al. (1996) reported higher albumen weight, albumen percentage and albumen protein content in eggs with increased lysine intake, but no effect on yolk weight. Similarly, Alagawany and Mahrose (2014) reported significant influence of various levels of dietary lysine on albumen percent, yolk : albumen ratio and Haugh unit in Lohmann Brown hens. In contrary, Mohapatra et al. (2019) reported no influence of dietary lysine levels (0.65, 0.70 or 0.75%) in low CP diet (13%) on various egg quality parameters (albumen %, yolk %, eggshell %, Haugh unit, eggshell thickness and eggshell weight) of Vanaraja laying hens.

None of the serum biochemical parameters such as serum calcium, phosphsphorus, total cholesterol, triglycerides and uric acid except total protein concentration in serum was influenced due to variation in lysine content of diets in the present study (Table 4). The serum protein concentration increased marginally by increasing the lysine content of diets

from 0.60 to 0.65%. Further increasing the level of lysine to 0.70%, significantly increased the serum protein concentration compared to 0.60% lysine. The concentration of protein in serum of laying hen fed diets containing 0.70 and 0.75% lysine in diets was comparable. Shahir et al. (2006) reported that dietary lysine levels had significant influence on the blood biochemical parameters in Hy-Line W36 hens and the overall lysine requirement was found to be 717 mg/hen/day for optimum concentrations of blood parameters.

Table 4. Effect of supplemental lysine on serum biochemical parameters of Gramapriya laying hens

Parameters	% lysine in the diet				SEM	P value
	0.60	0.65	0.70	0.75		
Total protein (g/dl)	5.04[b]	5.28[ab]	5.48[a]	5.54[a]	0.05	0.05
Calcium (mg/dl)	11.6	11.8	11.5	11.4	0.25	0.64
Phosphorous (mg/dl)	4.79	4.92	4.84	4.76	0.11	0.55
Total cholesterol (mg/dl)	168.76	177.84	184.42	172.86	4.84	0.43
Triglyceride (mg/dl)	248.24	264.24	256.28	252.22	4.22	0.76
Uric acid (mg/dl)	4.24	4.14	4.12	4.08	0.10	0.76

[a, b,] Means with different superscript in a row differs significantly
SEM – Standard Error of Mean

CONCLUSION

In the present study, a lower level of protein in the diet was tested with variable contents of lysine. The diet containing lowest level of lysine (0.60%) was not adequate to support optimum production performance, egg quality and serum biochemical indices in Gramapriya laying hens. Increasing lysine content of the diet to 0.65% (supplementing 0.05% lysine) significantly increased the egg production and egg mass, improved the FCR and serum protein concentration. However, higher albumen and lower yolk content, and higher Haugh unit was observed in the diet containing 0.70% lysine (supplementing 0.10% lysine). It is therefore concluded 0.70% lysine in the diet containing 14% CP is adequate for overall performance of Gramapriya laying hens.

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