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The effect of L-carnitine and low crude protein supplemented with crystalline essential amino acids diets on broiler chickens

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ABSTRACT

*Effect of L-carnitine on broiler chickens fed with low protein diet supplemented with crystalline amino acids was allocated . 192 female commercial broiler chicks were chosen at 10 days of age based on body weight gain and used for 21 days of this experiment. This study was conducted in factorials arrangement (3*2) in completely randomized design with 20, 18, and 16% crude protein supplemented with crystalline amino acids, 0.0 and 50 mg/kg L-carnitine. Body weight gain, feed intake and feed conversion ratio were measured at the end experiment. At 31 days of age 8 birds from each treatment were randomly taken for measure abdominal fat pad , liver, breast and thigh as weight percents of carcass weight. Fortifying a low crude protein diet with excess essential amino acids resulted in significantly(P<0.05) increase in body weight gain, feed intake and favorable decrease in feed conversion ratio. Significant(P<0.05) decrease was observed among treatments 0.0 and 50 mg/kg L-carnitine diets, for body weight gain and feed intake. But for feed conversion ratio no significant effect(P>0.05) , was observed. Abdominal fat deposition of chicks fed low protein diets supplemented with amino acids were significantly(P<0.05) higher than chicks fed control diet. Reducing dietary crude protein increased serum blood sodium and chloride . Overall, this study implicate that 50 mg/kg L-carnitine could decrease abdominal fat content, such as dietary crude protein can be decrease until 16% and the amount of excreted nitrogen was reduced with decrease crude protein levels.*

Keywords: broiler chick, low protein, crystalline amino acid, L-carnitine.

INTRODUCTION

Shortage of food and nutrients, especially animal protein, is one of the most important nutritional problems of the today world, especially in third world countries. Poultry industry, is one of the most effective methods of producing animal protein in the world. With development of poultry industry, the problem of nitrogen excretion became one of the biggest problems in developed and developing countries [1]. Lowering dietary protein

levels and the use of synthetic amino acids, while reduce cost of diet, will also reduce environmental pollution of nitrogen. It is important to know which levels of dietary protein is suitable for broiler performance. One problem with diets containing low levels of protein apart from its effects on performance, is greater fat in the carcass of broiler fed low crude protein diets [2,3]. L-carnitine, a zwitterionic compound synthesized *in vivo* from lysine and methionine, is essential for the transport of long-chain fatty acids from the cytosol into the mitochondria for β-oxidation. Broiler diets contain a large percentage of grain and byproducts that have low levels of L-carnitine. Also methionine and lysine that are essential for synthesis of L-carnitine, are limited in this diet and broilers to meet their needs to carnitine, just rely on internal synthesize. Amount of L-carnitine in broiler diet is not enough and may lead to greater carcass fat weight. So dietary L-carnitine supplementation could improve fatty acid and energy utilization and decrease esterification reactions and triacylglycerol storage in the adipose tissue, which eventually lead to decrease in body fat storage [4]. In this study, by using low crude protein diets supplemented with amino acids, reducing pollution of nitrogen and effect of L-carnitine on performance, blood composition, abdominal fat accumulation and body chemical composition in female broiler were investigated .

MATERIALS AND METHODS

Birds and Housing: This experiment was performed on 10-day-old female Ross 308 broiler chicks housed in unit testing group, on the litter. The experimental birds were given *ad libitum* access to water and diet. The ambient temperature was gradually decreased from 32 to 24 °C over the period of 1 to 31 d of age. The birds were exposed to a 24 h light. Chicken vaccination was carried out according to schedule.

Table 1) Ingredient and Nutritional composition of experimental diets (%) Treatments[1]

Ingredient	Diets[4] 1&4	Diets 2&5	Diets 3&6	Item	Diets 1&4	Diets 2&5	Diets 3&6
Yellow corn	57.66	63.38	68.6	AMEn(Kcal/Kg)	3150	3150	3150
Soybean meal	30.54	24.72	18.88	Crude protein(%)	20	18	16
Anchovy meal	4	4	4	Ca (%)	0.9	0.9	0.9
Soybean oil	4.52	4	3.7	Available P (%)	0.45	0.45	0.45
Di calcium phosphate	1.24	1.28	1.31	Chlorine (%)	0.21	0.16	0.2
Sodium bicarbonate	0.0	0.3	0.66	Potassium (%)	0.81	0.72	0.62
Calcium chloride	0.15	0.1	0.1	DEB(mEq/kg)	250	250	250
Calcium sulfate	0.0	0.06	0.0	Sodium(%)	0.1	0.14	0.24
Limestone	0.89	0.89	0.97	Solfor (%)	0.21	0.20	0.17
Sodium chloride	0.1	0.0	0.01	Total and standardized ileal digestible amino acids[5]			
Mineral premix[2]	0.25	0.25	0.25	L-Lys (%)	1.1	1.1	1.1
Vitamin premix[3]	0.25	0.25	0.25	DL-Met (%)	0.56	0.61	0.63
DL-Methionine	0.26	0.31	0.35	Met+Cys (%)	0.84	0.84	0.84
L-Lys Hcl	0.13	0.30	0.47	L-Thr (%)	0.75	0.73	0.73
L-Thr	0.0	0.07	0.15	L-Ile (%)	0.88	0.76	0.75
L-Arg	0.0	0.07	0.22	L-Arg (%)	1.22	1.14	1.14
L-Trp	0.0	0.0	0.03	L-Trp (%)	0.2	0.18	0.18
L-Ile	0.0	0.0	0.08	L-Leu (%)	1.57	1.46	1.34
L-Val	0.0	0.0	0.04	L-Val (%)	0.89	0.81	0.75

[1]Teratments: 1) 20% CP, 2) 18% CP +100% EAA, 3) 16% CP + 100% EAA, 4) 20% CP +100% EAA + L-Carnitine 5) 18% CP +100% EAA + L-Carnitine 6) 16% CP +100% EAA + L-Carnitine .

[2]mineral premix Added (mg/kg) to the diet: Manganese,110.60; Zinc,110..40; Iron(ferrous sulfate),50; Copper,8.30;Selenium (sodium selenite),0.30; I,1.08; Co,0.1; Mo, 0.05 .

[3]Vitamin premix added (per kg of diet): A (retinyl acetate),11.023 IU; D(cholecalciferol), 118 IU; E (DL-a-tocopheryl acetate), 23.54 IU; K (menadione), 1.47 mg ; B_{12},0.0151 mg ; riboflavin,5.895 mg ; niacin,42.93 mg ; D-Pantothenic acid, 12.11 mg ; Choline, 477.7 mg ; Folic acid, 1.15 mg ; Pyridoxine,4.17 mg ; Thiamin, 1.23 mg and D-Biotin, 0.075 mg .

[4]Diet= diets 1,2,3 without L-carnitine and diets 4,5,6 with L-carnitine (50 mg/kg diets) .

[5]Includes amino acids from intact protein and crystalline sources . Crystalline amino acids were assumed 100% truly digestible .

Diet Formulation: Corn, soybean meal and fish meal were sampled before diet formulation to determine crude protein as Kjeldahl(nitrogen × 6.25), moisture, metabolized energy [5]. To calculate the electrolyte balance, percentage of electrolytes in feed ingredients were extracted from feedstuffs Table [6]. The dietary electrolyte balance was maintained at 250 mEq/kg in all dietary treatments by using of calcium carbonate, calcium chloride, calcium sulfate, potassium chloride, and potassium sulfate. All diets were formulated to be isoenergetic (3150 kcal/kg of AMEn). The concentration of dietary calcium (Ca), available phosphorus (P), sodium(Na) and potassium(K) was maintained equal in all treatments (Table 1). Diets were formulated base on computer software (UFFDA) Tables 1. Dietary amino acids were adjusted in higher levels than recommendations of NRC [7], and according to the rearing guide of Ross 308 strain. Dietary essential amino acids (methionine, lysine, threonine, tryptophan, arginine, valine and isoleucine) were balanced based on standardized ileal digestibility. Experimental design was a 3*2 factorial arrangement in a completely randomized design with 20, 18 and 16% crude protein (CP) levels, 0.0 and 50 mg/kg L-carnitine on 192 broilers allocated in 6 treatments each with 4 replicated of 8 birds .

Performance, Carcass Characteristics and Whole-Body Analyses: At the end of each week feed intake and body weight gain of chickens were measured to determine feed conversion ratio. At the end of the experimental period (d 31), two birds per replicate (with a body weight close to the replicate mean), were slaughtered. After slaughter liver, abdominal fat, breast and thigh as weight percentage of total carcass weight were determined. Also thigh and breast muscles were isolated from the bone and four uniform samples from each treatment were elected to measure protein and fat. At the end of the experimental period (d 31) one birds per replicate (with a body weight close to the replicate mean), were slaughtered by cervical dislocation for determination CP and Fat% (dry matter percentage) of whole-body composition according to procedures described by Barker and Sell. [8]. At 31 days of age two birds from each treatment were selected and kept in individual cages and excreta were collected and lyophilized, and were sent to the laboratory for determining nitrogen by Kjeldahl method to determine the nitrogen excretion.

Blood samples: At the age of 31 days blood sampling was performed in order to measure some parameters of blood. Blood samples were taken per replicate from the heart and placed into tubes. Samples were put on ice immediately and processed within 1 h of collection. Serum samples immediately were transferred into micro tubes and sent to the laboratory to determine some parameters of blood such as; sodium, chlorine, potassium, cholesterol, triglycerides, glucose, albomin, and uric acid. The serum concentration of Na and K were determined with ISE method and serum Cl was detected by spectrophotometry. Serum uric acid was measured by the method of Liddle et al. [9] by enzymatic (uriase) spectrophotometery.

Statistical Analysis: Data were analyzed using the general linear model ANOVA (SAS Institute. [10].) in a completely randomized design. Means were compared using Duncan's multiple range test. In all cases, significance was set at $P < 0.05$.

RESULTS AND DISSCUSION

The effects of dietary treatments on performance of broiler chickens in grower period are reported in Table 2. In low CP diet supplemented with synthetic essential amino acids (18

and 16 percent protein) compared with controls diet (20 percent protein) body weight gain and feed intake was increased significantly (P <0.05). By reducing dietary protein, Feed conversion also decreased significantly (P <0.05). Since in this experiment the dietery essential amino acids were above NRC [7] suggestion, standardized ileal digestibility of amino acids was used instead of total amino acids for feed foramation and optimum dietary electrolyte balance (250 mEq/kg) was used, reducing dietary protein level supplement with essential amino acids up to 16% in the grower period, had positive effect on birds performance. The results of this experiment is in agreement with other studies[11-14] . Use of 50 mg/kg L-carnitine in the diets reduced body weight gain and feed intake significantly(P <0.05), but did not affect on feed conversion. These results is in agreement with studies of Xu *et al*.[4] , Kheirkhah *et al*.[15] , Darsi *et al*. [14] , and in opposite with Rabie *et al*.[16] , Mast *et al*.[17]. These differences probably is related to the amount of carnitine supplementation, gender and composition of experimental diets. Abdominal fat deposition of chicks fed low protein amino acids supplemented diets were significantly(P <0.05) higher than chicks fed control diet. This result was in agreement with Yamazaki.[18] , Namroud *et al*. [19]. On the other hand, the reduction in dietary protein levels increased liver weight percentage of carcass weight, but was not significantly different. Low protein diet supplemented with amino acids compared to the control group (20% protein) increased breast weight percentage of total carcass weight that was in agreement with Oyedeji *et al*.[20] , Horniakova and Abas.[21]. But about tight weight percentage of total carcass weight we observe linear reduction that was not significantly different. Carnitine supplemented diets (50 mg/kg) had no significant effect (P>0.05) on tight and abdominal fat content weight percentage of total carcass weight but significantly(P< 0.05) reduced weight percentage breast [4.14.15.22]. The liver weight percentage of total carcass weight was reduced (P < 0.05) in L-carnitine supplemented diet(Table 3). This is due to the fact that liver is the main place of fat metabolism in the birds, and L-carnitine increases fatty acid transport into mitochondria and increases beta-oxidation of fatty acids. This result was obtained by Hidari.[23] , Namroud *et al*.[19].

Using different levels of protein showed significant(P < 0.05) difference on serum glucose, uric acid, triglyceride and cholesterol, whereas albumin was not significantly different(P>0.05). Low protein diet supplemented with amino acids, decreased serum uric acid of the birds (Table 3). In low CP diet, if amino acid profiles are set, the amount of fecal nitrogen metabolites such as ammonia, urea and uric acid decreases. Ferguson *et al*.[24] , Namroud *et al*.[19] also observed similarly results. These study Albumin, uric acid, triglyceride and cholesterol concentration in serum were similar to the values obtained by Victoria et al.[25]. Supplementation of L–carnitine had significant(P < 0.05) effect on serum glucose, albumin, uric acid, triglyceride and cholesterol concentration in broiler chickens. In a study that was conducted by Kheirkhah et al.[15] They observed that dietary L-carnitine had no significant effect on serum triglyceride and cholesterol concentrations, that is in contrary with our result. The influence of L–carnitine and ractopamin on serum triglyceride and cholesterol and blood glucose was examined by Jalali Haji Abadi *et al*.[26] in rainbow trout that increased serum triglyceride and cholesterol significantly but did not affect blood glucose. Blood glucose was significantly decreased in L–carnitine supplemented diet in our experiment, because L-carnitine increases fatty acid oxidation so has the sparing effect on the blood glucose. This is in agreement with Hidari.[23].

Table 2) Effect of L-carnitine and dietary CP level supplementation with essential amino acids(EAA) on performance, rlaetive weight percentage of visceral organs, abdominal fat, breast, and thigh[1] (during 10 to 31 d of age)

Levels of CP	BWG(g)[2] ± SE[3]	FI(g) ± SE	FCR(g) ± SE	Abdo fat(%) ±SE	Liver ± SE	Breast ± SE	Thigh ± SE
20% CP	575^{b} ± 66	997^{c} ± 98	1.73^{a} ± 0.22	2.3^{b} ± 0.1	2.1 ± 0.1	15.3 ± 0.4	14.7 ± 0.3
18% CP + EAA[4]	955^{a} ± 30	1434^{b} ± 43	1.50^{b} ± 0.31	2.5^{a} ± 0.1	2.3 ± 0.1	15.5 ± 0.3	14.5 ± 0.3
16% CP + EAA	1004^{a} ± 30	1554^{a} ± 45	1.55^{b} ± 0.16	2.7^{a} ± 0.2	2.4 ± 0.1	15.8 ± 0.2	14.2 ± 0.2
Significance level(P< 0.05)					NS	NS	NS
Levels of L-carnitine(mg/kg Diets)							
0.0 (mg/kg diet)	877^{a} ± 53	1402^{a} ± 58	1.6^{b} ± 0.19	2.6 ± 0.2	2.4^{a} ± 0.1	16.2^{a} ± 0.3	14.9 ± 0.3
50 (mg/kg diet)	752^{b} ± 31	1275^{b} ± 66	1.7^{a} ± 0.27	2.4 ± 0.3	2.2^{b} ± 0.1	14.3^{b} ± 0.3	14.7 ± 0.2
Significance level(P< 0.05)				NS			NS
Intraction Between Levels of CP and L-carnitine (mg/kg Diet)							
20%CP +0.0 L-carnitine	634^{b} ± 80	1139^{b} ± 74	1.80^{ab} ± 0. 2	2.4 ± 0.1	2.2^{ab} ± 0.1	15.9^{ab} ± 0.4	14.9^{ab} ± 0.3
18%CP+EAA+0.0 L-carnitine	988^{a} ± 45	1464^{a} ± 58	1.48^{b} ± 0.03	2.6 ± 0.2	2.4^{a} ± 0.1	16.7^{a} ± 0.2	14.8^{b} ± 0.3
16%CP+EAA+0.0 L-carnitine	1009^{a} ± 31	1601^{a} ± 39	1.59^{b} ± 0.06	2.7 ± 0.6	2.5^{a} ± 0.3	16.1^{ab} ± 0.1	14.8^{ab} ± 0.2
20%CP + 50 L-carnitine	416^{c} ± 51	855^{c} ± 102	2.06^{a} ± 0.25	2.3 ± 0.1	2.0^{b} ± 0.1	11.9^{c} ± 0.4	13.2^{c} ± 0.3
18%CP+EAA+50 L-carnitine	922^{a} ± 13	1403^{a} ± 26	1.52^{b} ± 0.03	2.5 ± 0.1	2.2^{ab} ± 0.2	15.7^{ab} ± 0.6	16.0^{a} ± 0.2
16%+EAA+ 50 L-carnitine	1019^{a} ± 28	1566^{a} ± 50	1.54^{b} ± 0.03	2.5 ± 0.2	2.2^{ab} ± 0.3	15.5^{b} ± 0.2	14.9^{ab} ± 0.2
Significance level(P< 0.05)					*NS*		

[a-d] Values within columns without a common letter differ significantly . *[1]Results are the means of 4 replicates (8 chicks per replicate) per treatment .*
[2]BWG=Body Weight gain, FI= Feed intake, FCR=feed conversion ration, and Abdo Fat= Rlative weight percent of abdominal fat.
[3]SE = Standard error. *[4]EAA =Amino acids status: 100% total essential amino acids (L-Thr , L-Arg , L-Trp , L-Ile , and L-Val (%)) above NRC (1994) .*

Table 3. Effects of L-carnitine and dietary CP level supplementation with excess essential amino acids(EAA) on blood serum sample[1] (31 d of age)

Levels of Crude Protein	Glu[2] ±SE[3]	Alb ± SE	U.A ± SE	TG ± SE	Chol ± SE	Na(mEq/L)± SE	Cl(mEq/L) ± SE	K(mEq/L) ± SE
20% CP	292.5^{c} ± 1	1.4 ± 0.1	5.1^{a} ± 0.1	86.5^{b} ± 1	120^{c} ± 1	145.5^{b} ± 1	82 ^{b} ± 1	5.3 ± 0.1
18% CP + EAA[4]	304.5^{b} ± 1	1.3 ± 0.1	4.8^{b} ± 0.1	87.5^{b} ± 1	123.5^{a}± 1	146^{a} ± 1	86.5^{a} ± 1	5.4 ± 0.1
16% CP + EAA	307^{a} ± 1	1.4 ± 0.1	3.7^{b} ± 0.1	89.5^{a} ± 1	122^{b} ± 1	148.5^{a} ± 1	90 ^{a} ± 1	5.4 ± 0.1
Significance level(P< 0.05)		NS						NS
Levels of L-carnitine								
0.0 (mg/kg diet)	304.7^{a} ± 1	1.3^{a} ±0.1	4.7^{a} ± 0.1	87.3^{b} ± 1	122^{a} ± 1	143.7^{b} ± 1	88.7 ± 1	5.3 ± 0.1
50 (mg/kg diet)	298^{b} ± 1	1.1^{b} ±0.1	2.9^{b} ± 0.1	89.3^{a} ± 1	119^{b} ± 1	145.7 ^{a} ± 1	90.3 ± 1	5.4 ± 0.1
Significance level(P< 0.05)							NS	NS
Intraction Between Levels of CP and L-carnitine (mg/kg diet)								
20%CP +0.0 L-carnitine	295^{d} ± 1	1.3^{ab} ± 0.1	4.9^{a}± 0.1	100^{a} ± 1	116^{c} ± 1	138^{c} ± 1	84^{c} ± 1	5.3 ± 0.1
18%CP+EAA+0.0 L-carnitine	309^{a} ± 1	1.3^{ab} ± 0.1	4.8^{a}± 0.1	83^{c} ± 1	129^{a} ± 1	146^{b} ± 1	90^{ab} ± 1	5.2 ± 0.1
16%CP+EAA+0.0 L-carnitine	310^{a} ± 1	1.4^{a} ± 0.1	4.5^{b} ± 0.1	79^{d} ± 1	121^{b} ± 1	147^{ab} ± 1	92^{a} ± 1	5.4 ± 0.1
20%CP + 50 L-carnitine	290^{c} ± 1	1.0^{b} ± 0.1	2.9^{c} ± 0.1	76^{d} ± 1	124^{b} ± 1	139^{c} ± 1	91^{ab} ± 1	5.2 ± 0.1
18%CP+EAA+50 L-carnitine	300^{c} ± 1	1.1^{ab} ± 0.1	2.8^{c}± 0.1	92^{b}± 1	112^{d} ± 1	148^{ab} ± 1	92^{a} ± 1	5.5 ± 0.1
16%+EAA+ 50 L-carnitine	304^{b} ± 1	1.2^{ab} ± 0.1	2.9^{c} ± 0.1	100^{a} ± 1	123^{b}± 1	150^{a} ± 1	88^{b} ± 1	5.4 ± 0.1
Significance level(P< 0.05)	NS							

$^{a-d}$ Values within columns without a common letter differ significantly . ^{1}Results are the means of 4 replicates (2 chicks per replicate) per treatment .
^{2}Glu = glucose (mg/dl), Alb = albomin (mg/dl), U.A = uric acid (mg/dl) , TG = triglycerides (mg/dl) , Chol = chlostrol (mg/dl), Sodium=Na, Chlorine=Cl, and Potassium=K,
^{3}SE = Standard error. ^{4}EAA=essential amino acids (L-Thr , L-Arg , L-Trp , L-Ile , and L-Val (%)) .

Table 4. Effects of L-carnitine and dietary CP level supplementation with excess essential amino acids(EAA) on Whole-body chemical composition , Nitrogen excretion, and chemical composition(% dry matter) of breast and drumstick + thigh[1] (31d of age)

Levels of Crude Protein	Fat[2](%) ± SE[3]	CP(%) ± SE	EN(%) ± SE	Breast CP ± SE	Breast Fat± SE	Dru+Thi[4] CP± SE	Dru+Thi[4] Fat± SE
20% CP	13.7 ± 0.6	20.2^{a} ± 0.2	75.8^{a} ± 0.1	22.5 ± 0.2	3.2 ± 0.3	18.5 ± 0.2	7.1^{c} ± 0.1
18% CP + EAA[5]	14.0 ± 1.1	19.2^{b} ± 0.3	54.8^{b} ± 0.8	22.4 ± 0.2	3.3 ± 0.2	18.4 ± 0.1	8.3^{b} ± 0.1
16% CP + EAA	14.1 ± 0.6	18.7^{c} ± 0.4	50.1^{b} ± 2.3	22.2 ± 0.1	3.5 ± 0.2	18.2 ± 0.1	11.3^{a}± 0.1
Significance level(P< 0.05)	NS				NS	NS	
Levels of L-carnitine(mg/kg diet)							
0.0 (mg/kg diet)	13.9 ± 0.5	19.2^{a} ± 0.3	60.3 ± 1.6	22.5^{a} ± 0.1	3.1± 0.3	18.4 ± 0.2	8.9 ± 0.2
50 (mg/kg diet)	13.3 ± 1.0	17.9^{b} ± 0.4	61.7 ± 2.1	21.8^{b} ± 0.2	3.3 ± 0.3	18.3 ± 0.2	8.8 ± 0.1
Significance level(P< 0.05)	NS		NS		NS	NS	NS
Intraction Between Levels of CP and L-carnitine (mg/kg diet)							
20%CP +0.0 L-carnitine	12.7 ± 0.4	20.7^{a} ± 0.2	76.6^{a} ± 0.4	22.6^{a} ± 0.1	2.9 ± 0.1	18.5^{a} ± 0.3	7.2^{c} ± 0.1
18%CP+EAA+0.0 L-carnitine	14.4 ± 0.7	19.2^{bc} ± 0.2	56.8^{b} ± 1.3	22.4^{ab} ± 0.1	3.2 ± 0.2	18.3^{ab} ± 0.2	8.5^{b} ± 0.1
16%CP+EAA+0.0 L-carnitine	14.5 ± 0.4	17.9^{d} ± 0.4	51.7^{b} ± 3	22.5^{ab} ± 0.1	3.5 ± 0.5	18.4^{a} ± 0.1	11.6^{a}± 0.2
20%CP + 50 L-carnitine	12.6 ± 1.5	19.7^{ab} ± 0.2	74.9^{a} ± 0.6	21.2^{c} ± 0.3	3.1 ± 0.2	17.9^{b}± 0.1	7.0^{c} ± 0.1
18%CP+EAA+50 L-carnitine	13.7 ± 1	18.4^{cd}± 0.5	59.0^{b} ± 0.3	22.2^{ab} ± 0.1	3.3 ± 0.3	18.2^{ab} ± 0.1	8.1^{b} ± 0.1
16%+EAA+ 50 L-carnitine	13.6 ± 1	15.6^{e} ± 0.5	49.7^{b}± 3.3	21.1^{b} ± 0.1	3.7 ± 0.3	18.1^{ab} ± 0.1	11.1^{a}± 0.1
Significance level(P< 0.05)	NS					NS	

[a-d]Values within columns without a common letter differ significantly.[1]Results are the means of 4replicates (1 chicks per replicate) per treatment.[2]Fat, CP = crude protein(Results are the means of 2 replicates per treatment) and EN= Excretion Nitrogen(% dry matter).[3]SE=Standard error. [4]Dru+Thi =drumstick + thigh(% dry matter).[5]EAA=essential amino acids.

We found an increase ($P < 0.05$) in the serum sodium and chloride concentration by lowering dietary CP but no significant difference was observed for potassium level (Table 3). Since a significant proportion of sodium and potassium ions are excreted through connection to uric acid with negative charge, with decreases of the uric acid production, the excretion of two above electrolytes decreased too and they accumulate in the body. Therefore it is recommended in broiler chicks fed low CP amino acids-supplemented diets, too reduce electrolyte balance in parallel with decline in nitrogen intake. Dietary L-carnitine supplementations increased serum sodium concentration.

Low CP diets supplemented with synthetic essential amino acids increased fat content of breast and carcass (Table 4). Fat content of tight muscle significantly ($P < 0.05$) increased. This result was also obtained by Parr and Summers.[27] , Namroud *et al*.[19] , Darsi *et al*.[14]. Fat content of tight muscle was reduced, but fat content of breast is increase in L-carnitine supplemented broiler, although was not significan different. Rabie *et al*.[16] , Rabie and Szilagyi.[22] , Xu *et al*.[4] , Darsi *et al*.[14] , observed similar results. By contrast, Barker and Sell.[8] , Kheirkhah *et al*.[15] , observed that dietary L–carnitine had no effect on broiler carcass fat. In another study, Cartwight.[28] , concluded that deficiency of carnitine precursors (lysine and methionine) increase broiler carcass fat. Low CP amino acids-supplemented diets, L-carnitine supplemented diet and interaction of them significantly reduced protein content of total carcass, tight and breast muscles (Table 4). Aletor *et al*.[1] and Bregendahl *et al*.[3] also observed significant reduction in total carcass protein by reducing dietary CP level. Nitrogen excretion of broiler chick fed low-protein diets reduced significantly (Table 4) whereas L-carnitine supplementations had no effect and interaction of dietary protein levels and L–carnitine reduced nitrogen excretion significantly ($p<0.05$). According to Aletor et al.[1] nitrogen excretion was decreased by 41% as dietary CP was decreased. Regression analysis showed a very highly significant positive correlation between nitrogen excretion and CP consumption. This result is in agreement with studies of Namroud et al.[19].

CONCLUSION

The results of this study showed that low protein amino acids-supplemented diets formulated based on standardized ileal digestibility and appropriate electrolyte balance(250 mEq/kg in diet) had no adverse effect on broiler performance in 10 to 31 days of age, but increased abdominal fat content. L-carnitine supplementation (50 mg/kg) of broiler diets decreased carcass and abdominal fat content.

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