Effect of Feed Additive on Base of L-carnitine in Drinking Water on Internal and External Egg Quality

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Abstract
The objective of present study was to investigate the effect of feed additive on base of L-carnitine (30%) on some parameters of egg quality. Totally 40 White Leghorn laying hens were divided in two groups: control group (n=20) received drinking water without any additives and experimental group (n=20) received feed additive in dose 1 ml per 1.2 l of drinking water for a period of 5 days in 2 week intervals from 26 to 56 week of age. Hens in both groups were feeding ad libitum with commercial layer diet. A total of 200 eggs (100 eggs from both group) were collected to study for external and internal quality of eggs. Albumen index and Haugh unit were improved ($p<0.05$), while yolk index and yolk color were not affected by administration of L-carnitine ($p>0.05$). The albumen percentage increased ($p<0.05$) and that yolk percentage decreased ($p<0.05$) in response to supplementation of L-carnitine. Addition of L-carnitine did not influence egg weight, egg shape index and egg shell quality (shell percentage, shell thickness, shell strength).

Key words: egg quality, feeding, hen, laying, L-carnitine.

1. Introduction

L-carnitine is a water-soluble quaternary amine with a low molecular weight, and occurs naturally in microorganisms, plants and animals [1].
L-carnitine is synthesized in vivo 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 [2-4].
It has been reported that L-carnitine has two major functions. The best known is to facilitate the transport of long-chain fatty acids across the inner mitochondrial membrane. L-carnitine also facilitates the removal of short and medium-chain fatty acids from the mitochondria that accumulate as a result of normal and abnormal metabolism [5-7].
Thus, dietary L-carnitine supplementation promotes the β-oxidation of these fatty acids in order to generate adenosine triphosphate (ATP) energy and improve energy utilization [8-10].
Consequently, L-carnitine supplementation in diets reduces the amount of long-chain fatty acids availability for esterification to triacylglycerols and storage in the adipose tissue [7, 11].
In addition, L-carnitine has secondary functions, including the containment, buffering and removal of potentially toxic acyl groups from cells, equilibrating the ratio of free CoA and acetyl-CoA between the mitochondria and cytoplasm, participating in biological processes such as regulation of gluconeogenesis, stimulating fatty acid and the

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metabolism of ketones, branched-chain amino acids, triglycerides and cholesterol [10].

Poultry diets are composed mainly of maize and soyabean and plant products are low in carnitine, while animal-derived feedstuffs are rich in L-carnitine. Poultry feeds contain high percentages of cereals and this situation may lead to a deficiency of carnitine [12,13].

Consequently, L-carnitine supplementation in diet or in drinking water would be useful for poultry [13-15].

The objective of this study was to evaluate the effect of feed additive on base of L-carnitine supplementation on external and internal egg quality parameters of hens during laying period.

2. Materials and methods

Hens were placed in outdoor unheated breeding pens with free range. Birds were exposed to natural light as a practiced in rural areas of South-West Slovakia.

A total 40 White Leghorn hens were randomly divided into two groups (control and experimental – preparation with 30 % of L-carnitine). Laying hens in the control (C, n=20) and experimental groups (E, n=20) received a feed of the same nutritional value and laying hens from experimental group were supplemented drinking water by feed additive (Biofaktor, Sp. z.o.o., Skierniewice, Poland) on the base L-carnitine (30.00 %), arginin chloride (19.33 %), taurine (13.33 %), magnesium gluconate (6.67 %), N-acetylocysteine (6.67 %), biotine (0.00667 %), sorbitol (0.30 %), aromatic additives (5.28 %) and vehiculum (wheat feed flour ad 1000 g). Laying hens were feeeding ad libitum with commercial layer diet (Mevit s.r.o, Dvory nad Žitavou, Slovak Republic). The nutritive values of the feed mixture are presented in Table 1.

Table 1. Nutritional value in 1 kg complete feed mixture

Nutrient	Unit	Value
Metabolizable energy	MJ	11.50
Crude protein	g	153.00
Fat	g	24.00
Fibre	g	60.00
Lysine	g	7.00
Methionine	g	3.50
Calcium	g	28.00-45.00
Phosphorus	g	5.00
Sodium	g	1.20-2.50
Cooper	mg	4.00
Zinc	mg	60.00
Manganese	mg	40.00
Iron	mg	40.00
Vitamin A	m.j.	8000.00
Vitamin D_3	m.j.	1600.00
Vitamin E	mg	10.00

The study was performed in the laboratory of the Department of Poultry Science and Small Animal Husbandry at the Faculty of Agrobiology and Food Resources of Slovak University of Agriculture in Nitra. A total of 200 eggs (100 eggs from both group) were collected to study for external and internal quality of eggs.

Egg weight was individually determined to 0.01g accuracy using a laboratory scale Owa Labor (VEB Wägetechnik Rapido, Germany). Egg length (along the longitudinal axis) and egg width (along the equatorial axis) were measured with a micrometer. Egg shape index was calculated as the ratio of egg width to length (%) by the method of [16].

After the eggs were broken, egg shells were washed with water and dried in order to clean the remaining albumen. Following this procedure, shell weight (with membrane) was measured using a laboratory scale Owa Labor (VEB Wägetechnik Rapido, Germany) and the percentage proportion of the shell in the egg was determined. Shell thickness (with membrane) was measured at the sharp poles, blunt poles and equatorial parts of

each egg. Shell thickness was obtained from the average values of these three parts. The egg shell strength was determined manually using an Egg Crusher device (VEIT Electronics, Moravany, Czech Republic).

The albumen weight was calculated from the difference between the egg weight, and the yolk and shell weight and the percentage proportion of the albumen in the egg was determined. Albumen index (%) was determined by the method of [17] on the basis of the ratio of the thick albumen height (mm) measurement taken with a micrometer to the average of width (mm) and length (mm) of this albumen with 0.01 mm accuracy. Haugh unit was calculated according to the procedure of [18].

Yolk weight with 0.01 g accuracy was determined using the laboratory scale Owa Labor (VEB Wägetechnik Rapido, Germany) and its percentage proportion was calculated. Yolk index (%) was measured on the basis of the ratio of the yolk height (mm) to the yolk width (mm) by the method of [19] using micrometer with 0.01 mm accuracy. Yolk colour was determined with the scale of Hoffman La Roche (Hoffman–La Roche, Switzerland).

Data were analyzed using analysis of variance [20]. Significant difference was used at 0.05 probability level and differences between groups were tested using the Duncan's Multiple Range Test [21].

3. Results and discussion

The effects of dietary L-carnitine on egg quality of laying hen are shown in Table 2.

In this experiment, application of L-carnitine in feed additive not affect egg weight, which is in agreement with the findings of [22,23]. [22] reported that supplementation of 50, 100, or 500 ppm of dietary L-carnitine did not affect egg weight during the late laying period from 65 to 73 wk in a Hungarian brown hybrid line. These investigators also reported a lower yolk percentage in eggs of hens consuming dietary L-carnitine. [23] reported that egg weight was not affected by supplementation of 50 ppm of L-carnitine in the drinking water of 47-wk-old laying hens for 8 wk. Also [24] found that supplementation of L-carnitine to hen diets did not affect egg weight.

Table 2. Effect of feed additive on base of L-carnitine on egg quality

Parameter	Control	Experimental
Egg weight (g)	61.27±5.06	61.69±5.24
Egg shape index (%)	75.69±2.24	75.79±2.17

Values shown are mean ± SD (standard deviation)

Table 3 shows that values of albumen index and Haugh unit were increased by addition of carnitine [22] in laying hens. They concluded that L-carnitine has a beneficial effect on albumen quality and could modify the components of the edible part of the egg.

Table 3. Effect of feed additive on base of L-carnitine on albumen quality

Parameter	Control	Experimental
Albumen weight (g)	36.71±2.86	37.38±2.38
Albumen percentage (%)	59.95±3.05	60.62±3.27[b]
Albumen index (%)	87.11±11.29	89.83±11.76[b]
Haugh units	87.53±3.28	89.92±3.44[b]

Values shown are mean ± SD (standard deviation)

As shown Table 4, in agreement with this experiment, [22] reported that L-carnitine supplemented diets decreased ($p<0.01$) yolk weight and yolk percentage. An additional possibility is that the presence of carnitine in the yolk may have affected the efficiency of enzymes involved in fatty acid metabolism. L-carnitine plays a well established role in lipid metabolism, so it may induce some favourable modifications in poultry products, particularly eggs and meat [25].

Table 4. Effect of feed additive on base of L-carnitine on yolk quality

Parameter	Control	Experimental
Yolk weight (g)	18.42±1.89[a]	16.12±1.62
Yolk percentage (%)	30.01±1.76[a]	29.55±1.72
Yolk index (%)	52.17±2.53	52.11±2.51
Yolk colour (°LR)	10.27±1.18	10.34±1.22

Values shown are mean ± SD (standard deviation)

The effects of dietary L-carnitine on egg quality of laying hen are shown in Table 5. In this study, feeding supplemental carnitine had no effect on egg shell breaking strength and egg shell thickness. [26] also reported that the feeding of supplemental carnitine to laying quails had no effect on egg shell thickness. Similar to the results of the present study, egg shell thickness was not affected by carnitine [22].

Table 5. Effect of feed additive on base of L-carnitine on egg shell quality

Parameter	Control	Experimental
Egg shell weight (g)	6.15±0.67	6.07±0.56
Egg shell percentage (%)	10.04±0.58	9.83±0.47
Egg shell thickness (μm)	379.18±22.53	677.53±21.49
Egg shell strength ($N.cm^{-2}$)	29.84±4.96	29.78±4.62

Values shown are mean ± SD (standard deviation)

4. Conclusions

In the study, data revealed that addition of feed additive on base of L-carnitine resulted positive affected albumen quality parameters but decreased some yolk parameters. The experiment indicated non significant effect of L-carnitine supplementation on egg and egg shell quality parameters.

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