Egypt Poult. Sci. Vol (27) (I): (121-150)

INFLUENCE OF L-CARNITINE SUPPLEMENTATION AT DIFFERENT DIETARY ENERGY LEVELS ON BROILER PERFORMANCE

By

A. E. Abou - Zeid, Kh. Amber[*], Y. A. Mariey[**], and M. M. El - Mansy
Animal Production Department, Faculty of Agriculture, Tanta University.
[*]Poultry Production Dep., Fac.Of Agric. Kafer – El-Sheikh University.
[**]Animal Production Res., Instit. Agric. Res. Center, Minist. of Agriculture.

Received: **4/1/2007** Accepted: **27/2/2007**

Abstract: *This study highlights the potential effect of L-carnitine administration with different dietary energy levels on broiler performance. Four hundred sixty eight one-day-old unsexed Hubbard broiler chicks were assigned randomly to 12 equal experimental groups. The feeding period consists of three stages, the first was (starting period), its basal diet contained 22 % CP .The second was (growing period, 20% CP) and the third period was (finishing period, 18 % CP). Within each protein level used, three levels of energy (2800, 3000 and 3200 Kcal / kg diet) were tested with various levels of L-carnitine (0, 100, 200 and 300 mg / kg diet). The results showed that birds fed 200 mg L-carnitine/kg diet possessed the best body weight, weight gain and feed conversion ratio followed by birds fed 300mg L-carnitine/kg diet and 100 mg L-carnitine/ kg diet compared to the control. The effect of dietary energy levels per se showed that body weight, weight gain and feed conversion of broiler fed 3200 kcal/kg diet were significantly higher than those fed 2800 kcal/kg diet. Dietary energy and L-carnitine levels interacted significantly to influence performance parameters. Slaughter test data showed statistical differences in dressing, front part (F.P) hind part (H.P), liver, gizzard, heart and abdominal fat percentage due to L-carnitine administration levels per se. Dietary energy levels per se were also affected carcass traits. Dietary energy and L-carnitine levels interacted positively to affect carcass traits. Plasma biochemical parameters indicated that total lipids, triglycerides and cholesterol were responded positively with L-carnitine and energy levels each. Higher values of plasma triglycerides, cholesterol and total lipids were noticed in birds fed 3200 kcal/ kg diet. The economic efficiency of birds fed 3200 kcal/kg diet with 200 mg L-carnitine recorded the highest value, it increased by 30.4% compared to the birds fed 2800 kcal/kg diet with 0.0 mg L-carnitine/kg diet. In conclusion, it is recommended that the level of 200 mg L-carnitine/kg diet could be added to broiler diets to improve growth performance and economic efficiency.*

INTRODUCTION

In the last decade, meat type chicken has been selected for increasing body weight yield. This strategy has resulted in greater growth performance. Undesirable, indirect selection responses such as pronounced fat deposition, increased leg problems and some metabolic disorders were also noticed. Accumulation of fat in carcasses of broiler, particularly in abdominal and visceral areas, represents a waste product to consumers who are increasingly concerned about the nutritional and health aspects of their food. Such fatty broiler will be unattractive to those consumers and thus will lead to decrease salability, which in turn reduces the net returns for the producers. Some of these undesirable selection responses could be partially counteracted by genetic means. However, this will only give satisfactory results in the long term and attention should, therefore, be paid to short term solutions which may involve nutritional or management factors. From the nutritional point of view, L-carnitine supplementation may participate to some extent in solving such problems of broiler **(Rabie and Szilagyi, 1998)**. The use of L-carnitine as feed additives has been evaluated by (**Yalcin *et al*., 2005, Nofal *et al*., 2006 and Adabi *et al*., 2006).** L-carnitine (β - oH - [γ - N - trimethylamino]- butyrate) is a small molecular weight- water soluble amine which occurs naturally in micro-organisms, plants and animals **(Bremer, 1983)**. L-carnitine is synthesized from lysine and methionine, the former providing the carbon framework, while the latter supplies the methyl group. Supplementation of L-carnitine has been shown to improve growth, breast meat yield and feed conversion in response to an improved utilization of dietary N through more efficient fat oxidation **(Rabie and Szilagyi, 1998)**. It has antioxidant properties, which may satisfy some of the adverse consequences of oxygen free radical over production as observed in a number of disease states **(Becker *et al*., 1999)** as well as increase antibody production response **(Mast *et al*., 2000).** It is worthy to note that L-carnitine is well recognized for playing an important role in the mitochondrial oxidation of long chain fatty acids to produce energy via β oxidation and oxidative phosphorylation **(Borum, 1983)**, by decreasing their availability for estrification to triglyceride and storage in the adipose tissue. Providing the body with sufficient supplies of L-carnitine can induce more efficient utilization of dietary energy and protein. **(Cyr *et al*., 1991 and Harmeyer, 2002)**.

It is well known that L-carnitine plays an important role in reducing fat deposition. At the same time elevating energy levels lead to increase fat deposition. Thus, the present study aimed to assess if there is any synergistic or antagonistic effect between L-carnitine and dietary energy levels in increasing growth performance traits as well as minimizing fat deposition of broiler.

MATERIALS AND METHODS

Management and allocation of birds:

Four hundred sixty eight one-day-old unsexed Hubbard chicks were obtained from commercial hatchery, wing banded, individually weighed and assigned randomly to 12 equal experimental groups of 39 birds each.Birds of each group were further subdivided into three replicates of 13 birds each and housed in floor pens supplied with clean wood shavings. Temperature was maintained at 32°C for the first 5 days and then gradually reduced according to normal management practices. A 23 hr constant light schedule was maintained. Throughout the entire experiment feed and water were added ***ad Libitum***. All chicks were kept under the same managerial, hygienic and environmental conditions throughout the entire experimental period that lasted for 6 weeks.

The experimental diets:

A conventional corn-soybean meal basal diet was used to meet more or less the requirement recommended by NRC, (1994). The feeding period in the current investigation consisted of three stages; the first was starting period, its basal diet contained 22 % CP and lasted for 3 weeks. The second was growing period; its basal diet contained 20 % CP and lasted for 2 weeks. The third period was finishing period; its basal diet contained 18 % CP at the last week of the experiment. Within each protein level used, three levels of energy (2800, 3000 and 3200 Kcal / kg diet) were tested with various levels of L-carnitine (0, 100, 200 and 300 mg / kg diet). L-carnitine was incorporated into the diets at the expense of yellow corn. The experimental design was a factorial 3 energy levels × 4 L-carnitine levels. Each diet supplemented with BHT (50 mg □kg diet). The composition of the diets is detailed in Table 1.

Growth performance traits:

Individual body weight, feed consumption and feed conversion ratio were recorded weekly. The feed conversion ratio was calculated on group basis. The general status of birds was noticed and dead birds were removed, weighed and kept for post mortem examination

Slaughter test:

At the end of the experimental period (6 weeks of age), three birds from each replicate were taken randomly, individually weighted and slaughtered after fasting for 10 hrs. After sacrificing, the carcasses were eviscerated.

The eviscerated carcasses were cut. The breast and thigh meat were separated and weighed. The internal organs (liver, gizzard, heart and abdominal fat) were removed carefully and weighed. All organs and different cuts were expressed as a percentage of body weight.

Biochemical analysis:

At the end of starting and finishing periods, three birds from each replicate were slaughtered and blood collected in test tubes. The heparinized blood was centrifuged immediately for 10 min at 3000 rpm to produce plasma. The plasma was kept in ependorf tubes and frozen rapidly until time of analysis.

Triglycerides was determined according to **Sidney and Barnard (1973)** using commercial kits from Human Co (Human Gesellschaft fur Biochemica und Diagnostica mbh Max-planck-Ring21-D-Wiesbaden-Germany), and was measured in spectrophotometer using wavelength of 500 nm.Plasma cholesterol was determined according to **Allain *et al.*, (1974)** using kits of Quimica Clinica Aplicada .Plasma total lipid was detected by specific diagnostic kits produced by Biodiagnastic according to method of **Zallner and Krisch (1962)**.

Economical efficiency:

The economical efficiency of the tested rations was calculated from input-output analysis **(Heady and Jensen, 1954)** assuming that the other head costs were constant.

$$\frac{\text{Selling price/ kg weight gain} - \text{Feed cost/ kg gain} \times 100}{\text{Feed cost/ kg gain}}$$

Statistical analysis:

Data were analyzed using SAS procedure (1985). Tests of significance for the differences among treatments were done according to **Duncan (1955).**

RESULTS

Effect of L-carnitine on performance traits:

Performance data of broiler chicks as influenced by L-carnitine levels at different dietary energy levels are illustrated in Tables (2&3). The effect of L-carnitine administration ***pre se*** was recognized compared with un-supplemented L-carnitine diet. At the end of starting period, the birds fed 300 mg L-carnitine/kg diet had higher body weight by (18.1 %) followed by birds of group fed 200 mg L-carnitine/ kg diet (17.9 %) and group fed 100 mg L-carnitine/ kg diet (8.2 %) compared to the control group (0.0 mg L-carnitine/ kg diet). At the end of growing period, increasing L-carnitine levels from 0 to 100 mg and 200 mg / kg diet leads to increase body weight by (7.2%) and (13.9%), respectively compared to the control group while the birds fed 300 mg L-carnitine/kg diet had lower body weight than those fed 200 mg L-carnitine /kg diet. Similarly, the data of the finishing period showed that birds fed 200 mg L-carnitine/kg diet possessed the highest body weight. The effects of L-carnitine supplementation ***per se*** on weight gain of chicks are shown in Table (2). Weight gain was statistically affected at all investigated periods; the highest weight gain was noticed in birds received 200 mg L-carnitine/ kg diet during the all experimental periods. Its value was 119.9% at starting period, 112% at the end of growing period, 110.3% at the end of finishing period and from 0 to 6 weeks it was 114.2 % of the control group.

The effect of different dietary L-carnitine levels on broiler feed intake are tabulated in Table (3). Feed intake was not statistically affected by L-carnitine supplementation. The effect of L-carnitine on feed conversion ratio of broiler chicks is presented in Table (3). At all investigated periods, birds received 200 mg L-carnitine/ kg diet recorded the best feed conversion ratio followed by birds received 300 mg L-carnitine/kg diet compared to the un-supplemented group.

Effect of energy level on performance traits:

Data of body weight of broiler chicks fed different dietary energy levels are presented in Table (2).At the end of starting period, the results showed that increased energy levels resulted in increased body weight. Birds fed 3200 kcal/kg diet had the highest body weight. Similar trend was noticed in finishing and growing period. The effects of dietary energy levels on weight gain are illustrated in Table (2). The effect of energy ***per se*** revealed that high level of energy (3200 kcal/kg diet) significantly increased weight gain.

From 1 to 42 days, the data showed that birds fed 3200 kcal/kg diet have higher weight gain by 15.2 % compared to those fed 2800 kcal/kg diet.

The data of feed intake of broiler chicks as affected by different dietary energy levels are summarized in Table (3).During the starting period, increasing energy levels from 2800 to 3000 kcal / kg diet led to decrease feed intake by 5.6 %.Similarly, increasing the dietary energy levels from 2800 to 3200 kcal/kg diet decreased dietary feed intake by 11.4 %. Similar trend was also observed at the end of growing and finishing period. The effect of energy level on feed conversion ratio of broiler chicks is show in Table (3). Statistical differences were noticed with feed conversion ratio between treated groups.

At the starting, growing, and finishing period, the diet which contains 3200 kcal/kg diet improved feed conversion ratio compared to the birds received 2800 kcal / kg diet. At the period (0 to 6 weeks), the level of 3200 kcal/kg diet improved feed conversion ratio by 24.0 % compared to the level of 2800 kcal/kg diet. The level of 3000 kcal/kg diet improved feed conversion ratio by 13.1 % compared to the birds fed 2800 kcal / kg diet.

Interaction:

The interaction of L-carnitine × energy level was analyzed. L-carnitine × dietary energy level interacted significantly to affect the all investigated performance parameters. At the end of starting and growing period, the highest body weight and weigh gain were noticed with birds receiving 200 mg L-carnitine/ kg diet and 3200 kcal/ kg diet, where body weight at starting period significantly increased by 49.0 % than those fed un-supplemented diet (0.0 mg L-carnitine/ kg diet and 2800 kcal/ kg diet). The lowest body weight and weight gain observed with the level of 0.0 mg L-carnitine plus 2800 kcal/ kg diet. Similar trend was quite evident for body weight at the end of finishing period and from 0 to 6 weeks.

Feed intake did not influenced by the interaction of L-carnitine and energy levels. Dietary energy and L-carnitine levels interacted significantly to influence feed conversion ratio Table (3). The best treatment during the all experimental periods was noticed in group fed 3200 kcal/kg diet plus 200 mg L-carnitine/ kg diet while the worst treatment was observed in group fed 2800 kcal plus 0.0 mg L-carnitine/ kg diet.

Effect of L-carnitine on carcass traits:

Results of slaughter test of birds fed L-carnitine and dietary energy levels are summarized in Table (4). Statistical analysis revealed significant differences in dressing, front part (F.P), hind part (H.P), liver, gizzard, heart and abdominal fat percentage. Birds fed 300 mg L-carnitine possessed significantly the highest dressing (4.4%), front parts (5.3%), hind part (3.5%) and giblets (15.5%) compared to the control. Also, birds fed 200 mg L-carnitine/kg diet had higher percentage of the previously mentioned parameters when compared to control by 3.2, 4.5, 2.5 and 8.9 %, respectively. Birds received 100 mg L-carnitine/ kg diet was higher also by 1.2, 1.4, 1.6, and 4.4 %, respectively compared to control. In contrast, increasing dietary L-carnitine levels resulted in decreasing abdominal fat content. Birds fed 300 mg L-carnitine/kg diet had lower fat content by 23.8% followed by birds fed 200 mg L-carnitine/kg diet (19.2%), then birds received 100 mg L-carnitine/ kg diet (11.9%) compared to the control.

Effect of energy level on carcass traits:

Concerning carcass traits, it can be noticed from Table (4) that carcass traits were influenced significantly by energy levels. The enhancement of carcass characteristics was apparently related to an improved the utilization of high energy diet (3200 kcal/kg diet). This improvement was demonstrated by significant increase in dressing by 3 %, front part (3%), hind part (1.6%), giblets (8.2 %) and abdominal fat (5.7%) followed by the level of 3000 kcal/ kg diet by (1.6, 1.7, 0.62, 4.1 and 5.1 %), respectively, compared to the birds fed 2800 kcal/ kg diet.

Interaction:

Dietary energy and L-carnitine level interacted significantly to influence dressing, F.P, H.P, giblets and abdominal fat. The best results were noticed in the group fed (300 mg L-carnitine/ kg diet plus 3200 kcal/ kg diet) while the lowest results were observed in the group fed (0.0 mg L-carnitine/ kg diet plus 2800 kcal ME/ kg diet).

Effect of L-carnitine on biochemical traits:

Plasma biochemical parameters have been used as indicators of the nutritional and physiological status of birds. The results of the determined plasma's parameters are presented in Tables (5).

At the end of starting period, the lowest plasma total lipid was noticed with birds received 300 mg L-carnitine /kg diet, it decreased by 34% compared to control. The same trend was noticed with plasma triglyceride, where birds fed 200 mg L-carnitine/kg diet showed the lower record of plasma triglyceride, it decreased by (25.5%) followed by birds fed 300 mg L -carnitine /kg diet (21.6%) and birds fed 100 mg/kg diet (22.1%) compared to the control group.Increasing L-carnitine levels from 0.0 to 100, 200, and 300 mg L-carnitine /kg diet resulted in decreasing plasma cholesterol by 17.1, 31.8, and 37.6 %, respectively compared to the control group.

At the end of the finishing period, it is obvious that plasma total lipid decreased by (26%) when L-carnitine increased from 0.0 mg to 100 mg/kg diet and from 0.0 mg to 200 and 300 mg L-carnitine /kg diet (31.9 and 33%). The lowest plasma triglyceride was detected in birds received 200 mg L-carnitine /kg diet, its value decreased by (23.7%) compared to the control group. Plasma cholesterol followed the trend which clearly showed that the highest cholesterol value was noticed in birds received un-supplemented control diet. Plasma cholesterol tended to decrease significantly with increasing L-carnitine levels from 0.0 mg to 100 mg /kg diet by 14%, followed by the birds fed 200 mg L-carnitine /kg diet (36.4%) then birds fed 300 mg L-carnitine/ kg diet (43.2%) compared to the control.

Effect of energy levels on biochemical traits:

The effect of energy levels on biochemical traits during starting and finishing period are presented in Tables (5).Plasma total lipid, triglyceride and cholesterol were not significantly affected by energy levels at the end of starting period. At the end of the finishing period, however increasing energy levels resulted in significant increase of plasma total lipid, triglyceride and cholesterol. The higher level of energy resulted in higher level of triglyceride and cholesterol. Triglyceride value at the level of 3200 was statistically similar to that of 3000 kcal/kg diet. Higher values of plasma triglyceride and cholesterol were noticed in birds fed 3200 kcal/ kg diet where plasma triglyceride increased by 8.3% and cholesterol by 7.8% compared to birds fed 2800 kcal /kg diet. A linear relationship can be noticed between plasma total lipid and dietary energy levels where birds fed 3200 kcal/kg diet had higher total lipid value followed by birds fed 3000 kcal/kg diet compared to the birds fed 2800 kcal/kg diet.

Interaction:

The interactions of L-carnitine × energy levels were studied. At the end of starting period, the higher values of plasma total lipid and triglyceride were noticed for birds fed (3200 kcal/kg diet plus 0.0 mg L-carnitine/ kg diet) while the lower values were observed in birds fed (2800 kcal/kg diet × 200 mg L-carnitine/ kg diet). The latter value was statistically equal with those fed (2800 kcal × 300 mg L-carnitine). This result may indicate that L-carnitine supplementation with the 2800 kcal/kg diet leads to decrease plasma triglyceride.

L-carnitine and energy levels were interacted positively to affect plasma cholesterol significantly, where the best record was noticed with chicks fed (300 mg L-carnitine/kg diet and 2800 kcal/kg diet) which was statistically equal to those fed (200 mg L-carnitine/kg diet and 2800 kcal/kg diet).The worst cholesterol record was detected in birds received (0.0 mg L-carnitine/kg diet × 3200 kcal /kg diet).

At the end of finishing period, the data in Table (5) clearly showed that total lipids, triglycerides and cholesterol were significantly affected by dietary energy level and L-carnitine supplementation. The highest value of total lipids, triglycerides and cholesterol were detected in group fed (3200 kcal/kg diet × 0.0 mg L-carnitine/kg diet) while the lowest value was observed in birds fed 2800 kcal/kg diet × 200 mg L-carnitine/kg diet. This supports the conclusion that 200 mg L-carnitine/kg diet × 2800 kcal/kg diet act synergistically to decrease total lipids, triglycerides and cholesterol.

Economic efficiency:

Economic evaluation of using L-carnitine at different dietary energy levels in broiler chicks is recorded in Table (6). The best record was detected in birds fed the highest dietary energy level 3200 kcal/kg diet. The net revenue of birds fed dietary energy 3200 kcal/kg diet at different L-carnitine levels increased than those fed un-supplemented diet. The economic efficiency for birds fed (3200 kcal/kg diet with 200 mg L-carnitine) recorded the highest value, it increased by 30.4% compared to birds fed (2800 kcal/kg diet with 0.0 mg L-carnitine/kg diet).

DISCUSSION

Effect of L-carnitine on performance traits:

As previously mentioned the object of the present study was to examine the influence of L-carnitine at different dietary energy levels on performance traits. The improvements in body weight, body weight gain and feed conversion ratio of birds were anticipated in the presence of L-carnitine.It could be concluded that L-carnitine supplementation improved most investigated performance traits. These results are in line with those found by **Rabie and Szilagyi (1998), Lien and Horng, (2001), (Kita *et al*., 2002**). **Xu *et al.*(2003)** , **Kim *et al*., (2004), Yalcin *et al*., (2005), Adabi *et al*., (2006).**They mentioned that growth performance traits improved significantly with supplemental L-carnitine to the diet. Growth performance of broiler tended to improve by increasing the level of dietary L-carnitine from 20 up to 60 mg/ kg diet **(Lettner *et al*., 1992)**.The highest body weight gain achieved by birds fed diets supplemented with L-carnitine compared to the control, may explain the better feed conversion since feed intake were approximately similar, irrespective of dietary energy level. The growth promoting effect of L-carnitine may possibly be related to its prophylactic medication property which reduces fat deposition in broiler, through its effect on long chain fatty acids by transporting it across the inner mitochondrial membrane before β oxidation **(Bremer,1983)**,thereby decreasing their availability for esterification to triglycerides and storage in the adipose tissue. Thus, under conditions of L-carnitine insufficiency, the transport of long chain fatty acids could be impaired. Diets supplemented with L-carnitine, therefore, should enhance the oxidation of these fatty acids. The reduction in absolute weights of abdominal fat content observed in the present study in response to L-carnitine supplementation may attributable, partly to an increase of fatty acid oxidation rate within the cell (in mitochondria) induced by L-carnitine. The loss of substrate (fatty acids) in turn, could result in a reduction of hepatic lipogenic capacity. The depression of fat content in the investigated research may ascribable to an increasing rate of fatty acid oxidation that may supported by L-carnitine, this in turn, led to decrease in the hepatic lipogenic ability, where the liver is the principle site of lipogensis in avian **(Saadoun and Leclercq,1983)**.Another innovation that may explain the striking effect of L-carnitine supplementation on body weight gain was suggested by **Rabie and Szilagyi, (1998)**.The improvement in body weight gain in response to L-carnitine supplementation may be due to the increase in dietary N utilization that can be achieved through more utilization of fat oxidation by L-carnitine. The increased fatty acid oxidation induced by L-carnitine, may result in decreased availability of long chain fatty acids for estrification to triacylglycerols and at the same time can raise the mitochondrial level of acetyl-CoA. Such a situation can affect the activity of pyruvate carboxylase which is an acetyl-Co A-dependent enzyme that can supply C chains for amino acid biosynthesis **(Cyr *et al*., 1991)**. **Ji *et al.* (1996)** suggested that dietary L-carnitine may alter some indices of intermediary metabolism either directly through sparing its precursors for protein biosynthesis and other cellular functions, or indirectly by optimizing the balance between essential amino acids within the cell. Such a situation allows an improvement in the metabolic efficiency of dietary protein utilization and a reduction in N losses. The growth promoting effect of L-carnitine was also detected in another animal species by **Weeden *et al*., (1991)** who pointed out that daily weight gain of pigs improved significantly, when they were fed starter diet supplemented with 1000 mg L-carnitine /kg diet followed by diets supplemented with 250 or 500mg L-carnitine /kg diet at 3 weeks of age. The improvements in growth rate and feed conversion for African catfish fed diets supplemented with L-carnitine were also observed by **(Torreele *et al*., 1993)**. Other researchers pointed out that body weights gain and degree of protein conversion (efficiency of protein utilization) achieved by foals that received 10 g/ d supplemental dietary L-carnitine for 78 days were significantly greater than those fed un-supplemented diet **(Hausenblasz *et al*., 1996)**.In contrast, **Cartwright (1986)** exhibited that performance of broiler in terms of body weight and feed consumption was not affected by feeding diet supplemented with 0.05% L-carnitine of the diet from 5 to 7 weeks of age. Likewise, **Barker and Sell (1994)** showed that dietary L-carnitine levels (50 or 100 mg / kg diet) did not affect performance traits of broiler and young turkeys fed low or high-fat diets. **Leibetseder (1995)** found that performance (body weight gain, feed conversion and abdominal fat content) of broiler were not influenced by dietary carnitine (L or DL form) at the level of 200 mg / kg diet. This discrepancy may be due to the differences in managerial, housing or environmental conditions than those applied in the present study. L-carnitine supplementation did not affect mortality rate significantly. These results are consistent with those reported by **Kidd *et al*., (2005)**. They showed that mortality rate was not affected by L-carnitine levels. Similar results were detected by **Yalcin *et al*., (2005).**

Effect of energy levels on performance traits:

The current results showed that body weight, weight gain and feed conversion ratio improved significantly with increasing dietary energy level. Feed intake decreased linearly in all investigated intervals with increasing dietary energy levels. These results are consistent with those reported by **Rabie and Szilagyi, (1998)** who found that feed intake decreased significantly with increasing energy levels.Broiler need a certain amount of energy for maintenance and production purposes and is able to consume an amount of feed that will meet these requirements. When high energy diets are fed, broiler will decrease their feed intake to the point that their energy requirement has been met. Broiler are not normally eating to physical capacity and have a remarkable ability to control energy intake to adjust their feed intake in response to energy needs.**Veldkamp *et al.*, (2005)** manifested that turkeys which consumed the highest energy diets had the lowest feed intake, but their body weight gain was only marginally affected, resulting in a greatly improved feed: gain ratio. The effect of extra dietary energy on feed intake was more pronounced among turkeys exposed to the low temperature than the highest temperature regimen. Genetic improvements in growth rate have been continues and generally ahead of the established nutrients requirement needed for optimal performance (NRC, 1994). Within these nutrient needs, ME intake is well documented to influence body composition **(Morris, 2004),** and performance of growing broilers **(Leeson *et al.*, 1996)**. It is expected that growing broiler deposit nutrients into body tissue, such as fat and protein, quite efficiently relative to other poultry species **(Leeson and Summers, 2001)**. Metabolizable energy intake (ME) is generally partitioned into energy retained (ER) in body tissue [mainly as energy retained from fat (ERF) and energy retain from protein (ERP)] and as heat production (HP). Metabolizable energy (ME) = heat production (HP) + energy retained (ER) **(Lawrence and Fowler, 2002)**. Under thermoneutral conditions, HP represent heat associated with the utilization of ME intake for maintenance (MEm) and productive process, which in equivalent about 52 to 64 % of energy consumed by broiler **(Vanmilgen *et al.*, 2001)**. Therefore, energy retained represents the difference between metabolizable energy (ME) and heat production (HP). (Energy retained = Metabolizable energy - Heat production).The present results demonstrated that feed conversion improved when dietary energy level increased. This finding is in accordance with those reported by **Deaton and Lott, 1985** and **Leeson *et al.*, (1996)**.The present study also showed that dietary energy level did not significantly affect mortality rate. These results are in harmony with those reported by **Kiiskine (1983)** who pointed out that mortality was not significantly affected by different dietary energy levels, when two dietary ME levels (11.2 and 12.1 MJ / kg diet) with various rapeseed oil meal levels (0, 8, 16 or 22 %) were fed. The same conclusion were found by **Hussein *et al.* (1996)** who reported that mortality rate was not significantly affected by the energy level used during the final 4 weeks of age.

Effect of L-carnitine on carcass traits:

L-carnitine supplementation improved most carcass traits in the current investigation. These results are backed up with the results observed by **Rabie *et al.*,(1997[a])** who pointed out that abdominal fat content of broiler were significantly decreased in response to carnitine supplementation.

The current results support the results obtained by **Rabie and Szilagyi (1998)** who manifested that the weights of breast yield and thigh meat yield were increased by adding L-carnitine to the diet.The results of **Xu *et al*., (2003)** confirmed that L-carnitine had little effect on leg muscle and breast muscle yield while abdominal fat content decreased significantly. The same conclusion was ascertained by **(Kita *et al*., 2002**).**Xu *et al.* (2003)** explicated that L-carnitine decreased fat deposition in carcass through its effect on glucose-6-phosphate dehydrogenase, malie dehdrogenase and isocitrate dehdrogenase. The activities of glucose-6-phosphate dehydrogenase (G-6-PD), malie dehdrogenase(MDH), iso citrate dehdrogenase (ICD) in subcutaneous fat were decreased by adding dietary L-carnitine levels to the diet. It is well known that G-6-PD, MDH and ICD are NADPH generating enzyme in cytosol. NADPH is hydrogen provider for prolonging carbon chain necessary for fatty acid formation. L-carnitine supplementations indirectly influence fatty acid formation and deposition through its effect on decrease generating rate of NADPH (*hydrogen provider for carbon chain necessary for fatty acid formation*). Increasing L-carnitine levels leads to decrease the total activities of lipoprotein lipase (LPL) which reduce fat deposition in carcass through its hydrolysis effect on very low density lipoprotein (VLDL) which in turn, leads to minimize fat composition **(Griffin and Whitehead, 1982)**.L-carnitine plays an important role in muscles activity, where increasing dietary L-carnitine resulted in increased carnitine concentration in muscle and liver. This increase led to increase the activity of carnitine acetyl transferase and accelerate the transportation of acetyl Co A from mitochondria to cytosol. The increase of acetyl Co A in cytosol induce an increase in Malonyl Co A. The increase in malonyl Co A leads to decrease carnitine palmitoil transferase 1 (CPTI). CPT1 may facilitate the free carnitine to bind with activated fatty acid to from long chain acyl-carnitine that cross to the inner mitochondria membrane where it is oxidized through β-oxidation and thus CPT1 controls the rate of β-oxidation and regulates the deposition or oxidation of fatty acids **(Zammit, 1999).** This in turn, led to decrease the rate of transportation of long chain fatty acid to mitochondria (lower rate of β-oxidation of fatty acids) thus, enhancing some formation of fat in muscles (**Velasco *et al.,* 1997**).

During physical exercise, muscles activity increase, the free fatty acid oxidation increase by withdrawal free fatty acids from muscles, consequently, malonyl Co A decreased. When malonyl Co A decreased CPT1 increased. This increase resulted in increased β-oxidation rate and fat content in muscles decreased. The observed decrease in abdominal fat content of broiler in response to dietary L-carnitine are compatible with the results obtained by **Weeden *et al*., (1991) and Burtle and Liu (1994)**who reported that body fat and carcass fat were significantly reduced by L-carnitine supplementation.

Conversely, other studies by **Barker and Sell (1994)** and **Leibetseder (1995)** have been shown that abdominal fat was not affected by added dietary L-carnitine. Likewise, **Barker and Sell (1994)** stated that breast meat yield of broiler was not affected by feeding diets containing L-carnitine up to 100 mg/kg.

Effect of energy levels on carcass traits:

Dressing percentage, front part%, hind part%, giblets%, and abdominal fat increased linearly with increasing energy levels. These results are in line with those reported by **Deaton and Lott (1985)** who pointed out that abdominal fat content of broiler was decreased when the energy content of the diet decreased. The same conclusion was observed by **Marks (1990)** who reported that faster growing birds deposit more fat than their slower growing birds. Excess energy from diets with higher ME values will normally be stored as fat.**Leeson *et al.* (1996)** elucidated that absolute and proportional weight of the abdominal fat pad decreased linearly with decreasing energy level in diet. They explained that birds fed 3300 kcal / kg diet had significantly heavier carcass weight than birds fed low energy level.**Rabie and Szilagyi (1998)** suggested that the lower weights of some carcass variables achieved by birds fed the lowest energy level in most cases compared with those of birds fed the higher energy level might be related directly to the lower body weight of the former. The increase in abdominal fat content of broiler in the present study with high energy level is compatible with the results observed by **Bender and Mays (2003)** who confirmed that after the provision of water, the body's first requirement is for metabolic fuels and feed intake in excess of energy expenditure leads to obesity, while intake less than expenditure lead to emaciation and wasting. The results observed by **Raju *et al*., (2004)** are in line with the results of the current study. They reported that abdominal fat increased with increasing energy content. **Nahashon *et al.* (2005)** demonstrated that average weights of abdominal fat in birds fed diet containing 3100 and 3150 kcal ME / kg diet were 4.3 and 14 % higher than those of birds fed 3050 kcal ME / kg diet, respectively.

In contrast to present results, **Ayorinde (1994)** showed that the dressing percentage of carcass was not significantly affected by dietary energy level. The same conclusion were found by **Veldcamp *et al*., (2005)** who reported that breast meat yield of turkeys was negatively affected by high energy diets. These studies may have been performed under managerial, housing or environmental conditions different from those applied in the present study.

Effect of L-carnitine on biochemical traits:

L-carnitine supplementation improved most biochemical traits under investigation. These results are consistent with the results observed by **Lien and Horng (2001), Xu *et al*., (2003),** and **Kim *et al*., (2004)** who pointed out that L-carnitine administration leads to a decrease of triglyceride fatty acids stored in the adipose tissue in the form of neutral triacylglycrides serves as the body's major fuel storage reserve. Triacylglycrols provide concentrated stores of metabolic energy. It is well known that feeding L-carnitine increase the activity of hormone sensitive lipase (HSL) and decreased the activity of lipoprotein lipase (LPL) which removes FA from either C1 or C3 of TG to produce fatty acid and glycerol, consequently reducing the concentration of TG in plasma **(Xu *et al*., 2003).**

Cholesterol is present in tissue and in plasma lipoproteins either as free cholesterol or combined with a long-chain fatty acid (at carbon 3) as cholesterol ester. It is synthesized in many tissues from acetyl-Co A and finally removed from the body in the bile as cholesterol or bile salts. L-carnitine affects LPL by decreasing its activity, when it occurs, LPL increase hydrolysis of very low density lipoprotein where VLDL is a major component of plasma cholesterol, consequently total cholesterol decreased. Total cholesterol includes very low density lipoproteins (VLDL), low density lipoproteins (LDL) and high density lipoproteins (HDL). Lipoproteins are molecular complex of lipids and proteins, a polylipoproteins. These dynamic particles are in a constant state of synthesis, degradation and removal from the plasma. On the other hand **Kita *et al*., (2002)** reported that plasma triglyceride and cholesterol were not affected by L-carnitine supplementation. The same conclusion were found by **Arslan *et al*., (2003)** who fed Turkish native duck dietary L-carnitine at the level of 200 mg in drinking water. They stated that L-carnitine administration did not affect serum cholesterol, total lipid and triglyceride.

Effect of energy levels on biochemical traits:

Increasing dietary energy level leads to an increase in plasma total lipids, triglycerides, and cholesterol. These results are in harmony with those reported by **El-Husseiny and Ghazalah (1989)** who explained that lipid constituents of the blood serum increased with increasing the oil/ fat level in the experimental diet. The same conclusion was reported by **Zeweil (1989)** who stated that rabbits fed diet with high level of cottonseed oil (6%) had the highest level of lipid in their serum (4.7 g /L) compared to those fed 2 % and 4 % cottonseed oil. Birds fed the high dietary energy had a large amount of acetyl-CoA through citric acid cycle. Cholesterol is synthesized in the body entirely from acetyl-CoA. Three molecules of acetyl-CoA form mevalonate via the important regulatory reaction for the pathway, catalyzed by HMG-CoA reductase. Next, a five carbon isoprenoid unit is formed and six of these condense to form squalene. Squalene undergoes cyclization to form the parent steroid lanosterol, which after the loss of three methyl groups forms cholesterol, so that increasing dietary energy level led to increase cholesterol level **(Mays and Batham, 2003)**.Triacylglycerol is the main storage form of lipid in adipose tissue. Upon mobilization, free fatty acids are an important fuel source, consequently, the highest energy level resulted in increasing the storage lipid in form triacylglycerol in adipose tissue and triglycerol in blood **(Mays and Batham, 2003)**.**Ozek and Bahtiyarca (2004)** reported similar findings where, birds fed diets containing 12.55 / 13.18 ME MJ/ kg diet had lower triglycerides than other birds fed diets containing 13.39/ 13.81 ME MJ/ kg diet.

Conclusion

From the nutritional and economic point of view, it can be noticed that birds received 200 mg L-carnitine had gain more profit than the control birds so that additional L-carnitine to the diet produce some improvement in performance traits, plasma constituent and significantly decreased abdominal fat in broiler chicks.

Table (1): Composition and calculated analysis of the starting, growing and finishing diets.

Energy / Ingredients	2800 kcal / kg diet			3000 kcal / kg diet			3200 kcal / kg diet		
Yellow corn	55	59	60.0	55.5	59	60.0	54.2	58.5	60.0
Wheat bran	5.8	6.3	7.7	2	2.7	3.8	-	-	-
Soybean meal	27	25	26.5	27.5	26	27.9	27	25.5	29.2
Corn gluten meal	7.5	5	-	8	5.1	-	9.1	6.3	-
Soybean oil	-	-	1.1	2.3	2.5	3.6	5	5	6.1
Di-Calcium phosphate	2	2	2	2	2	2	2	2	2
Limestone	2	2	2	2	2	2	2	2	2
Dl-Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Salt (Nacl)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
(Premix)*	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis									
Crude Protein (CP).	22.02	20.05	18.00	22.00	20.00	18.00	22.0	20.04	18.00
Metabolizable energy (Kcal/kg).	2802.	2805.6	2801.5	3000.2	3004.8	3002.1	3200	3206.4	3201.6
Ether extract (EE).	2.7	2.8	3.9	4.9	5.2	6.3	7.5	7.6	8.6
Crude fiber (CF).	3.8	3.8	4.0	3.5	3.5	3.7	3.2	3.2	3.4
Calcium	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Available phosphorus	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lysine	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Methionine.	0.5	0.5	0.4	0.5	0.5	0.4	0.6	0.5	0.4
Methionine + Cystine	0.9	0.8	0.7	0.9	0.8	0.7	0.9	0.8	0.7

Each 3 kg premix contain : vit. A 12000000 IU, vit. D3 2000000 IU, vit. E 10000 mg, vit. K 2000 mg, vit. B_1 1000 mg, vit. B_2 5000 mg, vit. B_6 1500 mg, vit. B_{12} 10 mg, Folic acid 1000 mg, Biotin 50 mg, Pantothenic acid 10000 mg, Niacin 30 000 mg, Fe 30000 mg, Cu 10000 mg and Se 100 mg, Zinc 50000mg, manganese 60000 mg.

Table (2): Body weight (BW) and body weight gain (BWG) of broiler chicks as affected by L-carnitine at different energy levels.

Traits / Treatments	Starting period		Growing period		Finishing period		0-6 weeks
	BW (g)	BWG (g)	BW (g)	BWG (g)	BW (g)	BWG (g)	BWG (g)
L-carnitine (mg/kg)							
0	575.7^{c}	536.1^{c}	1252.6^{d}	677.5^{d}	1657.8^{d}	405.3^{b}	1619.0^{d}
100	622.7^{b}	583.2^{b}	1342.1^{c}	719.7^{c}	1753.1^{c}	411.2^{b}	1714.2^{c}
200	679.0^{a}	642.5^{a}	1427.1^{a}	759.0^{a}	1881.3^{a}	446.9^{a}	1848.4^{a}
300	679.6^{a}	638.7^{a}	1411.6^{b}	731.2^{b}	1845.5^{b}	433.0^{a}	1802.9^{b}
SE	3.1	3.1	5.4	4.3	2.9	4.3	2.9
Energy(kcal ME/kg)							
2800	586.1^{c}	545.3^{c}	1273.9^{c}	686.4^{c}	1671.8^{c}	397.8^{c}	1629.5^{c}
3000	633.5^{b}	593.9^{b}	1347.9^{b}	714.6^{b}	1770.9^{b}	423.1^{b}	1731.6^{b}
3200	700.5^{a}	661.2^{a}	1464.5^{a}	764.6^{a}	1915.6^{a}	451.5^{a}	1877.3^{a}
SE	2.6	2.7	2.7	3.8	2.5	3.8	2.5
Interaction Energy × L-carnitine							
2800 0	503.0^{h}	463.0^{i}	1125.8^{h}	622.8^{f}	1516.4^{h}	390.5^{e}	1476.4^{h}
2800 100	560.4^{g}	520.4^{b}	1249.6^{f}	689.2^{d}	1631.7^{g}	382.1^{e}	1591.7^{g}
2800 200	627.4^{f}	587.4^{g}	1355.3^{e}	727.9^{c}	1773.9^{e}	418.6^{cd}	1733.9^{e}
2800 300	650.3^{e}	610.3^{f}	1355.9^{e}	705.6^{cd}	1756.0^{f}	400.1^{de}	1716.0^{f}
3000 0	569.1^{g}	529.1^{h}	1229.9^{g}	660.9^{e}	1630.1^{g}	400.2^{de}	1590.1^{g}
3000 100	620.6^{f}	580.6^{g}	1340.3^{e}	719.7^{c}	1755.6^{f}	415.3^{cd}	1715.6^{f}
3000 200	670.7^{d}	630.7^{de}	1427.5^{c}	756.8^{b}	1869.6^{c}	442.1^{b}	1829.6^{c}
3000 300	675.3^{cd}	635.3^{cd}	1396.1^{d}	720.8^{c}	1831.1^{d}	434.9^{bc}	1791.1^{d}
3200 0	655.9^{e}	616.3^{ef}	1404.8^{d}	748.9^{b}	1830.1^{d}	425.3^{bc}	1790.5^{d}
3200 100	688.6^{c}	648.7^{c}	1438.8^{c}	750.3^{bd}	1875.1^{c}	436.3^{bc}	1835.3^{c}
3200 200	749.7^{a}	709.4^{a}	1511.5^{a}	792.1^{a}	2021.9^{a}	480.1^{a}	1981.6^{a}
3200 300	710.6^{b}	670.5^{b}	1477.7^{b}	767.1^{b}	1941.8^{b}	464.2^{a}	1901.7^{b}
L-carnitine	***	***	***	***	***	***	***
Energy	***	***	***	***	***	***	***
L-carnitine × Energy	***	***	***	***	***	***	***

Means within column for each item having different superscript differ significantly *** ($P \leq 0.001$)

Table (3): Feed intake (FI) and feed conversion ratio (FC) of broiler chicks as affected by L-carnitine at different energy levels.

Traits / Treatments		Starting		Growing		Finishing		0-6 weeks	
		FI	FC	FI	FC	FI	FC	FI	FC
L-carnitine (mg/kg)									
0		884.9	1.68[a]	1507.0	2.24 [a]	1143.4	2.83[a]	3535.4	2.20[a]
100		895.5	1.55[b]	1514.0	2.11[b]	1147.0	2.80[b]	3556.5	2.09[b]
200		899.2	1.41[c]	1518.9	2.01[d]	1148.1	2.58[d]	3566.2	1.94[d]
300		902.7	1.42[c]	1520.0	2.08[c]	1150.6	2.67[c]	3573.2	1.99[c]
SE		7.0	0.006	7.4	0.003	6.0	0.004	12.2	0.003
Energy(kcal ME/kg)									
2800		943.9[a]	1.75[a]	1558.8[a]	2.28[a]	1174.8[a]	2.96[a]	3677.4[a]	2.27[a]
3000		895.2[b]	1.52[b]	1515.6[b]	2.13[b]	1161.3[b]	2.75[b]	3572.0[b]	2.07[b]
3200		847.6[c]	1.29[c]	1470.6[c]	1.92[c]	1105.8[c]	2.46[c]	3424.0[c]	1.83[c]
SE		6.0	0.005	6.4	0.003	5.2	0.003	10.5	0.003
Interaction Energy× L-carnitine									
	0	934.7	2.02[a]	1550.4	2.49[a]	1180.0	3.02[b]	3665.1	2.48[a]
2800	100	942.7	1.81[b]	1557.7	2.26[c]	1175.0	3.08[a]	3675.3	2.31[b]
	200	947.7	1.61[d]	1563.0	2.15[e]	1170.3	2.80[e]	3681.0	2.12[e]
	300	950.7	1.56[e]	1564.0	2.22[d]	1173.7	2.93[c]	3688.3	2.15[d]
	0	887.0	1.68[c]	1507.7	2.28[b]	1150.0	2.87[d]	3544.7	2.23[c]
3000	100	895.8	1.54[e]	1515.0	2.11[f]	1161.0	2.80[e]	3571.8	2.08[f]
	200	897.7	1.42[f]	1518.3	2.01[g]	1166.0	2.64[g]	3582.0	1.96[h]
	300	900.3	1.42[f]	1521.3	2.11[f]	1168.0	2.69[f]	3589.7	2.00[g]
	0	833.0	1.35[g]	1463.0	1.95[h]	1100.3	2.59[h]	3396.3	1.90[i]
3200	100	848.0	1.31[h]	1469.3	1.96[h]	1105.0	2.53[i]	3422.3	1.87[j]
	200	852.3	1.20[i]	1475.3	1.86[j]	1108.0	2.31[k]	3435.7	1.73[l]
	300	857.0	1.28[h]	1474.7	1.92[i]	1110.0	2.39[j]	3441.7	1.81[k]
L-carnitine		N.S.	***	N.S.	***	N.S.	***	N.S.	***
Energy		***	***	***	***	***	***	***	***
L-carnitine × Energy		N.S.	***	N.S.	***	N.S.	***	N.S.	***

Means within column for each item having different superscript differ significantly *** (P≤0.001)

Table (4): Carcass traits % of broiler chicks as affected by L-carnitine at different energy levels.

Traits / Treatments		Carcass traits				
		Dressing (%)	**Front part (%)**	**Hind part (%)**	**Giblets (%)**	**Abdominal Fat (%)**
L-carnitine (mg/kg)						
0		74.20^{d}	35.80^{d}	31.80^{d}	4.50^{d}	2.10^{a}
100		75.10^{c}	36.30^{c}	32.30^{c}	4.70^{c}	1.85^{b}
200		76.60^{b}	37.40^{b}	32.60^{b}	4.90^{b}	1.70^{c}
300		77.50^{a}	37.70^{a}	32.90^{a}	5.20^{a}	1.60^{d}
SE		0.06	0.06	0.07	0.01	0.03
Energy(kcal ME/kg)						
2800		74.70^{c}	36.20^{c}	32.20^{c}	4.65^{c}	1.75^{c}
3000		75.90^{b}	36.80^{b}	32.40^{b}	4.84^{b}	1.84^{b}
3200		76.90^{a}	37.30^{a}	32.70^{a}	5.03^{a}	1.85^{a}
SE		0.05	0.05	0.006	0.002	0.003
Interaction Energy × L-carnitine						
2800	0	72.80^{i}	34.93^{h}	31.55^{k}	4.37^{k}	1.92^{g}
	100	74.20^{h}	35.79^{g}	32.07^{i}	4.55^{i}	1.81^{f}
	200	75.60^{f}	36.85^{de}	32.33^{g}	4.76^{f}	1.63^{b}
	300	76.30^{d}	37.07^{d}	32.71^{d}	4.93^{d}	1.62^{ab}
3000	0	74.03^{h}	35.66^{g}	31.85^{j}	4.54^{j}	1.99^{h}
	100	75.10^{g}	36.30^{f}	32.16^{h}	4.73^{g}	1.93^{g}
	200	76.60^{c}	37.40^{c}	32.52^{f}	4.94^{d}	1.78^{e}
	300	77.80^{b}	37.95^{ab}	33.00^{b}	5.17^{b}	1.65^{c}
3200	0	75.70^{ef}	36.68^{e}	32.07^{i}	4.69^{j}	2.23^{i}
	100	75.90^{e}	36.66^{e}	32.57^{e}	4.91^{g}	1.80^{f}
	200	77.60^{b}	37.84^{b}	32.87^{c}	5.12^{d}	1.77^{d}
	300	78.30^{a}	38.14^{a}	33.11^{a}	5.41^{b}	1.61^{a}
L-carnitine		***	***	***	***	***
Energy		***	***	***	***	***
L-carnitine × Energy		***	***	***	***	***

Means within column for each item having different superscript differ significantly*** (P≤0.001).

Table (5): Effect of L-carnitine at different energy levels on plasma biochemical traits at starting and finishing periods.

Traits / Treatments		Total lipids (mg/l)		Triglycerides(mg/dl)		Cholesterol (mg/dl)	
		starting	finishing	starting	finishing	starting	finishing
L-carnitine(mg/kg)							
	0	4.308[a]	4.367[a]	79.583[a]	84.083[a]	145.500[a]	153.750[a]
	100	3.117[b]	3.233[b]	62.000[b]	67.083[b]	120.667[b]	132.250[b]
	200	2.867[b]	2.975[b]	59.333[b]	64.167[b]	99.250[c]	97.750[c]
	300	2.842[b]	2.925[b]	62.417[b]	64.333[b]	90.750[c]	87.333[d]
	SE	0.156	0.131	2.118	1.801	3.767	2.803
Energy(kcal ME/kg)							
	2800	3.144	2.981[c]	63.125	65.812[b]	110.562	109.312[b]
	3000	3.300	3.319[b]	65.875	70.375[a]	112.437	118.875[a]
	3200	3.406	3.825[a]	68.500	73.563[a]	119.125	125.125[a]
	SE	0.135	0.114	1.835	1.559	3.262	2.427
Interaction Energy × L-carnitine							
2800	0	4.075[a]	3.725[bc]	78.250[a]	81.250[a]	143.000[ab]	139.000[b]
	100	3.000[b]	2.875[d]	57.750[b]	62.250[bc]	118.000[cd]	127.750[b]
	200	2.750[b]	2.625[d]	57.250[b]	59.500[c]	96.000[ef]	89.250[de]
	300	2.750[b]	2.700[d]	59.250[b]	60.250[c]	85.250[f]	81.250[e]
3000	0	4.400[a]	4.250[b]	79.250[a]	83.000[a]	142.000[ab]	158.750[a]
	100	3.100[b]	3.150[cd]	63.000[b]	68.250[bc]	113.500[cd]	133.250[b]
	200	2.850[b]	2.950[d]	58.500[b]	65.000[bc]	100.500[def]	98.000[cd]
	300	2.850[b]	2.925[d]	62.750[b]	65.250[bc]	93.750[ef]	85.500[de]
3200	0	4.450[a]	5.125[a]	81.250[a]	88.000[a]	151.500[a]	163.500[a]
	100	3.250[b]	3.675[bc]	65.250[b]	70.750[b]	130.500[bc]	135.750[b]
	200	3.000[b]	3.350[cd]	62.250[b]	68.000[bc]	101.250[def]	106.000[c]
	300	2.925[b]	3.150[cd]	65.250[b]	67.500[bc]	93.250[ef]	95.250[cde]
L-carnitine		*	*	*	*	**	***
Energy		N.S.	**	N.S.	*	N.S.	*
L-carnitine ×Energy		*	***	*	***	***	***

Means within column for each item having different superscript differ significantly

* (P≤0.05) ** (P≤0.01) *** (P≤0.001)

Table (6): Economic efficiency of different experimental treatments.

	2800 Kcal / Kg diet				3000 Kcal / Kg diet				3200 Kcal / Kg diet			
	0	**100**	**200**	**300**	**0**	**100**	**200**	**300**	**0**	**100**	**200**	**300**
Average feed intake	3688.3	3681	3675.3	3665.1	3589.7	3582	3571.8	3544.7	3441.7	3453.7	3422.3	33963
Total feed cost*	4.03	4.19	4.34	4.5	4.13	4.3	4.46	4.61	4.19	4.36	4.52	4.66
Average weight gain	1476.4	1591.7	1733.9	1716	1590.1	1715.6	1829.6	1791.1	1790.5	1835.3	1981.6	1901.7
Price of weight gain**	11.1	11.94	13.00	12.87	11.93	12.87	13.752	13.43	13.43	13.77	14.86	14.26
Net revenue ***	7.07	7.75	8.66	8.37	7.8	8.57	9.26	8.82	9.24	9.41	10.34	9.6
Economic efficiency	175.4	185.0	199.5	186	188.9	199.3	207.6	191.3	220.5	215.8	228.8	206.0
Relative E.E.	100%	105.5%	113.7%	106%	107.7%	113.6%	118.4%	109.1%	125.7%	123%	130.4%	117.4%

* Feed cost = feed consumption (g) / bird during the experimental period × price of g / feed

** Price of weight gain = body weight gain / bird × price of kg of live body gain.

*** Net revenue = difference between price of weight gain and feed cost.

Economic efficiency = net revenue / feed cost × 100.

REFERENCES

Adabi, Sh. G., Gh. Moghaddam, A. Taghizadeh, A .Nematollahi ,and T. Farahvash (2006). *Effect of L-carnitine and vegetable fat on broiler breeder fertility, hatchability, egg yolk and serum cholesterol and triglyceride. International Journal of Poult. Sci., 5(10): 970-974.*

Allain, C. C., L.S.Pool, C.S.G.Chan, W. Richmond, and P.C.Fu (1974). *Enzymatic determination of total cholesterol. J.Clin.Chem.20:270 - 275.*

Arslan, C., M. Citil, and M. Saatci (2003). *Effects of L-carnitine administration on growth performance, carcass traits, blood serum parameters and abdominal fatty acid composition of ducks. Arch. Tierernahr, 57(5): 381 – 388.*

Ayorinde, K. L. (1994). *Effects of genotype and dietary energy on performance of broilers. Nigerian Journal of Animal Production, 21(1-2): 5 –10.*

Barker, D. H. and J. L. Sell (1994). *Dietary carnitine did not influence performance and carcass composition of broiler chickens and young turkeys fed low or high fat diets. Poultry Science, 73: 281 – 287.*

Becker, K., S. Schreiber, C. Angoni ,and R. Blum (1999). *Growth performance and feed utilization response of Oreochromis niloticus X Oreochromis aureus hybrids to L-carnitine measured over a full fatting cycle under commercial conditions. Aquaculture, 174: 313 – 322.*

Bender, D. A., and P. A. Mays (2003). *Nutrition, Digestion, and Absorption. Harpers Illustrated Biochemistry , Twenty Six edition . 474-480 .*

Borum, P. B. (1983). *Carnitine. Annu. Rev. Nutr., 3: 233 –259.*

Bremer, J. (1983). *Carnitine: metabolism and functions.Phy. Rev., 63: 1421 – 1480.*

Burtle, G. J., and Q. Liu (1994). *Effects of dietary l-carnitine supplements on growth and muscle lipid of fingerling channel catfish. Journal of the World Aquaculture Society, 24: 421 – 427.*

Cartwright, A.L. (1986). *Effect of carnitine and dietary energy concentration on body weight and body lipid of growing broilers. Poultry Science, 65:21.*

Cyr, D. M., S. G. Egan, C. M. Brini ,and G. C. Trenbly (1991). *On the mechanism of inhibition of gluconeogenesis and ureagenesis by sodium benzoate. Biochemical Pharmacology, 42: 645 – 654.*

Deaton, J.W.,and B. O. Lott (1985). *Age and dietary energy effect on broiler abdominal fat deposition. Poultry Science, 64: 2161- 2164.*

Duncan, D. B. (1955). *Multiple range and multiple F tests. Biometrics. 11:1-42.*

El-Husseiny, O. and A. A. Ghazalah (1989). *True metabolizable energy and nutritional evaluation of fat sources and levels in broiler diets. Egyptian Poultry Science ,10: 385- 411.*

Griffin, H. D., and C. C. Whitehead (1982). *Plasma lipoprotein concentration assay for plasma very low density lipoprotein. British Poul. Sci., 25: 277-286.*

Harmeyer, J. (2002). *The physiological rol of L-carnitine. Lohman Info., 27: 15 -21.*

Hausenblasz, J. M. Acs, A. Petri ,and M. Mezes (1996). *Effect of L-carnitine on some metabolic parameters of foals. Allattenyestes es Takarmanyozas, 45: 397 – 403.*

Heady, E. O. and H. R. Jensen (1954). *Farm Management Economic. Prentice-Hall Inc, Englewood Cliffs, N. J., USA.*

Hussein, A. S., A. H. Cantor, A. J. Pescatore, and T. H. Johanson (1996). *Effect of dietary protein and energy levels on pullet development. Poultry Science, 75: 973 –978.*

Ji, H., T. M. Bradley ,and G. C. Tremblay (1996). *Atlantic Salmon (Salmo Salar) fed L-Carnitine exhibit altered intermediary metabolism and reduced tissue lipid, but no change in growth rate. Journal of Nutrition, 126: 1937 – 1970.*

Kidd, M. T., C. D. Mcdaniel, E. D. Peebles, S. J. Barber, A. Corzo, S. L. Branton ,and J. C. Woodworth (2005). *Breeder hen dietary L-carnitine affects progeny carcass traits. British Poultry Science, 46: 97– 103.*

Kiiskine, T. (1983).*The effect of diets supplemented with rapeseed meal on performance of broiler chicks. Annakes-Agriculturae-Fenniae, 22: 206 – 213.*

Kim, E., H. Park ,and Y. S. Cha (2004). *Exercise training and supplementation with carnitine and antioxidants increases carnitine stores, triglyceride utilization and endurance in exercising rats. J. Nutr. Sci. Vitaminol, 50: 335 – 343.*

Kita, K., S. Kato, M. Amanyaman; J. Okumura and H. Yokota (2002).*Dietary L-carnitine increases plasma insulin-link growth factor I concentration in chicks fed a diet with adequate dietary protein level. Bri. Poul. Sci., 43: 117 – 121.*

Lawrence, T. L. L., and V. R. Fowler (2002). *Efficiency and growth in farm animals . 216 - 228 Ed. CABI Publishing, New York.*

Leeson, S., L. J. Caston ,and J. D. Summers (1996). *Broiler response to energy and protein dilution in the finisher diet. Poultry Science, 75: 522-528.*

Leeson, S. ,and J. D. Summers (2001). *Energy .pages 34- 99 Nutrition of the Chicken. University Books, Gulph, Canada.*

Leibetseder, J. (1995). *Studies of L-carnitine effects in poultry. Archive of Animal Nutrition. 48: 97- 108.*

Lettner, F., W. Zollitsch ,and E. Halbmayer (1992). *L-carnitine in broiler diets. BodenKultur., 43: 161 – 167.*

Lien, T. F. ,and Y. M. Horng (2001). *The effect of supplementary dietary L-carnitine on the growth performance, serum components, carcass traits and enzyme activates in relation to fatty acid bet-oxidation of broiler chickens. British Poultry Science, 42: 92 – 95.*

Marks, H. L. (1990). *Genotype by diet interactions in body and abdominal fat weight in broilers. Poultry Science, 69: 879-886.*

Mast, J., J. Buyse ,and B. M. Goddeeris (2000). *Dietary L-carnitine supplementation increases antigen–specific immunoglobulin production in broiler chicks. British Journal of Nutrition, 83:161–166***.**

Mays, P. A. ,and K. M. Botham (2003). *Lipid transport and storage Harpers illustrated biochemistry, Twenty Six editions. 205 - 218.*

Morris, T. R. (2004). *Nutrition of chicks and layers. Worlds Poul. Sci., 60:5-18.*

Nahashon, S. N., N.Adefope, A.Amenyenu, and D. Wright (2005). *Effects of dietary metabolizable energy and crude protein concentration on growth performance and carcass characteristics of French guinea broilers. Poultry Science, 84: 337- 344.*

Nofal, M. E., H. R. Samak, Y. A. Mariey ,and R.M. Mahamoud (2006). *Production performance and serum constituents of aged Gimmizah hens as affected by dietary supplementation with L-carnitine. Egypt Poult. Sci. 26: 1269 – 1283.*

NRC, (1994). *National Research Council. Nutrient Requirements of Poultry. Ninth edition. National Academy Press, Washington, D.C.*

Ozek,K., and Y. Bahtiyarca (2004). *Effects of sex and protein and energy levels in the diet on the blood parameters of the chukar partridge. British Poultry Science, 45(2)290- 293.*

Rabie, M. H., M. Szilagyi ,and T. Gippert (1997[a]). *Effect of dietary L-carnitine supplementation and protein level on performance and degree of meatiness and fatness of broilers. Acta Biolgica Hungarica, 48 (2): 221 – 239.*

Rabie, M. H., M. Szilagyi, and T. Gippert (1997[b]). *Effect of dietary L-carnitine on the performance and egg quality of laying hens from 65 – 73 weeks of age. British Journal of Nutrition, 78: 615 – 623.*

Rabie, M. H. ,and M. Szilagyi (1998). *Effect of L-carnitine supplementation of diet differing in energy levels on performance, abdominal fat content and yield and composition of edible meat of broilers. British Journal of Nutrition, 80: 391 – 400.*

Raju, M. V., G. S. Sunder, M. M. Chawak, S. V. R. Rao ,and V. R. Sadagopan (2004). *Response of naked neck (Nana) and normal (nana) broiler chickens to dietary energy levels in a subtropical climate. British Poultry Science, 45: 186 – 193.*

Saadoun, A. and B. Leclercq (1983). *Composition of in vivo fatty acid synthesis of the genetically lean and fat chickens. Comparative Biochemistry and Physiology, 75: 641 – 644.*

Santuli, A. and V. D'Amelio (1986). *Effects of supplemental dietary Carnitine on growth and lipid metabolism of hatchery-reared sea bass (Dicentrarchus labrax l.). Agriculture, 59: 177 – 186.*

SAS, Institute (1985). *SAS Users Guide: Statistics version, Fifth edition. SAS institute Inc.,Carry,U.S.A.*

Sidney,P.G., and R.Barnard (1973). *Improved manual spectrophotometric procedure for determination of serum triglycerides. Journal Clinical Chemistery, 19: 1077- 1078.*

Torreele, E., A. Sluiszen ,and J. Verreth (1993). *The effect of dietary L-carnitine on the growth performance in fingerlings of the African catfish (Clarias Gariopinus) in relation to dietary lipid. Br. J. Nutr., 69: 289 – 299.*

Uysal, H., I. Bayram, A. Denz ,and A. Altintas (1999). *The effect of L-carnitine and vitamin C on some blood parameters in Japanese quails. Vertiner Fakultesi Dergisi, Ankara Universitesi, 46: 77– 84.*

Vanmilgen, J., J. Noblet, S. Dubois, B.Carre ,and H. Juin (2001). *Utilization of metabolizable energy in broiler chickens. Poultry science, 80: 170.*

Velasco, G., T. Gomez pulgar, D. Carling, and M. Guzman (1997). *Evidence that the AMP – activated protein kinase stimulates rat liver carnitine palmitoyltransferase I by phosphorylating cytoskeletal components. FEBS lett., 439:317- 320.*

Veldkamp, T., R. P. Kwakkel, P. R. Ferket ,and M. W. A. Verstegent (2005). *Growth responses to dietary energy and lysine at high and low ambient temperature in male turkeys. Poultry Science, 84: 273 – 282.*

Weeden, T. L., J. L. Nelssen, J. A. Hansen, G. E. Fitzner ,and R. D. Goodband (1991). *The effect of L-carnitine on starter pig performance and carcass composition. Journal of Animal Science, 69, 105.*

Xu, Z. R., M. Q. Wang, H. X. Mao, X. A. Zhan ,and C. H. Hu (2003). *Effect of L-carnitine on growth performance, carcass composition and metabolism of lipids in male broilers. Poultry Science, 82: 408 – 413.*

Yalcin, S., A. Ergun, H. Erol and B, Ozsoy (2005). *Use of L-carnitine and humate in laying quail diets. Acta Vet. Hung., 53: 361 – 370.*

Zallner, N. ,and K. Z. Krisch (1962). *Sur die gesampce. Exp. Med., 135-145.*

Zammit, V. A. (1999).*Carnitine acyltransferases: functional significance of sub cellular distribution and membrane topology. Prog. Lipid Res., 38: 199 – 224.*

Zeweil, H. S. (1989). *Cottonseed oil supplementation of diets for growing rabbits. Egyptian Poultry Science, 10:413- 427.*

الملخص العربي

تأثير اضافة الكارنيتين للعلائق مع مستويات مختلفة من الطاقة على الاداء الانتاجي لدجاج التسمين

عادل السيد أبو زيد – خيرى عمبر – يحيى مرعى– محمد المنسى

قسم الانتاج الحيوانى ــ كلية الزراعة ــ جامعة طنطا
قسم انتاج الدواجن ــ كلية الزراعة ــ جامعة كفر الشيخ
قسم الانتاج الحيوانى ــ مركز بحوث الجميزه ــ معهد بحوث الانتاج الحيوانى

تهدف هذه الدراسة الى القاء المزيد من الضوء على تأثير اضافة الكارنيتين للاعلاف مع مستويات مختلفة من الطاقة على الاداء الانتاجي لدجاج التسمين .أجريت هذه التجربة باستخدام 486 كتكوت هبرد عمر يوم و قسمت التجربه إلى ثلاث فترات هى البادئ وفيها غذيت الطيور علي عليقة بها 22 ٪ بروتين خام وفترة النامي (20 ٪ بروتين خام) و فترة الناهي (18 ٪ بروتين خام) ومع كل مستوي بروتين تم استخدام ثلاث مستويات من الطاقة (2800 ، 3000 ، 3200 كيلوكالورى / كجم عليقة) وتم معاملة كل مستوي طاقة بمستويات مختلفة من مادة الكارنيتين (0 ، 100 ، 200 ، 300 ملجم / كجم عليقة).اظهرت النتائج ان الطيور المغذاه على عليقه تحتوي على 200 ملجم من الكارنيتين انتجت افضل وزن للجسم وتحسن فى الكفاءة التحويلية يليها المجموعة المغذاه على مستوى 300 ملجم ثم مستوى 100 ملجم /كجم عليقة بالمقارنة بالمجموعة الكنترول.ادى تأثير الطاقة بمفرده الى تحسن وزن الجسم والكفاءة التحويلية للطيور المغذاه على مستوى 3200 كيلوكالورى بالمقارنه بمستوى 2800 كيلوكالورى / كجم عليقة.حدث تداخل معنوي بين مستويات الطاقة والكارنيتين وأثرذلك على كل من وزن الجسم والكفاءة التحويلية.اوضحت نتائج اختبار الذبح ان هناك اختلافات احصائية ترجع لاضافة مستويات الكارنيتين للعليقة في كل من النسب المئوية للذبيحة و الاجزاء الامامية و الاجزاء الخلفية و القلب و الكبد و القونصة ودهن البطن.تأثرت قياسات الذبيحة معنويا باستخدام مستويات الطاقة المختلفة بمفردها كما حدث ايضا تداخل معنوي موجب بين الطاقة والكارنيتين للتأثير علي صفات الذبيحة.انتج التداخل بين الطاقة و الكارنيتين تأثيرا معنويا على الليبيدات الكليه والتراي جليسرايد والكوليستيرول . اشارت نتائج التقييم الاقتصادي الى ان صافي العائد من الطيور المغذاه على مستوى على 3200 كيلوكالورى / كجم عليقة مع الكارنيتين كان اعلي من تلك التي لم يضاف لها الكارنيتين فقد زادت بمقدار 30.4 ٪ بالمقارنة بالطيور المغذاه على مستوى 2800 كيلوكالورى / كجم عليقة مع اضافة الكارنيتين. يقترح من هذه النتائج ان استخدام مادة الكارنيتين بمستوى 200 ملجم / كجم عليقة يؤدي الي حدوث تحسن في قياسات النمو والجدوى الاقتصادية.