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EFFECT OF DIETARY L-CARNITINE ON THE PERFORMANCE OF BROILER CHICKENS FED ON DIFFERENT LEVELS OF FAT

(With 6 Tables)

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مدي تأثير اضافة الكارنيتين علي اداء بداري التسمين المغذاة علي مستويات مختلفة من الدهون

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أجريت هذه التجربة لدراسة مدي تأثير أضافة الكارنيتين علي اداء بداري التسمين بالاضافة الي تصافي الذبيحة ودهون أحشاء البطن .تم استخدام كتاكيت من نوع ايفيان ٤٣ في هذه التجربة . وقد تم تكوين ثلاث علائق في هذه الدراسة واستخدمت العليقة الاولي كعليقة ضابطة بينما أحتوت العليقة ٢ و ٣ علي ٢ و ٤ %من الدهون النباتية(زيت عباد الشمش) وعند عمر ٢١ يوما تم تقسيم كل من المجموعتين الثانية والثالثة الي مجموعتين ٤ و ٥ أضيفت اليها ٥٠ مجم من الكارنيتين لكل كجم من العليقة واستمرت التجربة لمدة سبعة أسابيع . وقد خلص البحث الي زيادة في كل من كمية الاكل المستهلك ومعدلات النمو والتحويل الغذائي في المجموعات التي غذيت علي علائق تحتوي علي دهون مقارنة بالمجموعة التي غذيت علي العليقة الضابطة. أضافة الكارنيتين أدت الي زيادة في كل من كمية الاكل المستهلك ومعدلات النمو والتحويل الغذائي في المجموعات التي غذيت عليه مقارنة بالمجموعات الاخري. كذلك نقص محتوي دهون أحشاء البطن في المجموعات التي أضيف الكارنيتين الي غذائها وقد سجلت المجموعة التي غذيت علي ٢ %دهن مع الكارنيتين أكبر نقص في هذه الدهون. كما نقص مستوي الكوليسترول والدهون الكلية في دم المجموعات التي أضيف الكارنيتين الي غذائها. نستخلص من هذه الدراسة أن أضافة الكارنيتين الي علائق بداري التسمين خاصة اذا أحتوت هذه العلائق علي دهون يؤدي الي تحسن في كل من وزن الجسم ومعدلات النمو والتحويل الغذائي كما يؤدي ايضا الي نقص في محتوي الدهون التي تختزن داخل الجسم. مما يؤدي إلى زيادة العائد الإقتصادي الناتج عن تربية بداري التسمين.

SUMMARY

Because of the well established function of carnitine, effects of dietary L-carnitine supplementation on the performance, abdominal fat, carcass yield, serum cholesterol and total lipid of broiler chickens were investigated. A total of 75 broiler chicks " Avian 43 " were experimented on. Chickens were divided into 3 experimental groups, group 1 considered as control (15 birds) fed on basal diet, groups 2 & 3 (30 each) fed on basal diet supplemented with 2&4% vegetable oil (Sunflower oil). At the age of 21 days, groups 2&3 were subdivided to four groups (15 birds each) to test the effect of adding 50 mg L-carnitine/kg diet until the age of 49 days. Performance and abdominal fat were influenced by dietary fat. Supplemental L-carnitine increased feed intake, weight gain and feed conversion compared to control group and their analogue groups. Carnitine supplementation to the diet having 2% fat significantly ($P<0.05$) decreased the abdominal fat. However, serum cholesterol and total lipid decreased with carnitine supplementation to diets with both fat levels. So, under the conditions of this study, a supplementation of 50 mg L-carnitine/kg diet proved to be effective specialy with diets enriched with fat, which leads to increasing economic efficiency.

Key Words *: L-carnitine, Growth, Broilers, Performance*

INTRODUCTION

L-carnitine is a water-soluble quaternary amine which occurs naturally in micro-organisms, plants and animals (Bremer, 1983). Its major role appears to be the transport of long-chain fatty acids into mitochondria for oxidation (Borum, 1983, 1987 & Bremer, 1983). Recent studies show that lysine is a precursor of carnitine and that the lysine-carnitine relationship may be analogous to that of tryptophan-niacin (Latifa and Mahtab, 1978). In animals, L-carnitine concentrations vary widely in different species (Szilagyi et al., 1992) and among tissues (Bremer, 1983; Rinaudo et al., 1991). L-carnitine plays an important role in energy metabolism. L-carnitine allowed for the utilization of additional energy dervied from lipids metabolism, it also reduced the unwanted accumulation of lipid in the tissue of chickens . Since the essential amino acid lysine is a precursor of carnitine, the effects of cereal diets unsupplemented or supplemented with carnitine, lipid levels

in tissue were studied. Lipid accumulation in the liver due to lysine deficient diets has been attributed partly to impaired synthesis of lipoproteins and partly to deficiency of carnitine needed for intramitochondrial transport of fatty acids, a prerequisite for their oxidation (Latifa and Mahtab, 1978). Numerous investigators have observed that animals fed isonitrogenous diets retain more nitrogen when energy content of the diet is increased. Such diets hold promise for more economical production of farmed animals through better utilization of dietary nitrogen for body growth, and a reduced environmental burden of waste nitrogen (Estornell et al., 1994). Oxidation of fat provides the most cost-effective energy yield per unit weight of dietary ingredients, and oxidation of fat is promoted by carnitine. Several reports on broiler chickens, quails and turkey poults have demonstrated that growth performance can be improved by feeding supplementary dietary L-carnitine (Lettner et al., 1992; Neuendorf, 1994; Wyatt & Goodman,1994; Rabie et al., 1997a,b; Rabie & szilagyi, 1998 and Soltan, 1999); and increased water or feed intake of pigeons (Janssens & De Wilde, 1995). It has been reported that little L-carnitine is found in cereal grains and their by-products (Tanphaichitr et al., 1976; Mitchell, 1978 and Borum, 1983). Because cereal grains usually represent the major component of poultry diets, it may be useful to incorporate this compound into the diets. Accordingly, the addition of carnitine to animal feed has drawn attention for its potential to enhance the protein sparing action of fat and promote growth (Heo et al., 2000).

Responses to supplemental dietary L-carnitine of broilers fed on diets with different levels of fat were investigated using growth performance and some carcass measurments.

MATERIALS and METHODS

A total of 75 one day old chicks (Avian 43) floor reared in an experimental room bedded by a layer of wheat straw and provided with clean feeders and waterers were experimented on. Chickens were divided into 3 experimental groups, group 1 was considered as control (15 birds) fed on basal diet, groups 2 & 3 (30 each) fed on basal diet supplemented with 2&4% vegetable oil (Sunflower oil). At the age of 21 days, groups 2 & 3 were subdivided to four groups (15 birds each) to test the effect of adding 50 mg L-carnitine/kg diet until the age of 49 days. The diets were

formulated to be adequate in all nutrients for this strain as recommended by NRC (1994).

Feed and water were provided ad libitum throughout the experimental period. Feed consumption and body weight through the first 21 days were recorded. After 21 days, after L-carnitine addition, these parameters were weekly recorded. Weight gain and feed conversion were calculated.

At the end of the experiment (49 days), 5 birds from each group were randomly taken, weighed and slaughtered. Weights of abdominal fat and liver were expressed as a percentage of body weight. Blood samples were collected from each group and serum samples were separated for determination of cholesterol and total lipids after Loeffer and Mcdougald, (1963).

Economical efficiency of production: Total production cost was calculated including prices of one-day old chicks, feeding, heating, veterinary care, management and housing. Selling price was calculated by multiplying total live body weight of the birds produced by the price per unit weight commonly offered in the market.

Economical efficiency = {net revenue / total production cost X100}

Statistical analysis: Data were analysed by the one-way analysis of variance (ANOVA) technique and Duncan's multiple range test (Snedecor & Cochran, 1967).

RESULTS and DISCUSSION

The results obtained for broiler performance in terms of feed intake, live body weight, body weight gain and feed conversion are presented in Tables (2 & 3). The amount of feed consumed per bird for the whole growing period in the different groups was greatly affected by the levels of dietary fat (groups 2 & 3) which recorded an increasing by 106 and 295gm respectively than control. L-carnitine supplementation resulted in additional increase in the feed intake by groups 4&5 recorded 59 & 87 gm respectively. So, Carnitine supplementation had effect on the feed intake of the broiler chickens. These results were supported by the findings of Janssens and De Wilde (1995) who reported that feed intake were increased by carnitine supplementation in racing pigeons.

The growth data revealed that, the addition of fat to the experimental diets improved weight gain by 14% and 20.4% in groups fed on 2% & 4% fat in comparison to those of control. The improvement in weight gain achieved by chicks receiving the high fat level (4%) confirms the findings (Gazia, 1971; Donaldson , 1985 and Barbour et al., 2000) who reported that incorporation of fat into a balanced diet without altering the energy nutrient balance enhances chick growth. Addition of the L-carnitine to the diets containing 2% & 4% fat gave additional increase in the weight gain of the broiler chicks by 5% and 5.7% respectively. Supplemental L-carnitine increased body weight significantly ($P<0.05$) in compared to both control and their analogue groups. These results are in agreement with that previously found by Rabie et al. (1997a,b) and Rabie and Szilagyi (1998) with broiler chicks. This data would indicate that in the presence of L-carnitine, broiler chicks may be able to more efficiently utilize the added oil as reported by some autheors (Neuendorf, 1994; Wyatt & Goodman, 1994; Janssens & De Wilde, 1995 and Soltan, 1999). On the other hand, the obtained results seems to be contradicted with the findings of Barker and Sell (1994) and Leibtseder (1995) who reported that, the growth of broiler chicks not affected by carnitine. The positive effect of L-carnitine on growth may be attributed to the improved lipid metabolism and enhanced protein synthesis.

The efficiency of feed utilization expressed as gm of feed per gm of gain for different treatments are shown in Table (3). Favorable effect of dietary fat and L-carnitine supplementation on broiler weight gain was parallel to the improvement in the feed conversion. Feed conversion improved with L-carnitine supplementation of the groups fed on the diets containing fat. Similar results were reported by Rabie et al. (1997a,b) and Rabie and Szilagyi (1998).

Addition of L-carnitine to the diet having 2% fat significantly ($P<0.05$) decreased the abdominal fat content of the broilers. This may be due to the acceleration of fatty acid oxidation which might improve nitrogen retention in carnitine fed diets. These results supported by the conclusion of Rabie et al. (1997a,b) and Rabie & Szilagyi (1998) with broiler chicks. On the contrary, Leibetseder (1995) stated that L-carnitine addition to the broiler diets did not affect abdominal fat.

The weight of liver (Table, 4) expressed as a percentage of dressing weight was increased in groups fed on 2 & 4% fat, while L-

carnitine addition decreased liver weight. This may be attributed to the decrease in the lipid content of the liver. These results are confirmed by Wyatt and Goodman (1994) who stated that dietary L-carnitine addition reduced the liver fat content by 5-8% in turkey poults.

The dressed carcass percentages (Table, 4) were increased in broiler chicks fed on the diets containing fat supplemented with carnitine as reported by Rabie et al. (1997b). This may be due to increase in the protein retention.

Regarding serum cholesterol and total lipids, the results showed that groups fed on diets containing fat recorded significant ($P<0.05$) increase in these levels, while the values were decreased in groups fed on diets containing fat supplemented with carnitine as shown in Table (5).

Data for feeding costs, total production, net revenue (LE/bird) and economic efficiencies of different broiler chicken groups are shown in Table (6). These results revealed the possibility of increasing economic efficiency by L-carnitine supplementation to the diets containing vegetable oils. The reason for that is may be due to better feed utilization obtained by those broiler chicken groups (4 & 5) compared to control and their analogue groups. The greatest economical efficiency was obtained by group 5 (36.74) followed by group 4 (33.33) which fed diets supplemented by 50 mg L-carnitine/kg diet with 4&2% vegetable oil respectively.

There is ample evidence that, raising the fat content of isonitrogenous diets promotes growth (Estornell et al., 1994). In conclusion, endogenous carnitine biosynthesis may be adequate to maintain sufficient tissue levels during growth, but a supplementation of 50 mg dietary L-carnitine/kg diet proved to be effective to alter nutrient partitioning and thus broiler performance.

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Table (1):- Composition of the starter and grower-finisher diets used in the experiment

Ingredients (%)	Starter diets			Grower-finisher diets		
	1	2	3	1	2	3
Yellow corn, ground	67.70	62.57	57.21	73.14	68.38	64.30
Soybean meal (44%)	21.00	25.57	30.68	18.30	21.79	23.87
Fish meal (72%)	4.00	4.00	2.00	3.00	2.00	2.00
Meat meal (60%)	5.84	4.00	4.00	4.00	4.00	4.00
Sunflower oil	----	2.00	4.00	----	2.00	4.00
Bone meal	0.08	0.65	0.66	0.45	0.46	0.46
Dicalcium phosphate	0.20	0.06	0.25	0.10	0.25	0.25
Limestone, ground	0.86	0.80	0.80	0.76	0.80	0.80
Salt	0.10	0.12	0.15	0.10	0.15	0.15
Methionine	0.07	0.08	0.10	----	0.02	0.02
Premix*	0.15	0.15	0.15	0.15	0.15	0.15
Calculated analysis:						
Crude protein (%)	21.38	21.83	22.20	18.83	19.24	19.85
ME (Kcal/kg)	2992	3032	3093	3082	3118	3181
C/P ratio	139.94	138.89	139.30	163.67	162.10	160.25
Ether extract (%)	3.55	5.27	6.90	3.51	5.25	7.12
Methionine (%)	0.45	0.47	0.47	0.34	0.35	0.36
Meth.+ Cystine (%)	0.78	0.81	0.81	0.64	0.66	0.67
Lysine (%)	1.14	1.19	1.20	0.97	0.99	1.00
Linoleic acid (%)	1.59	1.50	1.40	1.70	1.60	1.52
Calcium (%)	1.07	1.05	1.05	0.93	0.96	0.97
Total phosphorus (%)	0.68	0.67	0.69	0.61	0.63	0.64

*Broiler premix furnishing the following ingredients per kg of feed:- Vit.A 12000 IU, vit.D3 2000 IU, vit.E 10 mg, folic acid 1mg, niacin 20mg, pantothenic acid 10mg, vit.k 2mg, vit.B1 1mg, vit.B2 4mg, vit.B6 1.5mg, vitB12 10µg, biotin 50 µg, iron 30mg, copper 10mg, zinc 55mg, manganese 55mg, iodine 1mg, selenium 0.1mg, choline chloride 500mg.

Table (2):-Body weight development (g/chick) of the experimental groups

Age (days)	Groups				
	1	2	3	4	5
0	41.0±4.00	40.0±3.96	42.0±3.52	40.0±3.80	39.0±3.15
21	425±13.10	455±13.35	485±12.95	459±13.50	491±11.50
28	620±24.13	680±24.50	720±24.92	687±23.90	735±25.01
35	987±26.10	1078±26.80	1180±27.30	1130±27.01	1198±27.41
42	1335±29.50	1528±30.42	1645±31.10	1615±30.80	1697±31.15
49	1611±31.10^{d*}	1830±32.15^{c}	1933±32.28^{b}	1920±32.70^{b}	2037±33.10^{a}

*Figures in the same row having the same superscripts are not significantly different (P<0.05).

Table (3):-Feed intake, weight gain (g/chick) and feed conversion of the experimental groups of chicks

Age (days)	Groups				
	1	2	3	4	5
Feed intake:					
0-21	800	820	840	827	845
22-49	2660	2746	2915	2798	2997
0-49	3460	2566	3755	3625	3842
Weight gain:					
0-21	384±13.10	415±13.35	443±13.60	419±13.30	452±13.70
22-49	1186±27.11	1375±29.87	1448±30.15	1461±30.01	1546±30.45
0-49	1570±30.25	1790±31.12	1891±32.70	1880±32.50	1998±23.60
Feed conversion:					
0-21	2.08±0.10	1.98±0.05	1.90±0.03	1.97±0.08	1.87±0.02
22-49	2.24±0.14	2.00±0.09	2.01±0.10	1.92±0.05	1.94±0.03
0-49	2.20±0.12	1.99±0.07	1.99±0.08	1.93±0.06	1.92±0.05

Table (4):-Abdominal fat, liver weight and dressing weight (without giblets) % of the experimental groups of chicks

Items	Groups				
	1	2	3	4	5
Abdominal fat	1.10±0.03^{b*}	1.17±0.05^{b}	1.25±0.07^{a}	0.97±0.02^{c}	1.14±0.05^{b}
Liver weight	2.51±0.05	2.75±0.09	2.92±0.10	2.65±0.07	2.80±0.08
Dressed carcass	71.78±4.50	78.96±4.70	68.24±4.10	80.55±5.30	74.96±5.10

*Figures in the same row having the same superscripts are not significantly different (P<0.05).

Table (5):-Blood serum cholesterol and total lipid of the experimental groups of chicks

Items	Groups				
	1	2	3	4	5
Cholesterol (mg/100 ml)	135 ±6.12^{c}	158 ±6.50^{b}	187 ±7.12^{a}	141 ±5.98^{b}	173 ±7.10^{a}
Total lipid (gm/litre)	8.35 ±1.25^{ab*}	9.82 ± 1.30^{ab}	12.30 ± 2.05^{a}	7.20 ±1.10^{b}	10.70 ±2.01^{a}

*Figures in the same row having the same superscripts are not significantly different (P<0.05).

Table (6): The economical evaluation of broiler performance as affected by L-carnitine supplementation*

Items	Groups				
	1	2	3	4	5
Feeding cost	3.11	3.21	3.38	3.26	3.46
Total production cost**	5.61	5.71	5.88	5.76	5.96
Net revenue***	0.83	1.61	1.85	1.82	2.19
Economic efficiency	14.80	28.20	31.46	33.33	36.74

* Calculated by LE.
** Total production cost/bird = Cost of feed/bird + cost of other various items of production
*** Net revenue = Total price of bird at market age - total production cost