B-5115
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RESEARCH ARTICLE   Indian Journal of Animal Research

Efficacy of Best Prelay Diet on Production Performance of White Leghorn Layers Fed with Different Layer Diets

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10.18805/ajdfr.DRF-326

ABSTRACT

Background: Feeding high nutrient density best prelay diet (BPD) 2-3 weeks before egg production is beneficial and may allow to reduce layer diet nutrient density.

Methods: Total 180, 16-week-old White Leghorn pullets were assigned to six-layer feeding strategies (kcal ME per kg/%CP/%Ca) during 19-40 weeks. Treatments were T0 (BIS control-2600/18.0/3.0), T1 (2500/18.0/3.0), T2 (2500/18.0/4.0), T3 (2500/17.0/4.0), T4 (2500/16.0/4.0) and T5 (2500/15.0/4.0). These layers were fed with same BPD (2700/18.0/2.5) during 16-18 weeks. Performance parameters were recorded during the study.

Result: Feeding BPD did not influence pullets (16-18 woa) CaI, PI and MEI. The 3.0% layer Ca (T0 and T1) decreased (p<0.01) CaI than 4.0% (T2 to T5) and layer diet CP reduction from 18.0 to 15.0% decreased PI but 2500 or 2700 kcal ME/kg layer diet did not affect MEI (19-40 woa). BPD did not support 16 or 15% layer diet CP (T4 and T5) but allowed to reduce CP (T3) by 1.0% (18.0 to 17.0%) to support production. BPD (2700/18.0/2.5) with layer diet in T0 (2600/18.0/3.0) is the best combination for supporting BWG without affecting FC and improving EN, HDEP, FCDE, EFPR and PEI in layers.

Key words: Layer diet, Prelay, Production performance.

INTRODUCTION

At the onset of egg production, the pullet's quality greatly determines her profitability during the laying cycle. Substantial body reserves before egg production are indispensable to achieve satisfactory hen performance (Eusebio-Balcazar *et al*., 2018). Earlier studies indicated that, the feeding high-nutrient-density diets during laying period had no beneficial effect on production performance of layers (Zang and Kim, 2013; Rama Rao *et al*., 2014; Ismail *et al*., 2015). Production performances were improved by feeding pullets with high nutrient density prelay diets (Cransberg *et al*., 2001; Babiker *et al*., 2010; Sujatha and Rajini, 2015; Lonkar, 2022). Recently, Lonkar *et al.* (2022a) and Lonkar *et al.* (2022b) concluded that prelay diet containing 18.0% CP, 2700 kcal ME/kg diet and 2.5% Ca was the best prelay diet for significant improvement in White Leghorn layers subsequently fed with BIS (2007) layer diet. Positive body energy and protein balance and calcium reserves in the medullary bone during the prelay period (transitional phase) are essential for sustained egg production and egg quality. Hence, the present study was undertaken to study the effect of high density best prelay diet (18.0% CP, 2700 kcal ME/kg diet and 2.5% Ca) on the production performance and cost-effectiveness of layers fed with reduced nutrient density than BIS (2007) layer diet.

MATERIALS AND METHODS

Experimental design

An experiment was conducted in 2020 (24th May to 14th November 2020) 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-layer feeding strategies (kcal ME per kg/% CP/% Ca) during 19-40 weeks. Treatments were T0 (BIS control-2600/18.0/3.0), T1 (2500/18.0/3.0), T2 (2500/18.0/4.0), T3 (2500/17.0/4.0), T4 (2500/16.0/4.0) and T5 (2500/15.0/4.0). Layers were fed the best prelay diet (2700/18.0/2.5) for 16-18 weeks. Each treatment consisted of five replicates with six pullets (30 pullets per treatment).

Parameters studied

The body weights were recorded on 16th and 18th weeks of age (woa) to calculate overall body weight gain for a period of 16-18 woa. Similarly, the body weights were recorded on

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How to cite this article: Lonkar, V.D., Savaliya, F.P., Mishra, R.K., Patel, A.B. and Bhagora, N.J. (2023). Efficacy of Best Prelay Diet on Production Performance of White Leghorn Layers Fed with Different Layer Diets. Indian Journal of Animal Research. DOI: 10.18805/ajdfr.DRF-326.

Submitted: 23-03-2023 **Accepted:** 01-08-2023 **Online:** 12-08-2023

19th and 40th woa to calculate overall body weight gain for a period of 19-40 woa. Daily weighed quantity of feed was offered to the birds and weekly feed refusal was recorded to calculate daily feed consumption (g) per bird (FC). From this daily FC per bird data, the average daily FC per bird for an overall period of 16-20 and 21-40 woa was calculated. Average daily calcium (g) intake (CaI) and protein (g) intake (PI) were recorded (FC per bird per day × % nutrient in feed/100) for overall period of 16-18 and 17-40 weeks of age. The metabolic energy (kcal/bird) intake (MEI) was recorded (FC per bird per day × ME content in feed /1000) for overall period of 16-18 and 17-40 weeks of age. Total egg number (TEN) per hen and per cent hen day egg production (HDEP) and feed efficiency as feed consumption (kg) per dozen eggs (FCDE) were recorded for 17-40 weeks.

The performance efficiency index (PEI) was recorded at the end of the 40th (PEI_{40}) week of age. The PEI was calculated based on average egg weight (EW), average body weight (BW), per cent egg production (P) and average feed consumption per day (FC) using the following formula as per Narahari *et al.* (2000):

$$PEI = \frac{30\ (EW)^2\ P}{BW \times FC}$$

The egg feed price ratio was calculated at the end of the experiment (40th week) to find out the ratio between egg receipts and expenditure on the feed by using the following formula as per Narahari *et al.* (2000):

$$EFPR = \frac{\text{Total value of egg produced (Rs)}}{\text{Total value of feed consumed (Rs)}}$$

Statistical analysis

The experiment was designed in completely randomized design (Snedecor and Cochran, 1994). The data was analysed by one way ANOVA with the help of IBM SPSS Software-20. The “Duncan’s multiple range test” (MRT) post-hoc analysis was done to test the significant mean differences between the groups with significance level defined at P<0.05.

RESULTS AND DISCUSSION

Body weight gain

Feeding BPD did not change pullets BWG during 16-18 woa (Table 1). When pullets fed with BPD and different nutrient density layer diets, the layer diet containing 2500 or 2600 kcal ME/kg with 17.0 or 18.0% CP (T0 to T3) maintained BWG than 16.0 (T4) or 15.0% CP (T5). The BPD did not support layers BWG when subsequently fed with low CP (16.0 or 15.0%) during 19-40 woa. Decreasing dietary CP (12.0, 14.0 and 16.0%) lowered (p<0.02) layers BWG (Novak *et al*., 2008) indicating role of dietary CP level in maintaining optimal WG during laying corroborates with the present findings. It confirmed that the BPD supported achieving BWG in layers fed with 2500 or 2600 kcal ME/kg with 18.0 or 17.0% CP during 19-40 woa but did not support BWG in layers subsequently fed with a low CP (16 or 15%) layer diet.

Feed consumption

Feeding same BPD to all groups (T0 to T5) did not change FC of pullets (Table 1) during prelay (16-18 weeks). Feeding different nutrient density layer diets (19-40 weeks) with same BPD indicating layer dietary CP and Ca levels did not change layers FC, but dietary ME changed FC (Table 1). The BPD maintained layers FC fed with BIS (2007) specifications layer diet (T0) during 19-40 woa. Layers’ FC predominantly depends on dietary ME and require to adjusting dietary CP and ME because altering CP level without considering ME may result in nutrient imbalance (Harms *et al*., 2000). Birds did regulate their FC according to energy level (Zhang and Kim. 2013). Different dietary CP levels did not affect FC with isocaloric diet confirmed by Rama Rao *et al.* (2011). Different layer dietary CP (Ribeiro *et al*., 2016) and Ca (Sudaryati, 2006) levels did not influence FC. Therefore, dietary ME affects laying hen’s FC. This study indicated that the higher dietary ME lowers FC and vice-versa in White Leghorn layers. Layers can be fed a 2600 kcal ME/kg diet with 18.0% CP and 3.0% Ca during 19-40 woa when fed with BPD to maintain FC.

Table 1: Body weight gain (g) and feed consumption (g) in bird fed with best prelay and different layer diets.

Treatment	Body weight gain, g		Average daily feed consumption, g	
	16-18 wk	19-40 wk	16-20 wk	21-40 wk
T0	151.60±7.12	553.53^a±9.53	90.71±0.13	110.05^b±0.11
T1	152.10±7.50	534.40^a±26.37	90.54±0.22	114.21^a±0.04
T2	151.47±17.31	548.57^a±14.50	90.50±0.11	114.19^a±0.02
T3	157.30±9.07	510.00^{ab}±11.86	90.80±0.13	114.20^a±0.05
T4	154.63±6.09	467.89^b±25.21	90.92±0.42	114.28^a±0.05
T5	155.70±5.26	475.36^b±16.99	90.84±0.09	114.27^a±0.09
SEM	3.590	9.300	0.085	0.290
CD at 1%	NS	73.321	NS	0.297
CV %	13.964	8.049	0.532	0.148
p-value	0.997	0.009	0.689	0.000

Means bearing different superscripts within the column differ significantly (p<0.01).

SEM: Standard error mean, CV: Coefficient of variation, wk: Week.

Table 2: Daily calcium, protein and metabolic energy intake of layers fed with best prelay and different layer diets.

Treatment	Calcium intake(g/day)		Protein intake(g/day)		Metabolic energy intake (kcal/day)	
	Age in weeks					
	16-18	19-40	16-18	19-40	16-18	19-40
T0	2.18±0.003	3.22^{d}±0.02	15.70±0.02	19.28^{b}±0.02	233.22±1.24	278.42±0.28
T1	2.18±0.005	3.31^{c}±0.04	15.68±0.04	19.89^{a}±0.01	235.24±0.61	276.16±0.08
T2	2.18±0.005	4.42^{b}±0.02	15.71±0.03	19.89^{a}±0.01	235.07±0.77	276.16±0.07
T3	2.19±0.005	4.42^{ab}±0.04	15.73±0.03	18.72^{c}±0.01	235.96±0.42	276.42±0.10
T4	2.18±0.007	4.43^{ab}±0.01	15.68±0.05	17.82^{d}±0.04	235.16±0.83	269.64±0.98
T5	2.18± 0.004	4.44^{a}±0.01	15.70±0.02	16.64^{e}±0.05	238.78±3.45	277.44±0.85
SEM	0.002	0.102	0.014	0.217	0.668	1.190
CD at 1 %	NS	0.025	NS	0.165	NS	NS
CV %	0.530	0.344	0.513	0.499	1.515	2.332
p-value	0.813	0.000	0.920	0.000	0.298	0.355

Means bearing different superscripts within the column differ significantly (p<0.01). SEM: Standard Error Mean, CV: Coefficient of variation, NS: Non-significant, CD: Critical difference.

Table 3: Egg number, hen day egg production and feed consumption (kg) per dozen eggs (17-40 woa) in layers fed with best prelay and different layer diets.

Treatment	TEN per hen	Per cent HDEP	Feed consumption (kg) per dozen eggs
T0	101.38^{a}±2.09	60.60^{a} ±1.17	2.13^{b}±0.04
T1	98.81^{a}±3.39	58.89^{a} ±1.98	2.27^{b}±0.07
T2	98.99^{a}±1.07	58.57^{a} ±0.35	2.25^{b}±0.02
T3	99.03^{a}±1.60	58.95^{a} ±0.95	2.25^{b}±0.04
T4	89.41^{b}±3.13	52.75^{b} ±2.17	2.51^{a}±0.09
T5	88.93^{b}±3.33	52.11^{b} ±1.79	2.53^{a}±0.09
SEM	1.336	0.836	0.037
CD at 1%	10.282	6.098	0.269
CV %	6.049	6.050	6.534
p-value	0.006	0.002	0.002

Means bearing different superscripts within the column differ significantly (p<0.01).

SEM: Standard error mean, CV: Coefficient of variation, EN: Egg number, HDEP: Hen day egg production.

Calcium, protein and energy intake

Daily CaI, PI and MEI during 16-18 and 19-40 woa are depicted in Table 2. Feeding of same BPD resulting similar FC in all groups did not influence pullets daily CaI, PI and MEI during 16-18 woa. Feeding of 3.0% layer Ca (T0 and T1) significantly (p<0.01) decreased CaI in layers (19-40 woa) than 4.0% (T2 to T5). Among T0 and T1, higher ME (2600 kcal/kg in T0) significantly (p<0.01) decreased FC than 100 kcal/kg less dietary ME (2500 kcal/kg in T1) leads to significantly (p<0.01) higher CaI in T1 than T0 indicating ME and Ca levels and proportion of FC govern layers CaI. Dietary ME in T2, T3, T4 and T5 was similar to T1 (2500 kcal/kg), which did not change FC and, thus, layers daily CaI. Rama Rao *et al.* (2013) recommended 3.68 g Ca/bird/day in White Leghorn layers during 21-72 weeks of age reared in tropics without use of prelay Ca. Recently, Lonkar *et al.* (2022a; 2022b) found that 2.5% prelay Ca supported 3.0% layer Ca for better productive performance, indicating best prelay Ca decreases layer Ca requirement.

Different layer CP (18.0, 17.0, 16.0, or 15.0%) feeding (Table 2) indicated that layers PI decreased with a reduction in CP from 18.0 to 15.0%. Further, PI changes with FC and FC is influenced by layer diet ME. Bouvarel *et al.* (2011) also suggested that layer's PI is determined primarily by ME that influences FC.

The present study indicated that 2500 or 2700 kcal ME/kg diet did not affect daily MEI in layers (Table 2). However, higher dietary ME caused lower FC and vice-versa. The ME levels influenced the FC without affecting daily MEI in layers. Jeroch (2011) reported that laying hens can adjust their daily energy intake by increased FC corroborates with present findings.

Total egg number per hen

Significantly (p<0.01), lower TEN (Table 3) was recorded in T4 and T5 than T0 and other groups (T1, T2 and T3). Control T0 recorded the highest TEN than others. Feeding of low CP (T4: 16.0% and T5: 15.0% CP) led to fewer egg production while higher CP (T0, T1 and T2: 18.0% and T3: 17.0% CP) did not affect TEN. Layers from T4 and T5 produced 11.91 and 12.45 fewer eggs than control T0. Similarly, Shim *et al.* (2013) and Ribeiro *et al.* (2016) reported that feeding of low CP in layers decrease egg production. It was also found that the change in either ME or Ca level in layer diet did not affect the EN corroborates with Harms *et al.* (2000); Zhang and Kim (2013) and Sudaryati (2006) who found that dietary ME did not affect egg production. Feeding BPD (16-18 woa) and different layer diets (19-40 woa) indicated that a BPD supported egg production for 18.0 or 17.0% than 16.0 or 15.0% CP. Williams *et al.* (2000) suggested that higher EP could be associated with positive energy and protein balance during the prelay period. Moreover, present result indicated that the layers can also

Table 4: Performance efficiency index (PEI) and egg feed price ratio (EFPR) of layers fed with best prelay and different layer diets.

Treatment	PEI_{40}	$EFPR_{40}$
T0	38.27^{a}±1.29	0.93±0.02
T1	34.10^{b}±1.59	0.89±0.03
T2	34.15^{b}±0.96	0.89±0.01
T3	33.85^{b}±0.94	0.90±0.01
T4	30.63^{bc}±1.79	0.83±0.03
T5	30.02^{c}±1.93	0.84±0.03
SEM	0.696	0.011
CD at 1%	5.128	NS
CV %	8.652	6.139
p-value	0.002	0.071

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

be fed 17.0% CP (1% lower than BIS 2007 specification) diet (19-40 woa) when fed with a BPD (16-18 woa).

Hen day egg production

Change in dietary ME from 2600 to 2500 kcal/kg, CP from 18.0 to 17.0% and Ca from 3.0 to 4.0% in laying diet among T0, T1, T2 and T3 did not show a significant difference (p<0.01) in HDEP during 17-40 woa (Table 3). Inclusion of low CP in layer diet from T4 (16.0%) and T5 (15.0%) resulted in a significant decrease (p<0.01) in HDEP. Shim *et al.* (2013) confirmed feeding low CP in layers decreases egg production. Harms *et al.* (2000) and Zhang and Kim (2013) reported that dietary energy did not affect EP. Sudaryati (2006) reported that the dietary Ca did not significantly affect EP. It is recommended to use BPD along with BIS (2007) specifications layer diet to support good HDEP. Moreover, the BPD allowed to reduce layer CP by 1.0% (18.0 to 17.0%).

Feed efficiency

Inclusion of low CP (T4: 16.0% and T5: 15.0% CP) significantly (p<0.01) resulted in poor FCDE (Table 3) than higher CP (T0, T1 and T2: 18.0% and T3: 17.0% CP). The 17.0% CP (T3) lower than BIS (2007) (18.0%) in T0 layer diet was supported by BPD for maintaining FCDE. The best (p<0.01) feed efficiency was recorded at 18.0% dietary CP (Ribeiro *et al*., 2016), while poor feed efficiency was recorded at 15.05% CP (Shim *et al*., 2013). The FCDE was not affected by 3.0 or 4.0% of Ca in layer diet.

Performance efficiency index and egg feed price ratio

The BPD feeding with BIS (2007) specification layer diet (T0) improved PEI than others (Table 4). Layers fed with low (16.0% and 15.0%) CP (T4 and T5) decreased PEI than others. Higher EN and less FC in layers fed with BIS (2007) specification layer diet (T0) numerically increased EFPR (Table 4). Lonkar *et al.* (2022a) reported better PEI and EFPR by feeding best prelay with BIS (2007) layer diet and economical in White Leghorn layers corroborates with present findings.

CONCLUSION

Feeding BPD (18.0% CP, 2700 kcal ME/kg diet and 2.5% Ca) three weeks (16-18 woa) before egg production and subsequent feeding of layer diet containing 2600 kcal ME/kg, 18.0% CP, 3.0% Ca during 19-40 woa is the best combination for improving EN, HDEP, FCDE, EFPR and PEI and found to be economical in White Leghorn layers. Moreover, the BPD allowed to reduce layer CP by 1.0% (18.0 to 17.0%).

ACKNOWLEDGEMENT

Authors thankful to AAU, Anand, Gujarat for providing facilities for Ph.D. research.

Conflict of interest: None.

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