RESEARCH ARTICLE

Effect of Varying Levels of Dietary Protein and Energy on Performance of Commercial Broiler Chicken

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Abstract

One hundred and sixty (160) straight run day-old commercial broiler chicks were randomly divided into 5 dietary treatments with four replicates having 8 chicks in each replicate. The five dietary treatments with varying levels of CP and ME were: T_1 diet with 21, 20 and 18% CP and 2800, 2900 and 3000 Kcal/kg ME in pre-starter, starter and finisher mash, respectively. T_2 diet with 22, 21 and 19% CP and 2900, 3000 and 3100 Kcal/kg ME in pre-starter, starter and finisher mash, respectively. T_3 diet was kept as basal diet as per BIS (23, 22 and 20% CP and 3000, 3100 and 3200 Kcal/kg ME in pre-starter, starter and finisher mash, respectively). T_4 diet with 24, 23 and 21% CP and 3100, 3200 and 3300 Kcal/kg ME in pre-starter, starter and finisher mash, respectively. T_5 diet with 25, 24 and 22% CP and 3200, 3300 and 3400 Kcal/kg ME in pre-starter, starter and finisher mash, respectively. Body weight and body weight gain of birds were significantly ($p < 0.05$) higher in group fed with T_5 ration than the birds fed with T_1, T_2, T_3 and T_4 rations. Feed consumption was significantly ($p < 0.05$) higher in group fed with T_4 ration than the birds fed with other rations. Feed conversion ratio was improved significantly ($p < 0.05$) in birds fed with T_5 ration than the birds fed with T_1, T_2, T_3 and T_4 rations. However, T_1 ration resulted in higher economic return (Rs./bird) in terms of return over feed cost (Rs. 47.61), followed by T_5, T_2, T_3 and T_4 diet (Rs. 36.28, 30.96, 21.04 and 20.59, respectively).

Keywords: Broiler, Crude protein (CP), Growth performance, Metabolizable energy (ME), Return over feed cost (ROFC).

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Introduction

Most determining factor for broiler producer is nutrition. Escalating feed cost in poultry production has been a matter of concern to poultry farmers and nutritionist. There are mainly two nutrients in the feed, *i.e.,* protein and energy, which cost about 90% of the total feed cost which should be utilized most efficiently for desired economy of production and formulation of poultry ration (Durunne *et al*., 2015). Protein and energy are the most analytic dietary factors determining feed costs and performance of the birds in the broiler industry. The role of dietary protein and energy as an independent and mutually dependent variable in poultry ration has been well documented. Protein is an essential constituent of all tissues of animal body and energy is required for body functioning. Protein has major effect on the growth performance of the bird and it is the most expensive nutrient in broiler diets which accounts for 15-20% of feed cost (Kamran *et al*., 2004). Dietary energy is also an expensive component of broiler diet, which accounts for 70-75 % of feed costs (Saleh *et al*., 2004). High cost of dietary energy necessitates an optimization of dietary metabolizable energy, especially during finishing period, coincided with greater feed consumption (Pesti *et al*., 2002). It is hoped that low dietary protein and energy would reduce the feed costs. If diets of low energy level are fed, the broiler will consume more feed. The objective of present study was to evaluate the effect of varying levels of dietary protein and energy on performance and economics of commercial broiler chicken.

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Materials and Methods

Experimental Design

A total of 160 straight-run commercial day-old broiler chicks of Vencobb strain were randomly distributed to five dietary treatments (T_1 to T_5) of varying levels of CP and ME. Each treatment consisted of four replicates containing eight chicks per replicate. The five treatments were: T_1 diet with 21, 20 and 18% CP and 2800, 2900 and 3000 Kcal/kg ME in pre-starter, starter and finisher mash, respectively. T_2 diet with 22, 21 and 19% CP and 2900, 3000 and 3100 Kcal/kg ME in pre-starter, starter and finisher mash, respectively. T_3 diet was kept as basal diet as per BIS (23, 22 and 20% CP and 3000, 3100 and 3200 Kcal/kg ME in pre-starter, starter and finisher mash,

respectively). T_4 diet with 24, 23 and 21% CP and 3100, 3200 and 3300 Kcal/kg ME in pre-starter, starter and finisher mash, respectively. T_5 diet with 25, 24 and 22% CP and 3200, 3300 and 3400 Kcal/kg ME in pre-starter, starter and finisher mash, respectively. Birds were reared in deep litter system using standard management and health care practices.

Parameters Studied

The body weight (BW) was recorded at day-old age (BW0) and at weekly interval (BW1, BW2, BW3, BW4, BW5 and BW6). The body weight gain (BWG) was recorded during pre-starter phase (BWG0-2), starter phase (BWG3-4) finisher phase (BWG5-6) and overall experimental period (BWG0-6). Feed consumption (g/bird) was recorded during pre-starter phase (FC0-2), starter phase (FC3-4) finisher phase (FC5-6) and overall experimental period (FC0-6). Feed conversion ratio was recorded at weekly interval. Economics (Rs./bird) of rearing of broiler birds was calculated at the end of the experiment in terms of return over feed cost (ROFC). The ROFC was derived from subtracting the feed cost from income of selling of birds on live weight basis.

Statistical Analysis

The data were analysed using completely randomized design as per Snedecor and Cochran (1994). Means of replicates under each treatment was considered for analysis.

Results and Discussion

Body Weight and Body Weight Gain

The data on mean body weight (BW) of broilers at day-old age and then at weekly interval is presented in Table 1. At the end of sixth week, mean body weight (BW6) of broilers from group T_5 fed with high protein and energy diet was significantly ($p < 0.05$) higher as compared to control group (T_1). Rahimi and Hassanzadeh *et al.* (2007), Mandal *et al.* (2010), Jafarnejad and Sadegh (2011), Marcu *et al.* (2012) and Perween *et al.* (2016) reported similar findings.

The BWG during pre-starter, starter, finisher phases and overall experimental period is given in Table 2. The mean body weight gains of birds fed with T_4 and T_5 rations were significantly ($p < 0.05$) higher than birds fed with T_1, T_2 and T_3 rations during pre-starter (0-2 week of age) and starter phase (2-4 week of age). The mean body weight gain of birds fed with T_5 diet was significantly ($p < 0.05$) higher than the birds fed with other four rations during finisher phase (4-6 week of age) as well as during the whole experimental period (0-6 week of age). These findings were in agreement with the reports of Erwan *et al.* (2008), Kamran *et al.* (2008), and Majumdar *et al.* (2012). The present results however differed from the findings of Oyedeji *et al.* (2005), Banday *et al.* (2013), Sarwar *et al.* (2015) and Srilatha *et al.* (2018). They reported non-significant difference in the body weight gains of higher levels of dietary protein and energy groups as compared to basal diet.

Feed Consumption

The feed consumed by the bird is one of the major economic traits which determine largely the profitability in poultry production. So, efforts are put to reduce feed consumption without affecting production performances. The data on feed intake (g/bird) recorded at a weekly interval as well as pre-starter, starter, finisher phase and overall experimental period is shown in Table 3. Mean total feed consumption (TFC0-6) of birds fed with T_4 ration was significantly ($p < 0.05$) higher than birds fed with T_1, T_2, T_3 and T_5 rations. The increased feed consumption is probably due to higher energy requirements of the broiler birds to cope with the higher growth rate which is achieved by higher intake of low energy diets. Findings of present study were similar to the results reported by Rahimi and Hassanzadeh *et al.* (2007), Erwan *et al.* (2008), Kamran *et al.* (2008) and Dairo *et al.* (2010), who observed significantly higher feed consumption in birds fed with high crude protein and high energy diet. Oyedeji *et al.* (2005), and Srilatha *et al.* (2018) however reported that the dietary treatments had no effect on the feed consumption during the overall experimental period.

Feed Conversion Ratio

Feed conversion ratio (FCR) is an important tool to measure the feed conversion efficiency of birds. It can indicate magnitude of profitability in broiler production. It can also reflect feeding management practices followed in broiler farm. The data on average weekly FCR is depicted in Table 4. The mean feed conversion ratio was improved significantly

Table 1: Weekly body weight (g) of broilers (Mean ± SE)

	Treatments								
Traits	T_1	T_2	T_3	T_4	T_5	*SEm*	*P Value*	*CD Value*	*CV%*
BW_0	41.96 ± 0.99	43.07 ± 0.29	43.05 ± 0.78	42.26 ± 0.56	43.33 ± 0.77	0.72	0.626	NS	3.34
BW_1	142.32^{b} ± 1.91	149.25^{b} ± 3.92	146.13^{b} ± 4.48	151.29^{b} ± 2.09	162.03^{a} ± 3.05	3.25	0.008	9.80	4.33
BW_2	369.38^{b} ± 7.50	361.66^{b} ± 16.52	378.06^{b} ± 9.28	419.00^{a} ± 4.73	446.72^{a} ± 8.19	8.18	0.000	30.29	5.09
BW_3	773.22^{b} ± 11.91	701.75^{b} ± 35.47	711.91^{b} ± 34.43	869.39^{a} ± 21.27	916.54^{a} ± 20.93	17.06	0.000	79.46	6.64
BW_4	1281.32^{b} ± 15.16	1201.35^{bc} ± 35.07	1171.52^{c} ± 48.52	1453.21^{a} ± 26.63	1512.13^{a} ± 28.98	32.75	0.000	98.69	4.95
BW_5	1798.60^{b} ± 26.15	1655.47^{b} ± 43.86	1633.91^{b} ± 82.94	2003.97^{a} ± 53.17	2089.06^{a} ± 63.12	57.09	0.000	172.06	6.22
BW_6	2162.78^{c} ± 38.99	1927.72^{d} ± 50.25	2008.74^{cd} ± 104.06	2352.43^{b} ± 42.91	2563.97^{a} ± 18.10	58.38	0.000	175.94	5.30

Table 2: Weekly body weight gain (g) of broilers (Mean ± SE)

	Treatments								
Traits	T_1	T_2	T_3	T_4	T_5	SEm	p Value	CD Value	CV%
BWG_{0-1}	$100.33^{b} \pm 2.06$	$106.18^{b} \pm 4.17$	$103.08^{b} \pm 3.85$	$109.03^{b} \pm 2.61$	$118.70^{a} \pm 2.40$	3.13	0.008	9.44	5.83
BWG_{1-2}	$227.07^{b} \pm 7.01$	$212.41^{b} \pm 13.55$	$231.94^{b} \pm 8.43$	$267.72^{a} \pm 4.82$	$284.69^{a} \pm 5.99$	8.52	0.000	25.68	6.97
BWG_{2-3}	$403.85^{b} \pm 6.84$	$340.09^{c} \pm 19.12$	$333.91^{c} \pm 30.69$	$450.38^{ab} \pm 16.85$	$469.81^{a} \pm 15.39$	19.36	0.000	58.35	9.69
BWG_{3-4}	$508.09^{b} \pm 6.74$	$499.59^{b} \pm 16.47$	$459.55^{b} \pm 33.48$	$583.83^{a} \pm 9.47$	$595.60^{a} \pm 8.44$	17.88	0.000	53.89	6.76
BWG_{4-5}	$517.28^{abc} \pm 24.90$	$454.13^{c} \pm 11.47$	$462.39^{bc} \pm 36.45$	$550.76^{ab} \pm 32.13$	$576.93^{a} \pm 37.85$	30.15	0.044	90.87	11.77
BWG_{5-6}	$364.19^{b} \pm 13.69$	$272.25^{c} \pm 18.57$	$374.83^{b} \pm 24.73$	$348.49^{bc} \pm 16.29$	$494.91^{a} \pm 49.07$	27.63	0.002	83.26	15.06
BWG_{0-2}	$327.40^{b} \pm 6.86$	$318.59^{b} \pm 16.65$	$335.02^{b} \pm 9.33$	$376.74^{a} \pm 4.71$	$403.39^{a} \pm 7.65$	9.92	0.000	29.90	5.63
BWG_{2-4}	$911.94^{b} \pm 12.80$	$839.69^{bc} \pm 23.04$	$793.46^{c} \pm 39.92$	$1034.21^{a} \pm 21.94$	$1065.41^{a} \pm 23.44$	25.77	0.000	77.65	5.55
BWG_{4-6}	$881.47^{b} \pm 36.53$	$726.38^{c} \pm 17.36$	$837.22^{b} \pm 57.05$	$899.25^{b} \pm 20.14$	$1051.84^{a} \pm 14.42$	33.16	0.000	99.95	7.54
BWG_{0-6}	$2120.80^{c} \pm 38.42$	$1884.66^{d} \pm 50.50$	$1965.69^{cd} \pm 104.39$	$2310.20^{b} \pm 42.78$	$2520.64^{a} \pm 17.46$	58.41	0.000	176.03	5.41

Table 3: Feed consumption (g/bird) of broiler (Mean ± SE)

	Treatments								
Traits	T_1	T_2	T_3	T_4	T_5	SEm	p Value	CD Value	CV%
FC_1	164.09 ± 7.30	157.97 ± 5.12	162.37 ± 5.01	158.02 ± 9.04	166.00 ± 5.48	6.58	0.873	NS	8.14
FC_2	381.84 ± 3.85	368.69 ± 12.84	378.38 ± 20.91	406.60 ± 11.35	391.66 ± 0.54	12.21	0.285	NS	6.34
FC_3	739.63 ± 8.65	729.59 ± 3.69	764.35 ± 57.43	773.88 ± 23.68	727.97 ± 6.42	28.25	0.705	NS	7.56
FC_4	955.75 ± 18.60	849.13 ± 20.31	815.84 ± 61.84	925.29 ± 82.45	875.91 ± 21.25	48.65	0.298	NS	11.00
FC_5	$1003.91^{b} \pm 35.44$	$923.13^{b} \pm 23.16$	$968.44^{b} \pm 13.10$	$1182.01^{a} \pm 96.33$	$1035.69^{ab} \pm 45.85$	51.67	0.029	155.70	10.10
FC_6	$1025.97^{b\,c} \pm 37.54$	$922.19^{c} \pm 30.07$	$1021.39^{b\,c} \pm 26.81$	$1137.54^{a} \pm 47.15$	$1086.94^{ab} \pm 26.02$	34.44	0.006	103.80	6.63
TFC_{0-2}	546.03 ± 11.14	526.66 ± 17.42	540.75 ± 22.80	564.62 ± 19.71	557.66 ± 5.24	16.51	0.541	NS	6.04
TFC_{3-4}	1695.38 ± 26.40	1578.72 ± 13.09	1580.20 ± 92.45	1699.16 ± 104.76	1603.88 ± 19.31	65.00	0.500	NS	7.97
TFC_{5-6}	$2029.88^{b} \pm 49.93$	$1845.32^{c} \pm 48.66$	$1989.83^{bc} \pm 29.14$	$2319.55^{a} \pm 52.12$	$2122.63^{b} \pm 63.89$	50.02	0.000	150.74	4.85
TFC_{0-6}	$4271.28^{ab} \pm 24.30$	$3950.69^{c} \pm 46.17$	$4110.77^{bc} \pm 141.34$	$4583.33^{a} \pm 166.21$	$4284.16^{ab} \pm 73.12$	105.52	0.009	318.00	4.98

Table 4: Feed conversion ratio of broilers (Mean ± SE)

	Treatments								
Traits	T_1	T_2	T_3	T_4	T_5	SEm	p Value	CD Value	CV%
FCR_{0-1}	1.15 ± 0.04	1.06 ± 0.01	1.11 ± 0.05	1.04 ± 0.06	1.03 ± 0.05	0.05	0.309	NS	8.32
FCR_{0-2}	$1.48^{a} \pm 0.04$	$1.46^{a} \pm 0.06$	$1.43^{a} \pm 0.06$	$1.35^{ab} \pm 0.05$	$1.25^{b} \pm 0.03$	0.05	0.038	0.157	7.49
FCR_{0-3}	$1.66^{ab} \pm 0.03$	$1.80^{a} \pm 0.07$	$1.84^{a} \pm 0.11$	$1.54^{bc} \pm 0.07$	$1.41^{c} \pm 0.04$	0.07	0.003	0.211	8.47
FCR_{0-4}	$1.75^{a} \pm 0.02$	$1.75^{a} \pm 0.02$	$1.81^{a} \pm 0.08$	$1.56^{b} \pm 0.09$	$1.43^{b} \pm 0.02$	0.06	0.001	0.175	6.97
FCR_{0-5}	$1.81^{a} \pm 0.03$	$1.83^{a} \pm 0.02$	$1.90^{a} \pm 0.09$	$1.72^{ab} \pm 0.12$	$1.53^{b} \pm 0.03$	0.07	0.019	0.211	7.96
FCR_{0-6}	$1.98^{a} \pm 0.03$	$2.05^{a} \pm 0.04$	$2.06^{a} \pm 0.09$	$1.95^{a} \pm 0.08$	$1.68^{b} \pm 0.03$	0.06	0.002	0.179	6.10

($p < 0.05$) in birds fed with T_5 ration than the birds fed with T_1, T_2, T_3 and T_4 rations.

These results were in accordance with the observations of Dehury *et al.* (2008), who reported improved feed conversion ratio during finisher phase in the groups fed with high dietary protein and energy levels than the group fed with basal diet. Yunana *et al.* (2019) also reported significantly ($p < 0.05$) improved feed conversion ratio (1.50) in birds fed diet with 24% CP and 3100 Kcal/kg ME in starter phase (0-4 weeks) and (2.09) in birds fed diet with 21 % CP and 3100 Kcal/kg ME in finisher phase (5-8 weeks).

Present results however differ with findings of Oyedeji *et al.* (2005), who did not observe significant difference in feed conversion ratio among different treatments. Majumdar *et al.* (2012) also failed to see difference in feed conversion ratio during starting period (0-3 weeks) and similar were the observations of Sarwar *et al.* (2015), who reported no significant difference in feed conversion ratio of birds fed with higher or lower levels of dietary protein and energy than the basal diet.

Economics

The return over feed cost (ROFC) can be derived by subtracting the feed cost from income of selling of birds on live weight basis. It clearly expresses the profitability of broiler production. The return over feed cost (Rs./ bird) for

Table 5: Return Over Feed Cost (Rs./bird) of broilers

Treat-ment	*Price of feed (Rs./kg)*			*Feed consumption (g/bird)*			*Cost of feed consumed (Rs./bird)*				*Final body wt. (g/bird)*	*Selling price (Rs./kg live body wt.)*	*Income from selling of bird (Rs./bird)*	*ROFC (Rs./ bird)*
--	0-2 week	3-4 week	5-6 week	0-2 week	3-4 week	5-6 week	0-2 week	3-4 week	5-6 week	Total				
	A	B	C	D	E	F	G	H	I	J	K	L	M	M-J
T_1	30.90	31.77	30.14	546.03	1695.38	2029.88	16.86	53.86	61.18	131.90	2.16	83.00	179.51	47.61
T_2	31.78	33.88	31.87	526.66	1578.72	1845.32	16.73	53.48	58.83	129.04	1.92	83.00	160.00	30.96
T_3	33.83	35.10	35.59	540.75	1580.20	1989.83	18.27	55.46	70.84	144.57	2.00	83.00	165.61	21.04
T_4	36.96	38.46	38.13	564.62	1699.16	2319.55	20.86	65.35	88.44	174.65	2.35	83.00	195.24	20.59
T_5	40.44	41.34	41.31	557.66	1603.88	2122.63	22.53	66.32	87.69	176.54	2.56	83.00	212.82	36.28

birds fed with T_1, T_2, T_3, T_4 and T_5 rations has been presented in Table 5. ROFC (Rs./bird) for birds fed with T_1, T_2, T_3, T_4 and T_5 rations was found to be 47.61, 30.96, 21.04, 20.59 and 36.28, respectively. The highest ROFC was found in the birds fed with T_1 ration followed by T_5, T_2, T_3 and T_4. Result indicated that the diet T_1 with 21, 20 and 18% CP and 2800, 2900 and 3000 Kcal/kg ME in pre-starter, starter and finisher mash, respectively, resulted in highest economic return in terms of return over feed cost (ROFC).

The present findings were in accordance with the results found by Dehury *et al.* (2008), Kamran *et al.* (2011) and Banday *et al.* (2013). They also observed highest ROFC in birds fed with lowest dietary protein and energy. The present findings were however in contrast to the results reported by Oyedeji *et al.* (2005), Wolde *et al.* (2011) and Majumdar *et al.* (2012), who did not observe significant difference in cost of production in birds fed with different levels of metabolizable energy.

Conclusions

Broiler birds fed with high CP and ME (ration T_5) had significantly ($p<0.05$) higher body weight and body weight gain with improved FCR as compared to those fed lower CP and ME (ration T_1, T_2, T_3 and T_4). Overall, it can be concluded that to get higher economic return, commercial broiler chicken can be fed with broiler ration with 2% reduction in crude protein and 200 Kcal/kg reduction in metabolizable energy as compared to BIS (2007) standard.

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