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Research Article

Productivity of broiler chicken fed plant-sourced diet supplemented with a novel protein ingredient (Pro-El)

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ABSTRACT

The study was conducted to investigate the growth performance of broilers fed diet supplemented with different level of high protein (Pro-EL) as a novel stuff from day 1 to 35 days. Day-old male broiler chicks (n=480; Cobb 500) were randomly distributed into four dietary treatments [D_1, D_2, D_3 and D4], each diet replicated six times with twenty birds per replicate. Treatment D_1 refers to control or basal diet with no Pro-EL, while D_2, D_3 and D_4 dietary treatments were supplemented with 1%, 2% and 3% Pro-EL stuff, respectively. Birds were reared in the floor pen with a mechanically–ventilated closed housing condition up to 35 days. Birds had a free access to iso-caloric and iso-nitrogenous starter diet up to 21d and then finisher diets were fed to the birds up to 35 days. The results demonstrated that the feed intake (FI) and live weight (LW) of broilers were influenced significantly ($P<0.05$; $P<0.001$) by dietary treatment, except for feed conversion ratio (FCR) and mortality (%) up to 35 days. Dietary treatment had no significant effect ($P>0.05$) on the FCR and mortality of birds up to 35 days. Birds fed on D_4 diet had a significantly poorer ($P<0.01$) FI and LW than the birds fed the other diets entire the trial period. Birds fed on D_1, D_2 and D_3 diets had a similar ($P>0.05$) FI and LW up to 35 days. In conclusion, growth responses of broilers fed on 1% and 2 % Pro-EL supplemented diets (D_2 and D_3) might show a satisfactory performance similar to D_1 diet, but the growth might be suppressed as a result of increased level of high protein supplementation in the broiler diet.

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1. INTRODUCTION

Broiler farming is now an emerging industry across the globe. It is a young chicken of either sex and is an efficient converter of feed to meat. Some important traits of broiler rearing are the rapid growth rate, well-developed muscle tissue attachment and quick return etc., which have given a deserving place to this birds to supply the premium quality of meat for human consumption. So the huge protein gap of the consumer world can be met by rearing broilers fed on a correct proportions of quality diet *i.e* rich in quality feed protein (Hossain *et al.*, 2013).

In view of above, it is crystal clear that protein is the essential and expensive component of feed, and this is very much needed for their optimum body growth and development. Although feed cost is the major cost in poultry production, the protein requirement alone incurs 45% of the total cost of poultry production (Ahmed *et al.*, 2006). It indicates that protein and amino acid requirements of the broilers involve the greater portion of costs for poultry production (May *et al.*, 1998; Corzo *et al.*, 2004). Of the total feed cost, about 95% is used to meet energy and protein requirements, 3% for major mineral, trace mineral and vitamin requirements, and 2% for various feed additives. Despite this, there might be occurred nutrient deficiencies and poor performance, if the broilers are raised with low quality protein diets under hot humid climatic condition (Donkoh, 1989; Furlan *et al.*, 2004).

The protein requirements of broiler chickens in their diet are met mostly by vegetable and animal protein sources with a bit synthetic protein sources. It becomes difficult to formulate balanced diet for poultry and to balance the requirements of protein and essential amino acid in the diets consist of all plant sources (e.g. soybean meal, canola meal, ground nut meal). In addition, although animal proteins are regarded as quality protein, many constraints such as exorbitant prices, zoonotic diseases, and poor shelf life of these ingredients discourage the farmers to extensive use of these products in the diet formulation for poultry (Hossain *et al.*, 2013). Therefore, the poultry industry is always exploring the cheapest sources of feed ingredients to gain maximum profit with the lowest investment in feed.

Owing to above, poultry nutritionists, feed formulators are trying to re-evaluate the present strategy of diet formulation by excluding or reducing expensive ingredients from livestock diets. This trend could make the feed formulation strategy more complex and unsatisfactory from quality standpoint to supply the quality diets for the ruminant and non-ruminant animals (Hossain *et al.*, 2013). The exclusion of animal protein from diet formulation not only reduces the nutritive value of the formulated diets but also limits the ability of the formulators to satisfy the required nutrients for the poultry. For this reason, there is need to explore the feasibility of developing poultry ration based on alternative protein sources for monogastric animal production. Identification of such feedstuffs would help diet formulators not only to cut down their production costs but also to improve the efficiency of their production (Teguia and Beynen, 2005).

However, broiler raising under tropical condition might face extreme heat stress, which might impair the productivity of animal. Broilers reared under heat stress condition might show poor growth responses when they are fed on poor quality diets (Alleman and Leclerq, 1997; FariaFilho, 2003). In this regard, a novel protein ingredient such as Pro-El as a high protein supplement, can be used successfully in poultry diet to fulfill the protein requirement of the bird. Costs of feeding broilers and its protein requirement could be easily reduced and met with the use of less costly feed ingredients such as Pro-EL i.e available in the market.

The previous research report revealed that Pro-EL is high in crude protein (>80%) with a good profile of essential and non-essential amino acids (Hossain et al., 2017), and hence could be used to reduce the quantity of animal and vegetable protein sources used for the broiler ration. Broiler chickens responded negatively fed on the increased level of Pro-El (15%) supplemented in the diet, although better methionine digestibility was found in this diet (Hossain *et al.*, 2017). From the results, it could be assumed that broiler diet supplemented with a lower level of Pro-EL might show a better growth potential for the broiler chickens. Moreover, the supplementation strategy might reduce the lacks and gaps of protein requirement as well as feed cost of the poultry production. However, there are no plenty data on the effect of feeding Pro-EL to chickens and although numerous protein sources have long been used in the country. Very few researches have been conducted and there is a scare of data regarding the nutritive value of this feedstuff. Considering this view, the present study has been undertaken to investigate the productivity of broiler chickens fed on different level of Pro-EL in the diet.

2. MATERIALS AND METHODS

Animal husbandry and experimental design

A total of 480 (Cobb 500) day-old male broiler chicks was procured from a local commercial hatchery to conduct this experiment from d1 to 35 days during January and February 2016. The chicks were weighed on receipt, and then randomly distributed into four dietary treatment groups, *i.e* D_1, D_2, D_3, and D_4. Each treatment had six replicates with twenty birds per replicate in a completely randomized design (Table 1). Dietary treatment D_1 is considered here as control diet, because it was prepared with the conventional feedstuffs without using any Pro-El, whereas D_2, D_3, and D_4 diets were considered here as test diets, and these were formulated with the same ingredients along with the supplementation of 1%, 2% and 3% Pro-EL ingredient, respectively (Tables 2 & 3). All the chicks were allotted into 24 floor-pens within a mechanically –ventilated closed housing condition. Wood-shaving litter materials were used to cover the surface of floor-pen. Each pen was furnished with hanging feeder and automatic drinker to get an easy access of feed and water for the birds *ad libitum* during the trial period. Chicks were brooded with a temperature of 33ºC for the first two days of rearing period. The temperature was then gradually reduced by 1 or 2ºC every 1 or 2 days until the chicks were 19 days old at which point the temperature was maintained at 24ºC for the rest of the trial. Continuous lighting program was maintained entire the trial period. The chicks were fed a standard broiler starter diet from day1 to 21d, and then finisher diet was used for rest of the trial period (35d), as shown in Tables (2 and 3). Both diets were iso-caloric and iso-nitrogenous and fed the birds *ad libitum* throughout the trial period. Starter diet and finisher diets in mash form, were formulated to meet or exceed the requirements as prescribed by Cobb 500 manual for broilers for this age. The diets containing Pro-EL were formulated according to digestible amino acids contents.

Table 1. Design for the experiment

Replicates	Dietary Treatments				
	D_1	**D_2**	**D_3**	**D_4**	**Total**
R1	20	20	20	20	80
R2	20	20	20	20	80
R3	20	20	20	20	80
R4	20	20	20	20	80
R5	20	20	20	20	80
R6	20	20	20	20	80
Total	**120**	**120**	**120**	**120**	**480**

[D_1 diet, considered as Control that is devoid of Pro-El stuff, whereas D_2, D_3 and D_4 diets were supplemented with 1, 2 and 3 % Pro-EL ingredient, respectively]

Data collection

Feed intake, live weight and feed conversion ratio were recorded weekly. Mortality (%) was calculated when it occurred.

Table 2. Ingredient and nutrient composition of the starter diet (1-21d)

Ingredients (%)	Diet (starter)			
	D_1	D_2	D_3	D_4
Corn	57.77	59.12	60.32	61.82
Soybean meal	34.58	32.82	31.00	28.92
High protein stuff (Pro-El)	0.00	1.00	2.00	3.00
Palm oil	3.60	3.20	2.80	2.30
DCP	1.68	1.70	1.72	1.74
Limestone	1.15	1.15	1.15	1.15
Salt/Nacl	0.40	0.40	0.40	0.40
Choline Cl-70%	0.05	0.05	0.05	0.05
Vita-premix1	0.05	0.05	0.05	0.05
Min-premix1	0.10	0.10	0.10	0.10
L-lysine	0.34	0.35	0.36	0.39
DL-methionine	0.19	0.02	0.00	0.00
L-Threonine	0.09	0.09	0.10	0.11
Calculated Nutrient composition (%)				
ME (Kcal/kg)	3035	3033	3032	3030
CP	21.02	21.0	21.02	21.0
Av.P	0.45	0.45	0.45	0.45
Ca	0.91	0.91	0.91	0.91
Na	0.18	0.18	0.18	0.18
D Lys	1.18	1.18	1.18	1.18
D Met	0.45	0.46	0.59	0.76
D Thr	0.77	0.77	0.77	0.77

[D_1 diet, considered as Control that is devoid of Pro-El stuff, whereas D_2, D_3 and D_4 diets were supplemented with 1, 2 and 3 % Pro-EL ingredient, respectively. 1Provided per kg of diet (mg): vitamin A (as all-trans retinol), 3.6mg; cholecalciferol, 0.09 mg; vitamin E (as dα-tocopherol), 44.7mg; vitamin K3, 2mg; thiamine, 2mg; riboflavin, 6mg; pyridoxine hydrochloride, 5mg; vitamin B12, 0.2mg; biotin, 0.1mg; niacin, 50mg; D-calcium pantothenate, 12mg ; folic acid, 2mg; Mn, 80mg; Fe, 60mg; Cu, 8mg; I, 1mg; Co, 0.3mg and Mo, 1mg]

Table 3. Ingredient and nutrient composition of the finisher diets (22-35d)

Ingredients (%)	Diet (Finisher)			
	D_1	D_2	D_3	D_4
Corn	61.50	62.89	64.04	65.36
Soybean meal	30.0	28.20	26.40	24.40
High protein stuff (Pro-El)	0.00	1.00	2.00	3.00
Palm oil	5.20	4.80	4.40	4.0
DCP	1.35	1.37	1.40	1.42
Limestone	1.00	1.00	1.00	0.97
Salt/Nacl	0.38	0.38	0.38	0.38
Choline Cl-70%	0.08	0.00	0.08	0.08
Vita premix1	0.05	0.05	0.05	0.05
Min premix1	0.10	0.10	0.10	0.10
L-lysine	0.16	0.18	0.19	0.21
DL-methionine	0.15	0.00	0.00	0.00
L-threonine	0.03	0.03	0.04	0.05
Calculated Nutrient composition (%)				
ME (Kcal/kg)	3181	3181	3180	3181
CP	19.01	19.0	19.03	19.02
Av.P	0.38	0.38	0.38	0.38
Ca	0.76	0.76	0.76	0.76
Na	0.17	0.17	0.17	0.17
D Lys	0.95	0.95	0.95	0.95
D Met	0.40	0.41	0.58	0.74
D Thr	0.65	0.65	0.65	0.65

[D_1 diet, considered as control that is devoid of Pro-El stuff, whereas D_2, D_3 and D_4 diets were supplemented with 1, 2 and 3% Pro-EL ingredient, respectively. 1Provided per kg of diet (mg): vitamin A (as all-trans retinol), 3.6mg; cholecalciferol, 0.09mg; vitamin E (as dα-tocopherol), 44.7mg; vitamin K3, 2mg; thiamine, 2mg; riboflavin, 6mg; pyridoxine hydrochloride, 5mg; vitamin B12, 0.2mg; biotin, 0.1mg; niacin, 50mg; D-calcium pantothenate, 12mg ; folic acid, 2mg; Mn, 80mg; Fe, 60mg; Cu, 8mg; I, 1mg; Co, 0.3mg and Mo, 1mg]

Statistical analyses

All collected data were statistically analyzed using Minitab software (Minitab Version 16, 2000). The data were analyzed using one-way ANOVA with diet as factor. The significance of differences between means was determined by Fisher's least significant difference $P \leq .05$.

3. RESULTS AND DISCUSSION

The results of weekly feed intake (FI), live weight (LW) and feed conversion ratio (FCR) of broiler chickens fed Pro-El diets were shown in Table 4. Except for 5th week, the FI and LW of birds was influenced significantly ($P<0.05$) by dietary treatment groups from 1st to 4th week. Birds on D_4 diet had lower LW and FI than those of other diet groups (Table 4). Except for 2nd week, the FCR of birds was unaffected ($P>0.05$) between treatments. The poorer ($P<0.05$) FCR was found in the birds those fed on D_4 diet during 2nd week (Table 4). At last week (5th) of the trial, the FI,

LW and FCR were not influenced (P>0.05) by dietary treatment.

The results of cumulative FI, LW, FCR and mortality (%) of broiler chickens fed Pro-El diets were shown in Table 5. The results revealed that the FI and LW of broilers were influenced significantly (P<0.05) by dietary treatment, except for FCR and mortality (%) up to 35 days. Dietary treatment had no significant (P>0.05) effect on the FCR and mortality of birds during 1-35 days. The FCR was influenced significantly (P<0.05) during second week only. The FCR was improved in the birds fed reduced percentage of Pro-El diet compared to greater amount (3%) at 14 days of age. Birds fed on D_4 diet supplemented with 3% Pro-El had a significantly poorer FI and LW than the birds fed the other diets entire the trial period. The cumulative FI and LW of birds fed on D_1, D_2 and D_3 diets were unaffected (P>0.05) by dietary treatment group up to 35 days.

It is obvious from the current study that birds fed increased amount (3%) of Pro-El diet (D_4) grew poorly as compared to reduced amount (1 to 2%) of Pro-EL diets (D_2 and D_3) fed the broilers. The reason behind this poor performance might be a result of reduced feed consumption of the birds as is evinced from our study. In addition, the poor feed intake of broilers on the increased (D_4) diet could be due to lower palatability and poor nutrient digestibility of the feed than the other diets. Though we know heat stress might affect the performance of broiler chickens, the chance of climatic effect or heat stress on the growth performance considered herein this study is negligible, because the birds were reared in a climate controlled house. However, the result is agreed with our previous report where birds showed reduced body weight and poor feed consumption when broilers fed diet supplemented with increased amount of Pro-El diet (15%) compared to control (Hossain *et al.*, 2017). The impaired performance of broilers fed on D_4 diet indicates that the broilers are less efficient to convert this feed to meat more rapidly than the birds fed on other diet group. Apart from these, the previous experimental findings reported that nutrient (amino acids) digestibilities of Pro-EL (15%) diet were a somewhat poorer than the basal diet, which might be another reason for the poor performance of the birds when broiler fed diet supplemented with increased amount of Pro-EL.

Table 4. Weekly feed intake (FI), live weight (LW), and feed conversion ratio (FCR) of birds fed diets supplemented with different level of Pro-EL from 1st to 5th week

Parameters	Age (days)	Week	Diet (Finisher)					
			D_1	D_2	D_3	D_4	Pooled SEM	P-values
FI(g/b/w)	1-7	1st	144.58[a]	144.66[a]	143.75[a]	130.00[b]	1.306	0.001
	8-14	2nd	431.25[a]	435.96[a]	417.48[a]	382.10[b]	3.418	0.001
	15-21	3rd	745.75[a]	743.90[a]	736.82[a]	681.58[b]	5.116	0.01
	22-28	4th	1083.90[a]	1108.60[a]	1070.20[a]	987.10[b]	9.694	0.01
	29-35	5th	1271.10	1260.00	1274.60	1188.50	16.490	0.243
LW(g/b/w)	1-7	1st	184.36[a]	174.23[a]	176.83[a]	167.03[b]	1.840	0.027
	8-14	2nd	331.50[a]	343.98[a]	330.65[a]	285.33[b]	3.265	0.001
	15-21	3rd	493.33[a]	500.58[a]	487.20[a]	459.71[b]	4.847	0.038
	22-28	4th	687.63[b]	697.13[a]	673.16[b]	627.32[b]	8.351	0.037
	29-35	5th	721.12	719.37	734.88	744.61	17.447	0.949
FCR	1-7	1st	1.04	1.15	1.11	1.07	0.016	0.12
	8-14	2nd	1.50[b]	1.48[b]	1.47[b]	1.60[a]	0.014	0.021
	15-21	3rd	1.66	1.65	1.68	1.65	0.013	0.801
	22-28	4th	1.69	1.71	1.71	1.69	0.016	0.952
	29-35	5th	1.94	1.91	1.87	1.70	0.058	0.497

[Data indicate mean values consisting of 20 birds per replicate from D1-35 days; SEM= Standard errors of mean; D_1 diet, considered as control that is devoid of Pro-El stuff, whereas D_2, D_3 and D_4 diets were supplemented with 1, 2 and 3 % Pro-EL ingredient, respectively, Means[a,b] bearing uncommon superscripts in a row are significantly different at *P<0.05]

The poor nutrient digestibility and lower palatability of the diet might be reasons of the poor feed intake and low growth performance of the birds (Jackson *et al.*, 1982; Mahmoudnia *et al.*, 2011). It is reported that the AAs imbalances in diets decreased the biological value of the diets and feed intake (Jackson *et al.*, 1982). Besides, other factors such as organoleptic traits (*e.g* colour, smell, odour, flavor, taste and texture) of diet might also affect the feed ingestion and feed regulation of broiler chickens (Cruze *et al.*, 2005). Further, dietary composition and sources of protein use in the practical diet could also influence the feed intake and feed preference of broiler chicken (Hossain, 2013).

Table 5. Cumulative feed intake (FI), live weight (LW), feed conversion ratio (FCR) and mortality of birds fed diets supplemented with different level of Pro-EL from d1-35 days

Parameters	Age (days)	Diet (Finisher)					
		D_1	D_2	D_3	D_4	Pooled SEM	P-values
FI (g/b)	1--7	144.58^a	144.66^a	143.75^a	130.00^b	1.306	0.001
	1-14	575.83^a	580.61^a	561.23^a	512.10^b	3.730	0.001
	1-21	1321.60^a	1324.50^a	1298.00^a	1193.70^b	7.653	0.001
	1-28	2405.50^a	2433.10^a	2368.20^a	2180.86^b	16.122	0.001
	1-35	3676.60^a	3693.20^a	3642.90^a	3369.30^b	16.510	0.001
LW (g/b)	1-7	184.36^a	174.23^{ab}	176.83^{ab}	167.03^b	1.840	0.027
	1-14	515.83^a	518.21^a	507.48^a	452.37^b	3.220	0.001
	1-21	1009.2^a	1018.8^a	994.7^a	912.16^b	6.979	0.001
	1-28	1696.80^a	1715.90^a	1667.80^a	1539.40^b	12.489	0.001
	1-35	2418.00^a	2435.30^a	2403.00^{ab}	2284.80^b	15.775	0.012
FCR	1-7	1.04	1.15	1.11	1.07	0.016	0.120
	1-14	1.22	1.23	1.22	1.26	0.006	0.084
	1-21	1.37	1.36	1.37	1.38	0.006	0.895
	1-28	1.46	1.46	1.46	1.46	0.006	0.992
	1-35	1.56	1.54	1.55	1.51	0.011	0.457
Mortality (%)	1-14	0.00	1.67	1.67	0.83	0.427	0.472
	1-21	0.83	1.67	1.67	0.83	0.475	0.856
	1-28	1.67	1.67	2.50	0.83	0.604	0.813
	1-35	1.67	1.67	4.17	2.50	0.756	0.619

[Data indicate mean values consisting of 20 birds per replicate from D1-35 days]

4. CONCLUSIONS

From an overview of the results obtained in this study revealed that, growth responses of broilers fed on 1% and 2 % Pro-El supplemented diets (D_2 and D_3) might demonstrate a satisfactory performance as is seen in control or basal diet, but the growth may be depressed as a result of inclusion of increased level of high protein supplement in the broiler diet. Birds fed on higher level of protein supplemented diet responded negatively as a result of impaired feed consumption and body growth. It would appear from the results that poor growth of broilers may be encountered due to addition of increased level of protein supplement in the broiler diet.

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