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Effect of Different Nutrient Density Prelay Diets on Production Performance of White Leghorn Layers

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ABSTRACT

Background: Transitional phase of 2-3 weeks (prelay) before onset of egg production is extremely important for efficient layer. This study evaluates different nutrient density prelay diets on the subsequent performance of White Leghorn layers.

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 growth and production parameters were recorded.

Result: The 18% CP (T4 and T5), 2.0-2.5% Ca (T2 to T5) and 2700 kcal ME/kg (T1 to T5) in prelay diet significantly increased pullets daily metabolic energy ($p<0.05$), protein ($p<0.05$) and calcium ($p<0.01$) intake during 16-18 weeks than 2600 kcal ME/kg (T0), 16.0% CP (T0 to T3) and 1.0% Ca (T0). Prelay diet (T5) improved egg number, per cent egg production, feed efficiency, performance efficiency index and egg feed price ratio without affecting weight gain and feed consumption suggesting that prelay diet is a compromise between grower and layer diets.

Key words: Laying performance, Prelay diet, Pullet.

INTRODUCTION

Due to a genetic progress, modern pullets mature earlier than the hen of two decades ago. At the onset of egg production, the pullet's quality greatly determines profitability during the laying cycle. Prelay period normally begins two to three weeks before the onset of egg production. Substantial body reserves before egg production are indispensable to achieve satisfactory hen performance (Eusebio-Balcazar *et al.* 2018). Adoption of proper nutrition needs to produce pullets that develop into profitable layers. Earlier studies suggest no beneficial effect by feeding high-nutrient-density diets during the laying period, but during the prelay period (Sujatha and Rajini, 2015). Based on the metabolic changes before onset of egg production, a low-density BIS (2007) diet during growing, may not support a present high-yielding layer to establish essential reservoirs. There is a need to consider dietary nutrient requirements for ME, CP and Ca during the prelay period in modern laying hens to match growing pullets' physiological requirements and improve subsequent egg production. Thus, it aimed to study the effect of different nutrient density prelay diets on the subsequent performance of White Leghorn layers.

MATERIALS AND METHODS

Experimental design

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).

Parameters studied

Body weight gain (BWG) was recorded during 16-18 and 19-40 weeks. Daily feed consumption (g) per bird (FC) was recorded at the end of 16th, 17th, 18th and during 21-40 weeks of age. Average daily calcium (g) intake (CaI) and protein (g) intake (PI) were recorded (FC per bird per day x % nutrient in feed /100) for overall period of 16-18 and 17-40

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weeks of age. The metabolic energy (kcal/bird) intake (MEI) was recorded (FC per bird per day x ME content in feed /1000) for overall period of 16-18 and 17-40 weeks of age. Production parameters viz., egg number (EN) and percent egg production (EP); and feed efficiency in terms of feed consumption (kg) per dozen eggs (FCDE) were recorded for overall period of 17-40 weeks. Performance Efficiency Index (PEI) recorded at 28th and 40th week and Egg Feed Price Ratio (EFPR) recorded at 40th week as per Narahari *et al.* (2000).

Statistical analysis

The 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

Body weight gain

Different prelay diets did not significantly affect pullets and layers BWG (Table 1) corroborates with Joseph *et al.* (2000), who reported that different prelay CP (14, 16, or 18%) did not influence BWG. The 18.0% CP fed pullets (T4 and T5) had numerically higher BWG during 16-18 weeks while lower during 19-40 weeks than 16.0% prelay CP (T0, T1, T2 and T3) indicated short labile growth spurt. Leeson and Summers (2008) suggested that high nutrient density prelay diet had only minor effects on manipulating BWG. The increase in prelay ME by 200 kcal/kg in T1 to T5 diets than control resulted in a numerical increase in 16-18 weeks BWG. Similarly, Husseins *et al.* (1996) observed an increase 15-18 weeks BWG in White Leghorn pullets using higher ME. Positive energy balance at the onset of lay is essential for sustained EP (Williams *et al.* 2000). Feeding a prelay diet containing 2700 kcal ME/kg, 18.0% CP and 2.0 or 2.5% Ca resulted in a beneficial labile growth spurt, which was observed by a numerical increase and decrease in BWG during 16-18 and 19-40 weeks, respectively.

Feed consumption

Pullet's (16th, 17th and 18th week) and laying hen's FC (21-40 weeks) by feeding different prelay and single layer diet did not differ significantly (Table 1). Prelay CP effect corroborates with Keshavarz (1998) and Babiker *et al.* (2010) findings. Different prelay Ca levels did not change pullet's FC corroborate with Kocbeker *et al.* (2017). Different prelay diets did not change layer's FC. Overall, dietary Ca and protein had little or no influence on pullet's FC provided that the diet's energy level adjusted to bird's requirement.

Calcium intake

Variation in the dietary prelay Ca caused significant differences ($p<0.01$) in the pullet's daily CaI (Table 2). Low-prelay-Ca (1.0%) in T0 and T1 significantly ($p<0.01$) reduced pullet's daily CaI than moderate prelay Ca (2.0-2.5%) in T2, T3, T4 and T5. Among T2, T3, T4 and T5, significantly ($p<0.01$) higher pullet's daily CaI was recorded in T3 and T5 (2.5% prelay Ca) followed by T2 and T4 (2.0% prelay Ca). Inclusion of moderate prelay Ca may help create better body Ca reserve than low prelay Ca (1.0%). Leeson and Summers (2008), Bouvarel *et al.* (2011) and Sujatha and Rajini (2015) suggested 2.0-2.5% prelay Ca agrees with the present findings. Low prelay Ca of 0.9-1.5% causes a negative Ca balance in hen (Bouvarel *et al.* 2011). This negative Ca balance occurred in young hen during early EP cannot be alleviated by high layer dietary Ca. Therefore, 2.0 to 2.5% prelay Ca significantly ($p<0.05$) improved pullet's daily CaI is recommended to ensure the Ca balance than 1.0% prelay Ca. The laying hen's daily CaI did not differ significantly due to the same Ca (3.0%) in all groups.

Protein intake

The 18.0% prelay CP (T4 and T5) significantly ($p<0.05$) increased pullets daily PI (Table 2) than 16.0% prelay CP (T0 and T1, T2 and T3). Results corroborate with the findings of Sujatha and Rajini (2015) recommended 18.0% prelay CP produced a pullet with better body protein before sexual maturity than 16.0% prelay CP. The higher PI at the beginning of the laying period might be required to produce larger eggs and to compensate BWG (Soares *et al.* 2003). However, the PI is dependent on the dietary energy concentration (Bouvarel *et al.* 2011). The laying hen's daily PI fed with the same layer diet found to be non-significant. Bouvarel *et al.* (2011) reported that PI depends on the dietary ME. However, in the present study, both layer dietary ME and CP levels are the same that might not change laying hen's PI.

Table 1: Average body weight gain (g) and daily feed consumption (g) per bird fed with different prelay and single layer diets.

Treatment	Body weight gain, (g)		Average daily feed consumption, (g)			
	16-18 wk	19-40 wk	16 wk	17 wk	18 wk	21-40 wk
T0	149.24±5.62	524.63±29.00	86.93±0.48	89.04±1.37	91.92±1.36	109.80±0.08
T1	148.20±6.17	513.17±10.09	85.60±0.69	87.59±0.11	90.27±0.49	109.76±0.05
T2	150.80±7.59	507.55±9.93	85.2±0.73	87.09±0.37	89.75±1.03	109.73±0.13
T3	157.87±8.82	548.03±16.13	84.69±0.77	86.54±0.60	88.85±0.36	109.72±0.10
T4	163.20±8.74	486.57±12.35	85.23±0.41	86.74±0.37	89.59±0.47	109.87±0.09
T5	167.27±5.00	499.27±14.63	85.02±0.23	86.59±0.05	89.17±0.72	109.75±0.04
SEM	2.977	7.174	0.256	0.291	0.376	0.034
CV %	10.242	7.267	1.547	1.670	2.196	0.182
p-value	0.323	0.188	0.159	0.094	0.217	0.844

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

Table 2: Average daily calcium, protein and metabolic energy intake per bird fed with fed with different prelay and single layer diets.

Treatment	Calcium intake (g/day)		Protein intake (g/day)		Metabolic energy intake (kcal/day)	
	Age in weeks					
	16-18	17-40	16-18	17-40	16-18	17-40
T0	0.89^{c}±0.006	3.21 ±0.002	14.29^{b}±0.093	19.27 ± 0.01	223.25 ^{b}±1.48	278.25 ±0.22
T1	0.88^{c}±0.002	3.21 ±0.002	14.04^{c}±0.033	19.25 ±0.08	237.11^{a}±0.38	277.99 ±0.12
T2	1.75^{b}±0.010	3.20 ±0.007	13.98^{c}±0.078	19.22 ±0.03	235.93^{a}±1.34	277.64 ±0.52
T3	2.17^{a}±0.013	3.22 ±0.015	13.87^{c}±0.084	19.22 ±0.02	234.08^{a}±1.41	277.44 ±0.30
T4	1.74^{b}±0.005	3.21 ±0.003	15.69^{a}±0.053	19.25 ±0.02	235.40^{a}±0.79	278.03 ±0.23
T5	2.20^{a}±0.028	3.21±0.002	15.61^{a}±0.061	19.23 ±0.01	235.11^{a}±0.95	277.76 ±0.20
SEM	0.100	0.003	0.145	0.008	0.962	0.119
CD at 5 %	0.041	NS	0.206	NS	3.293	NS
CD at 1 %	0.056	NS	0.279	NS	4.462	NS
CV %	1.976	0.499	1.084	0.237	1.080	0.236
p-value	0.000	0.719	0.000	0.509	0.000	0.440

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

Table 3: Average egg number, per cent egg production and feed consumption (kg) per dozen eggs (17-40 weeks) of hens fed with different prelay and single layer diets.

Treatment	Total EN per hen	Per cent EP per hen	Feed consumption (kg) per dozen eggs
T0	97.53±3.00	58.03±1.79	2.22±0.06
T1	102.60±1.07	61.07±0.63	2.11±0.02
T2	103.87±3.91	61.81±2.32	2.08±0.06
T3	101.30±1.99	60.29±1.18	2.13±0.02
T4	105.50±2.50	62.81±1.49	2.05±0.08
T5	108.30±4.57	64.40±2.76	2.00±0.04
SEM	1.300	0.776	2.026
CV %	6.655	6.694	6.748
p-value	0.246	0.256	0.285

SEM: Standard error mean, CV: Coefficient of variation, EN: Egg number, EP: Egg production.

Energy intake

Pullets MEI (Table 2) was significant (p<0.01) among different groups. The pullets daily MEI from control (T0) was significantly (p<0.01) lower than other prelay diets (T1 to T5). Low ME in the control diet (T0) caused significantly (p<0.01) lower daily pullets MEI than T1 to T5 diets. There was a slight numerically higher FC in pullets fed with diet T0 than T1 to T5 indicated that the prelay ME might change the pullet's FC. Husseins *et al.* (1996) and Ding *et al.* (2016) also observed similar effects of changing the ME level, not by protein (Summers and Leeson, 1993). The prelay diet should contain 2700 kcal ME/kg, which maintains BWG during the prelay period. The laying hen's daily MEI fed with the same layer diet (2600 kcal ME/kg) did not differ significantly. Rama Rao *et al.* (2011) recommended 2600 kcal ME/kg during initial production phase of White Leghorn layers than 2350 kcal ME/kg diet.

Egg number

Though EN (Table 3) was non-significant, the prelay diet (T5) produced 10.77 more eggs than control, indicating T5 diet supported for increasing EN agrees with the findings of Sujatha *et al.* (2014). Similarly, Cave (1984) observed higher EN (110 eggs/bird) in the 18.1% prelay CP than 15.4% prelay CP group (101 eggs/bird) during 35-50 weeks. Chauynarong *et al.* (2007) concluded that low prelay CP might affect ovary weight and EP in Isa-Brown hens. Kocbeker *et al.* (2017) reported no difference in the EP by using 0.8, 1.6 and 3.2% prelay Ca during 14-20 weeks.

Egg production

Though the layers from all groups fed with same layer diet, non-significantly higher percent EP (Table 3) was observed when the prelay diet contained higher ME (2700 kcal/kg) and CP (18.0%), but when prelay Ca was increased to 2.5% along with higher ME and CP, the best overall EP (64.40%) was observed in T5. Pullets fed with BIS (2007) specification (T0) had lower EP (58.03%). The EP was numerically increased by 6.37% in T5 fed with high nutrient density prelay diet than control (T0) fed with low nutrient density prelay diet. Previous reports about using different levels of Ca (Kocbeker *et al.,* 2017) in pullet's prelay diet did not show beneficial effect on EP. Low-prelay CP (14.0% and 15.4%) diets (Leeson and Summers, 1981) did not have a significant effect on EP, whereas higher prelay CP (18.1%) diet (Joseph *et al.,* 2000) had higher EP. Williams *et al.* (2000) suggested that higher EP could be associated with positive energy and protein balance during the prelay period. The best percent EP was observed in the present study with 2700 kcal ME/kg, 18.0% CP and 2.5% Ca in prelay diet, consistent with results reported by Sujatha *et al.* (2014).

Feed efficiency

Prelay ME, CP and Ca did not significantly differ layer's FCDE (Table 3). However, T5 recorded numerically improved

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

Treatment	PEI_{28}	PEI_{40}	$EFPR_{40}$
T0	23.16±1.93	32.71^{c}±1.45	0.94±0.03
T1	26.64±1.54	34.78^{bc}±0.48	0.99±0.11
T2	27.77±2.79	33.33^{bc}±1.45	1.01±0.18
T3	24.42±1.04	35.20^{bc}±0.70	0.98±0.02
T4	27.47±1.09	36.77^{ab}±1.44	1.02±0.02
T5	28.38±1.90	39.17^{a}±1.92	1.02±0.04
SEM	0.760	0.639	0.012
CD at 5%	NS	3.906	NS
CV %	15.448	0.470	6.680
p-value	0.299	0.026	0.266

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

FCDE due to improved EP than others. The non-significant prelay diet effect on FCDE was in agreement with Keshavarz (1998) and Babiker *et al.* (2010) findings. Chauynarong *et al.* (2007) reported that the different prelay CP (12.0, 14.0 and 16.0% CP) did not affect feed efficiency. Kocbeker *et al.* (2017) found no difference in the layer's feed efficiency provided with 0.8, 1.6 and 3.2% prelay Ca during 14-20 weeks.

Performance efficiency index and egg feed price ratio

The PEI (Table 4) did not differ significantly in 28th week; however, group T5 recorded non-significantly better PEI than others. Significantly (p<0.05) highest PEI was recorded in T5 in 40th week. Higher the value, better is the PEI. The EFPR (Table 4) did not differ significantly. Lower value for EFPR was observed in control (T0) due to less EN, while numerically better EFPR in T4 and T5 was due to higher EN. Higher EFPR is indicative of more profit. In agreement with current findings, Sujatha *et al.* (2014) observed that a prelay diet containing 2700 kcal ME/kg and 18.0% CP had the lowest pullet production cost.

CONCLUSION

Prelay diet affects the performance of laying hens. High nutrient density prelay diet (18.0% CP, 2700 kcal ME/kg diet and 2.5% Ca) along with BIS (2007) layer diet might improve EN, EP, FCDE, PEI and EFPR without affecting BWG and FC during the first phase of laying in White Leghorn layers.

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REFERENCES

Babiker, M.S., Abbas, S.A., Kijora, C., Danier, J. (2010). The effect of dietary protein and energy levels during the growing period of egg-type pullets on early egg production and egg weight and dimensions in arid hot climate. International Journal of Poultry Science. 9(10): 935-943.

Bouvarel, I., Nys, Y., Lescoat, P. (2011). Hen Nutrition for Sustained Egg Quality: Improving the Safety and Quality of Eggs and Egg Products (2nd ed.). Cambridge, Woodhead Publishing Ltd., Cambridge, UK.

Bureau of Indian Standards (BIS). (2007). Indian Standard Poultry Feeds- Specification. 5th edn. New Delhi.

Cave, N.A.G. (1984). Effect of a high protein diet fed prior to the onset of lay on performance of broiler breeder pullets. Poultry Science. 63: 1823-1827.

Chauynarong, N., Iji, P., Isariyodom, S., Choct, M., Mikkelsen, L. (2007). Change in body weight and ovary weight of prelay pullets fed maize-soy based diet supplemented with an exogenous microbial enzyme. Kasetsart Journal (Nature Science). 41: 49-55.

Ding, Y., Bu, X., Zhang., N., Li, L., Zou, X. (2016). Effects of metabolizable energy and crude protein levels on laying performance, egg quality and serum biochemical indices of Fengda-1 layers. Animal Nutrition. 2: 93-98.

Eusebio-Balcazar, P.E., Purdum, S., Hanford, K., Beck, M.M. (2018). Limestone particle size fed to pullets influences subsequent bone integrity of hens. Poultry Science. 97: 1471-1483.

Husseins, A.S., Cantor, A.H., Pescatore, A.J., Johnson, T.H. (1996). Effect of dietary protein and energy levels on pullet development. Poultry Science. 75: 973-978.

Joseph, N.S., Robinson, F.E., Korver, D.R., Renema, R.A. (2000). Effect of dietary protein intake during the pullet-to-breeder transition period on early egg weight and production in broiler breeders. Poultry Science. 79: 1790-1796.

Keshavarz, K. (1998). The effect of light regimen, floor space and energy and protein levels during the growing period on body weight and early egg size. Poultry Science. 77: 1266-1279.

Kocbeker, V., Bahtiyarca, Y., Demirors, G. (2017). Effect of diets with various calcium and boron levels in prelaying period on growth, bone ash and subsequent performance and shell quality of laying hens. International Journal of Medical Science and Clinical Invention. 4(11): 3335-3340.

Leeson, S. and Summers, J.D. (2008). Feeding Programs for Growing Egg-strain Pullets in Commercial Poultry Nutrition. (3rd ed.). Thrumpton, Nottingham, England: Nottingham University Press.

Leeson, S. and Summers, J.D. (1981). Use of single-stage low protein diets for growing Leghorn pullets. Poultry Science. 61: 1684-1691.

Narahari, D., Rajini, A., Prabaharan, R. (2000). Poultry Economics and Marketing (1st ed.). Chennai, India: New Print and Process.

Rama, R.S.V., Ravindran, V., Srilatha, T., Panda, A.K., Raju, M.V.L.N. (2011). Effect of dietary concentrations 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.

Snedecor, G.W. and Cochran, W.G. (1994). Statistical Methods. (8th ed.). New Delhi: Oxford and IBH Publishing Company.

Soares, R.D., Fonseca, J.B., Santos, A.D.O., Mercandante, M.B. (2003). Protein requirement of Japanese quail (*Coturnix coturnix japonica*) during rearing and laying periods. Brazilian Journal of Poultry Science. 5(2): 153-156.

Sujatha, T. and Rajini A. (2015). Transitional pullet feed and its significance at sexual maturity. Indian Journal of Animal Research. 49(1): 77-80.

Sujatha, T., Rajini A.R., Prabakaran, R. (2014). Efficacy of pre-lay diet. Journal of Applied Animal Research. 42(1): 57-64.

Summers, J.D. and Leeson, S. (1993). Influence of diets varying in nutrient density on the development and reproductive performance of White Leghorn pullets. Poultry Science. 72(8): 1500-1509.

Williams, B., Waddington, D., Solomin, C. (2000). Dietary effects on bone quality and turnover and Ca and P metabolism in chickens. Research in Veterinary Science. 69: 81-87.