Research Article

Influence of Low Crude Protein Diets on Broiler Chickens Performance

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Abstract | Two hundred one-day old (Cobb 500) broiler chicks were used to investigate the influence of low crude protein diets (LCP) fortified with synthetic essential and non-essential amino acids (AAs) as well as L-Carnitine for as a new nutrient requirement on growth performance, some serum biochemical parameters, carcass characteristics and economic efficiency. Chicks were randomly divided into four experimental treatments with five replicates per treatment (50 chicks/ treatment; 10 chicks/replicate). Broiler chicks fed standard CP control diet (group 1), group 1 at which CP reduced by 2 %, group 3 and group 4 at which CP was reduced by 4% and 6%, respectively during starter, grower and finisher stages for 42 days. Group 2 fed LCP (decrease by 2%) were recorded marked improvement in feed conversion ratio (P<*0.05*) while other dietary groups were noted marked (P<0.05) decreased in feed conversion ratio. Also, results indicated that the lowest levels of serum glucose, triglyceride and serum chloride were found in all experimental groups, while these groups had a significant (P<0.05) increased HDL-cholesterol concentration. Percentage weights of all carcass characteristics had no marked (P>0.05) effect on broilers fed on LCP (P>0.05). The broiler chickens fed on (LCP) decreased by 2% had the best growth performance and net profit values. In conclusions, our data shows that crude protein was reduced up to 6% with synthetic essential and non-essential amino acids fortification without affecting the broiler performance.

Keywords | Low crude protein, New requirements, Amino acids, Performance, Blood, Broilers

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INTRODUCTION

The cost of dietary feedstuffs (corn and soybean meal), continue to rise, while supplying the nutritional demands of growing broiler farms is the main of the production costs, and nearly 75% of the total expense. The major component of this cost is the high protein ingredients, such as soybean meal to get maximum tissue accretion. To deal with these constant elevating protein prices, with enhancing or at least maintaining bird performance, it is necessary to find ways to partially replace this high protein feed ingredient. Our results have shown that utilizing digestible formulations, ideal protein ratios and feed formulation software, with providing the total essential amino acids (TEAA) and non-essential amino acids (TNEAA) requirements deliver the least cost per unit of gain and lowering the feed costs. Recent study reported that one percent reduction in the CP value in the diets of turkey saved 5 dollars/ 1000 kg of feed (Mohammaddigheisar and Kim, 2018).

In addition to lowering feed costs, the advancement in poultry nutrition formulations can provide a variety of avenues to increase efficiency and reduce expense, and involve a considerable diversity of feed ingredients (Kerr and Kidd, 1999a) leading to decreased nitrogen excretion through reduced protein diets (Nahm, 2007).

Previous literature reported that reducing CP without fortification of AAs is harmful to broiler productive performance (Kerr and Kidd 1999b), while CP can be successfully lowered to a point with synthetic glutamic acid and indispensable amino acid fortification, which lead to comparable productive performance to compensate the high CP diets (Dean et al., 2006; Namroud et al., 2008). Moreover, dropped performance in broilers fed low CP, amino acids (methionine, threonine, lysine, valine, isoleucine, arginine, phenylalanine and tryptophan) supplemented diets with reductions in CP in number of cases to 3 or 4 % has been previously reported (Si et al., 2004; Namroud et al., 2008). So, the current study aims to investigate the growth performance, some serum biochemical parameters and carcass traits and economic efficiency of broiler chickens fed on LCP supplemented with synthetic amino acids and L-carnitine as a new nutrient requirement.

MATERIALS AND METHODS

Experimental design

The current animal study was conducted at the Poultry Research Farm, Faculty of Veterinary Medicine, Zagazig University, Egypt following the institutional guidelines and ethical rules. Chicks were cared for in accordance with husbandry guidelines of Zagazig University standard operating procedures. Two hundred unsexed one-day old broiler chicks of Cobb 500 chicks, weighing 40±1 g, were purchased from regional hatchery in Abu Kabir Sharkia. Chicks were randomly divided into four experimental treatments with five replicates / treatment (fifty chicks/ treatment; ten chicks/replicate). Diet used in this study was fully analyzed for components (DM, CP and EE) (AOAC, 2002).

Group 1 was negative control group, group 2 supplemented with 2% low crude protein (LCP) plus synthetic essential, non-essential amino acids and L-carnitine, group 3 received 4% LCP plus synthetic essential, non-essential amino acids and L-carnitine and group 4 treated with 6% LCP plus synthetic essential, non-essential amino acids and L-carnitine for 42 days (2 weeks intervals between each treatment). Chicks were vaccinated against Infectious bursal disease virus (IBDV) and Newcastle disease virus (NDV). Chicks kept in separate pens under constant lighting program and appropriate temperature throughout the experiment. The diet was formulated to supply the nutrient specifications based on the ideal protein concept containing both digestible essential and non-essential amino acids and were given in mash form (Wu, 2014). Briefly, the diet was isocaloric in each starter stage (3000 kcal/kg ME), grower stage (3100 kcal/kg ME) and finisher stage (3180 kcal/kg ME) (Tables 1).

Dietary electrolyte balance (DEB)

The normal value of DEB in broiler chickens is 250 mEq/ kg diets. The DEB of various diets was calculated based on the analyzed values of Na, K and Cl (with or without S) of feed ingredients. It was calculated by multiplying the % of the element by a convenient multiplier factor (434.78, 255.75, 281.69 and 208.3 for Na, K, Cl and S, respectively). The DEB equation measures the balance between the levels of sodium and potassium versus chloride as expressed in mEq/kg diet (DEB= $Na^+ + K^+ - Cl^-$) (Mongin, 1981).

Growth performance parameters

The broilers were weighed at the start and end of the experiment beside that, they weighed weekly to obtain body weight (BW). The average feed intake (FI) was recorded daily in grams as the reduction of feed. Body weight gain (BWG) and feed conversion ratio (FCR) were also calculated.

Biochemical analysis

Blood samples from five broilers per group at 42 day old were collected post-slaughtering in a sterile glass tubes without anticoagulant and placed in a slant position for twenty minutes at room temperature then centrifuged for ten min at 3000 rpm. Serum was then removed and stored at -20 °C until used for further biochemical investigation using various ELISA diagnostic kits (Roch Diagnostics, GmbH, USA). Serum glucose (Tietz, 2006); total cholesterol (Pisani et al., 1995); triglyceride (Stein and Myers, 1995); high-density lipoprotein concentration (Nitschke and Tall, 2005) and low-density lipoprotein (Sonntag and Scholer, 2001). Serum total protein and albumin (Burtis et al., 2006), globulin was calculated by difference (Doumas and Biggs, 1972). Blood urea nitrogen, creatinine and uric acids (Fossati, 1980). Alanine aminotransferase (ALT) was assessed according to the method described by Young (2001). Serum aspartate-aminotransferase (AST) was measured according to the method developed by Murray (1984) beside serum sodium, potassium and chloride (Stummvoll and Lehmann, 1996).

Carcass traits

After 42 days from the beginning of the trial, five broilers from each treatment were randomly chosen, fasted overnight, weighed then slaughtered by sharp knife for complete bleeding. The dressing percentage, in which the head, neck, feet and lower wing were removed and calculated by final weighting following plucking of the feather, evisceration. Liver, heart and digestive tract (intestine and crop, gizzard, proventiculus, abdominal fat and spleen) were selected, weighed and considered as percentage of live body weight.

Economic efficiency measurements

The cost parameters were categorized into total fixed costs (TFC), total variable costs (TVC), and total costs (TC) (Ahmed, 2007; Sara, 2007). On the other hand, returns parameters including total returns (TR) from chick sale

Table 1: Ingredient composition (%) and calculated analysis of the experimental diets used in experimental starter, grower and finisher stages (air dry basis).

Experimental diets												Ingredient
Finisher stage (2 weeks)				Grower stage (2 weeks)				Starter stage (2 weeks)				
LCP, 6%	LCP, 4%	LCP, 2%	Control	LCP, 6%	LCP, 4%	LCP, 2%	Control	LCP, 6%	LCP, 4%	LCP, 2%	Control	
78.52	73.44	67.96	62.34	74.45	69.22	63.28	57.27	67.48	62.67	57.17	50.34	Yellow corn
8.90	14.80	20.60	26.00	11.15	17.50	23.53	29.35	16.30	22.50	28.60	34.60	SBM, 44%
3.45	3.45	3.45	3.45	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	Corn gluten, 60%
2.40	3.00	3.60	4.40	1.70	2.20	3.00	3.90	1.75	2.15	2.80	4.05	Soybean oil
1.05	1.00	1.00	1.00	1.10	1.10	1.10	1.10	1.20	1.20	1.20	1.2	Calcium carbonate
1.55	1.50	1.45	1.40	1.75	1.70	1.60	1.55	1.85	1.80	1.75	1.7	Ca. dibasic ph.
0.15	0.30	0.30	0.30	0.15	0.30	0.30	0.30	0.10	0.30	0.30	0.30	Common salt
0.45	0.25	0.25	0.08	0.43	0.20	0.22	-	0.50	0.22	-	-	Sod. bicarbonate
0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	Premix[1]
0.44	0.26	0.1	-	0.52	0.33	0.16	0.03	0.67	0.49	0.32	0.15	Lysine, Hcl, 78%
0.10	0.08	0.05	0.03	0.12	0.10	0.08	0.05	0.18	0.16	0.13	0.11	DL-Methionine,98%
0.12	0.05	0.01	-	0.16	0.08	0.03	-	0.23	0.16	0.08	0.05	Threonine, 98.5%
0.03	-	-	-	0.03	-	-	-	0.04	-	-	-	Tryptophan,98.5%
0.10	-	-	-	0.12	-	-	-	0.20	0.10	-	-	Valine, 95%
0.13	-	-	-	0.15	-	-	-	0.26	0.10	-	-	Arginine, 95%
0.80	0.70	0.56	0.45	1.00	0.90	0.80	0.70	1.30	1.20	1.10	1.00	Glycine, 97%
0.44	0.23	0.01	-	0.60	0.35	0.15	-	0.85	0.60	0.40	0.20	L-Gluamate, 99.4%
0.22	0.16	0.08	0.05	0.37	0.30	0.25	0.20	0.77	0.70	0.65	0.60	Proline
0.10	-	-	-	0.10	-	-	-	0.20	0.10	-	-	Isoleucine
-	-	-	-	-	-	-	-	0.10	-	-	-	Alanine
0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	Antimycotoxin
0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	Anticoccidial
0.10	-	-	-	0.15	-	-	0.05	-	-	-	0.20	Calcium chloride
0.45	0.28	0.08	-	0.45	0.22	-	-	0.52	0.05	-	-	Potassium sulphate
+	+	+	-	+	+	+	-	+	+	+	-	L-carnitine
Calculated composition												
3192.27	3197.46	3187.58	3184.61	3106.56	3107.50	3104.84	3105.43	3001.37	3004.70	3004.78	3011.2	ME, Kcal/Kg
12.23	14.13	16.09	18.00	14.00	16.06	18.07	20.04	16.07	18.10	20.08	22.04	CP, %
260.92	226.28	198.11	177.44	221.83	193.55	171.80	154.97	186.81	165.96	149.63	136.6	C/P ratio
3.22	3.07	2.90	2.73	3.12	2.96	2.78	2.59	2.89	2.75	2.58	2.37	EE, %
2.15	2.47	2.77	3.04	2.25	2.60	2.90	3.20	2.48	2.82	3.14	3.43	CF, %
0.81	0.76	0.76	0.76	0.89	0.84	0.84	0.86	0.99	0.91	0.92	0.99	Ca, %
0.38	0.38	0.38	0.38	0.42	0.42	0.42	0.42	0.45	0.45	0.45	0.45	Available ph., %
0.77	0.76	0.76	0.80	0.89	0.89	0.89	0.91	1.12	1.12	1.12	1.12	Lysine, %
0.32	0.33	0.32	0.32	0.37	0.38	0.38	0.37	o.45	0.45	0.45	0.45	Methionine, %
0.35	0.37	0.37	0.37	0.40	0.41	0.42	0.42	0.48	0.49	0.50	0.50	Cysteine, %
0.62	0.73	0.83	0.92	0.68	0.79	0.90	1.00	0.75	0.87	0.98	1.08	Phenylalanine, %
1.41	1.42	1.40	1.42	1.64	1.65	1.66	1.66	2.07	2.07	2.09	2.09	Proline, %
0.64	0.75	0.84	0.93	0.72	0.83	0.93	1.03	0.80	0.91	1.01	1.11	Serine, %
0.53	0.53	0.56	0.62	0.62	0.62	0.64	0.68	0.74	0.75	0.75	0.79	Threonine, %
0.13	0.13	0.16	0.18	0.15	0.15	0.17	0.20	0.18	0.17	0.20	0.22	Tryptophan, %
0.53	0.61	0.68	0.75	0.58	0.66	0.73	0.80	0.63	0.71	0.79	0.86	Tyrosine, %

0.62	0.62	0.71	0.79	0.71	0.70	0.79	0.87	0.86	0.86	0.86	0.94	Valine, %
0.91	0.99	1.06	1.13	1.01	1.09	1.17	1.24	1.15	1.14	1.22	1.29	Alanine, %
0.82	0.84	0.97	1.10	0.96	0.98	1.12	1.25	1.18	1.18	1.23	1.37	Arginine, %
0.54	0.64	0.75	0.84	0.61	0.72	0.83	0.93	0.69	0.80	0.91	1.01	Asparagine, %
0.74	0.90	1.06	1.20	0.84	1.02	1.18	1.34	0.97	1.15	1.32	1.47	Asparate, %
1.35	1.36	1.35	1.53	1.60	1.58	1.60	1.65	2.02	2.00	2.02	2.03	Glutamate, %
1.25	1.43	1.59	1.74	1.35	1.54	1.70	1.86	1.47	1.66	1.83	1.99	Glutamine, %
1.35	1.36	1.34	1.33	1.60	1.63	1.64	1.66	1.98	2.01	2.03	2.04	Glycine, %
0.32	0.38	0.43	0.48	0.36	0.42	0.47	0.52	0.40	0.46	0.51	0.57	Histidine, %
0.54	0.53	0.62	0.70	0.60	0.61	0.70	0.79	0.78	0.78	0.77	0.86	Isoleucine, %
1.31	1.46	1.60	1.72	1.40	1.56	1.70	1.83	1.50	1.66	1.80	1.93	Leucine, %
1.84	1.77	1.68	1.60	1.91	1.84	1.75	1.66	1.80	1.73	1.65	1.54	Linolenic acid, %
0.23	0.23	0.23	0.19	0.22	0.22	0.22	0.17	0.22	0.22	0.16	0.16	Sodium, %
0.82	0.85	0.85	0.92	0.87	0.87	0.86	0.99	0.88	0.86	0.97	1.10	Potassium, %
0.20	0.23	0.23	0.23	0.23	0.23	0.23	0.26	0.25	0.23	0.23	0.36	Chloride, %
253.06	253.47	253.59	250.88	253.19	251.99	252.19	250.35	251.39	252.93	254.19	251.4	DEB, mEq/kg

1Muvco premix: Each 2.5kg contain vit. A (10, 000000 IU), vit. D3 (2, 000000 IU), vit. E (10 g), vit. k3 (1000 mg), vit. B1 (1000 mg), vit. B2 (5 g), vit. B6 (1.5 g), pantothenic acid (10 g), vit. B12 (10 mg), niacin(30 g), folic acid (1000 mg), biotin(50 g), fe (30 g), Mn (60 g), Cu (4 g), I (300 mg), Co (100 mg), Se (100 mg) and Zn (50 g).

Table 2: Overall performance of broiler chickens fed with low CP diets (LCP) and AAs and L-carnitine supplementation (Means ±SE).

Item	Experimental diets			
	Control	LCP, 2%	LCP, 4%	LCP, 6%
Initial body weight (g)	44.01± 0.42	44.57±0.43	42.95±0.41	43.99±0.28
Final body weight (g)	2812.30±129.59	3094.30±122.26	2604.40±73.54	2684.10±71.03
Absolute weight gain (g)	2768.30±129.21	3049.70±121.83	2561.50±73.16	2640.10±70.83
Total feed consumption (g)	4291.00±156.39	4262.90±117.41	4321.20±78.89	4438.70±159.57
Feed conversion ratio	1.55±0.02^{b}	1.40±0.01^{c}	1.68±0.02^{a}	1.68±0.02^{a}

^{abc} Means within the same row carrying different superscripts are significantly different at (P ≤ 0.05).

equals kg price (20 LE in May, 2016) x body weight and net profit (total returns minus total costs) were calculated.

Statistical analysis

The obtained results were statistically analyzed using one-way ANOVA by the statistical package for social science (SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp). Variations among treatment means were compared using Duncan's multiple range tests (Duncan, 1995). Statement of statistical significance was pronounced at *(P<0.05)*.

RESULTS AND DISCUSSION

Productive performance of broilers fed with the experimental diet is shown in Table 2. Our results revealed that no marked change in total final body weight, body weight gain and total feed intake when compared with the control one (P>0.05). Also, the feed conversion ratio had marked improvement in group 2 fed with low crude protein (decrease by 2%) (P<0.05) while marked decrease in other treated groups when compared with the control one (P<0.05).

Our results are in accordance with previous studies at which report that crude protein can be successfully reduced up to a 25% with using synthetic glutamic acid and indispensable amino acid fortification that results in the same performance for standard higher CP (Dean et al., 2006; Namroud et al., 2008). In addition, CP of broilers starter (up to 3 weeks) can be lowered to 19.20% with depending on indispensable amino acids supplementation without any harmful effect on productive performance under the hot and humid tropics (Awad et al., 2014). Also, feeding Cobb Avian 48 broilers on 1% lower protein diet at constant ME, with the same amino acids levels hadn't adversely affected the growth performance, liver functions and carcass parameters, whereas; dietary CP and crude fiber utilization were enhanced (Saleh, 2016). However, our results are disagreed with previous studies reported dropped performance in broilers fed LCP only 3 or 4 % CP with synthetic indispensable amino acid fortification (Si et al., 2004; Namroud et al., 2008). The results of the current study can be contributed to changes in the level of crude protein, essential and non-essential amino acids supplementation, dietary feedstuffs, chosen essential and non-essential amino acids specifications, as well as broiler age and strain may have contributed to some of the variation in reported performance (Corzo, 2005).

Data of some serum biochemical parameters of broiler chicken are presented in Table 3 which revealed no marked change in the total cholesterol, LDL, total protein, albumin, globulin, ALT, AST, creatinine, uric acid, urea, sodium and potassium among various treatments formulated based on low CP diets (LCP) and supplemented with synthetic essential, non-essential amino acids and L-carnitine (P>0.05). On the other side, there was a marked difference among treatments in the serum glucose, triglyceride, HDL and chloride (P<0.05).

Likewise, our results revealed a marked decrease in serum glucose level for group 4 fed on LCP (decrease by 6%) when compared to control group or other dietary treatment groups (P<0.05). The calculated parameters of serum triglyceride or chloride revealed a marked reduced within group 2 fed LCP (decrease by 2%) when compared to control group or other dietary treatment groups (P<0.05). Statistical data analysis revealed a significantly increase in serum HDL for group 4 fed on LCP (decrease by 6%) when compared to control group or other dietary treatments groups (P<0.05).

These results disagreed with previous study reported that chicken fed on low CP diets had significantly increased plasma triglycerides, free fatty acids and decreased uric acid levels while glucose levels were unaffected by the dietary composition which indicates that carbohydrate metabolism was not affected by the diet (Swennen et al., 2006).

Regarding triglyceride and high-density lipoprotein, our results disagreed with previous studies found markedly increased for liver weights in the chickens fed the LCP diet when compared to those fed diet with higher in CP (Swennen et al., 2006) which could be related to increased metabolizable energy (ME): crude protein (CP) ratio in the low CP diets (31.5 vs. 16.5) because increased ME: CP ratio can effectively increase the activity of body lipogenesis (Rosebrough and Steele, 1985). This fact is supported by the increased plasma triglycerides concentration of the chickens fed low CP diets. In our study, we find marked decrease in triglyceride and marked increase in HDL due to addition of L-carnitine that is a zwitterionic compound necessary for the transport of long-chain fatty acids from the cytosol into the mitochondria for β-oxidation (Rosebrough and Steele, 1985). So, dietary L-carnitine fortification could improve energy and fatty acid and utilization as well as decrease esterification reactions and triacylglycerol storage in the adipose tissue, which eventually lead to decrease in body fat storage.

Data of carcass traits are presented in Table 4 which revealed that no marked differences on weight percentages of dressing, gizzard, proventiculus, liver, spleen, heart, abdominal fat and crop relative to live body weight among all experimental treated groups (P>0.05).

The obtained results are in a close agreement with trial reported that no changes in carcass, breast meat yields and abdominal fat in broilers fed LCP diets with constant ME: CP (Hidalgo et al., 2004). Furthermore, the indispensable amino acid status of a diet influences the carcass composition of broilers and while in case of adequate essential AA, there is no effect on the protein and fat content of the carcass even if the CP is lowered (Si et al., 2004).

Regarding to abdominal fat, our study disagrees with study observed that abdominal fat weight was increased by 104% when the broilers were fed with 17% CP diet when compared to those fed 24% CP diet (Neto et al., 2000). Also, broilers fed with low CP diets retained more body fat than the broilers fed control diet. One major factor responsible for increased abdominal fat with low CP diets is the increased ME: CP (Namroud et al., 2008). This increased energy availability surplus that required for protein deposition resulting in increased body lipogenesis of broilers fed with low CP diets which results in increasing the content abdominal fat.

Regarding liver weight, the obtained results agreed with trial that found no effect of dietary CP levels on liver weights (Sterling et al., 2006). In contrast, our results disagreed with studies reported that increased liver weight as consequence of improved lipogenesis in the liver of birds fed with LCP diets due to increase ME: CP (Rosebrough and Steele, 1985; Swennen et al., 2006).

In this study, no marked differences on weight percentages of liver and abdominal fat relative to live body weight between all experimental treated groups has been detected (P>0.05) due to addition of L-carnitine which could improve energy and fatty acid utilization as well as decrease esterification reactions, and triacylglycerol storage in the adipose tissue, which eventually lead to decrease in body fat storage.

Also, our results revealed that no marked differences in TVC, TC and TR between all experimental treated groups (P>0.05) as shown in Table 5 while There was marked increase in the net profit in group 2 fed with LCP (decrease by 2%)

Table 3: Serum biochemical parameters of broiler chickens fed with low CP diets (LCP) and AAs and L-carnitine supplementation (Means ±SE).

Item	Experimental diets			
	Control	LCP, 2%	LCP, 4%	LCP, 6%
Glucose (mg/dl)	231.67±12.48[a]	225.40±4.19[a]	226.13±5.78[a]	190.30±14.03[b]
Total cholesterol (mg/dl)	151.07±16.33	160.93±6.63	159.20±11.85	168.83±14.10
Triglyceride (mg/dl)	47.51±5.94[a]	24.61±1.82[b]	33.84±2.36[ab]	38.09±6.71[ab]
HDL (mg/dl)	86.77±5.13[b]	100.88±5.29[ab]	105.22±7.75[ab]	113.70±3.51[a]
LDL (mg/dl)	16.78±9.22	35.44±3.08	20.14±5.29	17.03±4.87
Total protein (g/dl)	3.34±0.18	3.13±0.25	3.09±0.12	3.30±0.16
Albumin (g/dl)	1.48±0.06	1.60±0.09	1.47±0.01	1.59±0.03
Globulin (g/dl)	1.86±0.16	1.52±0.17	1.61±0.12	1.71±0.13
ALT (U/l)	10.61±3.72	8.97±0.89	10.80±3.84	9.76±3.74
AST (U/l)	292.26±13.92	270.07±26.76	238.73±23.36	239.90±18.79
Creatinine (mg/dl)	0.21±0.06	0.22±0.03	0.46±0.24	0.17±0.04
Uric acid (mg/dl)	1.90±0.75	1.26±0.08	1.10±0.04	1.31±0.12
Urea (mg/dl)	8.35±1.35	8.81±1.54	7.50±0.47	9.45±1.33
Sodium (mEg/l)	124.18±1.93	122.13±1.91	124.93±2.25	120.80±1.81
Potassium (mEg/l)	7.76±1.71	8.19±1.11	8.55±0.46	11.18±1.82
Chloride (mEg/l)	102.48±1.05[a]	90.23±1.17[b]	96.00±1.15[ab]	95.66±4.37[ab]

[abc] Means within the same row carrying different superscripts are significantly different at ($P \leq 0.05$).

Table 4: Carcass traits relative to the live weight of broiler chickens fed with low CP diets (LCP) and AAs and L-carnitine supplementation (Means ±SE).

Item	Experimental diets			
	Control	LCP, 2%	LCP, 4%	LCP, 6%
Live weight, g	2163.30±21.85	2205.00±85.44	2083.00±45.85	2210.00±78.10
Dressing, %	76.91±3.34	73.50±1.03	70.87±0.83	72.82±0.44
GIT, %	4.85±0.69	3.84±0.14	4.08±0.08	4.23±0.38
Gizzard, %	1.69±0.06	1.59±0.15	1.68±0.03	1.82±0.19
Proventiculus, %	0.46±0.00	0.53±0.08	0.48±0.01	0.45±0.01
Liver, %	2.24±0.35	2.12±0.13	2.00±0.14	2.11±0.04
Heart, %	0.54±0.07	0.45±0.01	0.64±0.07	0.68±0.23
Abdominal fat, %	2.69±0.48	2.85±0.36	2.88±0.28	2.56±0.08
Spleen, %	0.23±0.00	0.22±0.01	0.24±0.01	0.22±0.01
Crop, %	0.23±0.00	0.29±0.01	0.31±0.86	0.30±0.06

Table 5: Economic efficiency of broiler chickens fed with low crude protein diets (LCP) and amino acids and L-carnitine supplementation (means ±SE).

Parameters	Experimental diets			
	Control	LCP, 2%	LCP, 4%	LCP, 6%
TVC	15.35±0.59	15.45±0.46	15.75±0.22	16.27±0.67
TC	50.79±0.59	50.89±0.46	51.19±0.22	51.71±0.67
Return	61.87±2.85	68.07±2.68	57.29±1.61	59.05±4.93
Net profit	11.07±2.80[b]	17.17±2.70[a]	6.10±1.40[b]	7.33±0.90[b]

[ab] Means within the same row carrying different superscripts are significantly different at ($P \leq 0.05$).

when compared to control group or other dietary treatment groups ($P<0.05$). In conclusion, group 2 fed with LCP (decrease by 2%) showed a highest return and net profit values when compared with other groups.

CONCLUSION

Broiler chickens of all experimental treated groups did not reveal any significant difference in total final body weight, body weight gain and total feed intake when compared with the control group ($P>0.05$). The broiler chickens fed with LCP decreased by 2% had the best FCR and net profit values. In this study, the crude protein can be reduced with amino acids fortification up to 6% without any adverse effects on broiler performance. So, in future, when amino acid industry expanded and all (20) amino acids distributed as feed grade for animal use, we can reduce crude protein up to 6% which will be more economic. Also, the addition of L-carnitine with LCP ration leads to improvement in carcass traits by preventing excess abdominal fat.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

AUTHORS CONTRIBUTION

All authors contributed equally in this work.

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