NUTRITIONAL AND MANAGEMENT STUDIES ON THE PIGEON:

EFFECT OF DIETARY L- CARNITINE SUPPLEMENTATION WITH DIFFERENT ENERGY LEVELS ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF PIGEON

By

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Abstract: *This study investigated the effects of L-carnitine administration with different dietary energy levels on the productive and reproductive performances of pigeons. A total of 54 pair of parent Baladi pigeons (24 months old) was distributed equally according to their consistent mating systems (sex ratio of pigeons 1:1) to 9 treatments, each containing 6 pairs (3 replicates of 2 pairs each). The birds were housed under similar environmental conditions. The experimental design was a factorial 3 energy levels × 3 L-carnitine levels in which three levels of metabolizable energy (2600, 2800 and 3000 Kcal / kg diet) were tested with various levels of L-carnitine (0, 75 and 150 mg / kg diet). Feed and water were given ad libitum along the experimental period.*

Results obtained could be summarized as follows

1- Increasing energy levels (ME) had significant (P≥0.05) effect on body weight gain, feed intake for pigeons without or with squabs, egg cycle, egg number, egg weight, fertility and hatchability. Squabs fed diets containing the higher level of ME had significantly the highest number of weaned squabs, body weight, weight gain and economical efficiency during 28 days of age compared with those fed the lowest ME level. .

2- Body weight gain, feed intake for pigeons with squabs, egg cycle, and egg weight, were higher with diets containing the higher level of L- carnitine. Body weight, weight gain during 28 days of age and economical efficiency were significantly (P≥0.05) increased as dietary L- carnitine levels increased in the diet.

3- Dietary energy and L-carnitine levels interacted positively to affect body weight gain, decreased feed intake for pigeons without or with squabs, egg cycle, egg number, egg weight and hatchability. Squabs fed diets containing

3- Dietary energy and L-carnitine levels interacted positively to affect body weight gain, decreased feed intake for pigeons without or with squabs, egg cycle, egg number, egg weight and hatchability. Squabs fed diets containing the higher level of ME and L-carnitine had significantly the highest number of weaned squabs, body weight, weight gain during 28 days of age and economical efficiency.

It is concluded that additional L-carnitine to the pigeon diet high or low energy levels produce improvement in productive and reproductive performance. Diet containing either 3000 or 2800 kcal ME /kg diet with or without L-carnitine was suitable and satisfactory for production and reproduction of pigeons. While, the diet containing 2600 kcal/kg diet unsupplemented with L-carnitine had a negative effect on production and reproduction of pigeons under Egyptian conditions.

INTRODUCTION

Intensive research into carnitine was performed in the 1970s; only a very small amount of L-carnitine obtained from animal meat was available at that time. In the 1980s, the industrial production of L-carnitine was launched, which allowed significant expansion of research, making it possible to think about the use of L-carnitine in clinical practice. L-carnitine was shown to have beneficial effects on the heart and skeletal muscles and conditions such as disorders of the central nervous system, certain types of male sterility and some disorders in newborns **(Borum and Bennett, 1986)**. 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. 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. Interesting experiments with L-carnitine were reported in pigeons **(Borghijs and De Wilde, 1992 and Janssens *et al.*, 2000)**. 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)**.

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. **Neuman *et al.* (2002)** reported that L-

carnitine also reduces the availability of lipids for per oxidation by transporting fatty acids into the mitochondria for β- oxidation to generate adenosine triphoshate (ATP) energy. L-carnitine prevents obesity of abdominal fat of advanced age in the breeder chickens. Also, the effects of dietary carnitine on egg production and hatchability have been assessed in poultry by **(Leibetseder, 1995).** Supplementation of L– carnitine from 50 to 500 mg / kg diet did not influence daily feed intake, feed conversion, egg production rate, egg weight, egg mass and shell weight **(Rabie *et al.*, 1997).** Supplementation of the diet with 50 and 100 mg L-carnitine/ kg diet increased insignificantly egg production by 2.1 and 2.7 %, also no significant differences were found between the groups in feed intake and feed conversion **(Richter *et al.*, 1998). Arslan *et al.*, (2003)** observed that hatching rate was increased when ducks were supplemented with 50 to 100 mg L-carnitine/ kg diet **Baumgartner (2003)** showed that dietary supplementation of Lcarnitine at 20-30 ppm improved hatchability for breeding hens and layers of various species.

Sarica et al, (2007) cleared the role of dietary L-carnitine in the oxidation of long-chain fatty acids through its antioxidant properties and its importance in energy metabolism in Japanese quails. Feeding the diet containing 12.13 MJ ME/kg increased body weight and body weight gain significantly, and improved the feed conversion ratio above that of the lower energy diet. Feed intakes of the birds were unaffected by treatments.

Celik *et al.* (2003) reported that supplemental L-carnitine or L-carnitine + niacin could have positive effects on body weight gain and feed intake during the early stages of growing broiler. L-carnitine supplementation in pigeons have a lowering effect on several relevant blood parameters such as fatty acids, lactic acid, and creatinine phosphokinase **(Borghijs and De Wilde,1992).**

The objective of this study was to evaluate the effect of dietary metabolizable energy levels (2600, 2800 and 3000 Kcal ME /kg diet) and L-carnitine supplementation levels (0, 75 and 150 mg / kg diet) on the productive and reproductive performance of pigeons in the laying period under Egyptian conditions.

MATERIALS AND METHODS

The experimental work was carried out at El-Gimmizah Production Sector and El-Gimmizah Poultry Research Farm, Agricultural Research Center, Ministry of Agriculture, during the period from January 2009 up to June 2009. This experiment was designed in 3 x 3 factorial design to

determine the effect of feeding three levels of metabolizable energy with various levels of L-carnitine, incorporated at the expense of yellow corn, on the performance of pigeons. Diets were formulated in mash form to contain dietary protein level being 15.5% crude protein, while 3 energy levels (2600, 2800 and 3000 Kcal ME /kg of diet) were used with various levels of L-carnitine (0, 75 and 150 mg / kg diet). The composition of the experimental diets is shown in Table 1.

A total number of 54 pair of parent Baladi pigeons (24 months old) was distributed according to companion mating systems in pigeons (sex ratio of pigeons 1:1). At the beginning of experiment, pigeons were divided randomly into nine equal treatments containing 6 pairs (3 replicates of 2 pairs each) and housed under the same managerial and environmental conditions fitted in brooding battery cages. Feed and water were provided to birds *ad-libitum*. In each breeding cage, two male and two female pigeons were allowed to form couples on a random basis. In the breeding cages, the pigeons were able to feed their squabs up to weaning age (28 days). At this age, the squabs were directed for slaughter or transferred to separated battery cages for further rearing and maintained on a daily photoperiod of14 h.

During the experimental period, the following measurements were expressed as initial body weight, final body weight, change in body weight, daily feed intake per pair with or without squab and total feed intake per pair (during 6 months) as well as egg cycle (interval between to consecutive egg laying days), total egg production , egg weight, egg fertility, hatchability and squabs number per pair. Additionally live body weight and body weight gain (BWG) of squabs up to 28 days of age, mortality rate of squabs, livability, net return (NR) and economical efficiency (EE) of production in pigeons were also studied.

A completely randomized design, with a factorial arrangement of treatments (3x3) was used. Data were analyzed using General Linear Model (GLM) procedure of Statistical Analysis System **(SPSS 10, 1997).** Significant differences among means were separated by Dunces' multiple range test **(Duncan, 1955).**

RESULTS AND DISCUSSION

Live body weight and change in body weight:

Data of live body weight and change body weight pigeons as influenced by L-carnitine levels at different dietary energy levels are illustrated in Table (2). There were no significant differences in the means of the initial live body weight among treatments. Increasing dietary energy

level had no significant effect on live body weight at the end of the experiment. Birds fed on the high level of energy (3000 kcal/kg diet) recorded significantly the highest live body weight gain than those fed 2600 or 2800 kcal/kg diets.

The effect of L-carnitine supplementation was significant on live body weight gain. Data indicated that increasing L-carnitine levels from 0 up to 75 and 150 mg / kg diet increased body weight gain compared to the control group (0 mg L-carnitine/kg diet).

Live body weight was not influenced significantly by the interaction of L-carnitine and energy levels. Dietary energy levels and L-carnitine levels interacted significantly to influence body weight gain Table (2). The highest live body weight gain recorded by pigeon receiving 150 mg L-carnitine with 3000 kcal ME/ kg diet. While, the lowest observed with2600 kcal ME/ kg diet without L-carnitine supplementation with significant deferent between them.

These results are consistent with those reported by **Waldie *et al.* (1991)** who indicated that live body weight of pigeons was not significantly affected when they fed different energy levels (2650, 2900, and 3150 Kcal ME/kg of diet). Also, **Abd El-Azeem *et al.* (2007)** indicated that final live body weight and differences in live body weight of balady pigeons were not significantly affected when dietary ME levels increased from 2600 to 3200 ME Kcal /kg of diet. Also, **Abou Khashaba *et al.* (2009)** reported that increasing dietary energy level had no significant effect on live body weight of pigeon at the end of the experiment. They mentioned that growth performance improved significantly with supplemental L-carnitine to the diet. Also, 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 live body weight gain achieved by birds fed diets supplemented with L-carnitine compared to the control. Another innovation that may explain the striking effect of L-carnitine supplementation on body weight gain was suggested by **Rabie and Szilagyi (1998)** that, 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. 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 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 of broiler and young turkeys fed

low or high-fat diets. **Abou - Zeid *et al.* (2007)** showed that birds fed diets supplemented with 200 mg L-carnitine possessed the best live body weight and live body weight gain followed by those either 300 or 100 mg fed L-carnitine / kg diet compared to the control respectively.

The average body weight gain of pigeons fed the highest energy diet (3000 kcal/kg diet) with high level of L-carnitine (150 mg L-carnitine/ kg diet) was significantly ($P<0.05$) higher than that of the other groups. Simultaneously, decreasing dietary energy level (2600 kcal) without L-carnitine supplementation have a negative effect ($P<0.05$) on average body weight gain of pigeons.

Daily feed intake of the pigeons without or with squabs:

Results indicated that feed intake by pigeons without or with squabs were significantly ($P<0.05$) decreased as the ME levels increased from 2600 to 3000 ME Kcal/ kg (Table 3).

The feed intake by pigeons without or with squabs were significantly decreased at all periods when the L-carnitine level increases from 0 to 150 mg/ kg diet at 7 and 14 old days. While, feed intake was not significantly affected by L-carnitine supplementation at 21 and 28 old days.

The highest FI during the all experimental period was noticed in group fed 2600 kcal ME/kg diet plus 0 mg L-carnitine/ kg diet while the lowest FI was observed in group fed 3000 kcal plus 150 mg L-carnitine/ kg diet.

Feed intake linearly decreased linearly in all investigated intervals with increasing dietary energy levels. These results are consistent with those reported by **Nahashon *et al.* (2005)** who suggested that as dietary energy levels increased, birds satisfy their energy needs by decreasing feed intake. Furthermore, **Abd El-Azeem *et al.* (2007)** indicated that feed, protein and metabolizable energy intake were significantly ($P<0.05$) decreased as the ME levels increased from 2600 to 3200 ME Kcal /kg of diet. **Abou Khashaba *et al.* (2009)** reported that the feed intake by pigeons without or with squabs were decreased at all periods when the energy level increases from 2600 to 3200 Kcal ME / kg Supplementation of L– carnitine from 50 to 500 mg / kg diet did not influence daily feed intake and feed conversion **(Rabie *et al*, 1997)**. Supplementation of 50 and 100 mg L-carnitine/ kg diet resulted insignificant differences among groups in feed intake and feed conversion of laying hens **(Richter *et al*, 1998)** and **Janssens *et al.* (2000)** with pigeons.

It is worthy noted that pigeons fed the highest dietary energy level (3000 kcal ME/kg), followed by those fed 2800 kcal with all L-carnitine supplementation levels (0, 75 and 150 mg L-carnitine/ kg diet) with or without squabs consumed significantly ($P \leq 0.05$) lower daily feed intake compared to other groups. Pigeons fed the lowest dietary energy level (2600 kcal/kg) with either 0 or 75 mg L-carnitine/ kg diet recorded the highest intakes. Therefore, dietary energy level is considered as one of the major factors that affect the productive performance of pigeons. From economical point of view, energy cost is an important item in the total feed cost of pigeons feeding.

Egg laying cycle:

Parent pigeon birds fed high ME diets (3000 ME Kcal /kg of diet) recorded significantly the shortest length of the egg cycle (50.44 days) compared with those either fed (2600 or 2800 ME Kcal /kg of diet) being (53.45 and 52.44 days) respectively as shown in (Table 4).

Parent pigeon birds fed diet supplemented with L-carnitine to levels of (150 and 75 mg / kg diet) recorded significantly the shortest length of the egg cycle compared with those fed un-supplemented diet (Table 4).

Dietary energy and L-carnitine supplementtion levels interacted significantly to influence egg laying cycle (Table 4). The longest egg cycle was recorded by group fed 2600 kcal ME/kg without L-carnitine supplementation, while the shortest egg cycle was observed in group fed 3000 kcal plus 150 mg L-carnitine/ kg diet.

These results are in agreement with those obtained by **Abd El-Azeem (2005)** who found that the interval between two consecutive egg laying (days) were ranged from 45.80 to 54.60 depending on the activity of parents to rear of their squabs. Also, **Abou Khashaba *et al.* (2009)** reported that the length of the egg cycle of adult pigeons significantly increased due to decreasing dietary ME levels.

It is noticed that egg laying cycle length for pigeons fed the 3000 kcal/kg diets with L-carnitine levels of 75 or 150 mg / kg diet were significantly improved compared with those fed low energy (2600 kcal) with all L-carnitine levels addition .

Egg number (EN) and Egg weight (EW):

Total number and weight of egg produced per pair during the whole experimental period (180 days) were significantly increased by increasing ME from 2600 to 3000 Kcal/ kg in experimental diet (Table 4).

Egg number was not significantly affected by supplementing diet with L-carnitine as compared these of control diet (un-supplemented L-carnitine) while egg weight was significantly ($P \leq 0.05$) heavier for pigeons fed 75 mg/ kg of L-carnitine compared that of the control group.

The highest EN and EW were recorded for pigeons receiving 75 or150 mg L-carnitine/ kg diet with 3000 kcal/ kg diet, while the lowest observed with free L-carnitine supplementation with 2600 kcal/ kg diet.

The results of **Yanni (1969)** indicated that egg weight produced from pigeons ranged from 17.99 to 20.5 g on average. While, **Abd El-Azeem (1998)** indicated that egg weight produced from pigeons was ranged from 13.78 to 17.38g on average when dietary ME levels increased from 2600 to 3200 ME Kcal /kg of diet. Moreover, **Waldie *et al.* (1991)** indicated that egg production of pigeons was not significantly affected by increasing the dietary energy levels in the diet.

Theses results are in close agreement with those obtained by **Nofal *et al.* (2006)** who showed that egg number and hen- day percentage of ageed Gimmizah lying hens were not significantly affected by L-carnitine supplementation as compared with control group. **Rabie *et al.* (1997)** reported that supplementation of L-carnitine at 500 mg /kg diet had no effect on egg production rate during the early laying period of Hungarian brown line. While, **Richter *et al.* , (1998)** showed that supplemental 50 and 100 mg L-carnitine / kg diet increased egg production of Zeh ' s Brown Warren laying hens by 2.1 and 2.7 %, respectively.. Also, dietary supplementation of 20 to 30 ppm L-carnitine improved egg yield of Tetra SL breeding hens and layers **(Baumgartner, 2003). Nofal *et al.* (2006)** showed that egg weight was significantly ($P \leq 0.001$) heavier for hens fed 50 and 75 mg/ kg of L-carnitine levels inclusion than that of the control group. **Kiado (2005)** reported that L-carnitine supplementation increased egg weight of lying quail. **Suchy *et al.* (2008)** showed that L-carnitine increased egg weight ($P < 0.01$) and laying rate.

The EN and EW of experimental diet contained 3000 kcal/kg diet without or with either L-carnitine levels (75 and 150 mg/kg diet) being significantly superior compared with those of the other groups followed by diet of 2800 kcal/kg diet without or with either L-carnitine levels. While, the worst value was recorded by pigeons fed the 2600 kcal/kg diet either un supplemented with L-carnitine or plus 75mg/kg diet.

Fertility and hatchability:

Data showed that hatchability and fertility (%) were significantly affected by increasing ME levels in experimental diet (Table 4), while the apposite was dietary supplementation of L- carnitine. Also, fertility percentages did not influenced by the interaction of L-carnitine and energy levels. Dietary energy and L-carnitine levels interacted significantly affects hatchability percentages. The best percentage of hatchability during the whole experimental period was noticed in group of pigeons fed diet 3000 kcal/kg diet plus 0, 75 and 150 mg L-carnitine/ kg diet, while the worst was observed in group received diet of 2600 kcal plus 150 mg L-carnitine/ kg diet.

These results are in close agreement with those obtained by **Nofal *et al.* (2006)** who obtained that hens fed diet supplemented with 25, 50, 75, 100, and 125 mg L-carnitine/ kg diet increased fertility and hatchability percentages of total eggs compared with these of the control group. **Leibetseder (1995)** found that hatchability percentage was increased from 83% to 87 % and from 82.4 to 85.3% in groups of Hubbard broiler breeders received diet supplemented with 50 and 100 mg L-carnitine / kg diet respectively. Also, **Blum and Leibetseder (1994)** found that an increase in hatching percentage was improved when dietary L- carnitine was fed to breeders hens. **Baumgartner (2003)** observed that supplementation of 20-30 ppm L-carnitine improved hatchability of breeding hens and layers in various species. Dietary supplementation of 50 to 100 mg L-carnitine/ kg diet increased hatching rate in laying hens **(Harmeyer, 2002)**. Improved fertility may be due to increased sperm concentration by dietary L-carnitine supplementation and the decrease in sperm lipid peroxidation or its antioxidant properties that may preserve sperm membranes in roosters, thereby extending the life span of sperm **(Neuman *et al.* , 2002).**

Squab production:

Results indicate that number of squabs produced per treatment was significantly ($P<0.05$) increased by increasing ME levels in the diet (Table 5). Number of squabs was significantly higher for pigeon fed diet of 3000 ME Kcal /kg of diet than those fed 2800 or 2600 ME Kcal /kg containing diet at the end of 1^{st}, 2^{nd}, 3^{rd} week and weaned age (28 dayes). While number of squabs were not significantly affected by L-carnitine supplementation as compared with those of the control group through all experimental periods (Table 5).

The interaction between dietary energy L-carnitine levels affected significantly the number of squabs. The highest numbers of squabs during

all experimental periods were noticed in group of birds fed 3000 kcal ME plus 150 mg L-carnitine contining diet, while the lowest was observed in group fed diet of 2600 kcal without L-carnitine supplementation.

These results are in agreement with those obtained by **Abou Khashaba *et al.* (2009)** who reported that the number of squabs produced per treatment was increased significantly ($P<0.05$) by the increase in ME levels in the diet.

It is noticed that the squabs produced of 3000 kcal level either with or without L-carnitine levels (75and150mg/kg diet) containing experimental diet being significantly superior than the other groups followed by that of 2800 kcal with 150mg L-carnitine. While, the worst value was recorded by pigeons fed diet containing 2600 kcal with or without L-carnitine supplementation.

Squab growth during 28 days of age:

The results of squab's growth from hatching until 28 days of age (males and females) are tabulated in (Table 5). Significant differences were observed in the body weight of squabs at hatch, 7, 14, 21 days and weaned age (28 days). Results indicated that increasing dietary ME content significantly increased body weight of squabs during all grower stges.

The pigeons fed diet containing 150 mg L-carnitine/ kg gave the heaviest squabs followed by pigeons of group fed diet of 75 mg L-carnitine/ kg diet compared to those of the control group. Increasing L-carnitine levels up to 150 mg / kg diet increased body weight of squabs compared to the control group at hatch, 7, 14, 21 days and weaned age.

This result is in agreement with **Abd El-Azeem *et al.* (2007)** who reported that growth rate of squabs was not significantly affected from hatch to 3 days of age, while at 7,15, 21 and 28 days of age, the growth rate significantly ($P<0.05$) increased when dietary energy levels increased from 2600 to 3200 Kcal ME / kg diet. **Bokhari (1994)** indicated that squabs grow very rapidly until about 21 days, and then the growth continued at slower rate afterwards. **Essam (1997)** found that the highest growth rate of squabs was obtained during feeding the crop milk and the lowest was recorded during seeds feeding. **Abou Khashaba *et al.* (2009)** reported that increasing dietary ME content significantly increased body weight of squabs, the difference rats was high by 23.5% between the diets of the lowest and the highest ME content at the market age.

It is worthy noted that the pigeons fed diet containing 3000 kcal ME and 75 or 150 mg L-carnitine gave a significantly higher growth rate of squab than those fed the other energy and L-carnitine levels. While, squab growth during 28 days of age for the pigeons fed diet containing 2600 kcal diet but without or with 75mg L-carnitine and those fed 2800 kcal without L-carnitine were significantly the lowest than the other groups.

Squabs body weight gain (BWG) during 28 days of age:

The results obtained showed that the live body weight gain of squabs during 8 to 14 days of age was the highest comparing to other studied periods. While, the weight gain from 21 to 28 days of age was the worst. Where as the pigeon squabs reach the maximum weight gain through first 28 days of age, also an increase in dietary ME during 28 days significantly increase BWG of squabs (Table 6).

Concerning the effects of L-carnitine supplementation on live body weight gain of squabs during 28 days of age, the weight gain was significantly affected at all investigated periods except those 14 and 21 days of age; the highest squabs weight gain was noticed in pigeon group received 150 mg L-carnitine inclusion during the overall period (1 - 28) days of age with significant different with other levels.

The effect of L-carnitine administration was recognized compared with the un-supplemented diet on the squabs weight gain at hatch, 7, 14, 21 days or 28 days (weaned squabs age). The pigeon fed 150 mg L-carnitine/kg diet gave heaviest squabs weight gain followed by pigeons of group fed 75 mg L-carnitine compared to those of the control group (0.0 mg L-carnitine/ kg diet). While, the lowest squabs weight gain was observed in group fed diet containing 2600 kcal in bur without L-carnitine supplementation. Increasing L-carnitine levels up to 150 mg / kg diet increased body weight gain of squabs compared to the control group (un supplemented L-carnitine diets).

It is worthy noted that pigeons fed the 3000 kcal ME and 75 or 150 mg L-carnitine containing diet gave a significantly more gain in squabs than those fed the other experimental diets. While, squab growth during 28 days of age of the pigeons fed the 2600 kcal diet with or without 75mg/kg L-carnitine was significantly the lowest than the other groups.

Mortality rate:

Mortality rate of squabs during the 28 days of age was not significantly affected by increasing ME levels in the pigeons diet (Table 6). Mortality rate was not significantly affected also by L-carnitine

supplementation as compared with control group at all experimental periods (Table 6). Generally mortality rate did not influenced by the interaction of L-carnitine and energy levels.

This discrepancy may be due to differences in managerial, housing or environmental conditions than those applied in the present study. L-carnitine supplementation did not significantly affect mortality rate. These results are consistent with those reported by **Yalcin *et al.* (2005)**. who showed that mortality rate was not affected by L-carnitine levels.

Livability:

The livability percentage of pigeon squabs was not affected by the dietary ME levels (2600. 2800 and 3000 Kcal ME/kg of diet). Also the livability percentage of pigeon squabs were not significantly affected by L-carnitine supplementation as compared with control group at all experimental periods (Table 6).

Meanwhile, the livability percentage of pigeon squabs was not influenced by the interaction effect of L-carnitine and energy levels.

Net Return (NR) and Economical Efficiency (EE):

The cost of one kg diet decreased with the decrease in dietary energy levels containing diets (Table 7). The NR and EE at the end of experimental period (180 day) recorded the highest values for pigeon fed diets containing 3000 Kcal ME /kg at different L-carnitine levels. It is worth to note that the upper ME level with different L-carnitine levels recorded more higher NR and EE values than those of other levels.

Economical evaluation of using L-carnitine at different dietary energy levels in pigeons diets is recorded in Table (7). The best record was detected with pigeons fed the highest dietary energy level (3000 kcal ME containing). The net return of pigeons fed dietary energy of 3000 kcal ME /kg diet at different L-carnitine levels increased over those fed un-supplemented diet. The economical efficiency for pigeons fed diet of 3000 kcal ME/kg diet with 150 mg L-carnitine recorded the highest value compared to that of birds fed 2600 kcal ME /kg diet with 0.0 mg L-carnitine containing diet. These results are in close agreement with those obtained by **Sayed *et al.* (2001)** who showed that supplementing diet of L- carnitine improved performance and gave a better economical efficiency.

From results of this experiment, it can be concluded that the metabolizable energy content of pigeon diets plays an important role and significantly affect or the most important reproduction traits. Feeding high

metabolizable energy plus L-carnitine levels supplemented diets increases both the number and the weight of weaned squabs. This may be due to the increase of alive squabs in treatment one with the decrease of feed cost.

It is concluded that additional L-carnitine to the pigeon diet high or low energy levels produce improvement in productive and reproductive performance. Diet containing either 3000 or 2800 kcal ME /kg diet with or without L-carnitine was suitable and satisfactory for production and reproduction of pigeons. While, the diet containing 2600 kcal/kg diet un supplemented with L-carnitine had a negative effect on productive and reproductive performance of local Baladi squabs and pigeons under Egyptian conditions

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

Ingredients (%)	Diet 1 3000kcal ME/kg	Diet 2 2800kcal ME/kg	Diet 3 2600kcal ME/kg
Yellow corn	70.00	67.40	59.00
Soybean meal, 44 %	21.00	19.00	17.00
Wheat bran	2.60	9.50	20.00
Bone meal	2.30	2.00	1.50
Limestone	1.50	1.50	1.90
Vegetable oil	2.00	0.00	0.00
Common salt (NaCl)	0.30	0.30	0.30
Vit. & Min. mix.*	0.30	0.30	0.30
Total	100	100	100
Calculated values**:			
Crude protein, %	15.18	15..11	15.12
ME,Kcal/kg	3007.11	2805.11	2615.61
Crude fiber,%	3.42	3.98	4.79
Ether Extract,%	2.96	3..12	3.20
Calcium, %	1.38	1.32	1.32
Available phosphorus, AP %	0.41	0.40	0.40
Lysine, %	0.79	0.75	0.75
Methionine,%	0.28	0.27	0.26
Methionine + cysteine %	0.53	0.53	0.53
Pric of ton (LE)	1835	1755	1690

*Vit.& Min. mix:. each 1kg diet contains: 10,000 IU Vit. A; 2.000 IU Vit D_3 10 mg Vit. E;1mg Vit. K; 1mg Vit. B1; 5mg Vit. B2; 1.5mg Vit B6; 0.01mg Vit. B12; 0.30mg; Niacin, 10 mg ; Panatothenic acid. 0.50 mg. Biotin; 1 mg Folic acid:250 mg choline chloride; 60 mg manganese; 30 mg iron; 50 mg zinc; 4 mg copper;0.3 mg iodine; 0.1 mg Seleinium and 0.1mg cobalt.

** Calculated according to NRC (1994).

(Table 2): Effects of dietary energy and L- carnitine levels on live body weight and body weight gain, of pigeons from 24 to 30 manthes of age.

Items	Initial body weight (g)	Final body weight (g)	Body weight gain (g)
Energy (kcal ME/kg)	NS	NS	*
2600	307.23	307.01	-0.21c
2800	308.21	312.99	4.77b
3000	306.47	315.61	9.14a
±SEM	3.15	3.23	0.61
L-carnitine (mg/kg)	NS	NS	*
0	303.22	305.15	1.92c
75	310.42	315.61	5.18b
150	308.16	314.07	5.91a
±SEM	3.15	3.23	0.61
Interaction, Energy x L-carnitine	NS	NS	**
3000 x 150	307.97	319..10	11.12a
3000 x 75	309.25	318.70	9.45b
3000 x 0	302.18	309.04	6.85c
2800 x 150	308.31	313.92	5.61d
2800 x 75	310.33	315.21	4.88d
2800 x 0	305.99	309.83	3.83e
2600 x 150	308.19	310.42	2.22f
2600 x 75	311.68	312.91	1.23g
2600 x 0	301.50	296.58	-4.92h
±SEM	3.15	3.23	0.61

a-h: For each criterion. means in the same column bearing different superscripts differ significantly

** = P < 0.01, * = P < 0.05 and NS = Not significant ($P \geq 0.05$)

SEM = standard error mean

(Table 3): Effects of dietary energy and L- carnitine levels on the daily feed intake of pairs (g/day) without or with squabs of pigeons from 24 to 30 manthes of age.

Items	Without squabs	With squabs at 7 days	With squabs at 14 days	With squabs at 21 days	With squabs at 28 days	Total FI without-squabs during 180 days	Total FI with / without squabs during 180 days
Energy (kcal ME/kg)	**	**	**	**	**	**	**
2600	110.70a	126.00a	138.60a	152.15a	163.70a	19926.00a	23175.51a
2800	106.88b	119.11b	132.11b	147.88b	160.11b	19240.00b	22403.11b
3000	102.44c	114.27c	129.44b	143.33c	154.16c	18440.00c	21727.35c
±SEM	0.64	0.89	0.79	0.72	0.68	116.68	98.05
L-carnitine (mg/kg)	**	**	**	NS	NS	**	**
0	108.88a	121.61a	136.00a	148.72	160.27	19600.00a	22728.46a
75	106.88ab	120.83a	132.77b	148.61	159.50	19240.00b	22487.64b
150	104.90b	117.85b	132.10b	146.65	158.75	18882.00c	22198.43c
±SEM	0.64	0.89	0.79	0.72	0.68	116.68	98.05
Interaction Energy x L carnitine	**	**	**	**	**	**	**
3000 x 150	99.50e	113.50d	128.16e	140.16e	153.33e	17910.00e	21416.20e
3000 x 75	103.16d	114.50cd	129.00 e	145.00de	153.33e	18570.00d	21806.14de
3000 x 0	104.66cd	114.83cd	131.16de	144.83de	155.83de	18840.00cd	21959.69d
2800 x 150	105.00cd	118.00bcd	130.16cde	147.16cd	159.33cd	18900.00cd	22162.75cd
2800 x 75	107.33bc	119.33bc	131.16cde	148.50bcd	160.17bc	19320.00bc	22436.63bc
2800 x 0	108.33bc	120.00b	135.00bcd	148.00abcd	160.83abc	19500.00bc	22609.94b
2600 x 150	108.87b	121.00b	136.50bc	151.12abc	162.37abc	19597.50b	22811.86b
2600 x 75	110.16ab	128.67a	138.17ab	152.33ab	165.00ab	19830.00ab	23220.15a
2600 x 0	113.66a	130.00a	141.83a	153.32a	164.17a	20460.00a	23615.73 a
±SEM	0.64	0.89	0.79	0.72	0.68	116.68	98.05

a-e: For each criterion, means in the same column bearing different superscripts differ significantly

** = $P < 0.01$ and NS = Not significant ($P \geq 0.05$)

SEM = standard error mean

(Table 4): Effects of dietary energy and L- carnitine levels on the reproductive performance of pigeons from 24 to 30 manthes of age.

Items	Egg cycle (day)	Egg number	Egg weight (g)	Total fertility%	Total Hatchability%
Energy (kcal ME/kg)	**	*	**	*	*
2600	53.45a	6.40b	14.66c	91.78b	88.80b
2800	52.44b	7.27a	15.43b	92.46b	87.76b
3000	50.44c	7.61a	15.88a	97.12a	96.32a
±SEM	0.22	0.11	0.09	0.94	1.11
L-carnitine (mg/kg)	*	NS	*	NS	NS
0	52.77a	6.88	15..07b	93.71	92.09
75	52.05b	7.00	15.47a	93.58	90.50
150	51.70b	7.30	15.35ab	93.83	90.14
±SEM	0.22	0.11	0.09	0.94	1.11
Interaction Energy x L-carnitine	**	**	**	NS	**
3000 x 150	49.33d	7.83a	15.99a	97.91	97.91a
3000 x 75	50.33d	7.67ab	16.03a	95.53	93.15ab
3000 x 0	51.67c	7.33ab	15.63ab	97.91	97.91a
2800 x 150	52.00c	7.33ab	15.27bcd	91.07	88.69ab
2800 x 75	52.50bc	7.33ab	15.57ab	93.15	86.31b
2800 x 0	52.83abc	7.17ab	15.46abc	93.15	88.29ab
2600 x 150	53.25ab	6.87bc	14.94cd	92.85	85.41b
2600 x 75	53.33ab	6.00d	14.82d	92.06	92.06ab
2600 x 0	53.83a	6.16cd	14.12e	90.08	90.07ab
±SEM	0.22	0.11	0.09	0.94	1.11

a-d: For each criterion, means in the same column bearing different superscripts differ significantly

** = $P < 0.01$, * = $P < 0.05$ and NS = Not significant ($P \geq 0.05$)

SEM = standard error mean

(Table 5): Effects of dietary energy and L- carnitine levels the squabs production of pigeons from 24 to 30 manthes of age.

Items	Squab production (squabs number)					Squabs growth at 28 days of age (g)				
	Hatch number	Number in7 days	Number in14 days	Number in21 days	Weaning number	Hatch weight (g)	Weight at 7 days(g)	Weight at 14 days(g)	Weight at 21 days(g)	Weaning weight (g)
Energy (kcal ME/kg)	**	**	**	**	**	**	**	**	**	**
2600	5.65c	5.50b	5.25c	5.20c	4.90c	11.72c	66.61c	146.18c	212.53c	250.91c
2800	6.39b	5.94b	5.83b	5.72b	5.50b	13.30b	72.15b	151.84b	222.67b	270.64b
3000	7.33a	6.89a	6.50a	6.44a	6.11a	14.02a	79.11a	163.49a	235.45a	292.77a
±SEM	0.13	0.12	0.10	0.10	0.11	0.15	0.87	1.18	1.56	2.89
L-carnitine (mg/kg)	NS	NS	NS	NS	NS	**	**	**	**	**
0	6.33	6.00	5.72	5.67	5.38	12.64b	68.73b	148.82c	216.58c	256.97c
75	6.33	6.05	5.89	5.72	5.44	13.02a	73.62a	154.37b	224.03b	271.92b
150	6.60	6.20	5.90	5.90	5.60	13.21a	74.62a	157.11a	228.28a	281.97a
±SEM	0.13	0.12	0.10	0.10	0.11	0.15	0.87	1.18	1.56	2.89
Interaction Energy x L-carnitine	**	**	**	**	**	**	**	**	**	**
3000 x 150	7.67a	7.17a	6.67a	6.67a	6.33a	14.29a	80.41a	167.15a	237.73a	300.43a
3000 x 75	7.16ab	6.83ab	6.50ab	6.33ab	6.00ab	14.07ab	81.84a	166.76a	236.45ab	296.65a
3000 x 0	7.16ab	6.67ab	6.33ab	6.33ab	6.00ab	13.69abc	75.07b	156.57b	232.15bc	281.24bc
2800 x 150	6.50bc	6.00b	5.83bc	5.83bc	5.67abc	13.57bc	76.14b	156.74b	230.65c	282.92b
2800 x 75	6.33bcd	5.83cd	5.83bc	5,67bcd	5.33bc	13.30cd	73.71b	152.12c	221.73d	277.42c
2800 x 0	6.33bcd	6.00b	5.83bc	5.67bcd	5.50bcd	13.03d	66.60cd	146.67de	215.61ef	251.58e
2600 x 150	5.87cd	5.62d	5.37cd	5.37cd	5.00cd	12.14e	69.15c	149.85.cd	219.42de	267.42d
2600 x 75	5.50d	5.50d	5.33cd	5.16cd	5.00cd	11.68ef	65.31d	144.23e	213.91f	241.69f
2600 x 0	5.50d	5.33d	5.00d	5.00d	4.67d	11.21f	64.52d	143.24e	201.97g	238.09f
±SEM	0.13	0.12	0.10	0.10	0.11	0.15	0.87	1.18	1.56	2.89

a-f: For each criterion, means in the same column bearing different superscripts differ significantly

** = P < 0.01 and NS = Not significant (P≥ 0.05)

SEM = standard error mean

(Table 6): Effects of dietary energy and L- carnitine levels on the squabs production of pigeons from 24 to 30 manthes of age.

Items	Body Weight Gain in squabs (BWG)					Mortality rate+ %	Livability++ %
	Gain 1-7 day (g)	Gain 8-14 day (g)	Gain 15-21 day (g)	Gain 21-28 day (g)	Total gain 1-28 day (g)		
Energy (kcal ME/kg)	**	**	**	**	**	NS	NS
2600	54.89c	79.56b	66.35b	38.37c	239.18c	0.75	77.16
2800	58.85b	79.69b	70.81b	47.97b	257.34b	0.88	75.76
3000	65.08a	84.38a	71.95a	57.32a	278.75a	1.22	80.65
±SEM	0.76	0.62	0.84	1.66	2.77	0.10	1.23
L-carnitine (mg/kg)	**	NS	NS	**	**	NS	NS
0	56.09b	80.09	67.75	40.39c	244.32c	0.94	78.94
75	60.60a	80.75	69.65	47.89b	258.90b	0.88	78.12
150	61.41a	82.48	71.17	53.69a	268.76a	1.00	76.57
±SEM	0.76	0.62	0.84	1.66	2.77	0.10	1.23
Interaction Energy x L- carnitine	**	**	**	**	**	NS	NS
3000 x 150	66.11a	86.74a	70.58ab	62.69a	286.14a	1.33	80.95
3000 x 75	67.76a	84.92ab	69.69ab	60.19a	282.57a	1.16	78.27
3000 x 0	61.37b	81.50bc	75.58a	49.08bc	267.54b	0.17	82.73
2800 x 150	62.57b	80.60bc	73.90ab	52.27bc	269.35b	0.83	77.08
2800 x 75	60.41b	78.41c	69.60ab	55.68ab	264.11b	1.00	72..91
2800 x 0	53.57d	80.05bc	68.95b	35.96d	238.55d	0.83	77.28
2600 x 150	57.02c	80.69bc	69.57ab	48.00c	255.29c	0.87	72.91
2600 x 75	53.62d	78.92c	69.67ab	27.78e	230.01e	0.50	83.17
2600 x 0	53.31d	78.71c	58.72c	36.12d	226.88e	0.83	76.82
±SEM	0.76	0.62	0.84	1.66	2.77	0.10	1.23

a-e: For each criterion, means in the same column bearing different superscripts differ significantly

** = $P < 0.01$ and NS = Not significant ($P \geq 0.05$)

+ Mortality rate = {(No. of squabs at hatch day - No. of squabs at 28 day)/ No. of squabs at hatch day} x100

++ Livability = (No. of squabs at 28 day / No. of egg hatching) x100

SEM = standard error mean

(Table 7): Effects of dietary energy and L- carnitine levels on economical efficiency of pairs (g/day) without or with squabs of pigeons from 24 to 30 manthes of age.

Items	Feed intake of pairs (g) during 180 day)	*Price of ton (LE)*	Price of feed cost during 180 day(LE)	Number of squabs /pair	Sale price of squabs/ pair (LE)*	Net return**	Economic efficiency (%)***
3000 kcal ME/kg x 150 mg/kg	21416.20	1859	39.81	6.33	50.64	10.83	27.20
3000 kcal ME/kg x 75 mg/kg	21806.14	1847	40.27	6.00	48.00	7.73	19.19
3000 kcal ME/kg x 0 mg/kg	21959.69	1835	40.29	6.00	48.00	7.71	19.13
2800 kcal ME/kg x 150 mg/kg	22162.75	1779	39.42	5.67	45.36	5.94	15.06
2800 kcal ME/kg x 75 mg/kg	22436.63	1767	39.64	5.33	42.64	3.00	7.56
2800 kcal ME/kg x 0 mg/kg	22609.94	1755	39.68	5.50	44.00	4.32	10.88
2600 kcal ME/kg x 150 mg/kg	22811.86	1714	39.09	5.00	40.00	0.91	2.32
2600 kcal ME/kg x 75 mg/kg	23220.15	1702	39.52	5.00	40.00	0.48	1.21
2600 kcal ME/kg x 0 mg/kg	23615.73	1690	39.91	4.67	37.36	-2.55	-6.38

*During the course of study the sale price per squab was 8 L.E

** Net return = Price of squabs of pair during 180 day - Price of feed cost during 180 day

*** Economic efficiency = (Net return / Price of feed cost during 180 day) X100

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الملخص العربي

دراسات غذائية ورعاية على الحمام

تأثير ال – كارنتين مع مستويات الطاقة على معدل الأداء الإنتاجي والتناسلي فى الحمام

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أجريت هذة التجربة لدراسة تأثير اضافة ال – كارنتين مع مستويات الطاقة المختلفة على معدل الأداء الانتاجى والتناسلى فى الحمام البلدى تحت الظروف المصرية . تم عمل التجربة خلال فترة الانتاج حيث قسم عدد ٥٤ زوج حمام بالغ عمر(٢٤ شهرا) الى ٩ معاملات بكل معاملة ٦ أزواج ، قسمت المعاملة الى ٣مكررات بكل مكررة زوجين (النسبة الجنسية ١:١) تم تغذية الحمام على ٣ مستويات من ال – كارنتين (٠و ٧٥ و ١٥٠ مجم/ كجم عليقة) وتحت كل مستوى من ال – كارنتين ٣ مستويان من الطاقة الممثلة (٢٦٠٠و٢٨٠٠و٣٠٠٠ كيلوكالورى/كجم عليقة) وتم تقديم العلائق والماء بصورة حرة حتى الشبع خلال فترة التجربة.

وكانت اهم النتائج كما يلى :

١- وجد تاثيرا معنويا موجبا لزيادة مستوى الطاقة على كل من وزن الجسم المكتسب وتقليل كمية العذاء المتناول للحمام (مع أو بدون الزغاليل) و طول دورة البيض، و عدد البيض الناتج، و وزن البيض، و نسبة الخصوبة، ونسبة الفقس بالزيادة، و على عدد الزغاليل، و وزن الجسم للزغاليل و وزن الجسم المكتسب للزغاليل عند عمر ٢٨ يوما والكفاءة الأقتصادية للحمام مقارنة بالعلائق منخفضة الطاقة.

٢- باثر معنويا كلا من وزن الجسم المكتسب و كمية العذاء المتناول للحمام مع الزغاليل و طول دورة البيض و عدد البيض الناتج و وزن البيض مع التغذية على العلائق المحتوية على المستوى العالى من ال – كارنتين، كذلك زاد معنويا كل من عدد الزغاليل و وزن الجسم للزغاليل و وزن الجسم المكتسب للزغاليل عند عمر ٢٨ يوما والكفاءة الاقتصادية للحمام بزيادة مستوى ال – كارنتين فى العليقة.

٣- وجد تاثير ايجابى للتداخل بين كلا من مستويات الطاقة ومستوى ال – كارنتين على كل من وزن الجسم المكتسب وتقليل كمية العذاء المتناول للحمام مع أو بدون الزغاليل، و طول دورة البيض، و عدد البيض الناتج، و وزن البيض، ونسبة الفقس بالزيادة، و على عدد الزغاليل عند عمر ٢٨ يوما، و وزن الجسم للزغاليل عند عمر ٢٨ يوما، و وزن الجسم المكتسب للزغاليل عند عمر ٢٨ يوما، والكفاءة الأقتصادية للحمام .

نستخلص من هذة الدراسة ان اضافة أل – كارنتين ادى الى تحسن الاداء الانتاجى والتناسلى للحمام مع مستويات الطاقة العالية والمنخفضة و ان استخدام عليقة تحتوى على ٢٨٠٠ او٣٠٠٠كيلو كالورى طاقة ممثلة /كجم عليقة مع او بدون ال – كارنتين تغطى بنجاح الاحتياجات الانتاجية والتناسلية للحمام ، بينما مستوى ٢٦٠٠كيلو كالورى /كجم عليقة بدون اضافة أل – كارنتين لها تاثير سلبى على الاداء الانتاجى والتناسلى للحمام تحت الظروف المصرية.