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## L-carnitine improves egg production in black neck ostriches

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**Abstract.** The important functions of L-carnitine are fostering the oxidation of long-chain fatty acids by mitochondria and stimulating protein-sparing action by increasing energy derived from lipids. The present study was conducted to investigate dietary effects of L-carnitine on egg production of breeder ostriches. Ninety black neck ostrich breeder birds (60 females and 30 males) were examined randomly (completely randomised design) within three treatments and five replicates for 7 months in breeding season. A basal diet was formulated and used for the control group (L<sub>1</sub>), while two levels of L-carnitine, 250 mg/kg and 500 mg/kg, were included in the basal diet for treatments L<sub>2</sub> and L<sub>3</sub>, respectively. The egg production percentage, egg weight and defective eggshell percentage were measured. The supplementary diet with 500 mg/kg L-carnitine increased ( $P < 0.01$ ) the egg production percentage. Means ( $\pm$ s.e.) of egg production percentage for L<sub>1</sub>, L<sub>2</sub> and L<sub>3</sub> were 9.68, 12.95 and 17.13% ( $\pm$ 1.08), respectively. L-carnitine had no effect on the egg weight and the defective eggshell percentage. The results suggest that basal diet supplemented with 500 mg/kg L-carnitine can increase the egg production percentage of ostriches.

### Introduction

L-carnitine is a natural substance that acts in the cells as a receptor molecule for activated fatty acids. The formula for carnitine, original named vitamin Bt or B11, is C<sub>7</sub>H<sub>15</sub>NO<sub>3</sub> and the chemical name is L (-)-3-hydroxy-4-N,N,N-trimethylaminobutyrate. Isomers (D) and (L) are two chemical structures of carnitine but L is essential for both humans and animals (Harmeyer 2002).

A deficiency results primarily in impaired energy metabolism and membrane function. The highest synthesising capacity is found in the liver (Harmeyer 2002) and vitamin C or ascorbic acid is a cofactor during the two hydroxylation steps in the carnitine biosynthetic pathway (Neuman *et al.* 2000).

In neonates the capacity for endogenous synthesis is considerably restricted and develops only during early life; adult animals have the ability to synthesise the L-carnitine. In this process, the methyl group is derived from methionine while L-lysine provides necessary carbon chains and nitrogen. Vitamins B6, B12, C, folic acid, niacin and iron are also necessary for catalysis of the endogenous synthesis of L-carnitine. The major metabolic role of L-carnitine appears to be the transport of long-chain fatty acids into the mitochondria for  $\beta$ -oxidation. Long-chain fatty acids cannot enter the mitochondria and produce energy. In this process long-chain fatty acids are transferred to acyl-CoA. L-carnitine performs this shuttle function by replacing the CoA outside the mitochondrion and transporting the fatty acids into the mitochondrial matrix as acyl-carnitine. Acetyl-CoA is then regenerated by binding with CoA and releasing L-carnitine. Acyl-CoA enters the  $\beta$ -oxidation cycle and produces acetyl-CoA. Finally, acetyl-CoA enters the Krebs cycle and produces energy. Thus, energy production from long-chain fatty acids directly depends on carnitine (Harmeyer 2002).

The body cannot produce enough L-carnitine to fully cover its own needs thus it needs to be supplied with extra L-carnitine. L-carnitine occurs naturally in most foodstuffs in varying amounts. Foodstuffs of vegetable origin normally contain very little L-carnitine. Protein of animal origin (muscle tissue, blood meal, liver, etc.) and dairy products are rich in L-carnitine (Harmeyer 2002).

Leibetseder (1995) also reported that increasing L-carnitine in the feed of broiler breeders, influenced hatchability and produced an 83–87% increase in the hatching rate. A study by Rabie *et al.* (1997a) to determine the effect of L-carnitine supplementation on some indices of egg quality, showed that the percentage of egg white increased, while the percentage of egg yolk decreased with the corresponding increase of L-carnitine in the diet. However, dietary L-carnitine did not influence laying performance or external egg quality. With laying broiler hens, supplemental dietary L-carnitine resulted in an improvement in the albumen quality of eggs, measured as albumen height and Haugh unit score, during the early and late stages of the laying period (Rabie *et al.* 1997a, 1997b). With the increase of the L-carnitine supplement for broiler breeders, an increase occurred in the amount of L-carnitine in the yolk, as well as an increase in the hatching percentage (Tizler 1993). Çelik *et al.* (2004) conducted a study to investigate the effect of L-carnitine, supplied in drinking water, on the performance and egg quality of laying hens under high environmental temperature. Relative albumen weight and height were increased significantly by supplemental L-carnitine. Liveweight gain, feed intake, egg mass, egg weight, yolk weight, shell weight, yolk index, egg-shape index, yolk colour score and shell thickness were not affected by L-carnitine. The effect of L-carnitine and

magnesium on breeder ostriches was determined by Davis *et al.* (1997). Results from this study showed that the treated breeders started egg production sooner and produced more eggs than the untreated breeders. However, there are few scientific publications that deal with the effect of L-carnitine on the egg production of birds (Leibetseder 1995; Rabie *et al.* 1997a; Neuman *et al.* 2000).

The main objective of the present study was to assess the effect of a diet supplemented with L-carnitine on egg production of female ostrich breeders during the laying period.

## Materials and methods

### Experimental animals, location and design

This trial was carried out at the Iran Ostrich Research Company (Tehran) using 60 female and 30 male breeders, forming 15 units (breeder pens) consisting of four females and two males. At the beginning of the trial, all breeders were 5-year-old South African black neck ostriches. They were selected from ostriches that had a steady production rate during the previous two breeding seasons. The trial was conducted over a 7-month period, from the beginning of March to the end of September 2005.

### Experimental treatments

Fifteen experimental units were distributed randomly in three equal treatment groups with five replicates. The treatments were: L<sub>1</sub>, control group (basal diet); L<sub>2</sub>, control group + 250 mg L-carnitine per kg feed; and L<sub>3</sub>, control group + 500 mg L-carnitine per kg feed. The L-carnitine was supplied as a white powder with 20% purity (Lohmann Co., Cuxhaven, Germany).

### Basal diet fed to ostriches

Composition and proximate analyses of the basal diet are indicated in Table 1. Each ostrich breeder received 2.3 kg of diet once a day between 0900 and 1000 hours.

### Measurements

Mating occurred naturally and the eggs were collected each day at sunset. Data recorded were: the number of eggs laid, egg weight and the number of the experimental units. The fresh eggs were then sorted and the defective eggs were removed. Defective eggs, including deformed eggs, chalky eggs, cracked eggs and eggs without calcite shell membranes were not incubated.

Eggs production, egg weight and the number of defective eggshells were recorded and converted to percentages: (i) egg production percentage (EPP, North and Bell 1990) in each experimental group was calculated by dividing the number of eggs laid by the number of ostrich days in a month multiplied by 100; (ii) average weight of the eggs was calculated by dividing the total egg weight by the total number of produced eggs in each month for the experimental unit; and (iii) defective eggshell percentage (DEP) in each experimental group was calculated by dividing the number of defective eggshells by the total number of eggs produced in a month. Egg production percentage, egg weight (g) and DEP were statistically analysed during the whole period and monthly.

## Statistical analysis

The statistical analysis model used was:

$$Y_{ij} = \mu - t_i - \varepsilon_{ijk}$$

where  $Y_{ij}$  is any observation for which  $X_1 = i$  ( $i$  and  $j$  denote the level of the factor and the replication within the level of the factor, respectively);  $\mu$  is the general location parameter;  $T_i$  is the effect of having treatment level  $i$ ; and  $\varepsilon_{ijk}$  is random error. The statistical analysis of data was performed using the SAS (SAS Institute 1986) program based on ANOVA. Significant differences between means were determined using Duncan's multiple range test (Duncan 1955).

## Results

The effects of L-carnitine on egg production are presented in Table 2. The inclusion of L-carnitine in the diet of ostrich breeders significantly ( $P < 0.05$ ) increased egg production with the highest difference occurring between treatments L<sub>1</sub> and L<sub>3</sub>. There was no significant difference between the averages of egg production in treatment L<sub>2</sub> with treatments L<sub>1</sub> and L<sub>3</sub>. There was no significant difference in egg weights between the different treatments for the duration of the trial period (Table 2).

The effect of L-carnitine on the means of defective eggshell for the different treatments is shown in Table 2; however, there was no significant difference between the different treatments for the trial period.

## Discussion

The influence of dietary L-carnitine supplementation on egg production and fertility of ostriches was previously investigated by Davis *et al.* (1997). In their report, the supplement was given to the treatment group in drinking water at a rate of 1 mL/bird.day. Results from that study showed that the treated

**Table 1. Composition and proximate analyses of the basal diet of the ostrich (Aganga *et al.* 2003)**

Components of diet	Amount in diet (%)
Yellow maize	22.63
Alfalfa hay	23.14
Soybean oilcake meal	13.6
Wheat bran	18
Sunflower oilcake meal	12.32
Vegetable oil	1.33
Salt	0.43
Dicalcium phosphate	1.37
Limestone	5.93
DL-methionine	0.25
Vitamin and mineral premix	1
Calculated nutrient content	
TME <sub>n</sub> (Kcal/kg) <sup>A</sup>	2600
Crude protein (%)	16
Crude fibre (%)	12.72
Calcium (%)	3
Available phosphorus (%)	0.5
Sodium (%)	0.22
Lysine (%)	0.7
Methionine + cysteine (%)	0.5

<sup>A</sup>TME<sub>n</sub>, true metabolisable energy corrected for nitrogen retention.

**Table 2. The effect of added L-carnitine on ostrich egg production (%), egg weight (g/month) and defective eggshells (%) over the trial period**  
Within columns, means followed by different letters are significantly different at  $P = 0.05$

L-carnitine treatment	Mar.	Apr.	May	June	July	Aug.	Sept.	Whole period
<i>Egg production (%)</i>								
L <sub>1</sub> (0 mg/kg)	7.93b	9.83b	13.22b	8.54b	9.35b	9.19b	9.67b	9.68b
L <sub>2</sub> (250 mg/kg)	10ab	14.67a	16.61ab	14.51a	10b	13.38ab	11.45b	12.95ab
L <sub>3</sub> (500 mg/kg)	14.13a	17.09a	20.96a	17.09a	14.51a	18.22a	17.90a	17.13a
s.e.m.	1.41	1.54	1.54	0.96	1.34	1.84	1.95	1.08
<i>Egg weight (g/month)</i>								
L <sub>1</sub> (0 mg/kg)	1606.8	1614.8	1634.2	1640	1619.6	1625.2	1621	1628.49
L <sub>2</sub> (250 mg/kg)	1607.8	1619.8	1651	1649.4	1629.2	1646.4	1627.8	1632.37
L <sub>3</sub> (500 mg/kg)	1618.4	1637	1675.8	1666.6	1630.4	1649.4	1636.4	1640.14
s.e.m.	54.21	55.61	57.68	66.97	58.11	52.61	52.44	54.72
<i>Defective eggshells (%)</i>								
L <sub>1</sub> (0 mg/kg)	7.89	4.34	4.46	5.54	5.37	7.06	11.94	6.65
L <sub>2</sub> (250 mg/kg)	9.25	8.72	4.77	7.49	8.36	8.21	13.62	8.63
L <sub>3</sub> (500 mg/kg)	13	9.48	6.79	9.17	13.67	9.21	13.86	10.74
s.e.m.	2.87	2.86	1.64	1.82	2.81	2.63	5.16	1.14

breeders started egg production sooner and produced more eggs than the untreated breeders. The positive effects of supplemental L-carnitine on egg production in the present study support the finding reported by Davis *et al.* (1997). These authors also found that the correction of the L-carnitine deficiencies has a secondary stimulatory effect on steroid metabolism, especially the sex steroids. However, this observation requires further work in the future.

Although studies on the effect of L-carnitine on ostriches are limited, there are studies which have been conducted on other bird species. Golzar Adabi *et al.* (2006) found that L-carnitine had a significant effect on the egg production of broiler breeders in the fifth and sixth weeks of a 6-week trial. They concluded that since L-carnitine plays a well-established role in the metabolism of lipids, so it may induce some favourable modification in poultry products, particularly eggs and meat. Çelik *et al.* (2004) found that L-carnitine had no effect on liveweight gain, feed intake, egg mass, egg weight, yolk weight, shell weight, yolk index, egg shape index, yolk colour score and shell thickness. Suchy *et al.* (2008) studied the effect of a diet supplemented with L-carnitine on egg weight and laying rate in hens of pheasant (*Phasianus colchicus*). The experimental hens were supplemented with L-carnitine at a level of 0.01%. The results of this study showed that L-carnitine increased egg weight and laying rate. However, the result of egg production in other birds in the present study corresponds with the results from Suchy *et al.* (2008) and part of a study conducted by Golzar Adabi *et al.* (2006). But some researchers suggest that dietary L-carnitine does not influence laying performance. Rabie *et al.* (1997a, 1997b) found that L-carnitine had no effect on the external quality of the egg (i.e. egg weight, eggshell index, shell breaking, breaking strength, shell weight, and shell thickness). Yalcin *et al.* (2006) indicated that feeding ostriches diets supplemented with L-carnitine and humic substances did not significantly affect egg traits (daily feed intake, daily metabolisable energy intake, egg production, egg weight, feed efficiency, mortality, egg shape index, egg breaking strength, eggshell thickness, egg albumen index, egg yolk index, egg

Haugh unit and the percentage of eggshell, albumen and yolk). The evidence would suggest that these different expressions in animals' response to the dietary carnitine are mainly related to species differences, age, sex, nutrition, the situation and environment in which the animals are breeding, and the nutrient composition of their diets (Rabie *et al.* 1997a, 1997b).

Kita *et al.* (2005) studied the effect of L-carnitine supplementation (0, 25, 50 and 200 mg/kg) on egg weight, albumen height, Haugh unit, yolk weight and albumen weight of eggs from laying hens. Overall, egg weight was not affected by dietary L-carnitine supplementation. The present study showed that different levels of L-carnitine had no effect on egg weight or the numbers of defective eggshells produced during the trial period. This coincides with findings by Çelik *et al.* (2004), Kita *et al.* (2005) and Rabie *et al.* (1997a, 1997b). Further research is necessary to study the full impact of L-carnitine on egg production of ostrich breeders.

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### References

- Aganga AA, Aganga AO, Omphile UJ (2003) Ostrich feeding and nutrition. *Pakistan Journal of Nutrition* 2(2), 60–67.
- Çelik LB, Tekeli A, Öztürkcan O (2004) Effects of supplemental L-carnitine in drinking water on performance and egg quality of laying hens exposed to a high ambient temperature. *Journal of Animal Physiology and Animal Nutrition* 88(5–6), 229–233. doi:10.1111/j.1439-0396.2004.00477.x
- Davis HJ, Ganzevoort B, Blum R, Naude R, Mienie J (1997) The effect of L-carnitine and magnesium supplement on egg production and fertility of ostrich. *Australian Ostrich Journal* (June), 39–40.
- Duncan DB (1955) Multiple range and multiple F tests. *Biometrics* 11, 1–42. doi:10.2307/3001478

- Golzar Adabi Sh, Moghaddam Gh, Taghizadeh A, Nematollahi A, Farahvash T (2006) Effect of L-carnitine and vegetable fat on broiler breeder fertility, hatchability, egg yolk and serum cholesterol and triglyceride. *International Journal of Poultry Science* **10**, 970–974.
- Harmeyer J (2002) The physiological role of L-carnitine. *Lohman Information* **27**, 15–21.
- Kita K, Nakajima Sh, Nakagawa J (2005) Dietary L-carnitine supplementation improves albumen quality of laying hens. *Japanese Poultry Science* **42**, 79–83. doi:10.2141/jpsa.42.79
- Leibetseder J (1995) Studies on effects of L-carnitine in poultry. *Archives of Animal Nutrition* **48**, 97–108.
- Neuman SL, Lin T, Hester PY (2000) The effect of dietary carnitine on semen traits of white leghorn roosters. *Poultry Science* **81**, 495–503.
- North MO, Bell DD (1990) 'Commercial chicken production manual.' (Van Nostrand Reinhold: New York)
- Rabie MH, Szilagy M, Gippert T (1997a) Effect of dietary L-carnitine on the performance and egg quality of laying hens from 65–73 weeks of age. *The British Journal of Nutrition* **78**, 615–623. doi:10.1079/BJN19970178
- Rabie MH, Szilagy M, Gippert T (1997b) Influence of supplemental dietary L-carnitine on performance and egg quality of pullets during the early laying period. *Allattenyesztes es Takarmanyozas* **46**, 457–468.
- SAS Institute (1986) 'SAS user's guide: statistics.' (SAS Institute: Cary, NC)
- Suchy P, Strakova E, Vitula F (2008) The effect of a diet supplemented with L-carnitine on egg production in pheasant (*Phasianus colchicus*). *Czech Journal of Animal Science* **53**, 31–35.
- Tizler R (1993) Study effects of L-carnitine on hatching rate of chickens. *Veterinary Medicine* **80**, 10.
- Yalcin S, Ergin A, Özsoy B, Yalcin S, Erol H, Onbasilar I (2006) The effects of dietary supplementation of L-carnitine and humic substances on performance, egg traits and blood parameters in laying hens. *Asian-Australasian Journal of Animal Sciences* **19**, 1478–1483.

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