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Effect of Different Nutrient Density Prelay Diets on Egg Qualities of White Leghorn Layers

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ABSTRACT

Background: Currently prelay nutrition has gained attention in layer industry. Consumer concern attracted researchers to study on different egg qualities. The study was aimed to investigate the impact of different nutrient density prelay diets on egg qualities.

Methods: Total 180, 16-week-old White Leghorn pullets assigned to six-prelay feeding strategies (kcal ME per kg/%CP/%Ca) during 16-18 weeks. Treatments were T0 (BIS control-2500/16.0/1.0), T1 (2700/16.0/1.0), T2 (2700/16.0/2.0), T3 (2700/16.0/2.5), T4 (2700/18.0/2.0) and T5 (2700/18.0/2.5). Subsequently, pullets were fed with same layer diet (2600/18.0/3.0) during 19-40 weeks. Various egg quality parameters were recorded during 24-40 weeks of age.

Result: Inclusion of 18.0% CP, 2700 kcal ME/kg significantly improved 40th week egg weight ($p<0.05$) and albumen index while reduced yolk weight ($p<0.01$). Prelay diet did not influence shape index and yolk index. The 18.0% prelay CP significantly ($p<0.01$) improved albumen weight and haugh unit. Inclusion of 2.0-2.5% prelay Ca significantly ($p<0.01$) improved shell weight and shell thickness than 1.0%. It is recommended to use 18.0% CP, 2700 kcal ME/kg and 2.5% Ca in prelay diet during 16-18 weeks along with BIS (2007) layer diet during 19-40 weeks age in White Leghorn Layers.

Key words: Egg quality, Prelay diet, Pullet.

INTRODUCTION

The modern pullet experiences the potential to rise quickly to peak production. If the feeding programs for pullets and layers are well designed and implemented, egg producers can take advantage of today's modern layer's tremendous genetic potential. Several egg quality (EQ) traits are being studied due to their economic importance. These EQ traits are affected by various factors like management, nutrition and genotype (Yang *et al.,* 2014). Various researchers found that different levels of metabolic energy, crude protein and calcium included in prelay diet can affect various EQ parameters (Joseph *et al.* 2000; Sujatha *et al.* 2014).

The present study is aimed to investigate the effect of various nutrient density prelay diets on various EQ of laying hens.

MATERIALS AND METHODS

Experimental design

The experiment was conducted in the year 2019 (26th June 2019 to 16th December 2019) at Poultry Research Station, Veterinary and Dairy Science Unit, AAU, Anand, Gujarat. Total 180, 16-week-old White Leghorn pullets housed in California-type individual cages randomly assigned to six-prelay feeding strategies (kcal ME per kg/%CP/%Ca) during 16-18 weeks. Treatments were T0 (BIS control-2500/16.0/1.0), T1 (2700/16.0/1.0), T2 (2700/16.0/2.0), T3 (2700/16.0/2.5), T4 (2700/18.0/2.0) and T5 (2700/18.0/2.5). Subsequently, pullets from all groups were fed with BIS (2007) layer diet (2600/18.0/3.0) during 19-40 weeks. Each treatment consisted of five replicates, each with six pullets (30 pullets per treatment). The birds were reared under identical management conditions.

Parameters studied

The EQ parameters *viz*., egg weight (EW) in g, shape index (SI), yolk index (YI), albumen index (AI), percent albumen weight (AW), percent yolk weight (YW), percent shell weight (SW), shell thickness (ST) in mm and Haugh unit (HU) were estimated at the end of 24th, 28th, 32nd, 36th and 40th week of age. The SI, YI, AI, AW, YW, SW and HU parameters were depicted for overall period (24-40 weeks of age). The EW and ST parameters were depicted for various intervals (24th, 28th, 32nd, 36th and 40th week of age) as well as for overall period (24-40 weeks of age). Two eggs per replicate for

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consecutive last three days of a week were randomly selected to study the EW as per Kumari *et al.* (2017) and two eggs per replicate were randomly selected on last day of respective week to study the remaining EQ parameters. SI was calculated as per Shultz (1953). YI was calculated according to formula given by Heiman and Wilhelm (1937). AI was calculated as per Heiman and Carver (1936). HU was calculated using the recorded observation of albumen height and EW as per Haugh (1937). ST was measured in mm by using Digital Micrometre Screw Gauge. Percent component of shell and yolk was measured by weight of respective component in g/EW in g × 100. AW was measured by subtracting the shell and yolk weight from respective EW and expressed in percentage.

Statistical analysis

Data was analysed using Completely Randomized Design as per Snedecor and Cochran (1994). Replicate means under each treatment were used for analysis.

RESULTS AND DISCUSSION

Egg weight

Average EW (Table 1) from T5 fed with 18.0% CP, 2700 kcal/kg diet ME and 2.5% Ca in prelay diet significantly ($p<0.05$) increased at 40th week end and numerically higher at 24th, 32nd and 36th weeks end than control and other groups. Higher EW observed in T5 might be due to high prelay energy and protein. Feeding pullets with higher protein in prelay diet significantly improved EW. (Joseph *et al.* 2000) (Joseph *et al.* 2000) reported that higher dietary CP caused higher EW mainly due to increased AW and it is also related to the quantity of protein consumed. Consumption of an extra 1.0 g of protein per day increases EW by 1.4 g (Bouvarel *et al.*, 2011). Sujatha *et al.* (2014) reported that high prelay energy and protein diet resulted in heavier eggs. Present study also confirmed that 18.0% prelay CP produced heavier eggs. In present study, two prelay Ca levels (2.0 and 2.5%) were studied with 2700 kcal ME/kg and 18.0% CP. EW was higher in 2.5% Ca group than 2.0% Ca. However, Nagarajan (1997) reported 1.0, 2.0 and 3.5% prelay Ca in White Leghorn pullets did not improve EW. There might be a slight influence of higher prelay Ca on EW.

Shell thickness

Significantly ($p<0.01$) highest ST (Table 2) was recorded in T3 and T5 than other groups at 24th week. The 28th week ST was significantly ($p<0.05$) higher in T2, T3, T4 and T5 than T0 and T1. The 32nd week ST was significantly ($p<0.01$) higher in T3 and T5, followed by T4, T2, T0 and T1. The 36th week ST was significantly ($p<0.01$) higher T5 and T3 than T0, T1, T2 and T4. The 40th week ST was significantly ($p<0.01$) higher in T5 than T3 and T4. The ST did not differ significantly during the overall period (24-40 weeks of age) but numerically higher ST was observed in T3 and T5.

Inclusion of 2.0-2.5% prelay Ca significantly ($p<0.01$) increased ST than 1.0% Ca. Leeson *et al.* (1986) indicated a small increase in Ca retention in response to increased diet Ca and low Ca diets (0.9-1.5%) had a deleterious effect on early eggshell quality even common 3.5% Ca included in layer diet. Increase in dietary Ca two weeks before the first eggs' appearance is essential to enhance medullary bone formation and the first eggs' shell (Bouvarel *et al.*, 2011). Pavlovski *et al.* (2012) recommended 2.5% Ca in the pullet's diet before entering the laying phase. In the present study, 2.5% prelay Ca significantly ($p<0.01$) maintained higher persistence in ST. Therefore, it is inferred that the prelay diet should include 2.5% prelay Ca. The hens laying eggs with thick shells retained more Ca than hens laying eggs with thin shells (Clunies *et al.* 1992). Results indicated that prelay diet should contain 2.0-2.5% Ca to improve ST.

Yolk weight

Significantly ($p<0.01$) lowest overall YW was recorded in T4 and T5 than control and other groups (Table 3). Higher decreasing trend of YW in T4 and T5 might be due to increasing trend of percent AW observed in T4 and T5

Table 1: Average egg weights (g) of hens fed with different prelay diets.

Treatment	Age in weeks				
	24	28	32	36	40
T0	43.09±1.08	48.27±0.61	49.92±0.42	53.21±0.40	54.83^{cd}±0.54
T1	44.49±0.73	48.95±0.24	49.57±1.47	53.83±0.63	55.47^{bc}±0.32
T2	44.72±0.84	48.19±1.05	50.09±0.91	52.84±0.62	53.85^{d}±0.79
T3	44.42±1.11	50.35±0.36	52.37±0.71	54.36±1.22	56.50 ^{ab}±0.35
T4	45.29±1.19	48.87±0.47	50.69±0.55	52.49±0.78	55.81^{abc}±0.31
T5	45.59±0.82	49.49±0.69	52.67±0.63	54.91±0.71	57.06^{a}±0.50
SEM	0.394	0.271	0.389	0.327	0.271
CD at 5%	NS	NS	NS	NS	1.485
CD at 1%	NS	NS	NS	NS	2.013
CV%	4.931	2.881	3.776	3.221	2.047
p-value	0.570	0.186	0.071	0.245	0.002

Means bearing different superscripts within a column differ significantly ($p<0.05$ and $p<0.01$), SEM: Standard error mean, CV: Coefficient of variation.

containing higher CP (18.0%) than control and other groups (16.0%). Almeida *et al.* (2012) reported significant interaction between dietary energy and protein on yolk proportion. Shi *et al.* (2009) reported significant negative correlations of EW with percent YW confirmed in present study. Feeding of 2700 kcal ME/kg diet, 18.0% CP and 2.0-2.5% Ca in prelay diet significantly reduced per cent YW.

Albumen weight

Significantly (p<0.01) highest AW was recorded in T4 and T5 followed by T0, T1, T2 and T3 during overall period (Table 3). Better overall AW was observed in 18.0% prelay CP (T4 and T5). These results suggested some scope for slightly changing albumen proportion through dietary manipulation, as Novak *et al.* (2006) reported. The 18.0% prelay CP caused higher AW than 16.0% prelay CP agrees with Joseph *et al.* (2000), who reported increase in AW by 18.0% CP. Further, they reported diversion of additional nitrogen in a higher CP diet (18.0%) into egg formation. Shi *et al.* (2009) reported significant positive correlations between EW and AW percentage confirmed in present study. Higher prelay CP (18.0%) might improve AW.

Shell weight

The 2.0 (T2 and T4) to 2.5% (T3 and T5) prelay Ca significantly (p<0.01) increased (Table 3) overall SW than 1.0% prelay Ca (T0 and T1). However, significantly (p<0.01) better SW was observed in 2.5% prelay Ca (T3 and T5) than 2.0% prelay Ca (T2 and T4). Significant increase in SW might contribute to EW improvement which is in agreement with Farooq *et al.* (2001), who reported positive correlations between EW, SW and ST. The EW was significantly increased due to higher prelay protein (18.0% CP), energy (2700 kcal ME/kg) and Ca (2.5%). Joseph *et al.* (2000) reported significantly higher SW in 18.0% prelay CP diet. This confirmed the positive relation between SW and EW. It was concluded that 2.0-2.5% prelay Ca significantly (p<0.01) improved SW than 1.0% Ca.

Table 2: Average shell thickness (mm) of eggs laid by laying hens fed with different prelay diets.

Treatment	Age in weeks					
	24	28	32	36	40	24-40
T0	$0.334^{c}\pm$ 0.002	$0.344^{b}\pm0.002$	$0.372^{b}\pm0.003$	$0.372^{c}\pm0.003$	$0.374^{c}\pm0.002$	0.356±0.008
T1	$0.333^{c}\pm0.001$	$0.343^{b}\pm0.002$	$0.364^{c}\pm0.002$	$0.364^{d}\pm0.002$	$0.371^{c}\pm0.002$	0.352±0.007
T2	$0.336^{c}\pm0.003$	$0.363^{a}\pm0.004$	$0.374^{b}\pm0.002$	$0.374^{c}\pm0.002$	$0.374^{c}\pm0.002$	0.362±0.005
T3	$0.354^{a}\pm0.004$	$0.374^{a}\pm0.006$	$0.395^{a}\pm0.001$	$0.385^{b}\pm0.003$	$0.385^{b}\pm0.004$	0.380±0.008
T4	$0.343^{bc}\pm0.003$	$0.363^{a}\pm0.004$	$0.374^{b}\pm0.003$	$0.374^{c}\pm0.003$	$0.384^{b}\pm0.004$	0.364±0.006
T5	$0.351^{ab}\pm0.005$	$0.373^{a}\pm0.005$	$0.395^{a}\pm0.002$	$0.395^{a}\pm0.002$	$0.395^{a}\pm0.001$	0.384±0.010
SEM	0.001	0.002	0.001	0.001	0.001	0.003
CD at 5%	0.011	0.013	0.007	0.008	0.009	NS
CD at 1%	0.014	0.017	0.010	0.011	0.012	NS
CV %	3.431	3.914	2.148	2.332	2.606	4.959
p-value	0.000	0.000	0.000	0.000	0.000	0.056

Means bearing different superscripts within a column differ significantly (p<0.05, p<0.01), SEM: Standard error mean, CV: Coefficient of variation, CD: Critical difference.

Table 3: Overall (24-40 weeks age) percent yolk weights, albumen weights, shell weights; and shape index, yolk index, albumen index; and haugh unit of eggs laid by laying hens fed with different prelay diets.

Treatment	YW	AW	SW	SI	YI	AI	HU
T0	$28.73^{a}\pm0.12$	$59.48^{ab}\pm0.17$	11.78 ± 0.05^{c}	74.62±0.25	0.45±0.015	0.100±0.005	87.56±2.54
T1	$28.76^{a}\pm0.09$	$59.47^{ab}\pm0.14$	11.76 ± 0.07^{c}	74.86±0.23	0.46±0.017	0.100±0.005	88.18±2.39
T2	$28.76^{a}\pm0.14$	$59.23^{bc}\pm0.14$	12.01 ± 0.04^{b}	74.42± 0.32	0.45±0.014	0.098±0.007	87.95±2.37
T3	$28.65^{a}\pm0.16$	$58.86^{c}\pm0.17$	12.49 ± 0.04^{a}	74.73±0.34	0.46±0.015	0.100±0.005	87.95±2.37
T4	$28.11^{b}\pm0.25$	$59.89^{a}\pm0.25$	12.00 ± 0.05^{b}	74.95± 0.22	0.45±0.014	0.104±0.006	89.13±2.59
T5	$27.63^{b}\pm0.20$	$59.81^{a}\pm0.22$	12.56 ± 0.03^{a}	75.67±0.48	0.45±0.022	0.110±0.008	90.65±2.72
SEM	0.102	0.095	0.061	0.263	8.344	0.002	0.950
CD at 5 %	0.506	0.555	0.159	NS	NS	NS	NS
CD at 1 %	0.686	0.752	0.215	NS	NS	NS	NS
CV %	1.363	0.715	1.005	0.970	0.006	14.706	6.380
p-value	0.000	0.010	0.000	0.164	0.999	0.825	0.961

Means bearing different superscripts within a column differ significantly (p<0.05, p<0.01), SEM: Standard error mean, CV: Coefficient of variation, CD: Critical difference.

Shape index

Feeding of different nutrient density prelay diets did not affect egg SI (Table 3). These findings agree with Babiker *et al.* (2010). Results indicated that the different nutrient density prelay diets did not influence egg SI.

Yolk index

The overall YI did not differ significantly (Table 3). Duman *et al.* (2016) reported a significant negative correlation between SI and YI. Results indicated that feeding of different nutrient density prelay diet did not influence YI.

Albumen index

Albumen quality is an important indicator of egg freshness (Yildirim *et al.*, 2018). The different nutrient density prelay diets did not affect AI (Table 3). Numerical increase in the AI in T5 might be due to a slight numerical increase in SI because AI increased with increasing SI and a significant ($p<0.05$) positive correlation was determined between SI and AI (Duman *et al.* 2016). The AI of an egg is an indication of its protein content. Results indicated that feeding of 2700 kcal ME/kg diet, 18.0% CP and 2.5% Ca in prelay diet helps to increase AI.

Haugh unit

Overall HU (Table 3) was apparently increased in T4 and T5. Inclusion of 18.0% CP with 2.0-2.5% Ca in prelay diet improves HU compared to 16.0% CP with 2.0-2.5% Ca. The HU improvement from T4 and T5 might be due to improved egg size observed in present study. In contrast, Sujatha *et al.* (2014) observed no effect of prelay protein, energy and Ca on HU in their studies. The HU considers EW and albumen height and compares egg protein quality (Monira *et al.*, 2003 and Monika *et al.*, 2021). Higher the HU, better the quality of the egg is. Haugh unit indicates albumin height of an egg that signifies the protein content of the egg.

CONCLUSION

Prelay diet affects egg qualities. Inclusion of 18.0% CP, 2700 kcal ME/kg significantly improved 40th week EW ($p<0.05$) and AI while reduce YW ($p<0.01$) than 16.0% CP and 2600 kcal ME/kg diet. Prelay diet did not influence SI and YI. The 18.0% prelay CP significantly ($p<0.01$) improved AW and HU. Inclusion of 2.0-2.5% prelay Ca significantly ($p<0.01$) improved SW and ST than 1.0% Ca. It is recommended to use 18.0% CP, 2700 kcal ME/kg and 2.5% Ca in prelay diet during 16-18 weeks along with BIS (2007) layer diet during 19-40 weeks age in White Leghorn Layers.

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