

The effects of different levels of L-carnitine and fat on performance and egg quality of laying hens

M.REZAEI^{1*}, S.DEHGHANI¹, J.A.GHAFFARI¹, and A.HAGHNAZAR²

¹Dept. of Animal Science, Faculty of Animal Science and Fisheries, Mazandaran University, P. O. Box 578, Sari, Iran, ²Mazandaran Agricultural Research Center, Sari, Iran

*Corresponding author: m.rezaei@umz.ac.ir

L-carnitine is used as feed additive in poultry diets to increase yield and to improve feed efficiency. The major role of L-carnitine appears to be the transport of long-chain fatty acids into mitochondria for β oxidation. This experiment was conducted to study the effect of two levels of fat (10 and 30 g/kg) and two levels of L-carnitine (0 and 250 mg/kg) on performance, egg quality, and blood parameters of laying hens in a factorial arrangement (2 \times 2) with completely randomized design with six replicates and four laying hens in each replicate. During the experiment feed intake, egg weight, egg production, feed conversion ratio, and blood parameters (triglyceride, cholesterol, LDL, HDL), egg quality (albumen height, egg shell thickness, egg shell breaking strength), and cholesterol content of eggs were measured. Results indicated that supplementation of L-carnitine in diets hadn't significant effect on performance, cholesterol content of eggs, but decreased the levels of triglyceride, cholesterol, LDL in blood serum and increased albumen height of eggs significantly ($P < 0.05$). Supplementation of fat significantly increased feed intake and egg weight ($P < 0.05$), but hadn't significant effect on blood serum parameters, egg quality and cholesterol content of eggs.

Keywords: L-carnitine; fat; egg quality; cholesterol; laying hens

Introduction

L-carnitine (β -hydroxy γ -trimethyl amino butyrate) is a water-soluble quaternary amine that exists naturally in micro-organisms, plants and animals and is required for the long chain fatty acid transfer from cytoplasm to mitochondrial matrix for subsequent β -oxidation and energy production (Bremer, 1983). L-carnitine is used as feed additive in poultry diets to increase yield and to improve feed efficiency. Plants and plant-based feedstuffs generally contain very little carnitine compared with animal (Baumgartner, and Blum, 1993, 1997). The concentration of carnitine in animals varies widely across species, tissue type, and nutritional status of the animal (Rabie et al., 1997). L-Carnitine is biosynthesized in vivo from lysine and methionine (Rebouche and Paulson, 1986) in the presence of ferrous ions and three vitamins, ascorbate, niacin, and pyridoxine that are required as cofactors for the enzymes involved in the metabolic pathway of L-carnitine (Bieber, 1998, Feller, Rudman, 1987, Rebouche, C. J. 1991). Several reports on broiler and pig have demonstrated that growth performance can be improved by feeding supplementary dietary L-carnitine (Weeden et al, 1991, Lettner et al, 1992). There are limited papers about the effects of carnitine supplementation of laying hen diets on laying performance and egg quality (Leibetseder, 1995, and Rabie et al. 1997). Supplemental fat also had significant effect on breast meat percentage and fat content of breast meat and increases feed efficiency in broiler chicks and to improve egg weight in laying hens. Therefore the aim of this study was to determine the effects of the dietary L-carnitine and supplemental fat on laying performance, blood parameters and egg quality of laying hens.

Materials and methods

This experiment was conducted on 96 one year old Leghorn-type hens from May to July 2006 in poultry center, school of Agriculture in Sari, Iran. Leghorn-type laying hens were housed in individual cage and kept under similar management condition. Before the experiment, egg production of hens was measured and hens were distributed among cages on equal egg production basis. The size of each cage was (41×23×43) cm and 4 cages were considered to be one replicate. Diets were formulated basis on linear programming by using of UFFDA software. The amount of main ingredients in diets was about 680 g/kg corn, 230 g/kg soybean meal, 80 g/kg oyster shell. Metabolizable energy, crude protein and other nutrients in all diets were similar. Feed and water were provided *ad-libitum* during the experiment. This experiment lasted 10 weeks. During of the experiment daily feed intake, egg weight, egg production, feed conversion ratio was measured weekly. Egg quality (albumen height, shell thickness, shell breaking strength) and cholesterol content of eggs were measured bi-weekly during the experiment. In the end of the experiment blood samples from wing vein of two hens in each replicate were gotten and cholesterol, triglyceride, HDL, LDL of serum was measured (AOAC, 1984). The model of experiment was factorial arrangement with completely randomize design (CRD), and there were 4 treatments (2 levels of L-carnitine and 2 levels of fat), 6 replicates and 4 hens in each replicate. The data from this experiment were subjected to one-way analysis of variance by using of SAS software (SAS Institute, 1998). The differences among means were compared by the Duncan's multiple range test at $P < 0.05$ (Steel and Torrie, 1980).

Results and discussion

The effects of L-carnitine and fat on laying performance are shown in Table 1. Adding L-carnitine to laying hen diets hadn't significant effect on feed intake, egg production, egg weight, and feed conversion ratio. Use of supplemental fat in diets had significant effect on feed intake and egg weight ($p < 0.05$), but hadn't significant effect on other above traits. Use of supplemental fat in poultry diets reduces the dustiness and increases the palatability and due to these reasons the feed intake increases (Fedd et al, 1960). It was also reported that use of fat in laying hens diets increases the egg weight due to increasing the level of linoleic acid (Summers and Lesson, 1983). Interaction of L-carnitine and supplemental fat had not significant effect on performance. Effects of L-carnitine and fat on blood parameters are presented in Table 2. Adding L-carnitine to diets decreased triglyceide, cholesterol, and LDL levels in blood serum significantly ($p < 0.05$). Reducing of triglyceride level in bloos serum of hens fed with diets containing 250 mg/kg L-carnitine is probably related to increasing β -oxidation of fatty acids in inner mitochondria membranes (Xu et al., 2003). Lien and hong reported that activity of carnitine palmitoeil transferase enzyme increased in chicks fed with diets containing supplemental L-carnitine. This enzyme has key role in β -oxidation of lipids and decreases the secretion of VLDL in liver. Supplemental fat hadn't significant effect on blood parameters. Effects of L-carnitine and fat on egg quality indices and cholesterol content of eggs are shown in Table 3. Increasing the level of L-carnitine from 0 to 250 mg/kg diets improved albumen height significantly ($p < 0.05$), but hadn't significant effect on egg shell thickness, shell breaking strength, and cholesterol content of eggs. Interaction of L-carnitine and supplemental fat was not significant for egg quality traits. Results of the present study showed positive effect of fat on feed intake and egg weight, and significant effect of L-carnitine on decreasing of serum triglyceride, cholesterol, LDL level, and increasing of albumen height of laying hens.

Table 1 Effect of different levels of L-carnitine and fat on performance of laying hens

L-carnitine (mg/kg)	0		250		SEM
Fat (g/kg)	10	30	10	30	
Traits					
Feed intake (g/d)	112.5 ^b	118.9 ^a	112.5 ^b	119.08 ^a	0.517
Egg production (%)	77.83	77.16	74.00	75.66	2.50
Egg weight (g)	59.54 ^b	62.20 ^a	59.38 ^b	61.68 ^a	0.636
FCR	1.90	1.91	1.85	1.91	0.026

Means with different superscripts in each rows are significantly different (p<0.05).

Table 2 Effect of different levels of L-carnitine and fat on blood serum parameters (mg/dl)

L-carnitine (mg/kg)	0		250		SEM
Fat (g/kg)	10	30	10	30	
Traits					
Triglycerides	66.68 ^a	66.79 ^a	58.79 ^b	58.65 ^b	0.83
Cholesterol	130.99 ^a	130.64 ^a	113.82 ^b	115.98 ^b	2.93
LDL	70.44 ^a	69.61 ^a	61.01 ^b	64.57 ^b	2.41
HDL	51.47	52.79	52.89	53.12	2.36

Means with different superscripts in each rows are significantly different (p<0.05).

Table 3 Effect of different levels of L-carnitine and fat on egg quality indices and cholesterol content of eggs

L-carnitine (mg/kg)	0		250		SEM
Fat (g/kg)	10	30	10	30	
Traits					
Albumen height (mm)	6.51 ^b	6.36 ^b	7.2 ^a	7.02 ^a	0.127
Egg shell thickness (mm)	0.47	0.47	0.47	0.47	0.004
Egg shell breaking strength (kg/cm ²)	0.67	0.71	0.72	0.71	0.085
Cholesterol content of egg (mg/g yolk)	202.33	212.36	205.98	207.64	3.412

Means with different superscripts in each rows are significantly different (p<0.05).

References

- ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS.** (1984) Official Methods of Analysis. 14th ed. S. Williams, ed. AOAC, Arlington, Virginia.
- BAUMGARTNER, M., and BLUM R.** (1997) Typical L-carnitine contents in feedstuffs. In L-carnitine Folder, Lonza Ltd., Basel.
- BAUMGARTNER, M., and BLUM R.** (1993) L-carnitine in animal nutrition. Pages 413–418 in vitamins and weitere zusatzstoffe bei mensch und tier (vitamins and other supplements for humans and animals). G. Flachowsky and R. Schubert, ed. Friedrich-Schiller Univ., Jena, Germany.
- BIEBER, L. L.** (1988) Carnitine. *Annu. Rev. Biochem.* **57**:261–283.
- BREMER, J.** (1983) Carnitine: metabolism and functions. *Physiol. Review*, **63**: 1420- 1480.
- FEDD, M. R, WAIBLE, P.E. AND BURGER, R.E.** (1960) Factors affecting the absorbability of certain dietary fats in the chicks. *J. Nutr.* **70**:447-452.

- FELLER, A.G., and RUDMAN, D.** (1988) Role of carnitine in human nutrition. *J. Nutr.* **118**:541–547.
- LEIBETSEDER, J.** (1995) Studies of L-carnitine effects in poultry. *Arch. Anim. Nutr.* **48**:97–108.
- LETTNER, V.F., ZOLLITSCH W., and HALBMAYER, E.** (1992) Use of L-carnitine in the broiler ration. *Bodenkultur* **43**:161-167.
- LIEN, T.F. and HORNG Y.M.** (2001) The effect of supplementary dietary L-carnitine on the growth performance, serum component, carcass traits and enzyme activities in relation to fatty acid β -oxidation of broiler chicks. *Brit. Poult. Sci.* **42**: 92-95.
- RABIE, M. H., SZIIAGYI, M., GIPPERT T., VOTISKY. E., and GERENDAI. D.** (1997) Influence of dietary L-carnitine on performance and carcass quality of broiler chickens. *Acta Biol. Hung.* **48**:241–252.
- RABIE, M.H., and SZIIAGYI, M.** (1998) Effects of L-carnitine supplementation of diets differing in energy levels on performance, abdominal fat content, and yield and composition of edible meat of broilers. *Br. J. Nutr.*, **80** (4): 391-400.
- SAS INSTITUTE.** (1998) SAS/STAT User,s Guide. Release Version 7.00. SAS Institute Inc. Cary. NC.
- STEEL, R. G. D., and TORRIE. J.H** (1980) Principle and procedures of statistics. 2th ed. McGraw-Hill book Co. Inc. New York.
- SUMMERS, J.D, and LESSON, S.** (1983) Factors effecting early egg size. *Poult. Sci.* **62**:1155-1159.
- WEEDEN, T.L., NELSEN, J.A., HANSEN, G.E., FITZNER, G.E. and GOODBAN. R.D.** (1991) The effect of L-carnitine on starter pig performance and carcass composition. *J. Anim. Sci.* **69** (Suppl.) 105(Abstr)
- XU, Z.R., WANG, M.Q, MAO, H.X., ZHAN, X.A, and HU, C.H.** (2003) Effects of L-carnitine on growth performance, carcass composition, and metabolism of lipids in male broilers. *Poult. Sci.* **82**: 408-413.