# Effect of Different Levels of Terbutaline and L-carnitine on the Growth Performance, Carcass Traits, Blood Parameters and Immune System of Broiler Chickens

**Fallah[1*], R., Nazari[2] , P. and Mirzaei[3], E.**
[1]Department of Animal Science, Faculty of Agriculture, [2]Department of Animal Biology, Faculty of Basic Science, Lorestan University, Khorramabad, Iran, [3]Department of Veterinary Science, Boroujerd Branch, Islamic Azad University, Boroujerd, Iran
*Corresponding author: Falah.roz@fa.lu.ac.ir

Received: 25 May 2016. Accepted: 12 July 2016.

## Abstract

This study was conducted to evaluate the effects of different levels of Terbutaline and L-carnitine on the growth performance, carcass traits, blood parameters and immune system of broiler chickens. A total of 240 one-day old commercial Ross 308 broiler chickens were used in a completely randomized design study with four treatments :(1) control diet (no supplement), (2) basal diet supplemented with 20 mg Terbutaline per kg diet, (3) basal diet supplemented with L-carnitine 250 mg per kg diet and (4) basal diet supplemented with 10 mg Terbutaline per kg diet +L-carnitine 100 mg per kg diet, with six replicates per treatment. Addition of Terbutaline and L-carnitine was found to increase ($p<0.05$) body weight of chickens at 42 d of age in comparison to chickens in the control group. Significant differences ($p<0.05$) in feed intake was also observed between control and Terbutaline + L-carnitine treatments. Furthermore, the addition of Terbutaline and L-carnitine decreased ($p<0.05$) FCR in comparison to the control group. Broilers receiving Terbutaline and L-carnitine had higher liver, gizzard, spleen and bursa of Fabricius and lower abdominal fat relative to body weight compared to the control group. Birds which received Terbutaline and L-carnitine had the lowest total cholesterol, HDL and LDL concentrations in comparison to the control group. Birds receiving Terbutaline + L-carnitine had the highest anti body Influenza and Newcastle titres at 18 and 28 d compared to the other groups. In conclusion, these results demonstrate that Terbutaline and L-carnitine and its combination improved broiler performance, carcass characteristics by decreasing abdominal fat and enhanced immune system of broiler chickens at 42 d of age.

**Key words**: blood parameters, broiler chickens, carcass trait, immune, L-carnitine, Terbutaline

## Introduction

Excessive carcass fat accumulation, particularly in the abdominal and visceral areas, is one of the major concerns of broiler producers. This fat is generally undesirable for consumers and represents a waste product to the poultry processor. Numerous attempts have been made to minimize this fat accumulation, either genetically or by dietary manipulation, with different degrees of success**.** Dietary L-carnitine and B-adrenergic agonists were found to enhance leanness in livestock species and would not likely represent a credible risk to the consumers of edible tissues of properly treated animals (Abolghasemi *et al.,* 2007; Smith, 1998). The β-adrenergic agonists are used to increase growth and muscle development of farm animals (Duquett *et al*.,

1988). The function of these compounds is similar to catecholamine (Ansari-pirsaraei *et al.,* 2007). Reduction of fat content in animal body without any change on the bone mass and organs are important response of beta agonist in animal diet (Beerman, 2002). Apparently, the mechanism of this effect occurs through two metabolic pathways: reduction in lipogenesis and/or increase in lipolysis (Ferreira *et al.,* 2013). In several experiments, β-adrenergic agonists (cimaterol) supplementation to broiler chicks as summarized by Dalrymple and Ingle (1990), a consistent increase in weight gain was observed. Also the β-adrenergic agonist L340, 333 was found to increase weight gain of broilers (Duquette *et al.,* 1988) while Merkly and Cartwright (1989) did not observe any significant effect of 0.25 ppm cimaterol on weight gain of broilers. Because the growth-promoting effect of β-adrenergic agonists is likely to be dependent on its type, dosage, and possibly also on strain of broilers, those factors may account for the apparent discrepancies between broilers. The degree of fat reduction by β-adrenergic agonists in broiler chickens was more evident in subcutaneous fat content in the animal body than abdominal fat (Zamiri and Ehsani, 1995). In accordance with the effects of β-adrenergic agonists on fatty deposits in all domestic animal species and in small laboratory animals, fat deposition was pronounced after prolonged supplementation with clenbuterol, indicating that, at least for this parameter, clenbuterol is not a transient effect. According to Merkly and Cartwright (1989) B-adrenergic agonist properties of reduced fat, at least in poultry, are more likely due to the reduction in adipocyte cell size than in adipocyte number. Other studies showed that β-agonists increased skeletal muscle mass, protein deposition, carcass yield and decreased carcass fat of broiler chickens (Malucelli *et al.,* 1994; Zare Shahneh *et al.,* 2001). The positive effects of β-agonists on performance and repartitioning in livestock animals, including poultry, have been documented (Wellenreiter, 1991; Smith, 1998). The positive effects of β-agonists were more pronounced in sheep and cattle, which is in contrast to birds and pigs having low and intermediate activity, respectively (Gwartney *et al.,* 1991). Although the responses vary according to the species, the type of β-agonist used and duration of treatment may also be involved (Zare Shahneh *et al.,* 2001). Futher more investigations showed that addition of Terbutaline (a beta adrenergic agonist) on broiler chickens diet, didn't affect daily weight gain, but FCR of male chicks was reduced for 5 and10 mg/kg Terbutaline treatments compared with the control group (Abolghasemi *et al.,* 2007). Other studies showed that Terbutaline increased the relative weights of breast and drumstick muscles, plasma levels of free fatty acids and significantly decreased abdominal fat on Japanese quails (Boostan *et al.,* 2015).

L-carnitine is biosynthesized in the kidneys and liver from lysine and methionine amino acids, and it is formed with contributions from vitamins ascorbate, niacin, pyridoxine and folic acid, as well as iron (Golzar Adabi *et al.,* 2011). It has been reported that L-carnitine has two major functions. The best known is to facilitate the transport of long-chain fatty acids across the inner mitochondrial membrane. L-carnitine also facilitates the removal of short and medium-chain fatty acids from the mitochondria that accumulate as a result of normal and abnormal metabolism (Buyse *et al.,* 2001; Xu *et al.,* 2003). Thus, dietary supplementation of L-carnitine promotes the β-oxidation of these fatty acids in order to generate adenosine triphosphate (ATP) energy and improve energy utilization (Rabie *et al.,* 1997a; Corduk *et al.,* 2007). Consequently, L-carnitine supplementation in diets reduces the amount of long-chain

fatty acids availability for esterification to triacylglycerols and storage in the adipose tissue (Barker and Sell, 1994; Xu *et al.*, 2003). As indicated by previous research, L-carnitine can reduce body fat in pigs (Newton and Haydon, 1989; Owen *et al.*, 1996; Kachura *et al.*, 1995; Kaudo *et al.*, 1995). Results indicated the effects of L-carnitine on chickens were varied. Cartwright (1988) reported that L-carnitine did not affect abdominal fat in broiler chickens during 5 to 7 weeks of age. Moreover, Rabie *et al.* (1997a), Rabie and Szilagri (1998) and Xu *et al.* (2003) found that L-carnitine reduced abdominal fat content and increased breast muscle yield and leg meat yield. To our knowledge, the effects of Terbutaline and L-carnitine on the growth performance, carcass traits, blood parameters and immune system of broiler chickens have not been addressed previously. Therefore, this study aimed to evaluate the effects of different levels of Terbutaline and L-carnitine on the growth performance, carcass traits, blood parameters and immune system of broiler chickens.

## Materials and Methods

*Birds and Housing*

In this study, 240 one-day old male and female commercial Ross 308 broiler chickens of mixed gender were used in a completely randomized design study with four treatments and 6 replicates of 10 birds per replicate which were reared on the floor pens for 42 d. Feed and water were supplied *ad libitum.* Brooding temperature in the first wk of life was 32°C and decreased to 25°C until the end of the study. During the first wk, 23 h of light was provided with a reduction to 20 h afterward.

*Dietary Treatments*

The dietary treatments were: (1) control diet (no supplement), (2) basal diet supplemented with 20 mg Terbutaline per kg, (3) basal diet supplemented with L-carnitine 250 mg per kg diet., and (4) basal diet supplemented with 10 mg Terbutaline per kg +L-carnitine 100 mg per kg diet.. The chicks were fed with the starter diets from day 1 to 21 and grower feed from day 22 to 42 (Table 1). Diets were formulated and considered as control according to the recommendation of National Research Council (NRC, 1994).

Table 1: Composition of diets (percent of dry matter)

| Ingredient | Starter (1-21 d) | Grower (22-42 d) |
|---|---|---|
| Corn | 61.0 | 58.7 |
| Soybean meal | 29 | 30 |
| Wheat bran | 5 | 5 |
| Fish meal | - | 2 |
| Soybean oil | 2 | 1 |
| Oyster shell meal | 1 | 1.5 |
| DCP | 1.07 | 1 |

(Continue) Table 1: Composition of diets (percent of dry matter)

| Ingredient | Starter (1-21 d) | Grower (22-42 d) |
|---|---|---|
| Dl-Methionine | 0.13 | 0.10 |
| L- lysine | 0.25 | 0.15 |
| Salt | 0.25 | 0.10 |
| Coccidiostat (Maduramicin) | - | 0.05 |
| Calculated nutrient content | | |
| ME (kcal/kg) | 2850 | 2950 |
| Crude protein (%) | 20.48 | 18.44 |
| Crude fiber (%) | 3.89 | 3.81 |
| Lysine (%) | 1.68 | 1.25 |
| Methionine + Cystine (%) | 0.87 | 0.83 |

[1]Vitamin and mineral provided per kilogram of diet: vitamin A, 3600 Iu; vitamin D3, 800000 Iu; vitamin E, 7200 Iu; vitamin K3, 800 mg; vitamin B1, 720mg; vitamin B9, 400mg; vitamin biotin, 40mg; vitamin B2, 2640mg; vitamin B3, 400mg; vitamin B5, 12000mg; vitamin B6, 1200mg; vitamin B12, 6mg; choline chloride, 200000mg; Mn, 40000mg; Fe, 20000mg; Zn, 40000mg; Cu, 4000mg; I, 400mg, Se, 80mg

All floor-pens measured 1.3 × 2.5 m and had about 5 cm of built-up litter top-dressed with new wood shavings. Birds were vaccinated routinely against infectious bronchitis, Newcastle and Gambaro diseases, but no medication was administered during the entire experimental period.

*Parameter Measurement*

Birds were weighed weekly and final body weight for each bird was calculated. Feed intake and feed conversion ratio (FCR) were calculated weekly. At the end of 42 d of age, two birds were sampled randomly from each replicate. The chickens were killed and weights of internal organs (liver, heart, gizzard, spleen, Bursa of fabricius, Provintriculus) and abdominal fat were recorded as percent of live body weight. Total carcass weight was recorded and each carcass was split into four cuts. Breasts and thighs were each cut and weight was recorded. Weights of wings, neck and head were also recorded.

*Blood Biochemical Parameters*

Two 42 day-old birds per replicate were randomly chosen, then slaughtered and blood samples were collected into vials containing ethylenediamine tetraacetic acid (EDTA) and centrifuged for 20 min at 1500 rpm to separate the serum. The serum samples were stored at -20 $^{o}$C for the analysis of serum glucose (Coles, 1986), total protein (Wotton, 1964), uric acid (Trinder, 1969), total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides concentrations (Franey and Elias, 1986).

*Immune System*

Two 18 and 28 day-old birds per replicate were randomly chosen and blood samples were collected from the brachial vein and centrifuged for 20 min at 1500 rpm to obtain serum. Antibody titers against Newcastle and influenza viruses were measured using Hemagglutination inhibition test.

*Statistical Analysis*

All data were analyzed using the one-way ANOVA procedure of SAS (SAS, 2000). Differences between means were analyzed with Duncan's multiple range test. The significant difference statements were based on the probability of $p<0.05$, unless explained in another way.

## Results and Discussion

Terbutaline L-carnitine diet supplementation with Terbutaline and L-carnitine statistically increased ($p<0.05$) body weight at 42 days of age of chicks in comparison to the control chicks (Table 2). Treatment of Terbutaline + L-carnitine had the highest total body weight (2490 g), and the lowest total body weight was observed in the control group (2370 g). Significant differences in feed intake between control and Terbutaline + L-carnitine treatment was also observed. Broilers receiving different levels fo Terbutaline and L-carnitine had higher body weight and feed intake compared to the control group. Treatment of Terbutaline + L-carnitine had the lowest FCR (1.82), and the highest FCR was observed in the Terbutaline and L-carnitine groups (1.84).

Table 2: Effect of different Levels of Terbutaline and L-carnitine on the growth performance (mean ± se) of broiler chickens at 42 days of age

| Parameter | Control | Terbutaline | ControlL-carnitine | Terbutaline + L-carnitine |
|---|---|---|---|---|
| Final body weight (g) | 2370 ±113.51[b] | 2380 ±118.56[b] | 2450 ±116.32[a] | 2490 ±115.19[a] |
| Feed intake (g) | 4360 ±382.26[b] | 4390 ± 346.44[b] | 4530 ±358.22[a] | 4550 ± 375.85[a] |
| FCR | 1.83 ± 0.03 | 1.84 ± 0.05 | 1.84 ± 0.07 | 1.82 ± 0.06 |

[abc]Means on the same row with different superscripts are significantly different ($p<0.05$);

TerbutalineL-carnitine No significant differences ($p>0.05$) in heart, liver, gizzard, spleen, bursa of Fabricius, provintriculus and abdominal fat relative weights were detected among control and other treatments (Tables 3 and 4). Broilers receiving Terbutaline and L-carnitine had higher liver, gizzard, spleen and bursa of Fabricius relative weight compared to the control group. The highest relative weight of bursa Fabricius was shown in the group fed with Terbutaline + L-carnitine in the diet (0.18) and the lowest was in the control group (0.12).Adding Terbutaline + L-carnitine resulted in the lowest abdominal fat (1.72), and the highest abdominal fat weight was observed in the control group (1.83). The highest relative weight of gizzard was shown in group fed with L-carnitine in the diet (2.78) and the lowest of this was shown in the control group (2.70).

Table 3: Effect of different levels of Terbutaline and L-carnitine on internal organs mass ( means± se) of broiler chickens at 42 days of age (% live weight)

| Parameter | Control | Terbutaline | L-carnitine | Terbutaline + L-carnitine |
|---|---|---|---|---|
| Heart | 0.55 ± 0.012 | 0.53 ± 0.012 | 0.56 ± 0.011 | 0.55 ± 0.014 |
| Liver | 3.32 ±0.016 | 3.35 ±0.018 | 3.37±0.017 | 3.38±0.016 |
| Gizzard | 2.70 ±0.011 | 2.72 ±0.013 | 2.78 ±0.013 | 2.75±0.014 |
| Spleen | 0.16 ±0.013 | 0.18 ±0.014 | 0.17 ±0.016 | 0.18±0.015 |
| Bursa of Fabricius | 0.12 ±0.011 | 0.17 ±0.014 | 0.15 ±0.015 | 0.18±0.016 |
| Provintriculus | 0.38 ±0.017 | 0.35 ±0.016 | 0.37 ±0.017 | 0.38±0.018 |
| Abdominal Fat | 1.83 ±0.013 | 1.78 ±0.012 | 1.75±0.011 | 1.72±0.012 |

[abc]Means on the same row with different superscripts are significantly different ($p<0.05$)

The highest edible cuts as thigh relative weights were observed in chicks receiving L-carnitine in diet (24.87) and the lowest of these were observed in control group (22.38) (Table 4).. Further results showed that the lowest breast (30.58) was shown in the control group and the highest breast relative weight (32.28) was shown in L-carnitine group. However, there was no significant effect in thigh and breast relative weights between control and the other groups. Birds receiving Terbutaline + L-carnitine had the highest wing relative weights (7.83) compared to the other groups and the lowest relative weights of wing (7.28) was observed in the control group. The highest wing relative weight of head (2.63) were observed in birds which received Terbutaline and the lowest relative weight of head (2.35) was observed in the control group. However, there were no significant effects in wing and head relative weights between control and the other groups.

Table 4: Effect of different levels of Terbutaline and L-carnitine on carcass characteristics (mean ± se) of broiler chickens at 42 days of age

| Parameter (g) | Control | Terbutaline | L-carnitine | Terbutaline + L-carnitine |
|---|---|---|---|---|
| Thighs | 22.38 ± 0.75 | 23.52 ± 0.78 | 24.87 ± 0.72 | 23.75 ± 0.75 |
| Breast | 30.58 ±0.52 | 31.42 ± 0.55 | 32.28 ± 0.56 | 30.87 ± 0.58 |
| Neck | 5.48 ±0.32 | 5.60 ±0.38 | 5.37 ±0.35 | 5.53 ± 0.37 |
| Wing | 7.28±0.15 | 7.58 ±0.17 | 7.42 ±0.16 | 7.83 ± 0.18 |
| Head | 2.35 ±0.03 | 2.63 ±0.05 | 2.58 ±0.02 | 2.48 ± 0.04 |
| Total carcass weight | 1468 ±17.53[b] | 1492±17.68[b] | 1565 ±17.63[a] | 1484 ± 17.75[b] |

[abc]Means on the same row with different superscripts are significantly different ($p<0.05$

No significant differences were observed in blood glucose, total protein, uric acid and Triglycerides concentrations among treatments (Table 5). Broilers receiving

Terbutaline and L-carnitine *L-carnitine Terbutaline* had lower uric acid, total cholesterol, HDL, LDL and triglyceride concentrations compared to the control group. Further results showed that the lowest glucose concentration (267.61) was shown in the Terbutaline group and the highest glucose (285.49) was shown in control group. The highest total protein (7.78) was observed in birds which received L-carnitine and the lowest total protein (7.38) was observed in the control group. There were significant effects in total cholesterol, HDL and LDL concentrations between control and the other groups. Birds which received L-carnitine + Terbutaline had the lowest total cholesterol, HDL and LDL concentrations. The highest triglycerides content was shown in the control group (108.53) and the lowest triglycerides concentration was shown in tTerbutaline + L-carnitine group (102.57).

Table 5: Effect of different levels of Terbutaline and L-carnitine on blood parameters (mean± se) of broiler chickens at 42 days of age

| parameters | Control | Terbutaline | L-carnitine | Terbutaline + L-carnitine |
|---|---|---|---|---|
| Glucose (mg/dl) | 285.49±18.65 | 267.61 ±15.36 | 283.84 ±16.85 | 271.58 ±16.28 |
| Total protein (g/dl) | 7.56 ± 0.14 | 7.38 ±012 | 7.78 ±0.18 | 7.67 ±0.15 |
| Uric acid (mg/dl) | 55.18 ± 2.75 | 52.35 ± 2.68 | 52.16 ±2.47 | 51.74± 2.84 |
| Total cholesterol (mg/dl) | 155.85 ± 8.33 [a] | 133.58 ± 8.15 [b] | 138.63 ± 8.40 [b] | 125.84± 8.25 [c] |
| HDL (mg/dl) | 65.32 ± 5.85[a] | 63.47 ± 5.16[b] | 63.18 ± 5.54[b] | 61.42± 5.67[c] |
| LDL (mg/dl) | 35.63± 4.48[a] | 33.27 ± 4.32[b] | 33.52 ± 4.25[b] | 31.84± 4.18[c] |
| Triglycerides (mg/dl) | 108.53 ± 15.90 | 105.68 ± 15.83 | 107.85 ± 15.68 | 102.57± 15.46 |

[abc]Means on the same row with different superscripts are significantly different ($p<0.05$

The highest anti body Newcastle titres at 18 and 28 d were observed in chickens which received Terbutaline + L-carnitine in the diet, and the lowest was observed in the control group (Table 6). However, there were no significant effects between control and the other groups in anti body Newcastle titres at 18 and 28 d of age. Birds receiving Terbutaline + L-carnitine had the highest antibody Influenza titres at 18 and 28 d compared to the other groups, and the lowest antibody Influenza titres was observed in the control group. There were no significant effects in antibody Influenza titres between the control and the other groups at 18 and 28 d of age.

Table 6: Effect of different levels of Terbutaline and L-carnitine on immune system of broiler chickens

| Parameters | Control | Terbutaline | L-carnitine | Terbutaline + L-carnitine |
|---|---|---|---|---|
| Anti body titres - Newcastle (log2) | | | | |
| at 18 d of age | 4.3± 0.52 | 4.5±0.5 5 | 4.6±0.57 | 4.8±0.58 |
| at 28 d of age | 5.2±0.21 | 5.4±0.22 | 5.5±0.23 | 5.6±0.25 |
| Antibody titres - Influenza (log2) | | | | |
| at 18 d of age | 4.3±0.51 | 5.4±0.54 | 5.6±0.55 | 5.9±0.58 |
| at 28 d of age | 5.8± 0.34 | 6.2±0.37 | 6.3±0.36 | 6.5±0.38 |

[abc]Means on the same row with different superscripts are significantly different ($p<0.05$)

The present study demonstrates that inclusion of beta adrenergic agonists, Terbutaline and L-carnitine, in the diets of broiler chickens had considerably increased body weight, feed intake and improved feed conversion ratio at 42 d of age. The finding that beta-adrenergic agonist induced the changing of the metabolic pathway by inactivation of protein acceleration (Leeson, 2000; Hamano, 2002). In another study, feed intake was not affected by dietary supplementation with gemfibrozil in mice and hamsters (Cunningham *et al.*, 2010). Other investigation showed that L-carnitine had an effective influence in improving body weight gain, mainly in groups fed with diets marginally in lysine and methionine plus cystine content, respectively (Schumacher *et al*., 1993). Lettner *et al*. (1992) reported that addition of L-carnitine from 20 to 60 mg/kg tended to improve growth performance of broiler chickens. The improvement in body weight gain caused by use of L-carnitine in the diet may be partially explained by an increasing plasma concentration of insulin-like growth factor-I, which consists of 70 amino acids and has the potency to stimulate body weight gain (Kita *et al*., 2002). FCR was influenced by L-carnitine at 250 mg per kg diet. This level improved the FCR and is similar to Rabie *et al.* (1997) and Rodehutscord *et al*( 2002). Other studies reported finding of no effect of L-carnitine on FCR (Barker and Sell, 1994; Buyse *et al.*, 2001; Lien and Horng, 2001). Nouboukpo *et al*. (2009), who investigated the effect of L-carnitine supplementation in drinking water on the growth performance of broiler chickens, observed at 7 d of rearing that chickens from the control group had significantly lower body weight compared to the experimental groups receiving 30 and 60 mg of L-carnitine in drinking water. Rabie and Szilagyi (1998) and Buyse *et al*. (2001) observed positive effect of L-carnitine on the body weight of chickens on the end of fattening period but the differences were not significant. Other authors who studied the effect of L-carnitine on broiler performance found that it had no effect on body weight (Leibetseder, 1995; Lien and Horng, 2001; Xu *et al*. 2003; Cevik and Ceylan, 2005).

Our results show that broilers receiving Terbutaline and L-carnitine improved carcass characteristics by decreasing abdominal fat at 42 d of age. Furthermore our results show that broilers which received Terbutaline and L-carnitine increased spleen and bursa Fabricius relative weights in comparison of the control group. Gwartney *et al.* (1991)

showed that addition of cimaterol (a beta adrenergic agonist) in the diet of broiler chickens at 1 ppm had no advantage in carcass composition after a 1-week withdrawal period. Birds given diets containing metaproterenol sulfate, had a trend of lower liver, heart weight and abdominal fat pad ($p<0.05$) which is in agreement with Jones *et al.* (1985) and Takahashi *et al.* (1993). The reduction of carcass fat may be inactivated by inhibition of lipid synthesis (Duquett and Muir, 1982). Improvement in body weight gain and subsequently breast weight indicated that probably these compounds promote muscle hypertrophy as reported by Hanrahan *et al* (1987). Several investigations reported that adding 25 or 50 ppm L-carnitine decreased abdominal fat pads (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 altered fat metabolism and reduced body fat content of broiler chickens. Previous studies reported L-carnitine alone showed no effect on the abdominal fat, heart and liver weights, as well as total cholesterol and triglyceride levels (Arslan *et al.*, 2003; Barker and Sell, 1994; Leibetseder, 1995; Lien and Horng, 2001). This was attributed to the limited intestinal absorptive capacity of carnitine as well as it being easily degraded by microbes in the intestine (Xu *et al.*, 2003). Consequently, L-carnitine supplementation in diets reduced the amount of long-chain fatty acids availability for esterification to triacylglycerols and storage in the adipose tissue (Barker and Sell, 1994; Xu *et al*. 2003). Other studies reported either a decrease in abdominal fat (Xu *et al.*, 2003) and lowered triacylglycerol and nonesterified fatty acid concentrations (Lien and Horng, 2001) or increases in triglyceride concentrations (Buyse *et al.*, 2001) in response to dietary supplementation with L-carnitine. The other results of this study show that addition of Terbutaline and L-carnitine decreased blood triglyceride, total cholesterol, HDL and LDL concentrations at 42 d of age. The other results also show that addition of L-carnitine with gemfibrozil at the highest level reduced blood triglyceride concentration. The exact mechanism through which gemfibrozil influences blood triglyceride concentrations is unclear. However, this phenomenon has been observed in humans (Munoz *et al.*, 2013) and rats (Macan *et al.*, 2010). Gembrozil has been shown to inhibit cholesterol absorption in the rat intestine (Umeda *et al.*, 2001). Buyse *et al*. (1991) reported that the chronic administration of Clenbuterol did not affect plasma glycerol, glucose or triglyceride, although plasma level of VLDL was decreased in chickens fed with Clenbuterol. However, Abolghasemi *et al*. (2007) reported an increase in the plasma level of cholesterol, triglyceride, and glucose in chickens receiving Terbutaline. These researchers also reported that the level of cholesterol was increased, but that of triglyceride was not affected in chickens fed with Salbutamol (Ansari *et al*., 2002).

The pharmacodynamic properties of a particular beta agonist administrated to a particular species are expected to be influenced by genetic, sex, and age-borne variations in drug metabolism and delivery systems. Our results show that broilers receiving Terbutaline and L-carnitine increased antibody Newcastle and Influenza titres of broiler chickens at 18 and 28 d of age ($p<0.05$). Parsaeimehr (2014) also showed that adding L-carnitine had a significant effect on Newcastle antibody titre on day 42. The mechanism accounting for the positive effect of L-carnitine on antibody production is currently not clear. Mast *et al.* (2000) reported that addition of Lcarnitine at 100 mg / kg had a significant effect on immune response by increasing the total Ig and IgG levels in 2 to 6 wk old animals. In

modern broiler production, the rapid growth requires more nutrients than recommended by NRC (Williams *et al.*, 2000).

## Conclusion

Considering the results obtained in the current study it could be concluded that dietary inclusion of different levels of Terbutaline and L-carnitine would increase chicken body weight, feed intake and improve FCR and carcass characteristics by decreasing of abdominal fat at 42 d of age. In addition, birds fed with Terbutaline and L-carnitine would likely decrease serum triglyceride, HDL and LDL concentration at 42 d of age, and enhance antibody titer production of broiler chickens at 18 and 28 d of age.

## References

Abolghasemi, S.A.H., Jafari-Sayadi, A.R., Jalali-Hajiabadi, S.M.A. and Ansari-Pirsaraei, Z. 2007. The effect of a beta adrenergic agonist on performance of broiler chicks (in Persian with English abstract). J. Sci. Tech. Agri.. Nat. Res. 10: 471-480.

Ansari-pirsaraei, Z., Abolghasemi, A.H., Jafari-Sayadi, A.R. and Jalali-Hajiabadi, M.A. 2007. Effect of Terbutaline feeding on some blood parameters and carcass characteristics in broiler chicks. Proceedings of the 16th European Symposium on Poultry Nutrition; Strasbourg. France. 483-486.

Ansari, Z., Zamiri, M.J., Moeeinizadeh, H., Aminlari, M. and Sefidbakht, V.N. 2002. Effects of a β2-selective agonist (Salbutamol; Albuterol) on blood serum factors and carcass characteristics and composition in broiler chicks (in Persian with English abstract). J. Sci. Tech. Agr. Nat. Res. 1: 67-79.

Arslan, C., Citil, M. and Saatci, M. 2003. Effects of L-carnitine administration on growth performance, carcass traits, blood serum parameters and abdominal fatty acid composition of ducks. Arch. Tierernahr. 57: 381-88.

Barker, D.L. and Sell, J.L. 1994. Dietary carnitine did not influence performance and carcass composition of broiler chickens and young turkeys fed low- or high-fat diets. Poult. Sci. 73: 281-287.

Beermann, D.H. 2002. Beta-Adrenergic receptor agonist modulation of skeletal muscle growth. J. Anim. Sci. 80: (1): E18-E23.

Boostan, M.J. Zare Shahneh, A., Shivazad, M. and Akhlaghi, A. 2015. Effects of dietary beta adrenergic agonist, Terbutaline , on carcass characteristics and blood attributes in Japanese quails (*Coturnix coturnix* japonica). Poult. Sci. J. 3 (1): 17-25.

Burtle, G.J. and Liu, Q.H. 1994. Dietary carnitine and lysine affect channel catfish lipid and protein composition. J. World. Aqua. Soc. 25: 169-174.

Buyse, J., Janssens, G.P. and Decuypere, E. 2001. The effects of dietary L-carnitine supplementation on the performance, organ weights and circulating hormone and metabolite concentrations of broiler chickens reared under a normal or low temperature schedule. Brit. Poult. Sci. 42: 230-41.

Buyse, J., Decuypere, E., Huyghebaert, G. and Herremans, M. 1991. The effect of clenbuterol supplementation on growth performance and on plasma hormone and metabolite levels of broiler. Poult. Sci. 70: 993-1002.

Cartwright, A.L., Marks, H.L. and Campoin, D.R. 1988. Adipose cellularity in nonselected and selected broiler stocks: measurements at equal weight and age. Poult. Sci. 67: 1338-1344.

Cevik, A.F. and Ceylan, N. 2005. Effects of dietary L-carnitine supplementation on performance and carcass traits of broiler chickens. 3rd Ulusal Hayvan Besleme Kongresi, Adana. 391–396.

Coles, E.H. 1986. Veterinary clinical pathology, 4th Edn. W.B. Saunders. Philadelphia, London, Hong Kong.

Corduk, M., Ceylan, N. and Ildiz, F. 2007. Effects of dietary energy density and L-carnitine supplementation on growth performance, carcass traits and blood parameters of broiler chickens. South Afr. J. Anim Sci. 37(2): 65-73.

Cunningham, M.L., Collins, B.J., Hejtmancik, M.R., Herbert, R.A., Travlos, G.S., Vallant, M.K. and Stout, M.D. 2010. Effects of the PPARalpha agonist and widely used antihyperlipidemic drug gemfibrozil on hepatic toxicity and lipid metabolism. PPAR Res.

Dalrymple, R.H. and Ingle, D.A .1990. Effect of cimaterol implants on lamb growth and carcass characteristics. New Zealand. J. Agric. Res. 33: 413-427.

Duquett, P.F. and Muir, L. 1982. Effect of the betaadrenergic agonists isoproterenol, celnbuterol, L- 640, 033 and BRL 35135 on lipolysis and lipogenesis in rat adipose tissue in vitro. J. Anim. Sci. 46: 310-321.

Duquett, P.F., Rickes, E.L., Olson, G., Capizzi, T.P. and Convey, E.M. 1988. Growth and carcass composition of broilers fed beta-adrenergic-agonist L-640,033, in: Beta-agonists and their effects on animal growth and carcass quality. Elsevier. Appl. Sci. New York. 173-177.

Ferreira, M.S.S., Garbossa, C.A.P., Oberlender, G., Pereira, L.J., Zangeronimo, M.G., Sousa, R.V. and Cantarelli, V.S. 2013. Effect of ractopamine on lipid metabolism in vivo. Brazil. Arch. Biol. Technol. 56: 35-43.

Franey, R.J. and Elias, A. 1986. Measurement based on ethanol extraction and ferric chloride-sulfuric acid. Clin. Chim. Acta. 21: 225-263.

Golzar Adabi, S.H., Cooper, R.G., Ceylan, N. and Corduk, M. 2011. L-carnitine and its functional effects in poultry nutrition. Worlds. Poult. Sci. J. 67: 277–288.

Gwartney, B. L., Calkins, C. R. and Jones, S.J. 1991. The effect of cimaterol and its withdrawal on carcass composition and meat tenderness of broiler chickens. J. Anim. Sci. 69: 1551.

Hamano, Y. 2002. Influence of lipolic acid on lipid metabolism and $ - adrenergic response to intravenous or oral administration of clenbutarol in broiler chickens. Poult. Sci. 42: 307-316.

Hanrahan, J.P. 1987. Beta-Agonists and their effects on animal growth and carcass quality. Elsevier Applied Science. NY.

Jones, R.W., Easter, R.A., Mckeith, F.K. and Becht, P.J. 1985. The effect of a $-adrenergic agonist on the growth and carcass characteristics of finishing swine. J. Anim. Sci. 61: 4-9.

Kachura, S.A. 1995. Influence of carnitine and dietary energy level on the productivity of early weaned piglets. Byulleten'-Vsesoyuznogo- Nauchno-issledovatel' skogo-Instituta-Viziologii,-Biokhimii-i-Pitaniya- Sel' skokhozyaistvennykh- Zhivotnykh. 96: 39-43.

Kaudo, N., Barr, A.J., Barr, R.L., Desai, S. and Lopaschuk, G.D. 1995. High rates of fatty acid oxidation during reperfusion of ischemic hearts are associates with a decrease in malonyl-CoA levels due to an increase in 5' P-AMP- activated protein kinase inhibition of acetyl-CoA carboxylase. J. Biol. Chem. 270: 17513-17520.

Kita, K., Kato, S., AmanYaman, M., Okumura, J. and Yokota, H. 2002. Dietary L-carnitine increases plasma insulin-like growth factor-I concentration in chicks fed a diet with adequate dietary protein level. Brit. Poult. Sci. 43: 117-121.

Leeson, S. 2000. Nutrition and quality of the broiler carcass. J. Agri. Food. Sci. 43: 547-553.

Leibetseder, J. 1995. Effects of L-carnitine in poultry. Arch. Tierernahr. 48: 97-108.

Lettner, V.F., Zollitsch, W. and Halbmayer, E. 1992. Use of L-carnitine in the broiler ration. Bodenkultur. 43: 161-167.

Lien, T.F. and Horng, Y.M. 2001. The effect of supplementary dietary L-carnitine on the growth performance, serum components, carcase traits and enzyme activities in relation to fatty acid beta-oxidation of broiler chickens. Brit. Poult. Sci. 42: 92-95.

Macan, M., Vrkic, N., Vrdoljak, A.L., Radic, B. and Bradamante, V. 2010. Effects of high sucrose diet, gemfibrozil, and their combination on plasma paraoxonase 1 activity and lipid levels in rats. Acta. Biochim. Polon. 57: 321-326.

Malucelli, A., Ellendorff, F. and Meyer, H.H. 1994. Tissue distribution and residues of clenbuterol, salbutamol, and Terbutaline in tissues of treated broiler chickens. J. Anim. Sci. 72: 1555-1560.

Mast, J., Buyse, J. and Goddeeris, B.M. 2000. Dietary Lcarnitine supplementation increases antigen specific immunoglobulin G production in broiler chickens. Brazil. J. Nutr. 83: 161-166.

Merkly, J.W. and Cartwright, A.L. 1989. Adipose tissue deposition and cellularity in cimaterol-treated female broilers. Poult. Sci. 68: 762-770.

Munoz, M., Liu, A., Delaney, W., Brown, J.A.C., Mugavero, E., Mathews, M.J., Napravnik, W.C., Willig, S., Eron, J.H., Hunt, J.J., Kahn, P.W., Saag, J.O., Kitahata, M.S. and Crane, H.M. 2013. Comparative effectiveness of fish oil versus fenofibrate, gemfibrozil, and atorvastatin on lowering triglyceride levels among hiv infected patients in routine clinical care. J. Acq. Immuno. Defi. Synd. 64: 254-260.

Newton, G.L. and Haydon, K.D. 1989. Carnitine supplementation for finishing pigs. J. Anim. Sci. 67(1): 267.

NRC. 1994. Nutrient requirements of domestic animals. Nutrient requirements of poultry. National academy of Science. Washington, DC.

Owen, K.Q., Nelssen, J.L., Goodband, R.D., Weeden, T.L. and Blum, S.A. 1996. Effect of L-carnitine and soybean oil on growth performance and body composition of early weaned pigs. J. Anim. Sci. 74: 1612-1619.

Parsaeimehr, K., Afrouziyeh, M. and Hoseinzadeh, S. 2014. The effects of L-Carnitine and different levels of animal fat on performance, carcass characteristics, some blood parameters and immune response in broiler chicks. Iran. J. Appl. Anim. Sci. 4: 561-566.

Rabie, M.H. and Szilagyi, M. 1998. Effects of L-carnitine supplementation of diets differing in energy levels on performance, abdominal fat content, and yield and composition of edible meat of broilers. Br. J. Nutr. 80: 391–400.

Rabie, M.H., SzilÁgyi, M. and Gippert, T. 1997a. Effects of dietary L-carnitine supplementation and protein level on performance and degree of meatiness and fatness of broilers. Acta. Biol. Hung. 48: 221-239.

Rabie, M.H., SzilÁgyi, M., Gippert, T., Votisky, E. and Gerendai, D. 1997b. Influence of dietary L-carnitine on performance and carcass quality of broiler chickens. Acta. Biol. Hung. 48: 241-252.

Rodehutscord, M., Timmler, R. and Dieckmann, A. 2002. Effect of L-carnitine supplementation on utilization of energy and protein in broiler chicken fed different dietary fat levels. Arch. Tierernahr. 56: 431-41.

SAS. 2000. Statistical Analysis System. SAS User Guide: Release 9.2. SAS Institute INC, Cary NC, USA, 2000.

Schumacher, A., Eissner, C. and Gropp, J.M. 1993. Carnitine in fish, piglets and quail. Pp. 407-412 in Vitamine und weitere Zusatzstoffe bei Mensch und Tier (vitamins and other supple-ments forhumans and animals). G. Flachowsky and R. Schu-bert, Eds. Friedrich-Schiller-Universita t, Jena, Germany.

Smith, D.J. 1998. The pharmacokinetic, metabolism, and tissue residues of Beta adrenergic agonists in livestock. J. Anim. Sci. 76: 173-194.

Takahashi, K., Akita, K. and Horiguchi, M. 1993. Effect of beta-adrenergic agonist (clecnbutarol) on performance, carcass composition, hepatic microsomal mixed function oxidase and antibody production in female broiler treated with or without corticosterone. Brit. Poult. Sci. 34: 167-175.

Trinder, P. 1969. Determination of glucose in blood using glucose oxidase with an alternative oxygen acceptor. Ann. Clin. Biochem. 6: 24.

Umeda, Y., Kako, Y., Mizutani, K., Iikura, Y., Kawamura, M., Seishima, M. and Hayashi, H. 2001. Inhibitory action of gemfibrozil on cholesterol absorption in rat intestine. J. Lipid. Res. 42: 1214-1219.

Wotton, J.A. 1964. Principle of animal physiology, 2nd Edn., Macmillan Publishing Co. Inc New York.

Williams, B., Solomon, S., Waddington, D., Thorp, B. and Farquharson, C. 2000. Skeletal development in the meat-type chicken. Brit. Poult Sci. 41: 141-149.

Wellenreiter, R.H. 1991. β-Adrenergic agonists for poultry. Crit. Rev. Poult. Biol. 3: 229-237.

Xu, Z.R., Wang, M.Q., Mao, H.X., Zhan, X.A. and Hu, C.H. 2003. Effects of Lcarntine on growth performance, carcass composition, and metabolism of lipids in male broilers. Poult. Sci. 82: 408-413.

Zamiri, M.J. and Ehsani, K. 1995. Salbutamol affects body composition of the guinea pig. Iran. Agri. Res. 14: 1-18.

Zare Shahneh, A., Mataji, R., Zamiri, M.J. and Moradi Shahre-Babak, M. 2001. Effects of beta-adrenergic agonist metaproterenol on carcass characteristics of Varamini ewes. J. Sci. Technol. Agric. Nat. Res. 5: 157-166.