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EFFECT OF DIETARY L-CARNITINE SUPPLEMENTATION ON PRODUCTIVE PERFORMANCE AND CARCASS QUALITY OF LOCAL DUCK BREEDS IN SUMMER SEASON

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ABSTRACT: A total number of 270 Domyati ducklings at 21-day-old were used, weighed and divided into five experimental groups to investigate the effect of dietary L-carnitine (LC) supplementation level (0, 150, 300, 450 and 600 mg/kg) on growth performance, carcass quality, hematological and blood serum constituents as well as economic efficiency in summer season. The results indicated that dietary LC supplementation resulted in a significant (P≤0.01) improvement in live body weight at 63 and 84 day of age, while body weight gain, feed conversion ratio and production index were significantly (P≤0.01) improved as compared to the control group during the overall experimental period (21-84 day of age). Eviscerated carcass and total edible parts (%) were significantly (P≤0.05) improved by supplementing different LC levels to the diet as compared to the control, but abdominal fat (%) was significantly (P≤0.01) decreased. Breast and thigh yield (%) were significantly (P≤0.01) higher for ducklings fed diets supplemented with 450 and 600 mg LC/kg than those fed the control diet. Dietary supplementation of different LC levels resulted in a significant improvement in muscles (%) for both breast and thigh, while skin with subcutaneous fat (%) was significantly decreased as compared to the control. Dietary supplementation of different LC levels resulted in a significant (P≤0.01) increase in crude protein and decrease in ether extract content for breast and thigh muscles than the control group. Hemoglobin content was significantly higher for ducklings fed diet supplemented with 300 up to 600 mg LC/kg as compared to those fed the control diet. Lymphocytes (L) cells (%) was significantly (P≤0.01) increased, while heterophils (H) cells (%) and H/L ratio were significantly (P≤0.01) decreased for ducklings fed diets supplemented with different LC levels than the control. Serum triglycerides constituent was significantly decreased for ducklings fed diets supplemented with different LC levels than those fed the control diet, while, total cholesterol was significantly decreased by feeding these diets except for 150 mg LC/kg diet which was insignificantly decreased. Economic efficiency was significantly higher for ducklings fed diets supplemented with different LC levels, while, 300 and 450 mg LC/kg diet recorded the best values than those fed the control diet .

Key Words: Ducks, L-Carnitine, Growth Performance, Carcass Quality.

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These results indicate that dietary L-carnitine supplementation with 300 or 450 mg/kg for Domyati ducklings in summer season could maximize and improve the productive and physiological performance, carcass traits and quality as well as economic efficiency during growth period.

INTRODUCTION

Shortage of food and nutrients, especially animal protein sources, is one of the most important nutritional problems of the world, especially in third world countries. Poultry industry, is one of the most effective methods for producing animal protein in the world (**Ardekani et al., 2012**). Egyptian duck production was 42.0 thousand tons representing about 1.7% from the world production in 2006 **(Soltan et al., 2014*)***. It is becoming specialized and attention focused lately to increase meat production especially from local breeds. Domyati ducks is one of the local duck breeds which reared for diverse production situations and it's more favorable to the Egyptian consumer ***(*Awad et al., 2011*)***. However, ducks are genetically predisposed to the fatness. Excessive fat in ducks is unattractive to consumers who are concerned about the negative effects of saturated fat intake on health **(Arslan et al., 2003).** This fat represents a waste product from ducks, so, numerous attempts have been made to minimize this fat accumulation, either genetically or by dietary manipulation, with different degrees of success (**Awad et al., 2014**).

Recently, poultry diets are formulated based mainly on plant sources, especially with the concern of consumer's health from animal feedstuffs sources. Poultry diets have a high percentage of cereal grains that are poorly in essential amino acids for better performance (**Baumgartner and Blum, 1997**). Moreover, the stress of high ambient temperature may negatively influence the performance of poultry production by reducing feed intake, live weight gain and feed efficiency as well as environmental stress causes oxidative stress and impairs antioxidants status and bird resistance (**Sahin, et al., 2001**).Therefore, improving performance and carcass composition by using a natural feed additives has become a main focus in poultry researches (**Taklimi et al., 2015**). Although, L-carnitine is synthesized in the body from lysine and methionine, and it is formed with contributions from vitamins B_3, B_6, B_{12}, C and folic acid, as well as iron (**Michalczuk et al., 2012**). According to **Harmeyer (2002)** the body can not produce enough L-carnitine to fully cover its own needs because some conditions such as stress, disease, and physical strain may result in L-carnitine deficiency. So that, dietary L-carnitine supplementation resulted in improving growth rate, feed conversion efficiency, breast and thigh meat yield and reduced abdominal fat in broilers (**Rabie et al., 1997**). Also, dietary L-carnitine supplementation decreased serum cholesterol and triglyceride levels in broilers (**Line and Horng, 2001**). Furthermore, it could play a role in reducing the undesirable fat in broiler carcasses (**Rabie and Szilagyi, 1998**), increasing the chick's resistance for the acute heat stress. Additionally, L-carnitine strengthened immune function by enhancing antibody responses (**Deng et al., 2006**). Moreover, L-carnitine is used in poultry for multi-functional purposes that include promoting growth and improving antioxidant status (**Adabi et al., 2011**).

Because the literature related to the usage of L-carnitine and its effect on growth performance and carcass quality for ducks are scarce, the objective of this study was to investigate the potential effect of dietary L-carnitine supplementation on growth performance, carcass traits and quality as well as economic efficiency for local duck breeds (Domyati ducklings) during summer season.

MATERIALS AND METHODS

Birds and management:-

This study was carried out at El – Serw Water Fowl Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. It was carried out in summer 2015. A total number of two hundred and seventy Domyati ducklings, 21-day-old were used, weighed and distributed into five experimental groups (54 ducklings each). Each experimental group was consisted of three replicates (18 ducklings each). Ducklings were reared under similar hygienic, environmental and managerial conditions. Feed and fresh water were available all the time through the experimental period. Ducklings were fed a grower diet from 22 up to 42 day and a finisher diet from 43 to 84 day of age. The basal experimental diets were prepared and divided into five parts then supplemented with graded levels of L-carnitine (0, 150, 300, 450 and 600 mg / kg diet) and fed to ducklings from 22 until 84 day of age. The composition and calculated analysis of the basal diets are shown in Table 1.

Data collection and estimated parameters:

1. **Growth performance parameters**: Body weight of ducklings was recorded at 21, 42, 63 and 84 day of age. Feed consumption (FC) and mortality were recorded. Body weight gain, FC and feed conversion ratio were calculated through the periods from 21– 42, 42–63, 63–84 and 21–84 day of age, whereas, viability percentage was calculated during the overall experimental period. Production index (PI) was calculated for each period as live body weight (Kg)/ feed conversion x 100 according to **North (1981)**.
2. **Hematological parameters:** At day 77, blood samples were collected in vial tubes containing EDTA as anticoagulant from six ducklings (three males and three females) per each treatment to determine hemoglobin, red blood cell counts and total leukocytes counts as outlined by the standard avian guidelines introduced by **Ritchie et al. (1994).** Total white blood cells were determined by the Unopett method **(Campbell, 1995).** Heterophils (H) and lymphocytes (L) were counted in different microscopic fields in a total of 200 WBCs by the same person, and the H: L ratios were calculated **(Gross and Siegel, 1986).**
3. **Serum biochemical analysis:** During slaughter test, blood samples were individually collected in centrifugation tubes from six ducklings (three male and three female) per each treatment without anticoagulant and kept at room temperature for one hour to clot. The samples were centrifuged at 3500 rpm for 15 minutes to separate clear serum. After that, serum total protein, triglycerides, total cholesterol and liver enzymes activities (AST and ALT) were calorimetrically determined using available commercial Kits.
4. **Slaughter traits:** At the end of the 84thday, six ducklings (three males and three females) per each treatment group were randomly taken, fasted for 12 hours before slaughtering and individually weighed pre-slaughtering and post complete bleeding. Then, scalding, feather picking and evisceration were performed and different body parts, organs and abdominal fat were dissected and weighed. Relative weights of carcass traits were expressed as a percentage of live body weight. Breast and thigh parts were cut from the carcass and weighed, then expressed as a percentage of eviscerated carcass weight. Muscles and skin with subcutaneous fat for both breast and thigh were dissected, weighed and expressed to eviscerated carcass weight. Samples of breast and thigh muscles were taken , chopped and dried, then chemically analyzed for crude protein (CP), ether extract (EE), and ash

according to **AOAC (1995)** and the values were expressed on DM basis.

5. **Muscles drip loss:** In order to determine drip loss for carcass muscles, both breast and thigh were placed in duly identified polyethylene bags, sealed at atmospheric pressure, and frozen for 48 hours at -4°C. After this time, parts were again weighed (**Bridi et al., 2003**). Drip loss for breast and thigh muscles was calculated as the difference between initial weight and final weight, and expressed as a percentage.
6. **Economical efficiency and net return** were calculated based on the prices of L-carnitine (68.7%) tartrate (150 LE/ one kg), one kg of live body weight (21.0 LE) and the price of one duckling at 21 day of age (5.50 LE) prevailing during year 2015.
7. **Statistical analysis:** Data was statistically analyzed according to SAS program (**SAS, 2004)** using general linear model (GLM) based on the following model ;

   $Yij = \mu + Ti + eiJ$ where, Yij = an observation, μ = Overall mean , Ti = Effect of treatment (1, 2, … , 5) , and eiJ = Random error .

   The significant differences among treatments were determined by Duncan's multiple range test (**Duncan, 1955**).

RESULTS AND DISCUSION

Growth performance:-

Dietary L-carnitine supplementation (LC) resulted in a significant improvement in live body weight (LBW) for Domyati ducklings at 63 and 84 day of age (Table 2). Ducklings LBW were significantly improved by 7.14, 11.20, 12.74 and 9.74% for ducklings fed diet supplemented with 150, 300, 450 and 600 mg LC/kg, respectively as compared with those fed the control diet at 84 day of age. Also, dietary LC supplementation caused a significant improvement in body weight gain (BWG) at all experimental periods except of 21-42 day of age than the control group (Table 2). Ducklings BWG was significantly improved by feeding diets supplemented with 300 up to 600 mg LC/kg than the control group during the periods of 42-63 and 63-84 day of age. Generally, BWG was significantly improved by 8.95, 15.11, 16.50 and 12.92% for ducklings fed diet supplemented with 150, 300, 450 and 600 mg LC/kg, respectively as compared with those fed the control diet during the overall experimental period (21-84 day of age). Generally, ducklings fed diet supplemented with 300 or 450 mg LC/kg diet recorded the higher LBW and BWG value than the control. These improvements may be due to L-carnitine play a major role by increasing plasma insulin-like growth factor-I concentration, which serves as stimulating substances for chick's growth (**Xu et al., 2003**). Also, it may be due to improve the utilization of dietary ingredients as a result of L-carnitine transfer the long-chain fatty acids across the inner mitochondrial membrane and controls the rates of β-oxidation of long-chain fatty acids as well as it plays a pivotal role in energy metabolism **(Arslan, 2003).** These results are in agreement with those of **Abdel-Fattah et al. (2014)** who showed that dietary supplementation of L-carnitine (200-400 mg/kg) significantly increased live body weights and cumulative body weight gains for Japanese quail. **Parsaeimehr et al. (2014)** reported that dietary L-carnitine supplementation (300 mg/kg) had significantly improved body weight and body weight gain for broiler chickens. Also, **Taklimi et al. (2015)** found that bird's BWG had significant increase by supplementing 600 up to 800 mg LC/kg diet for broiler chickens. However, **Sarica et al. (2005)** revealed that supplementation of L-carnitine (25-100 mg/kg) to commercial male broilers diet had no significant effect on daily body gain. Also, **Deng et al. (2006)** found that feeding diets supplemented with 100 or 1000 mg LC/kg to egg Leghorn type chickens for short-term period (4 wks) after

hatching induced no difference in growth performance.

Feed consumption:-

Significant effects were observed in feed consumption (FC) for Domyati ducklings fed diet supplemented with different L-carnitine (LC) levels during some experimental periods (Table 2). Feed consumption was significantly decreased by 6.21 % for ducklings fed diet supplemented with 150 LC/kg at the period of 21-42 day of age, while it was significantly decreased by 4.42% as a result of supplementing 450 mg LC/kg diet during the period of 63-84 day of age than those fed the control diet. However, FC was numerically similar for ducklings fed different LC diets as compared to those fed the control diet during the overall experimental period (21-84 day of age). This may be due to ducklings are able to compensate their feed intake according to their energy requirements as well as the experimental diet had similar metabolizable energy. This result is similar with **Xu et al. (2003)** who reported that the supplementation of dietary L-carnitine did not affect feed intake of broiler chickens and young turkeys. **Murali et al. (2015)** reported that dietary L-carnitine (900 mg/kg diet) supplementation did not affect feed consumption in broilers during growing period (0-6 wks). However, **Bayram et al. (1999)** detected significant decreases in feed intake in quails fed diet supplemented with 500 mg LC/kg.

Feed conversion ratio:-

Significant differences were observed in feed conversion ratio (FCR) among experimental treatments due to supplementing different LC levels to the diet (Table 2). Feed conversion ratio was improved for ducklings fed diets supplemented with different LC levels during different experimental periods with or without significant than those fed the control diet. Generally, FCR was significantly improved by 9.67, 14.96, 14.05 and 10.77 % for ducklings fed diet supplemented with 150, 300, 450 and 600 mg LC/kg, respectively than those fed the control diet during the overall experimental period . Generally, the improvement in FCR is associated with decrease or similar FC and increase BWG of ducklings. So that, ducklings fed diet supplemented with 300 or 450 mg LC/kg diet recorded the best FCR value than the control. The improvement in FCR in this study may be due to L-carnitine enhances fatty acid burning, thus decreasing calorie requirements**,** as well as, it improves intestinal mucous membrane by active and passive mechanisms (**Fathi and Farahzadi, 2014).**These results are similar with those obtained by **Parsaeimehr et al. (2014)** who reported that dietary LC supplementation (200-300 mg/kg) resulted in improving feed conversion ratio of broiler chickens during growing period (45 day). Also, **Abdel-Fattah et al. (2014**) reported that a significant improvement in FCR of quails was occurred as a result of dietary supplementation with 200 - 400 mg LC/kg than the control. However, **Xu et al. (2003)** revealed that FCR had not significantly affected due to LC supplementation (25-100 mg/kg) to commercial male broilers diet. Also, **Deng et al. (2006)** found that L-carnitine (100 or 1000 mg/kg) supplementation had no significant effect on feed utilization efficiency for egg Leghorn type chickens during four weeks after hatching.

Production Index (PI):-

Significant differences were observed in production index (PI) among the experimental treatments due to L-carnitine (LC) supplementation during all the experimental periods (Table 2). Ducklings PI value was significantly higher by 18.57, 30.58, 31.06 and 22.93% for ducklings fed diet supplemented with 150, 300, 450 and 600 mg LC/kg, respectively as compared with those fed the control during the overall experimental period (21-84 day of age). Generally, ducklings fed diet supplemented with 300 or 450 mg LC/kg recorded the best

PI value than the control. These results may be due to L-carnitine improves body weight gain and feed conversion ratio as well as not increases feed consumption during the overall experimental period. Also, it may be due to L-carnitine has the ability to improve the use of dietary nitrogen, whether directly through sparing its precursors (methionine and lysine) for protein biosynthesis and other cellular functions or indirectly by optimizing the balance between essential and nonessential amino acids within the cell (**Sarica et al. , 2005*)***, which subsequently improved growth performance.

Duckling's viability (%):-

No Significant differences were observed in duckling's viability (%) among the experimental treatments due to L-carnitine (LC) supplementation during the overall experimental period (Table 2). Ducklings fed diets supplemented with different LC levels had higher viability (%) comparing to the control group**.** These results may be due to L-carnitine had strengthened immune function by enhancing antibody responses (**Deng et al., 2006**). Also, it may plays a major role in stabilizing cell membranes and in regulating the function of ion channels (role in calcium transport) by reducing the amount of oxidative damage that occurs as a result of peroxidation of polyunsaturated fatty acids found in membrane phospholipids (**Kalaiselvi and Panneerselvam, 1998*).***

Carcass traits:-

Results of Table 3 show the effects of dietary L-carnitine (LC) supplementation on carcass traits (expressed as percentages of LBW). Eviscerated carcass and total edible (%) were significantly improved, while abdominal fat (%) was significantly decreased by supplementing different LC levels to the diets as compared to the control. The improvement of eviscerated carcass and total edible parts (%) were reached from 3.54 to 4.57 and 3.94 to 4.47 %, respectively for ducklings fed diets supplemented with different LC levels as compared to the control, while, abdominal fat (%) was decreased by 36.14 to 45.18%. Generally, the improvement of eviscerated carcass and total edible parts percentage may be due to improving the final live weight and decreasing un-edible parts as a result of supplementing LC to the diet. The current findings are in agreement with those obtained by **Ibrahiem et al. (2011)** who reported that carcass percentage of geese was significantly ($P \leq 0.05$) improved by supplementing 150 mg L-carnitine /kg diet as compared to the control group. **Oladele et al. (2011)** found that dressing carcass percentage significantly ($P \leq 0.05$) increased with increasing inclusion levels of L-carnitine in broiler diets. Also, **Abdel-Fattah et al. (2014)** showed that supplemental L-carnitine (400 mg/kg diet) significantly increased the dressing percent of quails. However, **Daskiran and Teeter (2001)** observed no significant effect in dressing percentage of broilers in response to dietary L-carnitine. Also**, Sarica et al. (2005)** found that weights and yields of carcasses tended to be insignificantly improved in Japanese quail fed diet contained 200 mg LC/kg. The decrease of abdominal fat may be due to L-carnitine prevents fatty tissue buildup, decreases the calorie requirement and increases the tolerance to effort because it may plays a major role to facilitate the removal of short and medium-chain fatty acids from the mitochondria that accumulate as a result of normal and abnormal metabolism and promotes the β-oxidation of these fatty acids in order to generate adenosine triphosphate (ATP) energy and improve energy utilization by reduce the amount of long-chain fatty acids availability for esterification to triacylglycerols and storage in the adipose tissue (**Xu et al. 2003**).These result are similar **Parsaeimehr et al. (2014)** who found that supplementing L-carnitine (300 mg/kg) significantly reduced abdominal fat percentage of broiler chickens.

Breast and thigh yield and their contents:-

Breast or thigh yield (expressed as percentages of eviscerated carcass weight) was significantly improved due to dietary supplementation of L-carnitine with 450 and 600 mg/kg (Table 3). Breast yield (%) was significantly improved by 4.41 and 5.54% while thigh yield (%) was significantly higher by 5.94 and 9.77% for ducklings fed diet supplemented with 450 and 600 mg LC/kg than those fed the control diet, respectively. Moreover, breast and thigh muscles (%) were significantly higher for ducklings fed diets supplemented with different LC levels than those fed the control diet, while, skin with subcutaneous fat (%) was significantly decreased. Breast muscles (%) was significantly higher by 8.18- 11.20 %, while breast skin with subcutaneous fat (%) was significantly lower by 10.02 - 15.47 % for ducklings fed diet supplemented with different LC levels than those fed the control diet, respectively. Also, thigh muscles (%) was significantly increased by 12.21- 15.62 %, while thigh skin with subcutaneous fat (%) was significantly lower by 7.55 - 12.55% % for ducklings fed diet supplemented with different LC levels than those fed the control diet, respectively. Muscles drip loss (%) for both breast and thigh was insignificantly lower as a result of supplementing LC to the diet than the control. These results are in the same line with those obtained by **Xu et al. (2003)** who reported that the addition of L-carnitine significantly increase the proportion of breast muscle in the carcass for broiler**. Parsaeimehr et al. (2014)** and **Cyril et al. (2015)** reported that leg and breast muscles were significantly ($P \leq 0.05$) improved by supplementing L-carnitine to broiler diets. However, **Zhang et al. (2010)** and **Michalczuk et al. (2012)** found that non-significant increase in carcass yield and the proportion of breast muscle in the carcass by dietary supplementing LC.

Chemical analysis of breast and thigh muscles:-

Dietary LC supplementation had significant effects on both crude protein and ether extract content (%) for breast and thigh muscles, while dry matter (%) for breast muscles and ash (%) for thigh muscles were not significantly affected (Table 3). Crude protein content (%) was significantly increased by increasing LC supplementation for breast and thigh muscles than the control, while ether extract (%) was significantly decreased. Crude protein (%) was significantly higher by 8.13 – 22.62 and 6.04 – 18.11%, respectively in breast and thigh muscles for ducklings fed different LC diets than the control. Whereas, ether extract (%) was significantly decreased by 16.73, 21.10, 52.77 and 50.72% in breast muscles, and 10.50, 18.85, 45.59 and 50.27% in thigh muscles for ducklings fed diet supplemented with 150, 300, 450 and 600 mg LC/kg, respectively than those fed the control diet. These results may be due to L-carnitine may acts to decrease the total activities of glucose-6 phosphate dehydrogenize, malic dehydrogenize, iso-citrate dehydrogenize and lipoprotein lipase and total activities of carnitine palmitoyltransferase-I in breast muscles (**Xu et al., 2003**). Or, it accelerate lipid flux into oxidative metabolism, and consequently reduce the body lipid accumulation ***(*Shuenn et al., 2012).**These results are contrary with those obtained by **Celik and Ozturkcan (2003)** reported that the supplementation of L-carnitine to the broiler diet did not significantly affect the dry matter, CP, and ether extract components of breast or thigh meat. **Sarica, et al., (2005)** recorded that dietary L-carnitine supplementation did not significantly affect the dry matter or moisture, CP, and ether extract contents of the total edible meat (breast plus high meat) of 35-dold Japanese quail. Also, **Younis (2015)** reported that chemical composition of breast muscle didn't influence by addition of L-carnitine supplementation (500 mg/kg).

Hematological parameters:-

Results of Table 4 show the effect of dietary LC supplementation on some hematological parameters of Domyati ducklings at the 77th day of age. Blood hemoglobin (HB) content was significantly higher by 5.28, 7.56 and 16.10%, respectively for ducklings fed diet supplemented with 300, 450 and 600 mg LC/kg than those fed the control diet. Red blood cells (RBC) count was significantly increased by feeding diet supplemented with 450 and 600 mg LC/kg than the control, while white blood cells (WBC) count was insignificantly increased by supplementing 150, 450 and 600 mg LC/kg diet. Moreover, lymphocytes (L) cells (%) was significantly increased, while, heterophils (H) cells (%) and H/L ratio were significantly decreased by supplementing different LC levels to the diet as compared to the control. Generally, H/L ratio was significantly decreased by 29.41, 35.29, 37.25 and 45.10% for the groups fed diet supplemented with 150, 300, 450 and 600 mg LC/kg than the control, respectively. These results may be due to L-carnitine had strengthened immune function by enhancing antibody responses (**Deng et al., 2006**). Also, it may plays a major role in stabilizing cell membranes and in regulating the function of ion channels (role in calcium transport) by reducing the amount of oxidative damage that occurs as a result of peroxidation of polyunsaturated fatty acids found in membrane phospholipids (**Kalaiselvi and Panneerselvam, 1998*).***These results are in agreement with those obtained by **Jameel (2014)** who reported that RBCs count and hemoglobin content were increased, while H/L ratio was significantly ($P \leq 0.05$) decreased for chicks fed diet supplemented 50 mg LC/ Kg as compared with those fed the control diet.

Blood serum constituents:-

Dietary LC supplementation had no significant effects on all studied serum constituents except of triglycerides and total cholesterol (Table 4). Serum triglycerides level was significantly decreased by 26.58, 28.85, 22.58 and 17.86% for ducklings fed diet supplemented with 150, 300, 450 and 600 mg LC/kg, respectively than those fed the control diet. However, serum total cholesterol level was significantly lowered by 10.86, 9.12 and 13.89% for ducklings fed diet supplemented with 300, 450 and 600 mg LC/kg than those fed the control diet, respectively. The decrease of serum triglycerides level for ducklings fed diets supplemented with L-carnitine probably related to increasing oxidation of fatty acids by increasing the transportation capacity of fatty acids to inner mitochondrial membrane (**Shuenn et al., 2012*)***. Also, it may be due to L-carnitine increased the activity of lipase and decrease activity of lipoprotein lipase, thereby leading to a higher concentration of fatty acid in serum by accelerating hydrolysis of triglycerides to glycerol and fatty acid (**Zhang et al., 2010**). The reduction of serum total cholesterol by L-carnitine supplementation was attained mostly via a decrease of cholesteryl esters rather than by a decrease in free cholesterol. Moreover, it may be due to an increase in biliary sterol excretion or an increase in the conversion of cholesterol to bile acids (**Maritza et al., 2006*).***These results are in agreement with those obtained by **Xu et al. (2003)** who reported that adding L-carnitine to diet significantly decreased the level of serum triglyceride in broilers**.** However, **Tufan et al. (2015)** found that supplementing L-carnitine (150 mg/kg diet) to Japanese quails had no significant effect on serum total cholesterol.

Economical efficiency:-

Calculations of economic efficiency (EE) were listed in Table 5. Different levels of L-carnitine (LC) supplementation had significant effects on both total cost and return as well as economic efficiency values. Total cost was significantly higher by 4.59% for ducklings fed 600 mg LC/kg diet, while it was insignificantly higher by 3.18% for

ducklings fed 450 mg LC/kg diet comparing to those fed the control diet. However, total return was significantly increased by 7.15, 11.18, 12.74 and 9.73% for ducklings fed diet supplemented with 150, 300, 450 and 600 mg LC/kg, respectively than those fed the control diet. Generally, net return and EE values were significantly higher by feeding diet supplemented with different LC levels than the control. Economical efficiency value was significantly improved by 27.16, 38.83, 32.99 and 17.51% for ducklings fed diet supplemented with 150, 300, 450 and 600 mg LC/kg, respectively than those fed the control diet. It's clearly that supplementing 300 or 450 mg LC/kg diet resulted in the best EE during the experimental period (21-84 day of age) for Domyati ducklings.

CONCLUSION

Based on the present data, it is concluded that dietary L-carnitine supplementation with 300 or 450 mg/kg had positive effects on growth performance, duckling's viability and carcass traits and quality as well as economic efficiency for Domyati ducklings during summer season.

Table (1): Composition and calculated analysis of the basal diets.

Ingredients %	Grower (22-42 day)	Finisher (43-84 day)
Yellow Corn	67.80	71.00
Soybean meal (44 %)	23.78	17.60
Wheat bran	4.62	7.60
Di-calcium phosphate	1.62	1.60
Limestone	1.48	1.50
Vit. & Min. premix[1]	0.30	0.30
NaCl	0.35	0.35
DL. Methionine	0.05	0.05
Total	100.0	100
Calculated Analysis [2]		
Crude protein %	17.00	15.02
ME (Kcal / kg)	2861	2870
Ether extract . %	2.91	3.07
Crude fiber %	3.66	3.63
Calcium (%)	1.01	1.00
Av. phosphorus (%)	0.43	0.42
Lysine %	0.84	0.70
Methionine %	0.33	0.30
Methio + Cyst %	0.63	0.58
Sodium	0.16	0.16
Price (LE/kg) [3]	3.165	2.879

1- Each 3 kg of the Vit and Min. premix manufactured by Agri-Vit Company, Egypt contains: Vitamin A 10 MIU, Vit. D 2 MIU, Vit E 10 g, Vit. K 2 g, Thiamin 1 g, Riboflavin 5 g, Pyridoxine 1.5 g, Niacin 30 g, Vit. B12 10 mg, Pantothenic acid 10 g, Folic acid 1.5 g, Biotin 50 mg, Choline chloride 250 g, Manganese 60 g, Zinc 50 g, Iron 30 g, Copper 10 g, Iodine 1g, Selenium 0. 10 g, Cobalt 0.10 g. and carrier CaCO3 to 3000 g..

2- According to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (2001).

3- Price of one kg (LE) at time of experiment for different ingredients : yellow corn , 2.60 ; Soy bean meal, 4.50; wheat bran, 1.95; Di-calcium Phosphate,8.0 ; limestone, 0.25 ; Vit&Min.,25.0 ; Nacl,1.0 and Meth.,60.0 .

Table 2: Effect of dietary L-carnitine supplementation on growth performance traits for Domyati ducklings at different ages during growth period.

Age (day)	L-Carnitine (mg/kg diet)					SEM	Sig.
	0.0	150	300	450	600		
Live body weight (g/ duckling)							
21	495.0	500.0	485.0	495.0	490.0	3.0	**NS**
42	1317.4	1355.3	1323.0	1350.4	1361.7	9.1	**NS**
62	1806.4^{b}	1908.9^{a}	1931.6^{a}	1955.6^{a}	1951.7^{a}	16.9	**
84	2171.7 ^{c}	2326.7^{b}	2415.0 ^{a}	2448.3 ^{a}	2383.3^{ab}	27.3	**
Body weight gain (g/duckling/ 21 day)							
21-42	822.4	855.3	838.0	855.4	871.7	7.3	**NS**
42-63	489.0 ^{b}	553.6^{ab}	608.6 ^{a}	605.2 ^{a}	590.0 ^{a}	16.0	*
63-84	365.3 ^{b}	417.8 ^{ab}	483.4 ^{a}	492.7 ^{a}	431.6^{a}	15.5	**
21-84	1676.7^{c}	1826.7^{b}	1930.0^{a}	1953.3^{a}	1893.3^{a}	27.7	**
Feed consumption (g/duckling/21 day)							
21-42	2.639 ^{a}	2.475^{b}	2.531^{ab}	2.629^{a}	2.611^{a}	0.022	**
42-63	3.381	3.482	3.412	3.552	3.500	0.025	**NS**
63-84	3.168 ^{a}	3.087^{ab}	3.063^{ab}	3.028 ^{b}	3.150 ^{a}	0.019	*
21-84	9.188	9.044	9.006	9.209	9.261	0.040	**NS**
Feed conversion ratio (g. feed/ g. BWG)							
21-42	3.21 ^{a}	2.89 ^{b}	3.02 ^{ab}	3.07 ^{ab}	3.00 ^{ab}	0.04	*
42-63	6.91 ^{a}	6.28 ^{ab}	5.61 ^{b}	5.86^{b}	5.93 ^{b}	0.17	*
63-84	8.67 ^{a}	7.39 ^{ab}	6.34 ^{b}	6.14 ^{b}	7.30 ^{b}	0.29	**
21-84	5.48 ^{a}	4.95 ^{b}	4.66 ^{c}	4.71^{bc}	4.89^{bc}	0.08	**
Production index (LBW, kg/ FCR x 100)							
21-42	41.05 ^{b}	46.84 ^{a}	43.80 ^{ab}	43.94 ^{ab}	45.46^{ab}	0.76	*
42-63	26.13 ^{b}	30.35^{ab}	34.45 ^{a}	33.32 ^{a}	32.90 ^{a}	1.10	*
63-84	25.05 ^{c}	31.50 ^{b}	38.11 ^{a}	39.84 ^{a}	32.65 ^{b}	1.62	**
21-84	39.63 ^{c}	46.99 ^{b}	51.75 ^{a}	51.94 ^{a}	48.72 ^{b}	1.25	**
Viability, %							
21-84	97.22	98.61	100.0	98.15	100.0	0.56	**NS**

SEM = standard error mean; LBW : live body weight; BWG: body weight gain
NS : non-significant; * = P≤0.05;** = P≤0.01
a,b,c: means in the same row within each item bearing different superscripts are significantly different (P ≤ 0.05),

Table 3: Effect of dietary L-carnitine supplementation on carcass traits and parts and chemical analysis of breast and thigh muscles for Domyati ducklings at 84 day of age.

Traits	L-Carnitine (mg/kg diet)					SEM	Sig.
	0.0	150	300	450	600		
SLBW, (kg)	2.325	2.316	2.393	2.383	2.358	0.075	**NS**
Carcass traits (% of SLBW)							
Evs. carcass	69.84 ^{b}	73.04 ^{a}	72.88 ^{a}	72.32 ^{a}	72.72 ^{a}	0.42	*
Liver	1.79	1.80	1.86	1.90	1.74	0.03	**NS**
Gizzard	3.08	3.23	3.13	3.33	3.16	0.05	**NS**
Heart	0.73	0.74	0.78	0.79	0.79	0.01	**NS**
Total giblets	5.60	5.77	5.77	6.02	5.69	0.07	**NS**
Total ed. parts	75.44 ^{b}	78.81 ^{a}	78.65 ^{a}	78.34 ^{a}	78.41 ^{a}	0.43	*
Abdominal fat	1.66 ^{a}	1.06 ^{b}	0.94 ^{b}	0.98 ^{b}	0.91 ^{b}	0.09	**
breast yield and their contents (% of eviscerated carcass)							
yield	40.59 ^{b}	40.94^{b}	41.86^{ab}	42.38 ^{a}	42.83 ^{a}	0.36	*
Muscle	20.53 ^{b}	22.21 ^{a}	22.69 ^{a}	22.75 ^{a}	22.83 ^{a}	0.28	**
Skin with subc. fat	10.99^{a}	9.51 ^{b}	9.29 ^{b}	9.32 ^{b}	9.01 ^{b}	0.25	**
Thigh yield and their contents (% of eviscerated carcass)							
yield	31.32 ^{c}	31.83 ^{bc}	32.11 ^{bc}	33.18 ^{ab}	34.38 ^{a}	0.35	**
Muscle	15.81 ^{b}	17.96 ^{a}	17.74 ^{a}	18.20 ^{a}	18.28 ^{a}	0.30	**
Skin with subc. fat	10.20^{a}	9.24 ^{b}	9.42 ^{b}	9.37 ^{b}	8.92 ^{b}	0.15	*
Drip loss, %							
Breast muscles	3.53	2.17	2.53	2.06	2.80	0.36	**NS**
Thigh muscles	3.91	2.78	2.83	2.54	2.73	0.39	**NS**
Chemical analysis of breast muscles, %							
Dry matter	30.50	30.23	29.57	30.48	30.01	0.28	**NS**
Crude protein	65.17 ^{c}	70.47 ^{b}	72.93 ^{b}	79.86 ^{a}	79.91 ^{a}	1.54	**
Ether extract	22.89 ^{a}	19.06 ^{b}	18.06 ^{c}	10.81 ^{d}	11.28 ^{d}	1.25	**
Ash	6.65^{b}	7.15^{ab}	7.45^{ab}	7.64^{a}	7.54^{ab}	0.14	*
Chemical analysis of thigh muscles, %							
Dry matter	29.79^{b}	30.82^{ab}	30.49^{ab}	29.91^{b}	31.13^{a}	0.18	*
Crude protein	67.93 ^{d}	72.03 ^{c}	74.08 ^{b}	79.83 ^{a}	80.23 ^{a}	1.30	**
Ether extract	23.71 ^{a}	21.22 ^{b}	19.24 ^{c}	12.90 ^{d}	11.79 ^{d}	1.26	**
Ash	5.05	5.74	5.71	5.67	6.05	0.14	**NS**

SEM = standard error mean; SLBW : slaughter live body weight, Evs. : eviscerated
NS : non-significant; * = P≤0.05;** = P≤0.01
a,b,c, d : means in the same row within each item bearing different superscripts are significantly different (P ≤ 0.05),

Table 4: Effect of dietary L-carnitine supplementation on hematological and serum constituents for Domyati ducklings.

Parameters	L-Carnitine (mg/kg diet)					SEM	Sig.
	0.0	150	300	450	600		
Hematological parameters							
Hemoglobin (g/dl)	12.30^{c}	12.22^{c}	12.95^{b}	13.23^{b}	14.28^{a}	0.21	**
RBC (x10^{6}/mm3)	2.07^{b}	2.20^{b}	2.21^{b}	2.95^{a}	2.57^{ab}	0.12	*
WBC(x10^{3}/mm^{3})	17.00	18.17	17.00	19.00	18.50	0.41	NS
Heterophils, %	33.75^{a}	29.04^{b}	25.00^{c}	24.42^{c}	21.83^{c}	1.19	**
Lymphcytes, %	66.25^{c}	70.96^{b}	75.00^{a}	75.58^{a}	78.17^{a}	1.19	**
H/L	0.51^{a}	0.41^{b}	0.33^{c}	0.32^{c}	0.28^{c}	0.02	**
Serum constituents							
T. protein (g/dl)	4.30	4.71	4.48	4.51	4.43	0.06	NS
Triglycer. (mg/dl)	124.65^{a}	91.52^{cd}	88.69^{d}	96.51^{bc}	102.39^{b}	3.51	**
T. cholest.(mg/dl)	154.10^{a}	145.55^{ab}	137.36^{bc}	140.04^{bc}	132.69^{c}	2.34	**
AST (U/ dl)	70.85	70.89	70.77	70.69	68.60	0.51	NS
ALT (U/ dl)	17.80	16.60	17.67	17.23	16.70	0.19	NS

SEM = standard error mean ; NS : non-significant; * = P≤0.05;** = P≤0.01
a,b,c: means in the same row within each item bearing different superscripts are significantly different (P ≤ 0.05),

Table 5: Effect of dietary L-carnitine supplementation on economical efficiency (EE) for Domyati ducklings during the whole experimental period.

Parameters	L-Carnitine (mg/kg diet)					SEM	Sig.
	0.0	150	300	450	600		
Feed cost (LE)	27.21	26.75	26.65	27.27	27.41	0.14	NS
LC cost (LE)	0.00^{e}	0.31^{d}	0.63^{c}	0.98^{b}	1.30^{a}	0.12	**
Duckling price(LE)	5.50	5.50	5.50	5.50	5.50	0.00	NS
Total cost (LE)	32.71^{bc}	32.56^{c}	32.78^{bc}	33.75^{ab}	34.21^{a}	0.21	**
Total return (LE)	45.61^{d}	48.87^{c}	50.71^{ab}	51.42^{a}	50.05^{b}	0.56	**
Net return (LE)	12.90^{d}	16.31^{bc}	17.93^{a}	17.67^{ab}	15.84^{c}	0.51	**
Economic efficiency	0.394^{c}	0.501^{ab}	0.547^{a}	0.524^{ab}	0.463^{b}	0.016	**

Total cost = feed cost+ LC cost+ duckling price; LE= Egyptian pound.
SEM = standard error mean; NS: non-significant; * = P≤0.05; ** = P≤0.01
a,b,c…e : means in the same row within each item bearing different superscripts are significantly different (P ≤ 0.05),

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الملخص العربي

تأثير إضافة إل-كارنيتين للعليقة على الأداء الانتاجى وجودة الذبيحة لسلالات البط المحلية فى فصل الصيف

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إستخدم فى هذه الدراسة عدد ٢٧٠ كتكوت بط دمياطى عمر ٢١ يوم وذلك لدراسة تأثير إضافة مستويات متدرجة من إل-كارنيتين للعليقة (صـــفر ، ١٥٠ ، ٣٠٠ ، ٤٥٠ ،٦٠٠ ملجم / كجم) على أداء النمو وصـــفات وجودة الذبيحة وبعض مقاييس الدم ومحتويات السـيرم فضـلا عن الكفاءة الاقتصـادية خلال فترة النمو (٢١-٨٤ يوم من العمر) . تم وزن وتقسـيم الكتاكيت الى خمسـة مجموعات تجريبية (٥٤ كتكوت لكل مجموعة) وكذلك قسـمت العليقة المسـتخدمة إلى خمسـة أجزاء ليضـاف إلي كل منها أحد المسـتويات المسـتخدمة من إل-كارنيتين وتم تقديمها للمجموعات التجريبية خلال فترة التجربة .تم تسـجيل وزن الكتاكيت و كمية العليقة المأكولة وعدد النافق ، كما تم أخذ عينات دم وسـيرم لتقدير بعض محتوياتهم ، كما تم إجراء تجربة ذبح لعدد ٣ ذكور و٣ اناث من كل مجموعة لتقدير فياســات الذبيحة ومكوناتها وأخذت عينات من لحم الصدر والفخذ لاجراء التحليل الكيماوى لها ، كما تم حساب الكفاءة الاقتصادية خلال الفترة الكلية للتجربة (٢١-٨٤ يوم) .

وتوضح النتائج ما يلي :-

لوحظ أن إضافة المسنويات المختلفة من إل-كارنيتين للعليقة أدت الى زيادة معنوية فى وزن الجسم عند ٦٣ ، ٨٤ يوم من العمر ، بينما سجل معدل الزيادة الوزنية للجسم ومعدل التحويل الغذائى والدليل الانتاجى تحسنا معنويا مقارنة بالكنترول خلال الفترة الكلية للتجربة (٢١-٨٤ يوم من العمر). لوحظ تحسنا معنوبا لنسبتى الذبيحة المفرغة والأجزاء المأكولة الكلية بينما إنخفضت نسبة دهن البطن معنويا بإضافة المستويات المختلفة من إل-كارنيتين للعليقة بالمقارنة بمجموعة الكنترول. كما تحسنت معنويا نسبتى محصول الصدر والفخذ بإضافة ٤٥٠ و ٦٠٠ ملجم إل-كارنيتين/كجم عليقة مقارنة بالكنترول ، بينما تحسنت معنويا نسبة عضلات الصدر والفخذ وإنخفضت نسبة الجلد والدهن تحت الجلد لهما معنويا بإضافة المستويات المختلفة من إل-كارنيتين للعليقة مقارنة بالكنترول. لوحظ إرتفاع معنوي فى محتوى عضلات الصدر والفخذ من البروتين بإضافة المستويات المختلفة من إل-كارنيتين للعليقة بينما إنخفض محتواها من المستخلص الاثيرى مقارنة بالكنترول. لوحظ إرتفاع محتوى هيموجلوبين الدم معنويا بإضافة ٣٠٠- ٦٠٠ ملجم إل-كارنيتين لكل كجم عليقة بينما إرتفع عدد الخلايا الليمفاوية معنويا وإنخفض عدد الخلايا المتعادلة والنسبة بين الخلايا المتعادلة الى الليمفاوية بإضافة المستويات المختلفة من إل-كارنيتين للعليقة مقارنة بالكنترول. كما لوحظ إنخفاض مستوى الجليسريدات الثلاثية بسيرم الدم معنويا بإضافة المستويات المختلفة من إل-كارنيتين بينما إنخفض مستوى الكوليسترول الكلى به معنويا بإضافة ٣٠٠-٦٠٠ ملجم إل-كارنيتين لكل كجم عليقة ، تحسنت الكفاءة الاقتصادية معنويا بإضافة المستويات المختلفة من إل-كارنيتين ولوحظ أن إضافة ٣٠٠ أو ٤٥٠ ملجم /كجم للعليقة أدت الى أفضل القيم لها مقارنة بالكنترول.

وقد خلصت الدراسة إلى أن إضافة إل-كارنيتين لعلائق كتاكيت البط الدمياطى خلال فترة النمو بمستوى ٣٠٠ أو ٤٥٠ ملجم / كجم يمكن أن يؤدى الى تحسين الأداء الانتاجى والفسيولوجى لها و صفات وجودة الذبيحة فضلا عن الكفاءة الاقتصادية أثناء فصل الصيف.