IJARIIT INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 4 - V7I4-1288)
Available online at: https://www.ijariit.com

Reducing crude protein level in commercial layer chicken feed by balancing digestible amino acids

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ABSTRACT

A total of 10 commercial layer farms in the stage of phase-I laying period (25 to 40 weeks) reared in raised platform caged house with uniform management wereselected for the experiment. In each farm, 4000 birds will be selected and divided into two treatment groups of 2000 birds each. The feed formulation with reduced crude protein level (15 per cent) compared to standard level of 17 per cent will be formulated by balancing the digestible amino acids (Lysine, methionine+cysteine, threonine, tryptophan, arginine, isoleucine and valine). Feed ingredients used in feed formulation were maize, cumbu, broken rice, soya bean meal, sun flower cake, deoiled ricebran, rapeseed meal, fish meal,etc. Based on the above study it could be concluded that crude protein reduction is one of the way to reduce feed cost in commercial layer chickens, but should be properly balanced with all the essential digestible amino acids rather than total amino acids basis. But the quality of feed ingredients, loss in body weight and egg weight is the area of concern.

***Keywords**: Crude protein, Commercial layers, Chicken, Digestible aminoacids*

1. INTRODUCTION

Poultry is one of the fastest growing segments of the agricultural sector in India today. While the production of agricultural crops has been rising at a rate of 1.5 to 2 per cent per annum but eggs and broilers has been rising at a rate of 8 to 10 per cent per annum. As a result, India is now the world's third largest egg producer and the fifth largest producer of broilers. The poultry sector in India has undergone a paradigm shift in structure and operation. A significant feature of India's poultry industry has been its transformation from a mere backyard activity into a major commercial activity in just about four decades. In Tamil Nadu, Namakkal has the population of about 37 million birds producing at least 29.6 million eggs per day counting more than 50 per cent of the total egg production of the state. Poultry production has played a pivotal role in increasing source of income and employment generation for the educated unemployed youth.

Presently, Namakkal stands first in egg production in India. The poultry population in Namakkal poultry belt is around 4.5 crores (1200 layer poultry farms) with a daily egg production of 3.0 crores. The daily feed requirement is around 4500 tonnes per day with a daily turnover of Rs.75 crores which occupies 75 per cent of total expenditure in the layer poultry industry.The primary objective of poultry production is to achieve desired performance with minimum possible input cost while considering the environ- mental issues related to intensive poultry operations. The profitability of poultry farming primarily depends on the reduction in food cost which can be achieved by optimising the dietary concentrations of metabolisable energy (ME) and crude protein (CP), which represent major portion of food cost. Both higher and suboptimal dietary concentrations of these major nutrients not only will influence bird performance, but also will increase the cost of production. The feed cost is mainly determined by crude protein level in the layer chicken feed. The raw materials commonly included in the poultry feed formulation as a source of crude protein are mainly soya bean meal, sunflower cake, fish meal, groundnut oil cake etc. The cost of these feed ingredients is normally high with great fluctuations throughout the year. During some season, due to heavy raise in the cost of protein sources, some of the raw materials were imported as an alternative source for the substitution in the feed formulation, but it was also not a permanent remedy to reduce the cost of feed. Hence, the present study is designed to examine the performance of commercial layer chicken (phase-I) by reducing the crude protein level by balancing the digestible amino acids.

2. MATERIALS AND METHODS

2.1. Birds and management

A total of 4000 White Leghorn (Babcock, BV 300) layer pullets (average body weight, 1.46 ± 0.01 kg) were utilized for this study. At 25 weeks of age, the pullets were randomly assigned to 4-bird colony cages (46 × 38 × 45 cm) and 125 adjacent cages (500 birds) were considered as a replicate, which a common feeder to measure the group hadfeed intake and other variables at 28days intervals. The cages werefitted on elevated platforms in an open-sided poultry house. Natural day light andfluorescent illumination was used to provide 16hours light and 8 hours darkness perday throughout the trial period. The experiment was conducted following the guide-lines of the Institute Animal Ethics Committee. The experiment was conducted at 10 different commercial laying farms, Namakkal, Tamilnadu, India**.**

2.2. Diets

Two diets containing two CP concentrations (17%, 15%),with completely balancing the digestible amino acids(Lysine, methionine + cysteine, threonine, tryptophan, arginine, isoleucine and valine) treatments were formulated. Food ingredients were analyzed for CP, lysine and methionine (Llames and Fontaine, 1994) prior to the start of experiment and also when a new batch of food ingredients was received and accordingly, the concentrations of protein sources and crystalline amino acids were adjusted to meet the required dietary nutrient concentrations.Each diet was offered to 10 replicates (4000 birds/replicate) during 25–40 weeks of age.

2.3. Traits measured

Egg production was recorded twice. Feed intake per bird and Feed efficiency (quantity of food consumed to produce one egg) were calculated and compiled at every 28days intervals (period). Average Egg weight was recorded by weighing 30 eggs per replicate per day for 3 consecutive days at the end of each period (26–28 days). Individual body weights were recorded at 168^{th},196^{th},224^{th}, 252th and 280thdays of age. Daily maximum and minimum temperature and humidity were recorded (Traceable Digital Thermometer, Product 066624, Fisher Scientific, Mumbai, India), and the average value was calculated per each period.

2.4. Statistical analysis

The mean of each replicate was used as the experimental unit in the statistical analysis Mostoftheproductionvariablesduringtheinitial (periods 1–3) and post-peak production phases (periods 9–13) were unaffected by dietary concentrations of CP; hence, data from periods 1–3, 4–8 and 9–13 were combined for the statistical analysis.

3. RESULTS AND DISCUSSION

3.1 Hen day egg production

The interaction between dietary concentrations of Crude protein and digestible amino acids was significant for Egg production either during any individual production phase (initial, peak or post-peak) or over the entire experiment. Similarly, the Egg production was not affected by dietary concentrations crude protein during the different phases, except in summer season

3.2 Feed consumption

Interaction between ME and CP concentrations was not significant (P>0.05) for FI. Similarly, the dietary concentrations of CP had no influence (P>0.05) on the FI during initial and peak production phases, or overall experiment (Table 2). The FI during the post-peak production phase was significantly lower in layers fed on the 165 g/kg CP diet compared with those receiving the 150 g/ kg CP diet, while the FI of birds fed on the 180 g/ kg CP diet was intermediate. The FI decreased (P<0.01) progressively with each increment in the dietary concentration of ME from 10.04 to 11.30 MJ/kg in all periods, except during the peak production phase where reduction in FI was observed at the highest dietary concentration of ME (11.30 MJ ME/kg).

3.3 Feed efficiency

The interaction between ME and CP concentrations had no influence (P>0.05) on the FE during 21–72 weeks of age or during individual production phases. The FE during the initial production phase and overall production period (21–72 weeks) was significantly higher in groups fed on the 165 g CP/kg diet compared with those given the 150 g/kg diet, but no further improvement in FE was observed when the CP was increased to 180 g/kg diet. Feed efficiency improved progressively with increasing dietary ME concentrations during initial, post-peak and overall production periods. During the peak production phase, improvement in FE was observed in layers fed on the 11.30 MJ ME/kg dietcompared with those receiving lower concentrations of ME (10.04 or 10.67 MJ/kg).

3.4 Egg weight

EW was not influenced (P>0.05) by either the interaction between ME and CP or dietary concentrations of ME and CP during the different periods studied, except during the initial phase, where significant improvement in EW was observed when dietary CP was increased from 150 to 165 g/kg, but no further improvement was observed at 180 g CP/kg diet.

3.5 Body weight

Dietary concentrations of ME and CP had no effect (P>0.05) on the body weight (1493 ± 7.0 g) at 72 weeks of age and body weight gain (337 ± 6.7 g) over the experimental period (21–72 weeks of age) (data not shown).

Table:1. Hen day egg production (Mean ± S.E.) of commercial layer chicken (phase-I) as influenced by reduced crude protein level by balancing digestible amino acids

Poultry Farm No.	Days	T1 Control diet (17% crude protein)				T2 Treatment diet (15% crude protein by balancing digestible amino acids)			
Days	168th	196th	224th	252th	280th	196th	224th	252th	280th
1	**94.10**	96.52	96.90	96.20	95.40	95.92	96.33	95.58	94.51
2	**93.31**	95.48	96.52	96.46	94.31	95.56	95.56	95.59	94.43
3	**92.96**	96.50	97.10	96.22	95.31	95.70	96.78	96.21	94.89
4	**93.72**	94.25	95.61	94.56	92.86	95.43	95.56	95.22	91.96
5	**93.04**	94.68	95.70	95.50	93.34	94.33	95.66	95.46	92.45
6	**94.08**	95.33	96.69	96.11	94.34	94.25	96.50	96.02	94.50
7	**93.55**	94.28	95.86	95.38	93.16	94.57	95.44	95.41	92.88
8	**92.28**	94.20	96.50	95.15	93.11	95.34	96.35	94.51	93.34
9	**93.37**	93.51	95.66	96.67	93.69	93.26	94.68	96.20	93.11
10	**92.25**	94.92	95.32	95.25	94.32	94.84	94.39	94.33	93.50

Mean ± S.E	T1	T2
R1	94.967 ± 0.315147	94.92 ± 0.261175
R2	96.186 ± 0.197491	95.725 ± 0.24689
R3	95.75 ± 0.214191	95.453 ± 0.202359
R4	93.984 ± 0.285125	93.557 ± 0.3131

Table.2 .Hen housed egg production (Mean ± S.E.) of commercial layer chicken (phase-I) as influenced by reduced crude protein level by balancing digestible amino acids

Poultry Farm No.	Starting period	T1 Control diet (17% crude protein)				T2 Treatment diet (15% crude protein by balancing digestible amino acids)			
Days	168th	196th	224th	252th	280th	196th	224th	252th	280th
1	**27.70**	54.53	81.53	107.33	134.83	53.79	80.85	107.24	132.68
2	**27.11**	55.15	80.05	108.48	134.50	54.54	80.34	108.33	134.25
3	**26.58**	53.89	80.27	107.54	132.67	53.21	80.67	107.68	132.38
4	**25.96**	52.22	79.34	106.22	133.53	52.30	79.45	106.24	133.90
5	**27.39**	54.18	79.89	108.66	133.55	54.25	79.22	108.38	133.49
6	**26.42**	54.75	80.53	106.89	132.64	54.56	80.01	106.65	132.45
7	**26.58**	55.67	81.66	106.21	131.64	55.59	80.20	106.20	131.25
8	**25.65**	53.54	79.50	105.48	132.54	53.34	79.22	105.23	131.38
9	**27.82**	54.67	81.49	107.44	133.95	54.23	80.65	107.30	132.90
10	**26.33**	55.45	79.37	107.72	131.45	55.23	79.00	107.53	131.98

Mean ± S.E	T1	T2
R1	**54.405 ± 0.32129**	**54.104 ± 0.309982**
R2	**80.363 ± 0.287708**	**79.961 ± 0.217357**
R3	**107.197 ± 0.320163**	**107.078 ± 0.31574**
R4	**133.13 ± 0.359289**	**132.666 ± 0.316437**

Table.3. Feed consumption (Mean ± S.E.) of commercial layer chicken (phase-I) as influenced by reduced crude protein level by balancing digestible amino acids

Poultry Farm No.	Days	T1 Control diet (17% crude protein)				T2 Treatment diet (15% crude protein by balancing digestible amino acids)			
	168th	196th	224th	252th	280th	196th	224th	252th	280th
1	**105.35**	110.85	112.05	113.58	114.06	111.36	112.24	113.86	114.57
2	**105.70**	111.61	112.35	113.65	113.45	112.50	112.95	114.32	113.80
3	**104.94**	110.45	111.20	113.50	113.75	110.65	111.50	113.68	113.46
4	**105.52**	112.35	114.50	114.25	114.36	112.34	113.94	114.67	114.50
5	**105.65**	110.43	112.50	114.68	114.78	111.25	112.58	114.90	114.90
6	**106.83**	113.50	113.80	114.59	114.39	113.69	113.25	114.77	114.66

7	**104.87**	112.63	112.50	112.45	115.35	112.34	113.45	112.85	115.45
8	**106.25**	113.50	111.65	113.78	113.47	113.48	111.68	113.65	113.76
9	**105.75**	111.48	112.40	111.75	114.49	111.76	112.24	112.69	114.88
10	**106.38**	111.80	112.35	113.36	114.36	111.32	112.65	113.45	114.59

Mean ± S.E	**T1**	**T2**
R1	111.86 ± 0.357084	112.069 ± 0.312531
R2	112.53 ± 0.304613	112.648 ± 0.244197
R3	113.559 ± 0.286746	113.884 ± 0.245306
R4	114.246 ± 0.186388	114.457 ± 0.192704

Table.4 .Feed efficiency per egg (Mean ± S.E.) of commercial layer chicken (phase-I) as influenced by reduced crude protein level by balancing digestible amino acids

Poultry Farm No.	**Days**	**T1**				**T2**			
		Control diet (17% crude protein)				**Treatment diet (15% crude protein by balancing digestible amino acids)**			
	168th	**196th**	**224th**	**252th**	**280th**	**196th**	**224th**	**252th**	**280th**
1	**112.54**	113.88	116.40	116.65	117.04	114.77	116.16	116.46	117.57
2	**113.82**	113.80	115.65	117.56	118.60	113.31	116.34	117.52	118.90
3	**112.68**	114.24	115.80	116.85	118.56	114.78	116.50	116.56	118.75
4	**113.55**	114.46	114.68	117.92	118.90	114.81	114.78	117.10	117.55
5	**113.90**	114.35	116.45	116.87	117.89	113.69	116.56	116.46	117.85
6	**113.57**	114.48	115.75	116.45	117.76	114.23	115.12	116.40	117.64
7	**112.63**	113.97	114.46	116.75	118.55	113.68	114.45	116.58	118.69
8	**112.25**	113.81	114.87	117.04	118.87	113.35	115.04	117.75	118.35
9	**113.56**	114.31	115.69	117.30	118.88	114.78	115.60	117.53	118.69
10	**112.63**	113.90	114.88	117.57	118.90	113.45	114.54	117.75	118.90

Mean ± S.E	**T1**	**T2**
R1	114.12 ± 0.086641	114.085 ± 0.206734
R2	115.463 ± 0.222241	115.509 ± 0.262
R3	117.096 ± 0.14949	117.011 ± 0.182841
R4	118.395 ± 0.198842	118.289 ± 0.181136

Table.5. Egg weight (Mean ± S.E.) of commercial layer chicken (phase-I) as influenced by reduced crude protein level by balancing digestible amino acids

Poultry Farm No.	**Days**	**T1**				**T2**			
		Control diet (17% crude protein)				**Treatment diet (15% crude protein by balancing digestible amino acids)**			
	168th	**196th**	**224th**	**252th**	**280th**	**196th**	**224th**	**252th**	**280th**
1	**51.53**	55.54	56.31	56.70	57.10	55.26	55.46	56.23	56.50
2	**50.24**	53.25	56.35	55.24	56.34	52.68	56.10	55.14	56.75
3	**50.65**	54.10	54.22	56.66	56.87	53.67	53.80	55.55	56.67
4	**51.62**	52.66	53.90	54.41	56.45	51.88	53.89	54.65	56.55
5	**50.26**	53.23	55.67	56.90	57.56	53.90	54.99	56.47	56.80
6	**51.53**	54.12	53.15	54.25	56.35	53.98	52.84	54.85	55.46
7	**51.22**	52.90	54.78	56.50	57.90	52.79	54.75	56.74	57.81
8	**50.79**	52.66	55.97	56.35	57.78	52.45	55.65	56.65	57.42
9	**50.88**	51.46	54.85	55.90	56.10	52.45	54.68	55.45	55.85
10	**51.45**	51.75	53.75	55.58	56.70	51.50	53.45	56.01	56.63

Mean ± S.E	**T1**	**T2**
R1	53.167 ± 0.379002	53.056 ± 0.358237
R2	54.895 ± 0.360439	54.561 ± 0.33036
R3	55.849 ± 0.302484	55.774 ± 0.238582
R4	56.915 ± 0.204049	56.644 ± 0.212418

Table.6. Body weight (Mean ± S.E.) of commercial layer chicken (phase-I) as influenced by reduced crude protein level by balancing digestible amino acids

Poultry Farm No.	Days	T1				T2			
		Control diet (17% crude protein)				Treatment diet (15% crude protein by balancing digestible amino acids)			
	168th	196th	224th	252th	280th	196th	224th	252th	280th
1	**1415.28**	1460.35	1490.62	1510.70	1518.05	1448.50	1475.85	1501.40	1510.65
2	**1408.45**	1440.85	1495.46	1505.66	1532.35	1455.37	1469.68	1514.38	1543.51
3	**1410.38**	1453.74	1478.35	1524.64	1555.90	1412.39	1469.95	1515.96	1532.43
4	**1402.55**	1445.45	1484.70	1514.78	1540.38	1426.78	1478.56	1508.35	1526.32
5	**1408.94**	1436.84	1467.35	1534.45	1532.68	1441.35	1480.65	1517.38	1506.35
6	**1416.35**	1458.56	1483.65	1525.34	1552.36	1435.34	1475.67	1529.29	1527.24
7	**1411.74**	1460.66	1487.88	1513.56	1546.78	1455.90	1475.45	1506.25	1548.39
8	**1403.25**	1443.87	1472.42	1536.11	1552.56	1458.25	1460.86	1526.55	1568.06
9	**1410.65**	1444.28	1485.85	1512.43	1538.66	1435.32	1485.81	1537.90	1512.64
10	**1416.33**	1452.58	1482.455	1526.35	1540.46	1453.25	1455.68	1503.54	1549.47

Mean ± S.E	T1	T2
R1	1449.718 ± 2.711675	1442.245 ± 4.71593
R2	1482.874 ± 2.639822	1472.816 ± 2.871897
R3	1520.402 ± 3.291806	1516.1 ± 3.788726
R4	1541.018 ± 3.643864	1532.506 ± 6.280127

The results obtained are discussed in relation to the four production phases, namely (25– 28 weeks), (29–32 weeks) and (33–36 weeks) and (37-40 weeks). The data were analysed by both factorial and surface regression analyses, and the results of both analyses showed similarities such as the absence of response in majority of production variables during both initial (21– 32 weeks) and post-peak (53–72 weeks of age) laying phases. The effect of ME and CP on the production variables during peak production phase (33–52 weeks of age) was progressively increased with increasing dietary concentrations of these nutrients.

3.6. Production phase (25–32 weeks)

EP, EW and EM during the initial production phase were not affected by dietary concentrations of ME and CP. Thesefindings suggest that the lowest concentrations of ME (10.04 MJ/kg) and CP (150 g/kg diet) were sufficient for maximum performance during 21–32 weeks of age. Similar to the currentfindings, recommended 10.04 MJ ME/kg diet for brown egg-type layers reared in tropical climates for optimum EP. Contrary to thesefindings, Pesti (1991) reported improvement in EP with increase in dietary CP (120, 150, 180 and 210 g/kg) and ME (11.38, 12.55 and 13.39 MJ/kg) at 150 g/kg diet. The improvement in performance in thelatter study may be due to wide variation in concentrations of CP (120–222.4 g/kg) and ME (10.88–13.39 MJ/kg) tested. Pesti (1991) used considerably much lower concentrations CP (120 and 137.6 g, respectively, in experiments 1 and 2), which reduced performance of birds and further increase in dietary CP concentration improved the EP. In the present experiment, the lowest concentration of CP tested (150 g/kg) appears to be adequate for optimum EP. Although FE in birds fed on the 11.30 MJ ME/kg diet and 180 g CP/kg diet was higher compared with those fed on diets with lower concentrations of these nutrients, the absolute intake of energy to produce an egg was less in the latter treatment (1054 vs. 1100 J/egg). The data of EW and FE indicated that 11.30 MJ ME/kg diet and 172–178 g CP/kg as optimum for the maximum response in these performance variables. Contrary to the presentfindings, our previous work (Rama Rao et al., 2011) and that of Khajali et al. (2007) reported dietary CP concentrations of 165 and 163 g/kg, respectively, as optimum for layers up to 32 weeks of age. Pesti (1991), Balnave et al. (2000) and Novak et al. (2006) also observed increase in EW withincreasing dietary protein concentrations. The calculated daily intakes of ME, CP, lysine and methionine to produce an egg at 11.30 MJ ME/kg and 180 g CP/kg during the initial phase of production were 1127 J, 17.95 g, 808 mg and 409 mg, respectively.

3.7. Production phase (33–36 weeks)

Majority of the production variables (EP, FE and EM) improved with increasing dietary energy con- centration; therefore, the highest concentration of ME (11.30 MJ/kg) can be considered as the optimum concentration for layers during this period. The predicted value from surface regression analysis also indicated maximum responses at 11.30 MJ ME/kg diet for EP, FE and EM. In agreement, our previousfindings (Rama Rao et al., 2011) and those of Brown et al. (1965) and Peguri and Coon (1991) recommended similar energy (10.88–11.07 MJ ME/kg diet) concentrations for maximum EP. The predicted CP concentration (172–180 g/kg diet) was higher than the optimum concentration (150 g/kg diet) found in our previous studies during the peak EP phase (Rama Rao et al., 2011). The higher CP concentrations observed in the current experiment might be due to reduced FI at higher ambient temperatures due to summer. The calculated average daily intakes of ME, CP, lysine and methionine in layers fed on diets with the highest concentrations of ME and CP were 1121 J, 17.9 g, 804 mg and 407 mg, respectively. In contrast, Jalal et al. (2006) and Wu et al. (2007) failed to observe difference in layer performance with dietary ME concentrations. The absence of response in the latter studies might be due to higher concentrations of ME used (11.72 and 11.49 MJ/kg diet, respectively) than the optimum concentration observed in the present experiment (11.30 MJ/kg diet).

3.8. Production phase (37–40 weeks)

Based on EP, EW and EM, it can be concluded the lowest concentrations of energy and protein tested (10.04 MJ ME/kg and 150 g CP/kg) were adequate for maximum layer performance during 53–72 weeks of age. The CP concentration was similar to that observed (150 g/kg diet) in our previous experiment (Rama Rao et al., 2011) for layers under tropical environment. Although the FE improved with increasing dietary concentrations of ME and CP, the absolute intake of these nutrients required to produce an egg was less at the lower concentrations of ME and CP than those receiving higher concentrations. The calculated daily intakes of ME in layers fed on 10.04 and 11.30 MJ/kg diets to produce an egg are 1297 and 1322 J, respectively. Contrary to these observations, literature from temperate regions (Wu al., 2005, 2007) report higher energy requirements for layers (1407 J/egg). The lower ME values observed in the present study might partly be due to lower body weight (1.49 ± 0.01 kg at 72 weeks) of layers compared with the previous studies (1.58–1.74 kg at 36 weeks), which may be indicative of lower energy requirement for body maintenance at higher ambient temperatures (De Andrade et al., 1977). Similar to the presentfindings, Novak et al. (2006) did not observe difference in layer performance (44–63 weeks) when given 14.6 g compared with those receiving 17.0 g protein per hen per day. In contrast, however, Pesti (1991), Liu et al. (2005), Wu etal.(2005)andGunawardanaetal.(2008)reported increased EP with increasing dietary protein intakes from 8.51 to 17.1 g per hen per d. The improved performance in the latter studies may be due to utilisation of suboptimal concentrations of protein tested as minimum concentrations in the diet.

4. CONCLUSION

Dietary Crude protein concentration of 15% had no influence inlayer performance except on Egg weight and Body weight during the early lay period. A minimum of 16.5% Crude protein is required for optimal Egg weight in layer diets at 25 to 32 weeks of age. Although Egg production,Feed intake, Feed efficiency were not affected, Egg weight during most of the production phases and over the entire trial period decreased.White Leghorn layers (25 to 40 weeks of age) reared in open-sided houses under tropical conditions required approximately 0.70% lysine and 0.305% methionine in diets containing approximately 15% CP and 2,600 kcal of ME/kg of diet. However, to achieve optimal Egg weight, a level of 16.5% CP is essential from 25 to 40 weeks of age.

5. ACKNOWLEDGEMENT

The author wish to thank the Dean, Veterinary college and Research Institute, Namakkal and commercial layer farmers, Namakkal for providing infrastructure to complete this work.

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