Indian Journal of Poultry Science (2024) 59(1): 11–14; Research Article
https://doi.org/10.56093/IJPS.v59i1.154898

Effect of variation in nutrient density on production performance and serum biochemical parameters of Rhode Island Red laying hens

ARUN KUMAR PANDA*, BISWANATH SAHOO AND ANIL KUMAR

ICAR-Central Institute for Women in Agriculture, Bhubaneswar, 751003, India

(Received on March 10, 2023; accepted for publication on June 18, 2024)

ABSTRACT

Panda, A.K., Sahoo, B. and Kumar, A. 2024. Effect of variation in nutrient density on production performance and serum biochemical parameters of Rhode Island Red laying hens. Indian Journal of Poultry Science 59(1): 11-14.

The effect of variation in nutrient density of diets on production performance, egg quality and serum biochemical parameters of Rhode Island Red (RIR) laying hens was studied. A total of 96, RIR laying hens (28wk) were randomly distributed into three treatment groups with four replicates in each group with 8 birds in each replicates. These birds were reared in dip litter system under uniform management conditions throughout the experimental period (26-34wk = 8 wks). A standard diet (control diet) containing 2600kcal/kg ME, 16% CP, 0.7% lysine and 0.35% methionine was formulated. Subsequently, two other diets were formulated where in the above nutrients were either increased or decreased by 5%.A measured quantity of each diet was fed to one of the treatment groups for a period of eight wks to study their performance. Reducing the nutrient density by 5% resulted in negative growth and the layers lost body weight by 44.70g. The laying hens fed diet with 5% higher nutrient density gained highest weight of 72.21g which was significantly higher compared to the other two groups. Reducing the nutrient density by 5% resulted in reduced egg production, low egg mass output and poor feed efficiency compared to control. On the other hand increasing the nutrient density by 5% did not elicit any beneficial effects on these parameter compared to the control diet. None of the of the egg quality parameters (% albumen, % yolk, % eggshell, shell thickness and Haugh unit score) were significantly influenced due to variation in nutrient density in diets. Reducing the nutrient density of the diet by 5% significantly decreased the protein concentration in serum. However, no difference in serum protein concentration could be observed due to increase in nutrient density by 5% as compared to control. The concentration of uric acid in serum was lowest in the dietary groups in which nutrient density was reduced by 5%. Increasing the nutrient density by 5% significantly increased the uric acid concentration in serum of laying hens as compared to either control or low nutrient density diet. Thus it may be concluded that the diet containing 2600 kcal/ME per kg diet, 16.0% CP, 0.70 % lysine and 0.35% methionine could be adequate in maintaining optimum performance in RIR laying hens.

Keywords: Nutrient density, Production performance, Serum biochemical parameters, Laying hens

INTRODUCTION

Poultry egg and meat are important animal protein sources and essential in providing balanced diets for nutrition and health. Small scale poultry production represents suitable approach to feed the fast growing human population and to provide income to small and marginal farmers, especially women (Panda *et al.*, 2020). The RIR laying hens are being promoted in India for small scale layer production because of higher egg production potential (250-270 eggs annually) and brown egg shell. Meeting the nutrients requirement through précised feeding is highly essential for optimizing the production performance and higher profit in poultry (Rama Rao *et al.*, 2011). In the intensive system poultry production, feed costs around 70-80 % of the total cost of production. Any improvements in performance that can be related the diet invariably have a profound effect on profitability. Thus, there is a need to supply précised concentrations of all dietary nutrients to the bird not only to optimize production but also to economize the feed cost (AL-Saffar and Rose, 2002; Panda *et al.*, 2012). The present study was conducted to evaluate the effect of variation in nutrient density on production performance, egg quality and serum biochemical parameters of RIR laying hens during 28 to 36 weeks of age.

MATERIALS AND METHODS

Stock, diet and husbandry

A total of 96, RIR laying hens were randomly distributed into three dietary treatment groups having four replicates in each group with8 birds per replicates. These birds were reared in dip litter system having floor space of 20 sqft in each pen. A lighting regime of 16h was provided and all laying hens were kept under uniform management conditions throughout the experimental period (28-36wk). The experiment was conducted following the guidelines of Institute Animal Ethics Committee (IAEC/CIWA/2021/2).

A standard diet (control diet-T_2) containing 2600kcal/kg ME, 16% CP, 0.7% lysine and 0.35% methionine was formulated using maize-soybean meal, deoiled rice bran (Table 1). Subsequently, two other diets were formulated where in the above nutrients were either decreased by 5% (T_1) or increased by 5% (T_3) . The levels of calcium and non phytate phosphorus were kept constant in all the three diets. A measured quantity of

*Corresponding author Email: akpanda59@gmail.com

Table 1: Ingredient and nutrient composition of diets (% as such basis)

Ingredients	Parts per quintal		
	T_1	T_2	T_3
Maize	54.20	58.50	60.89
Soybean meal	18.40	21.70	24.10
De-oiled rice bran	16.80	9.19	4.40
Shell grit	8.70	8.70	8.70
Di-calcium phosphate	1.16	1.16	1.16
DL-methionine	0.06	0.08	0.10
Common salt	0.40	0.40	0.40
Vitamin premix	0.05	0.05	0.05
*Trace mineral premix	0.12	0.12	0.12
Toxin binder	0.05	0.05	0.05
Antibiotics	0.05	0.05	0.05
Total	100	100	100
Nutrient composition (Calculated value)			
ME (kcal/kg)	2470	2600	2730
CP (%)	15.20	16.00	16.80
Lysine (%)	0.67	0.70	0.74
Methionine (%)	0.33	0.35	0.37

*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.

each diet was fed to one of the treatment groups for a period of eight wks to study their performance.

Response Criteria

Egg production, feed efficiency and egg weight: Egg production was recorded on pen basis daily 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/bird/day. Feed efficiency 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 to measure the egg weight.

Egg quality: Twelve eggs were randomly chosen in each treatment from the eggs laid during the last three consecutive days of each 28-day period to measure the egg quality parameters like albumen weight, yolk weight, eggshell weight, shell thickness and Haugh unit score. The cleaned egg-shells were dried for 24 hr, subsequently 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 bio-chemical parameters: Around 3ml of blood was collected from brachial vein from 2 birds in each pen (8 birds perdietary treatment) after the completion of experimental period (36 wk). The serum was separated and the concentrations of total protein, albumen, globulin, calcium, phosphorous, total cholesterol, triglycerides, creatinine and uric acid were estimated 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). Significance was considered at $P \leq 0.05$ level.

RESULTS AND DISCUSSION

Production performance

The effect of variation in nutrient density of diets on production performance of RIR laying hens is presented in Table 2. The body weight gain of the laying hens was significantly influenced by the variation in the nutrient density of the diets. Reducing the nutrient density by 5% resulted in negative growth and the layers lost body weight by 44.70g during the experimental period of eight wks. The laying hens fed diet with 5% higher nutrient density gained highest weight of 72.21g which was significantly higher compared to the other two groups. The results were in agreement with the finding of Panda *et al.* (2021). Reducing the nutrient density by 5% significantly decreased the hen house egg production compared to the control group. However, no improvement in egg production was observed by increasing the nutrient density by 5% as compared to control. Egg weight was not influenced due to variation in the nutrient density in the present study. Lower egg mass per day and poor feed efficiency was observed in the dietary group in which nutrient density was lowered by 5% compared to control. The egg mass per day and feed efficiency was comparable between the control and 5% higher nutrient density group. Nutrient requirements depend on several factors such as strain of layer and its mature body weight, egg production potential and egg weight, (NRC, 1994; Panda *et al.*, 2012). In the present study, the nutrient density was either reduced or increased by 5 %. Reducing the nutrient density by 5% resulted in reduced egg production, low egg mass output and poor feed efficiency compared to control. On the other hand increasing the nutrient density by 5% did not elicit any beneficial effects on these parameter compared to the control diet. Hence, the diet containing 2600 kcal/ME per kg diet, 16.0% CP, 0.70 % lysine and 0.35% methionine could be adequate in maintaining optimum performance in RIR laying hens.

Egg quality

In the present study, none of the of the egg quality parameters (% albumen, % yolk, % eggshell, shell thickness and Haugh unit score) were significantly influenced due to decrease or increase in nutrient density of the diet by 5% as compared to control group (Table 3). The non- difference on albumin, yolk and eggshell

Table 2: Effect of variation in nutrient density on production performance of RIR laying hens

Parameters	T_1	T_2	T_3	SEM	P value
Body weight gain (g)	-44.70[c]	38.95[b]	72.21[a]	8.12	0.012
Hen housed egg production (%)	68.25[b]	74.05[a]	75.04[a]	0.75	0.047
Egg weight (g)	51.24	51.47	51.54	0.35	0.742
Egg mass/day (g)	34.97[b]	38.11[a]	38.67[a]	0.42	0.051
Feed efficiency (g egg/g feed)	0.304[b]	0.331[a]	0.336[a]	0.007	0.042

T_1- 5% reduction in Nutrient density; T_2 - Control, T_3- 5% increase in nutrient density
*Means with different superscripts in a row differ significantly; SEM- Standard Error of Mean

weight due to variation in nutrient density diet could be attributed to similar egg weight in all the dietary groups (Salah Uddin *et al.,* 1992). This finding was in line with the findings of Panda *et al.* (2012) who reported no adverse-affect of reduction in nutrient density upto 7.5% on egg quality of brown laying hens (Delham Red). Two important minerals such as calcium and non phytate phosphorus that influence eggshell quality were kept constant in all the diets in the present study. This could be the reason that no influence was observed on egg shell quality. Concomitant to the findings of the present study, Panda *et al.* (2021) also reported no difference in eggshell quality due to variation in nutrient density while keeping the ratio of calcium and non phytate phosphorus constant in the diets of laying hens.

Serum biochemical parameters

The effect of variation in nutrient density in diets on serum biochemical parameters of RIR laying hens is presented in Table 4. The serum protein concentration was 5g/dl in laying hens fed the control diet. Reducing the nutrient density of the diet by 5% significantly decreased the protein concentration in serum. However, no variation in serum protein content was found due to a 5% increase in nutritional density when compared to the control. Many studies have found that dietary protein amounts influence blood protein concentrations (Alagawany *et al.,* 2011; Prakash *et al.,* 2014; Sonia *et al.,* 2023). The concentrations of albumin, globulin, triglycerides, total cholesterol, creatinine, calcium and phosphorus in serum of laying hens were not influenced due to variation in nutrient density of the diet. The concentration of uric acid in serum was lowest in the dietary groups in which nutrient density was reduced by 5%. Increasing the nutrient density by 5% significantly increased the uric acid concentration in serum of laying hens as compared to either control or low nutrient density diet. Concomitant to the findings of the present study, Ghasemi *et al.,* (2014) reported low serum uric acid concentration in diets containing in low CP level as compared to higher CP levels. Uric acid is the main end product of nitrogen metabolism in poultry and its concentration in blood is related to the contents of dietary

Table 3: Effect of low density diets on egg quality of RIR laying hens

Parameters	T_1	T_2	T_3	SEM	P value
Albumen (%)	61.78	62.45	62.98	0.44	0.654
Yolk (%)	28.50	27.87	27.26	0.37	0.548
Eggshell (%)	9.72	9.68	9.76	0.15	0.828
Haugh unit	74.20	74.42	73.98	0.24	0.844
Shell thickness (mm)	0.368	0.372	0.374	0.004	0.616

T_1- 5% reduction in Nutrient density; T_2 - Control, T_3- 5% increase in nutrient density

Table 4: Effect of low nutrient density diet on different serum biochemical parameters of RIR laying hens

Parameters	T_1	T_2	T_3	SEM	P value
Total Protein (g/dl)	5.36[b]	5.78[a]	5.82[a]	0.08	0.050
Albumin(g/dl)	3.08	3.46	3.36	0.08	0.624
Globulin (g/dl)	2.28	2.32	2.46	0.13	0.704
Triglyceride (mg/dl)	244.2	248.4	252.5	2.24	0.486
Total Cholesterol (mg/dl)	198.3	208.3	204.6	5.32	0.752
Uric acid (mg/dl)	3.96[b]	4.02[b]	4.28[a]	0.02	0.046
Creatinine (mg/dl)	2.72	2.68	2.77	0.03	0.246
Calcium (mg/dl)	11.54	12.24	12.06	0.24	0.842
Phosphorus (mg/dl)	5.84	5.82	5.72	0.08	0.754

T_1- 5% reduction in Nutrient density; T_2 - Control, T_3- 5% increase in nutrient density
Means with different superscripts in a row differ significantly; SEM- Standard Error of Mean

protein. This could be the reason that highest uric acid concentration in serum was observed in the dietary group in which nutrient density was increased by 5%. However, the concentration of uric acid in the serum of laying hens is within the normal range as reported in chickens (Gumpha *et al.*, 2019).

CONCLUSIONS

Optimizing the nutrient intake of bird conserves resources, minimizes feed wastage, reduces environmental pollution and economize the feed cost. Based on the findings of the present study, it is concluded that the diet containing 2600 kcal/ME per kg diet, 16.0% CP, 0.70% lysine and 0.35% methionine could be adequate in maintaining optimum performance in RIR laying hens.

REFERENCES

Alagawany, M., El-Hindawy, M.M., Ali, A.A. and Soliman, M.M. 2011. Protein and total sulfur amino acids relationship effect on performance and some blood parameters of laying hens. *Egyptian Journal of Nutrition Feeds*, 14: 477-487.

Al-Saffar, A.A. and Rose, S.P. 2002. The response of laying hens to dietary amino acids. *World's Poultry Science Journal*, 58: 209-234.

Duncan, D.B. 1955. Multiple range and multiple F tests. *Biometrics*, 11: 1-55.

Ghasemi, R., Torki, M. and Ghasemi, H.A. 2014. Effects of dietary protein and electrolyte balance on production and blood biochemical of laying hens under tropical summer condition. *Tropical Animal. Health and Production*, 46: 717-23.

Gumpha, L.K., Babu, L.K., Kumar, A., Samal, P. and Panda, A.K. 2019. Effect of low protein diets on production performance, egg quality and serum biochemical indices of Vanaraja laying hens. *Animal Nutrition and Feed Technology*, 19: 349-359.

NRC. 1994. *Nutrient Requirements of Poultry*. 9th rev. ed. National Academy Press, Washington, DC.

Panda A.K., Sahoo, B. and Kumar, A. 2020. Rural poultry production for livelihood improvement and gender equity in India. *International Journal of Agriculture Sciences*, 12: 10500-10502.

Panda, A.K., Rama Rao, S.V., Raju, M.V.L.N., Niranjan, M. and Reddy, M.R. 2012. Effect of Nutrient density on production performance, egg quality and humoral immune response of brown laying (Dahlem Red) hens in the tropics. *Tropical Animal Health and Production*, 44: 293-299.

Panda A.K., Sahoo, B. and Kumar, A. 2021. Effect of Low Nutrient Density Diets on Performance of Vanaraja Laying Hens in Intensive System of Production. *Indian Journal of Animal Nutrition*, 37: 335-339.

Prakash, B., Shanmugam, M., Panda, A.K. and Rama Rao, S.V. 2014. Effects of feeding varying nutrient density diets on productive performances and semen quality parameters in Dahlem Red Birds. *Indian Journal of Animal Nutrition*, 31: 378-383.

Rama Rao, S.V., Ravindran, V., Srilatha, T., Panda, A.K. and Raju, C. 2011. Effect of dietary concentration of energy, crude protein, lysine and methionine on the performance of White Leghorn layers in the tropics, *Journal of Applied Poultry Research*, 20: 528-541.

Salah Uddin, M., Tareque, A.M., Howlider, M.A.R., Jasimuddin, M. and Ahmed, S. 1992. Effect of dietary and energy levels on the performances of Starcross layers. *Asian-Australasian Journal of Animal Sciences*, 5: 723-731.

Snedecor, G.W. and Cochran, W.G. 1989. *Statistical Methods*, Iowa State University Press, Ames, IA.

Sonia, C., Doley, S., Sailo, B., Singh, M.N., Tania, C., Akoijam, R. and Ningombam, A. 2023. Nutritional manipulation of broiler chicken for improving the performance and quality of meat. *Indian Journal Poultry Science*, 58(1): 17-22.