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EFFECT OF DIETARY SUPPLEMENTATION WITH DIFFERENT LEVELS OF L-CARNITINE ON PRODUCTIVE AND ECONOMIC PERFORMANCE OF BROILER CHICKENS

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Abstract

The experiment was conducted between March 8th, 2017 and April 26th, 2017 at the Poultry Farm of Animal Sciences Department, College of Agricultural Sciences, Sulaimani University to investigate the effects of dietary supplementation with different levels of L-carnitine on economic productivity and performance of broiler chickens. By using 260 one-day old of Ross 308 broiler chicks, divided into 5 treatments and 4 replicates based on completely randomized design for 49 days. Feed and water were providedas ad libitum. Chicks were divided into five treatments 52 birds for each treatment. Each treatment contained four replicates of 13 birds. Dietary L-carnitine was added to the diet from the first day to the end of experimental which lasted 49 days at levels of 0% (Control), 0.01% (T1), 0.02% (T2), 0.04% (T3) and 0.08% (T5). The body weight had significantly ($p<0.05$) affected by L-carnitine supplementation at period 6 and 7, feed intake at 6th, 7th and 8th period, L-carnitine had a significantly ($p<0.05$) effect on weight gain at 6th and 8th period, it had significant effect on feed conversion ratio at 5th and 6th period. While L-carnitine had no significant effect on the overall body weight, weight gain, feed intake and feed conversion ratio at the final of the experiment. However, L-carnitine had no significant effect on dressing percentage with and without giblets while it had a significantly ($p<0.05$) effect on abdominal fat at T5 compare to other treatments. In addition, there were no significant effects of treatments on the economic index (European Production Efficiency Factor and European Broiler Index).

Key words*: broiler chicks, diet, L-carnitine, performance, productive.*

INTRODUCTION

Poultry meat is nutritionally desirable because of its high-quality protein and low-fat content (Laudadio et al., 2012). Since poultry meat is an important source of high-quality protein, minerals, and vitamins to balance the human diet, poultry industry continues to play a positive role in the whole world as the major supplier for animal protein. Due to an increasing consumer demand for the lean tissue, the production of broiler meat that contains body fat is among one of the problems for the poultry meat industry (Daşkiran, 1996). This strategy increases the rate of growth and feed conversion but had undesirable influence in the form of increased abdominal fat, as a result, increased carcass fat levels can reduce the profits of poultry producers (Michalczuk et al., 2012). It is necessary to look at the development of chicksdiet that will meet the nutrient requirements of the bird more precisely for optimum growth and increased performance. The effect of nutrition and genetics on fat deposition is higher than environmental factors (Lin et al., 1980). Thus, livestock researchers and producers tend to evaluate ad try new feed additives that can be beneficial to poultry performance and production. This presents a large opportunity for the use of a recent physiological feed additive L-carnitine.

L-carnitine was needed to transport long-chain fatty acids into mitochondria, it takes part in β-oxidation which leads to theproduction of energy (Carter et al., 1995; Brooks, 1998). L-carnitine has two major functions. The best-known function is to facilitate the transport of long-chain fatty acids across the inner mitochondria membrane. L-carnitine also helps the removal of short and medium-chain fatty acids from the mitochondria that produced as a result of normal and abnormal metabolism (Matalliotakis et al., 2000; Buyse et al. 2001; Xu et al., 2003). Alterations in carnitine concentration or metabolism may significantly

affect energy production in mitochondria (Arslan et al., 2003). In addition, L-carnitine has secondary functions, including the containment, buffering and removal of potentially toxic acyl groups from cells, equilibratingthe ratio of free CoA and acetyl-CoA between the mitochondria and cytoplasm, participating in biological processes such as regulation of gluconeogenesis, stimulating fatty acid and the metabolism of ketones, branched-chain amino acids, triglycerides and cholesterol (Novotny, 1998; Corduk et al., 2007).

Some studies suggested that supplemental L-carnitine improved body weight gains and decreasedfat content deposition of chickens (Rabie et al., 1997a; Rabie and Szilagyi, 1998; Xu et al., 2003). According to these results, the aim of this study was to examine the overall performance, carcass parameters, abdominal fat and economic production of the addition of L-carnitine at different levels to broiler rations.

MATERIALS AND METHODS

This study was conducted at the Bakrajo Poultry Breeding Field, Animal Sciences Department, College of Agricultural Sciences, the Sulaimani University between March 8th 2017 and April 25th, 2017 to study the effect of dietary supplementation with different levels of L-carnitine (0, 100, 200, 400, 800 mg/kg) on the performance and carcass parameters of Ross 308 broiler chickens.

Two hundred and sixty one-day-old Ross 308 broiler chicks were obtained from Lawa Hatchery in Arbil Province and were randomly distributed into five treatment groups (52 chicks for each group) with four replicates (Table 1). Chicks were raised on floor cages (110×120×60 cm); and lighting was continuous (24 hours/day) at starter period (21 hours/day) at grower and (24 hours/day) at finisher periods.

Table 1. The Experimental treatments

Treatment	Feeding system
T1 (control)	Feed with 0 mg/kg L-carnitine
T2	Feed with 100 mg/kg L-carnitine
T3	Feed with 200 mg/kg L-carnitine
T4	Feed with 400 mg/kg L-carnitine
T5	Feed with 800 mg/kg L-carnitine

Temperature and humidity of the rooms were measured by electronic thermometers that were placed at different locations of the room about 50-60 cm above the floor level.

Feeding program

Feed and water were providing *ad libitum* during the experimental period. The diets were determined according to NRC (1994). The nutrition substances were as follows: Starter feed: (CP = 22.8% and ME = 3,079 kcal/ kg) between 1-11 days of age; Growth feed: (CP = 21.0% and ME = 3,139kcal/ kg) between 11-28 days of age; Finisher feed: (CP =19.1% and ME = 3,212 kcal/ kg) between 29-49 days.

Ingredients composition of commercial feed were soybean meal, wheat, yellow corn, sunflower seed oil, limestone, vitamin, minerals, salt (NaCl), and calcium phosphate (Table 2).

Production Traits

Live Body Weight

Birds weighted every week at day 1, 7, 14, 21, 28, 35, 42, 49 of broilers age by the following:

Body Weight = weight of the birds (g)/number of birds

Weight Gain

The average daily body weight gain was calculated by subtracting the average initial live weight of a certain period (which was usually weekly) from the average final live weight of the same period for each chick.

Feed Intake

Feed intake in each replicate was measured and recorded at the end of each week by subtracting feed residual from the total amount of feed supplied by the following formula:

Feed Intake Weekly = The feed intake (g/week)/(number of birds)

Feed Conversion Ratio

Feed Conversion Ratio is the amount of feed intake estimated to unit weight for each weight gain estimated in the same unit and calculated by the following formula:

Feed Conversion Ratio = Average of feed intake by one bird in a week (kg)/Average of weight gain by one bird in the same week (kg).

Table 2. Ingredient of the composition of commercial feed used in the experiment

Ingredients %	Period		
	Starter	Grower	Finisher
Yellow corn	32	32	35
Soybean meal	34	28	22.5
Protein conc.*	5	5	5
Wheat	24.3	30.2	32.5
Sunflower oil	3.5	3.5	3.7
Limestone**	1	1.2	1.2
Salt	0.2	0.1	0.1
Total	100	100	100
	Calculated composition***		
Protein	22.8	21	19.1
ME Kcal / Kg	3079	3139	3212
Calcium	0.76	0.82	0.81
Fiber	3.7	3.5	3.3
Lys.	1.34	1.19	1.04
Me.	0.89	0.83	0.77
Fat	5.6	5.6	6.0

* Protein concentrate used in the diets were produced in Holland (WAFI) which contains: 40% crude protein, 2100 Kcal ME / Kg, 5% crude fat, 2% crude fiber, 6.5% calcium, 2.50% phosphorus, 3.85% lysine, 3.70% methionine, and 4% cystine.
** Limestone:
*** The calculated composition of the diets was determined according to NRC (1994).

Mortality

Mortality is the ratio of number of died birds tototal number of birds of each treatment and calculated weekly by the following formula:

Mortality = [(number of died birds)/(total number of birds)] × 100

Carcass Traits

At the end of the experiment, 8 birds from each treatment (2 male and 2 female birds from each replicate) were randomly chosen for slaughter and evaluation carcass traits, dressing percentages educated with or without giblets and abdominal fat were determined as follows:

Dressing percentage with giblets = (Carcass weight with giblets/Live body weight) × 100

Dressing percentage without giblets = (Carcass weight without giblets/Live body weight) × 100

Abdominal fat percentage = (abdominal fat /live body weight) × 100

Economic Efficiency

Economic Efficiency of the experiment was calculated according to following equations:

Viability (%) = (number of live bird at final day/number of live bird at first day) × 100

European Production Efficiency Factor = (viability (%) × body weight (kg)/age (day) × feed conversion ratio) × 100

European Broiler Index = (viability (%) × average daily gain (g/check/day)/feed conversion ratio) × 10

Statistical Analysis

General Linear Model (GLM) within the statistical program XLSTAT (2004, version-7.5) was used to analyze treatments and periods affecting productive traits within the factorial Completely Randomized Design (CRD).

The significant differences between means of traits were determined using Duncan's multiple range test under the probability ($p<0.05$) (Duncan, 1955). The total variance was partitioned into main effects and their interaction according to the following model:

$Yij = \mu + Ti + Pj + TP\ ij + eij$

Where:

Yij= Observation of the performance traits.

μ = Overall mean.

Ti = Effect of treatments (T1 0%, T2 0.01%, T3 0.02%, T4 0.04%, T5 0.08%)

Tj = Effect of periods (day 1, 7, 14, 21, 28, 35 and 42 of age).

TDij = Interaction between treatments and periods.

eij= Random error assumed to be equal to zero and variance is $б^2e$ (N~ 0, б2e)

RESULTS AND DISCUSSIONS

The Effect of Treatments and Sex on Live Body Weight, Carcass, Clear Carcass and Abdominal Fat at Day 49 old Broiler Chickens.

Effect of treatments and sex at final period of experiment day (49) on live body weight,

carcass (g and %) and clear carcass (g and %) was not significant (Table 3). While abdominal fat (g and %) was significantly ($p<0.05$) affected by treatments. Females in T3 had significantly ($p<0.05$) higher abdominal fat (43.75g) when compared with other males and females in same or other treatments except for males and females in T4. On the other hand, females in T2 and T3 had significantly ($p<0.05$) higher abdominal fat (g and %) than males in same treatments. While abdominal fat (%) of females in T3 was significantly ($p<0.05$) higher than all females and males in other treatments. In general, the results revealed that abdominal fat (g and %) of males and females in T5 were significantly ($p<0.05$) or numerically lower than males and females in other treatments. Those results were similar to my results (Lien and Horng, 2001; Celik and Ozturkcan, 2003). All have shown that carcass weight and carcass yield of broilers was not affected by diet supplementation. Sarica et al., (2005) reportednon-significant effect of dietary L-carnitine on carcass weight in Japanese quail fed diet, contained 200 mg LC/kg. Barker and Sell (1994) showed that L-carnitine supplementation (0, 50 and 100 mg/kg) had no effect on performance and carcass composition of broilers and young turkeys fed with low- and high-fat diets. Zhang et al. (2010) and Michalczuk et al., (2012) reported non-significant increase in carcass yield by dietary supplementation of L-carnitine. Bozkurt et al., (2008) indicated that adding % 5 animal or vegetable fat in broiler breeder hens and males diet had no significant effect on performance at 22, 34, 46 and 58 weeks of age. Some studies have shown that supplemental L-carnitine had a significant effect to reduce abdominal fat content of broilers (Lettner et al., 1992; Markwell et al., 1973; Marquis and Fritz, 1965). L-carnitine supplementary to the diet had a positive effect to decrease the abdominal fat of carcasses on males (Rabie et al., 1997a; Rabie et al., 1997b; Rabie and Szilagyi, 1998; Xu et al., 2003). Burtle and Liu (1994) indicated that L-carnitine supplementation to diets increases fat metabolism and decreases abdominal fat. Parsaeimehr et al. (2014) showed that supplementing L-carnitine (300 mg/kg) significantly decreased the abdominal fat percentage of broiler chickens.

The Effect of Treatments on Weight Gain, Feed Intake and Feed Conversion Ratio From 1-49 Day-Old

Table 4 indicates that there was not any significant effect of treatments on weight gain, feed intake and feed conversion ratio at day 49. Nevertheless, feed conversion ratio was numerically better in T4 followed by T2, which had better weight gain compared toother treatments. These results are in agreement with those reported by other authors for broiler chickens (Buyse et al., 2001; Barker and Sell, 1994; Cartwright, 1986; Leibetseder, 1995). Lien and Horng (2001) showed that growth performance of broilers, in terms of body weight and feed intake, were not affected from diet supplemented feeding with 0.05% L-carnitine from 5 to 7 weeks of age. Buyse et al. (2001) and Rezaei et al. (2007), found that L-carnitine supplemented to chickens had no effect on feed conversion, feed intake, and weight gain.

Murali et al. (2015) showed that dietary L-carnitine (900 mg/kg diet) supplementation had no effect on feed consumption in broilers during growing period (0-6 wks.). Xu et al. (2003) observed that dietary supplementation of L-carnitine to commercial male broilers at 0, 25, 50, 75, or 100 ppm had no significant effect on daily body gain or feed conversion. Corduk et al. (2007), Sarica et al. (2007) and Daşkiran et al. (2009) revealed that various levels of L-carnitine did not affect body weight gain and feed intake of quails. Deng et al. (2006) found that short-term supplementation of L-carnitine at levels of 0 (control), 100 or 1000 ppm for chickens after hatching for 4 weeks did not have any effect on growth rates, feed intake or feed utilization efficiency. Yalçin et al. (2008) revealed that L-carnitine supplementation at 100 mg/kg had no significant effect on feed intake and feed conversion ratio. Sarica et al. (2005) showed that supplementation of L-carnitine (25-100 mg/kg) had no significant effect on daily body gain from commercial male broilers. Arslan et al. (2003 and 2004) reported that L-carnitine administration via drinking water 100 mg/l to Turkish native geese and 200 mg/l to Turkish native duck had no significant effect on growth performance on ducks and geese.

Table 3. The effect of treatments and sex on Live Body Weight, Carcass (g and %), Clear Carcass (g and %) and Abdominal Fat (g and %) at day 49 of age of broiler chickens

		Traits						
Treatments	Gender	Live BW	Carcass, g	Carcass, %	Clear Carcass, g	Clear Carcass, %	Abdominal Fat, g	Abdominal Fat, %
T1(0 mg/kg)	Male	2412.50±51.53	2018.75±46.79	85.91 ±0.52	1633.7 ±48.19	67.67 ±0.59	32.50b ±1.44	1.35b ±0.06
	Female	2400.00±61.23	1967.50±89.33	84.00±1.72	1275.00 ±428.61	52.35±17.46	32.50b±1.44	1.36b ±0.06
T2(100 mg/kg)	Male	2487.50±89.84	2056.25±80.42	82.64 ±0.72	1695.00 ±67.11	68.13 ±0.85	22.50c ±2.50	0.90c ±0.09
	Female	2375.00±101.3	1967.50±92.59	82.89 ±0.36	1601.25 ±88.70	67.32 ±0.84	33.75b ±2.39	1.42b ±0.04
T3(200 mg/kg)	Male	2462.50±96.55	2040.00±76.45	82.86 ±0.53	1686.25 ±80.24	68.41 ±0.80	30.00bc ±4.08	1.22bc ±0.17
	Female	2300.00±67.70	1873.75±64.07	81.44 ±0.79	1543.75 ±69.11	67.03 ±0.98	43.75a ±3.14	1.90a ±0.13
T4(400 mg/kg)	Male	2550.00±95.74	2151.25±113.42	84.28 ±2.17	1790.00 ±107.14	70.10 ±2.45	36.25ab ±3.75	1.42b ±0.14
	Female	2462.50±134.43	1867.50±293.55	75.09 ±9.56	1725.00 ±92.28	70.07 ±0.73	37.50ab ±3.22	1.52b ±0.08
T5(800 mg/kg)	Male	2525.00±110.88	2127.50±127.64	84.09 ±1.72	1780.00 ±120.98	70.29 ±2.03	22.50c ±1.44	0.89c ±0.04
	Female	2425.00±118.14	1961.25±155.33	81.66 ±7.03	1646.25 ±97.11	68.58 ±6.04	22.50c ±4.78	0.92c ±0.18

[a-j] Means followed by different letters are statistically different.

Table 4. The effect of treatments on weight Gain, feed intake and feed conversion ratio from day 1-49

Treatments	Feed intake (g)	Weight gain (g)	FCR
T1 (0)	4004.96±49.62	2358.75±36.99	1.70±0.02
T2 (100 mg)	4016.79±42.95	2384.50±91.38	1.69±0.07
T3 (200 mg)	4123.34±100.87	2335.75±52.16	1.77±0.04
T4 (400 mg)	4056.74±58.45	2459.50±82.52	1.66±0.07
T5 (800 mg)	4189.48±112.47	2430.00±93.72	1.74±0.11

The Effect of Treatments on Economic Efficiency

Table 5 revealed that there was no significant effect of treatments on economic efficiency (European Production Efficiency Factor and European Broiler Index), while T4 at (EPEF and EBI) had a higher number compared to control and other treatments but there was no significant ($P<0.05$) effect on treatments.

Table 5. The effect of treatments on Economic Efficiency

Treatment	European Production Efficiency Factor	European Broiler Index
T1 (0 mg)	250.51±13.27	245.56±13.01
T2 (100 mg)	286.50±30.89	281.02±30.44
T3 (200 mg)	254.43±15.71	249.57±15.45
T4 (400 mg)	301.54±29.84	295.97±29.53
T5 (800 mg)	282.22±36.20	277.16±35.75

The Effect of Interaction Between Treatments (Different Levels of L-Carnitine) and Periods on Body Weight

Effect of interactions between treatments and periods on body weight was shown in Table 6. The body weight increased with the increase of age periods, whereat effect of all treatments on body weight at P8 was significantly ($p<0.05$) higher than the same treatment prior to the period. Moreover, the effect of treatments was significant ($p<0.05$) at P6 and P7. At P6 significantly ($p<0.05$) higher body weight was obtained by birds in T4 followed by T5 compared to T3 and T1, respectively. Additionally, birds in T2 had significantly ($p<0.05$) higher body weight compared to birds in T1 at P6. While birds at P6 in T4 revealed significantly higher body weight compared to all other treatments except T5. There were no significant differences between treatments at other periods, although numerically higher body weight was obtained from birds in T4 followed by T5 at all other periods except P1 and P2. Hrnčár et al. (2015) also reported significant effect of L. carnitine on body weight at day 28, 35 and 42 compared to control. Rabie and Szilagyi (1998) and Buyse et al. (2001) also reported that supplementation of L-carnitine had a significant effect on body weight of chickens at the end of fattening period. While, Hrnčár et al. (2015) showed that supplementation of L-carnitine did not affect body weight at P1, P2, P3, and P4 periods. Buyse et al. (2001) reported a non- significant increase in average body weight of chickens receiving L-carnitine at 14, 21 and 28 days of rearing. Rabie et al. (1997a) reported that L-carnitine supplementary to diets had no significant impact on body weight of broilers at the end of the experimental period.

Table 6. Effect of interaction between treatments and periods on body weight

Periods (Days)	Treatments (different levels of L- carnitine)				
	T1 (0 mg)	T2 (100 mg)	T3 (200 mg)	T4 (400 mg)	T5 (800 mg)
P1 (1)	47.50^{j}±1.55	46.75^{j}±1.03	45.50^{j}±0.86	46.75^{j}±0.94	45.00^{j}±1.00
P2 (7)	104.14^{ij}±2.27	107.31^{ij}±1.03	100.96^{ij}±1.55	107.98^{ij}±3.44	107.79^{ij}±3.18
P3 (14)	205.00^{i}±5.66	216.71^{i}±5.77	199.60^{i}±7.40	221.11^{i}±8.55	221.44^{i}±3.09
P4 (21)	389.63^{h}±5.64	428.39^{h}±14.28	412.13^{h}±7.13	444.00^{h}±14.23	441.75^{h}±13.92
P5 (28)	695.31^{g}±14.74	728.12^{g}±32.32	687.50^{g}±25.25	781.25^{g}±34.04	768.75^{g}±25.25
P6 (35)	1125.00^{f}±40.50	1300.00^{de}±81.17	1215.63^{ef}±60.89	1371.88^{d}±59.37	1346.88^{d}±43.41
P7 (42)	1734.38^{c}±51.12	$1859.38b^{c}$±106.23	$1762.50b^{c}$±55.66	1890.63^{b}±55.05	1862.50^{bc}±61.66
P8 (49)	2406.20^{a}±37.32	2431.25^{a}±92.06	2381.25^{a}±52.41	2506.25^{a}±81.88	2475.00^{a}±93.54

$^{a-j}$ Means followed by different letters are statistically different at $p<0.05$

The Effect of Interactions Between Treatments (Different Levels of L-Carnitine) and Periods on Feed Intake.

Table 7 summarizes the significant ($p<0.05$) effect of interactions between treatments and periods on feed intake. Effect of treatments on feed intake at P6, P7, and P8 was significant ($p<0.05$), where significantly ($p<0.05$) higher feed intake were observed on birds in T5 at P6 which was also significantly ($p<0.05$) higher than other treatments in the same period. The first group was followed by birds in T3 and T5

at P7 which was significantly ($p<0.05$) higher than T1. The birds at P8 in T2 had significantly ($p<0.05$) lower feed intake than T3 and numerically lower intake when compared with other treatments in thesame period. Sayed et al. (2001) showed that supplementation of L-carnitine (50 mg/ kg) to diet containing 2 and 4% of sunflower oil increased feed intake, and Rabie et al. (1997a) demonstrated that L-carnitine supplementation (50, 100 and 150 mg/kg) had significant effects on feed intake.

Bayram et al. (1999) noticed there was a significant improvement in feed intake in quails fed ona diet supplemented with 500 mg LC/kg. However, the effect of treatments on feed intake at P2, P3, P4 and P5 were not significant. Rezaei et al. (2010) also found supplementation of L-carnitine had no significant effect on feed intake in the broiler chickens. Xu et al. (2003) reported that the supplementation of dietary L-carnitine had no significant effect on feed intake of broiler chickens and young turkeys. Barker and Sell (1994); Leibetseder (1995) and Buyse et al. (2001) reported that the supplementation of dietary L-carnitine did not affect feed intake. Lien and Horng (2001) Sarica et al. (2005) reported that L-carnitine supplement on diet had no significant effect on feed intake of Quail. Yalçin et al. (2008) indicated that L-carnitine supplementation at 100 mg/kg did not affect feed intake.

Table 7. Effect of interaction between treatments and period on feed intake

Periods (Days)	Treatments (different levels of L- carnitine)				
	T1 (0 mg)	T2 (100 mg)	T3 (200 mg)	T4 (400 mg)	T5 (800 mg)
P2 (7)	92.98^{i}±1.17	90.48^{i}±1.88	92.69^{i}±4.33	96.92^{i}±1.81	97.12^{i}±2.77
P3 (14)	184.62^{h}±2.91	195.14^{h}±4.30	186.54^{h}±3.09	194.90^{h}±2.52	196.34^{h}±4.61
P4 (21)	292.64^{g}±11.74	337.07^{g}±4.89	335.48^{g}±2.88	343.00^{g}±9.68	339.62^{g}±10.91
P5 (28)	613.99^{f}±6.87	657.76^{f}±18.63	647.33^{f}±15.69	671.55^{f}±13.75	645.48^{f}±10.76
P6 (35)	911.21^{cde}±19.75	902.97^{cde}±9.03	912.69^{cde}±12.45	908.26^{cde}±13.25	1020.38^{a}±51.95
P7 (42)	916.23^{cde}±34.34	959.01^{abc}±16.24	1006.29^{a}±41.40	960.70^{abc}±19.04	988.31^{ab}±37.86
P8 (49)	914.77^{cde}±34.07	874.36^{e}±20.04	942.31^{bcd}±36.82	881.41^{de}±20.35	902.24^{cde}±36.57

[a-j] Means followed by different letters are statistically different at $p<0.05$

The Effect of İnteraction Between Treatments (Different Levels of L-Carnitine) and Periods of Weight Gain

Influence of interaction between treatments and periods on weight gain was significant ($p<0.05$) as described in Table 8. Weight gain at P8 was significantly ($p<0.05$) higher compared to other periods followed by P7, P6, P5, P4, P3, and P2 of all treatments, respectively. Moreover, the highest weight gain was obtained by birds in T1 at P8 which significantly ($p<0.05$) differed from T2 at thesame period. While, at P7 birds in T1 had significantly ($p<0.05$) higher weight gain compared to T5 and numerically higher weight when compared with other treatments, although birds at P6 in T1 had significantly ($p<0.05$) lower weight gain when compared with all other treatments (Table 8). A number of studies hasshown that supplemental L-carnitine improved body weight gains of broilers (Lettner et al., 1992; Gropp et al., 1994; Rabie et al., 1997a). According to Parsaeimehr et al (2014), diet with L-carnitine significantly ($P<0.01$) increased the body weight gain of broiler chicks during the period between 28 to 42 days of age. Taklimi et al. (2015) reported that supplementation of 600 to 800 mg/kg L-carnitine in diet had significant increases on weight gain for broiler chickens. Abdel-Fattah et al. (2014) noticed that supplementation of L-carnitine (200-400 mg/kg) in Japanese quail diet significantly increased body weight gains, while, theeffect of treatment on weight gain at P2, P3, P4, and P5 were not significant. Parsaeimehr et al. (2014) reported that experimental diets with L-Carnitine had no effect on body weight gain in theperiodbetween 1-21days of age. Corduk et al. (2007), Sarica et al. (2007) and Daşkiran et al. (2009) reported that various levels of L-carnitine did not affect body weight gain over 28 days of the experimental period. Xu et al. (2003) indicated that dietary supplementation of L-carnitine to broilers had no significant effect on daily body weight gain. Barker and Sell (1994) also reported thenon-significant effect of l-carnitine on body weight gain from their study.

Table 8. Effect of interaction between treatments and periods on weight gain

Periods (Days)	Treatments (different levels of L- carnitine)				
	T1 (0 mg)	T2 (100 mg)	T3 (200 mg)	T4 (400 mg)	T5 (800 mg)
P2 (7)	59.81^{k}±2.51	57.39^{k}±1.39	55.46^{k}±0.93	61.23^{k}±3.65	62.79^{k}±2.82
P3 (14)	97.69^{jk}±5.73	112.57^{jk}±5.28	98.64^{jk}±6.24	113.13^{jk}±6.67	113.65^{jk}±4.72
P4 (21)	184.63^{ij}±5.30	211.61^{hi}±12.04	212.53^{hi}±7.37	222.89^{ghi}±5.87	220.31^{ghi}±12.62
P5 (28)	305.69^{fg}±14.47	299.81^{fgh}±21.01	275.38^{fgh}±18.84	337.25^{f}±20.66	327.00^{f}±12.69
P6 (35)	429.69^{e}±54.44	571.88^{bcd}±50.80	528.13^{bcd}±38.31	590.63^{abcd}±27.18	578.125^{bcd}±36.57
P7 (42)	609.38^{abc}±19.34	559.38^{bcd}±27.18	546.88^{bcd}±7.86	518.75^{cd}±40.34	515.625^{d}±26.70
P8 (49)	671.88^{a}±43.11	571.88^{bcd}±51.12	618.75^{ab}±44.04	615.63^{ab}±30.77	612.50^{ab}±72.52

[a-j] Means followed by different letters are statistically different at p<0.05

The Effect of Interaction between Treatments (Different Levels of L- Carnitine) and Periods on Feed Conversion Ratio.

The effects of interaction between treatments and periods on feed conversion ratio were summarized in Table 9. There was no significant difference between all treatments at all periods except at P5 and P6. Whereat, birds in T3 had significantly (p<0.05) lower feed conversion ratio compared to T5.

While birds at P6 in T1 and T3 had significantly (p<0.05) lower feed conversion ratio when compared with all other treatments in the same period. A better and significant (p<0.05) feed conversion ratio was obtained at P8 of all treatments followed by below periods. Significantly (p<0.05) better-feed conversion ratios was obtained on birds in T1 at P8.

While lower feed intake levels were obtained by birds in T3 at P5.Parsaeimehr et al (2013) and Schuhmacher et al. (1993) showed that diet with L-carnitine had a significant effect on feed conversion ratio. Barker and Sell, (1994) and Xu et al. (2003) reporteda diet with levels of animal fat + 300 mg/kg L-carnitine, which had a significant (P<0.05) effect on feed conversion ratio.

Bayram et al. (1999) reported significant decreases in feed efficiency in quails supplemented with 500 mg/kg diet L-carnitine. Parsaeimehr et al. (2014) reported that a dietary L-carnitine supplementation (200-300 mg/kg) had asignificant effect in improving feed conversion. While Buyse et al. (2001) and Rezaei et al. (2007) found that L-carnitine had no effect on feed conversion to chickens.

Effect of L-carnitine on feed conversion efficiency in geese at P1, P2, P3, P4, P8 were not significant (Arslan et al., 2004).

Leibetseder (1995) investigated the broilers fed with diets supplemented with 0 or 50 g fat/kg. and he found that feed conversion of broilers was not influenced by dietary carnitine (L or DL form) at a dosage of 200 mg/kg diet.

Table 9. The effect of interaction between treatments and periods on Feed Conversion Ratio

Periods (Days)	Treatments (different levels of L- carnitine)				
	T1 (0 mg)	T2 (100 mg)	T3 (200 mg)	T4 (400 mg)	T5 (800 mg)
P2 (7)	1.56^{efgh}± 0.05	1.58^{efgh}± 0.05	1.67^{cdefgh}± 0.05	1.60^{defgh}± 0.07	1.55^{fgh}± 0.02
P3 (14)	$1.91b^{cdef}$± 0.11	1.74^{cdefgh}± 0.07	1.92^{bcdef}± 0.14	1.740^{cdefgh}± 0.10	1.73^{cdefgh}± 0.03
P4 (21)	1.59^{efgh}± 0.07	1.61^{cdefgh}± 0.11	1.58^{efgh}± 0.04	1.54^{fgh}± 0.01	1.55^{fgh}± 0.04
P5 (28)	2.02^{abc}±0.10	2.23^{ab}±0.18	2.39^{a}±0.17	2.01^{abcd}±0.13	1.99^{bcde}±0.10
P6 (35)	2.23^{ab}±0.28	1.62^{cdefgh}±0.14	1.76^{cdefgh}±0.14	1.55^{fgh}±0.09	1.79^{cdefgh}±0.16
P7 (42)	1.54^{fgh}±0.07	1.73^{cdefgh}±0.11	1.84^{bcdefg}±0.05	1.90^{bcdef}±0.20	1.93^{bcdef}±0.11
P8 (49)	1.37^{h}±0.05	1.57^{efgh}±0.13	1.54^{fgh}±0.08	1.45^{gh}±0.10	1.56^{fgh}±0.23

[a-j] Means followed by different letters are statistically different p<0.05

CONCLUSIONS

The results of the present study showed that dietary supplementation with different levels of L-carnitine had significant effect on body weight at 6^{th} and 7^{th} period, there was a significant effect on weight gain at 6^{th} and 8^{th} period, on feed intake at 6^{th}, 7^{th} and 8^{th} period and L-carnitine had significant effect on feed conversion ratio at 5^{th} and 6^{th} periods. L-carnitine had a significant effect to reduce abdominal fat but there was no significant effect on thecarcass with giblet and without giblet. L-carnitine had no significant effect on body weight, feed intake, weight gain and feed conversion ratio at the final of the experimental

period.Using 0.08% (T5) L-Carnitine group seemed to have a beneficial effect on most of the performance traits (live body weight, feed intake, feed conversion ratio, weight gains and abdominal fat).

RECOMMENDATIONS

For the better production performance, we recommend the use of 0.04% L-carnitine on (T4) and 0.08% on (T5) and wait until 8 weeks of age to obtain the better production in broiler chicken.

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