Indian J. Anim. Nutr. 2020. 37 (4): 335-339
doi: 10.5958/2231-6744.2020.00054.7

Indian Journal of Animal Nutrition

Effect of Low Nutrient Density Diets on Performance of Vanaraja Laying Hens in Intensive System of Production

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ABSTRACT

An experiment was conducted to evaluate the effect of low nutrient density diets on production performance, egg quality and serum biochemical parameters of Vanaraja laying hens in the intensive system. A total of 72 Vanaraja laying hens were randomly distributed into three dietary treatment groups with four replicates in each group with 6 birds in each pen. These birds were reared in dip litter system under uniform management conditions throughout the experimental period (28-44 wk). A standard diet (control diet) containing 2600 kcal/kg ME, 16% CP, 0.7% lysine and 0.35% methionine was formulated. Subsequently, two low nutrient density diets were formulated by reducing the above nutrients by 3 and 6%. The levels of calcium and non-phytate phosphorus were constant in all the three diets. A measured quantity of each diet was fed to one of the treatment groups for a period of 12 weeks to study their performance. The birds fed control diet gained significantly higher weight of 45.36 g during the experimental period. Reducing the nutrient density by either 3 or 6% resulted in negative growth and birds lost body weight by 24.10 and 48.21g, respectively. The hen housed egg production, egg weight, egg mass per day and feed efficiency did not differ among the dietary group due to reduction in nutrient density of the diet. None of the egg quality parameters (% albumen, % yolk, % eggshell, shell thickness and Haugh unit) differed significantly due to reduction in the density of diets in Vanaraja laying hens. The concentrations of serum protein, albumin, globulin, triglycerides and total cholesterol, were not influenced due to reduction in the nutrient density by upto 6% in the diets. However, the serum concentrations of uric acid and creatinine was significantly decreased in the diet with 6% reduction in nutrient density compared to either control or 3% reduced nutrient density diet. It is concluded that the nutrient density can be reduced to 6% of the control diet and diet containing 2440 kcal/ME per kg diet, 15.0% CP, 0.66 % lysine and 0.33% methionine could be adequate in maintaining optimum performance of Vanaraja laying hens.

Key words: Intensive system, Low nutrient density diet, Performance, Vanaraja laying hens

INTRODUCTION

Rural poultry farming is recognized globally to alleviate poverty, eradication of malnutrition and creation of gainful employment in rural areas (Sharma and Chaterjee, 2009; Rajkumar *et al.,* 2010). Considering the importance of backyard/rural poultry farming in India, several research organizations have developed different chicken varieties which have successfully been reared by farmers from many parts of the country. Vanaraja is one such promising dual-purpose chicken variety developed by the ICAR-Directorate of Poultry Research, Hyderabad, India, for rearing in backyard on natural, scavenged food with minimal supplementation (Islam *et al.,* 2014). The birds can lay up to 130-140 eggs per year under backyard system of rearing. However, many farmers are rearing Vanaraja in intensive system of production, due to greater demand and high market price of egg produced from these birds (Niranjan *et al.,* 2008). In the intensive system of layer poultry farming, feed costs around 70-80 % of the total cost of production. Thus, there is a need to supply précised concentrations of all dietary nutrients to the bird to economize the feed cost (AL-Saffar and Rose, 2002). Optimizing the nutrient intake of bird conserves resources, minimizes feed wastage and reduces environmental pollution (Panda *et al.,* 2007). The present study was conducted to evaluate the effect of low nutrient density diets on production performance, egg quality and serum biochemical parameters of Vanaraja laying hens during

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28 to 40 weeks of age.

MATERIALS AND METHODS

A total of 72 Vanaraja laying hens were randomly distributed into three dietary treatment groups with four replicates in each group with 6 birds in each pen. These birds were reared in dip litter system having floor space of 1.39 sq m in each pen. A lighting regime of 16 h was provided and all laying hens were kept under uniform management conditions throughout the experimental period (28-44 wk). The experiment was conducted following the guidelines of Institute Animal Ethics Committee.

A standard diet (control diet - T_1) containing 2600 kcal/kg ME, 16% CP, 0.7% lysine and 0.35% methionine was formulated (Table 1). Subsequently, two low nutrient density diets were formulated by reducing the above nutrients by 3 (T2) and 6% (T3). The levels of calcium and non phytate phosphorus were constant in all the three diets. A measured quantity of each diet was fed to one of the treatment groups for a period of 12 weeks to study their performance.

Daily egg production was recorded on 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 28 d 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 and egg weight was recorded.

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 albumen weight, yolk weigh egg-shell weight, shell thickness and Haugh unit. 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)

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

Ingredients	Parts per quintal		
	T_1	T_2	T_3
Maize	58.50	54.10	47.50
Soybean meal	21.70	19.40	16.50
De-oiled rice bran	9.19	15.91	25.40
Shell grit	8.70	8.70	8.70
Di-calcium phosphate	1.16	1.16	1.16
DL-methionine	0.08	0.06	0.07
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)	2600	2520	2440
CP (%)	16	15.5	15.0
Lysine (%)	0.7	0.68	0.66
Methionine (%)	0.35	0.34	0.33

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

Table 2. Effect of low density diets on production performance of Vanaraja laying hens

Parameters	T_1	T_2	T_3	SEM	P value
Body weight gain (g)	45.60[a]	-24.10[b]	-48.21[c]	10.17	0.015
Hen housed egg production (%)	65.01	64.09	63.94	0.95	0.453
Egg weight (g)	52.24	52.54	52.51	0.356	0.950
Egg mass/day (g)	34.17	34.09	33.75	0.527	0.563
Feed efficiency (g egg/g feed)	0.272	0.269	0.268	0.005	0.648

T_1-Control; T_2- 3% reduction in nutrient density; T_3- 6% reduction in nutrient density; *Means with different superscripts in a row differ significantly; SEM- Standard Error of Mean

using a micrometer gauge (Mitutoyo Code, 7027, Japan).

At the end of experimental feeding (40th wk), around 3 ml of blood was collected from brachial vein from 2 birds in each pen (8 birds per) dietary treatment. Subsequently serum was separated and the concentrations of total protein, albumen, globulin, calcium, phosphorous, cholesterol, triglycerides creatinine and uric acid and were estimated in the serum by auto-analyzer using diagnostic kits (Coral Clinical Systems, Goa, India).

Data were subjected to statistical analysis following procedures for 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 $P<0.05$ level.

RESULTS AND DISCUSSION

The effect of low density diet on production performance of Vanaraja laying hens during the entire experimental period of 12 weeks is presented in Table 2. The birds fed control diet gained significantly higher weight of 45.36 g during the experimental period. Reducing the nutrient density by either 3 or 6% resulted in negative growth and birds lost body weight by 24.10 and 48.21g, respectively. The loss in body weight was more pronounced in the lowest nutrient density diet. The hen housed egg production, egg weight, egg mass per day and feed efficiency did not differ among the dietary group due to reduction in nutrient density of the diet. The results were in agreement with the finding of Wu *et al.* (2005, 2007). Similarly, Panda *et al.* (2011) did not observe any adverse effect on egg production, egg weight and egg mass due to reduction in nutrient density by up to 7.5% in Dahlem Red laying hens. The requirement of nutrients depends on several factors such as strain of layer and its mature body weight, egg production potential and egg weight. In the present study, the nutrient density was reduced by up to 6% and no adverse effect was observed on any production parameters of Vanaraja laying hens. Hence the nutrient density can be reduced by 6% of the control diet and diet containing 2450 kcal/ME per kg diet, 15.0% CP, 0.66 % lysine and 0.33% methionine could be adequate in maintaining optimum performance in Vanaraja laying hens.

None of the egg quality parameters (% albumen, % yolk, % eggshell, shell thickness and Haugh unit)

Table 3. Effect of low density diets on egg quality of Vanaraja laying hens

Parameters	T_1	T_2	T_3	SEM	P value
Albumen (%)	60.78	62.49	59.98	0.40	0.452
Yolk (%)	29.63	27.91	30.12	0.37	0.347
Eggshell (%)	9.58	9.58	9.88	0.15	0.648
Haugh unit	72.60	72.41	72.99	0.24	0.836
Shell thickness (mm)	0.374	0.368	0.369	0.005	0.510

T_1-Control; T_2- 3% reduction in Nutrient density; T_3- 6% reduction in nutrient density

Table 4. Effect of low nutrient density diet on different serum biochemical indices of Vanaraja laying hens

Parameters	T_1	T_2	T_3	SEM	P value
Total Protein (g/dl)	5.86	5.80	5.74	0.13	0.988
Albumin (g/dl)	3.22	2.99	3.08	0.08	0.476
Globulin (g/dl)	2.64	2.81	2.66	0.13	0.708
Triglyceride (mg/dl)	289.2	278.4	280.7	1.57	0.684
Total cholesterol (mg/dl)	204.3	198.8	189.2	7.34	0.654
Uric acid (mg/dl)	4.12^b	4.10^b	3.98^a	0.02	0.041
Creatinine (mg/dl)	2.74^b	2.68^b	2.37^a	0.03	0.047
Calcium (mg/dl)	12.84	13.90	14.09	0.42	0.482
Phosphorus (mg/dl)	5.88	5.92	5.72	0.12	0.852

T_1-Control; T_2- 3% reduction in Nutrient density; T_3- 6% reduction in nutrient density; Means with different superscripts in a row differ significantly; SEM- Standard Error of Mean

differed significantly due to reduction in the density of diets in Vanaraja laying hens (Table 3). Similar to the findings of present study, Panda *et al.* (2012) also reported no adverse effect of reduction in nutrient density by upto 7.5% on egg quality of brown laying hens. Wu *et al.* (2007) also reported no significant effect of dietary protein (14-16%) on Haugh unit, egg specific gravity and egg shell thickness in Hy-Line laying hens. In the present study Ca and non-phytate phosphorus, two important minerals which influence eggshell quality were kept constant in all the diets. This could be the reason that no influence was observed on egg shell quality. The non-difference on albumin and egg weight due to variation in nutrient density diet could be attributed to similar egg weight in all the dietary groups (Junqueira *et al.,* 2006).

The effect of low nutrient density diets on serum biochemical parameters of Vanaraja laying hens is presented in Table 4. The concentrations of serum protein, albumin, globulin, triglycerides and total cholesterol, were not influenced due to 6% reduction of nutrient density in the diets. Ding *et al.* (2016) also observed no significant effect of dietary protein levels (14.5, 15 and 15.5%) on the serum concentration of total protein, albumin, triglycerides and cholesterol in laying hens. The serum concentrations of uric acid and creatinine was significantly decreased in the diet with 6% reduction in nutrient density compared to either control or 3% reduced nutrient density diet. This was in agreement with the finding of Ghasemi *et al.* (2014) wherein low serum uric acid concentration was observed in low CP level (13.9) as compared to higher CP level (15.4%). Hsu *et al.* (1998) also observed significantly higher uric acid concentration in serum of laying hens fed 17% CP diet as compared to that of 14% CP diet. Uric acid is the main end product of nitrogen metabolism in poultry and its concentration in blood is related to the contents of dietary protein. This could be the reason that lowest uric acid concentration in serum was observed in the dietary group in which nutrient density was reduced by 6%. The concentrations of serum Ca and P were not influenced due to variation in nutrient density of the diets in the present study.

CONCLUSION

It is concluded that the nutrient density can be reduced by 6% of the control diet and diet containing 2440 kcal/ME per kg diet, 15.0% CP, 0.66 % lysine and 0.33% methionine could be adequate in maintaining optimum performance in Vanaraja laying hens.

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Received on 03-12-2020 and accepted on 02-01-2021