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EFFECT OF DIETARY SUPPLEMENTATION OF L-CARNITINE ON SERUM LIPID PROFILE AND ANTIOXIDANT STATUS IN BROILER CHICKEN FED WITH ANIMAL FAT-RICH DIET

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ABSTRACT

A study was conducted to evaluate the effects of L-carnitine supplementation on serum lipid profile and antioxidant status of broilers fed with animal fat-based diet. Eighty days old straight run commercial broiler chicks (Vencobb) were randomly grouped into two treatment groups with four replications of ten chicks each. The rations were prepared with 5% animal fat. One group was supplemented with 900 mg L-carnitine kg^{-1} feed. The L-carnitine supplementation significantly reduced the serum cholesterol and LDL cholesterol levels; whereas serum triglyceride, HDL-cholesterol and VLDL-cholesterol levels didn't show any significant changes. The serum reduced-glutathione and superoxide dismutase concentrations were significantly higher in L-carnitine supplemented group. The study revealed that the supplementation of L carnitine not only improves the immune status but also decreases the serum cholesterol and LDL cholesterol level in broiler birds.

Keywords: Broiler chicks, L-carnitine, reduced glutathione, serum cholesterol, superoxide dismutase

INTRODUCTION

Feed cost alone contributes 70% of the total cost of production in poultry farming and almost 40-50% of the cost is to meet the energy needs of the total feed cost (Thirumalaisamy *et al.*, 2016). One of the ways to reduce the feed cost for broiler birds is through the use of cheap and easily available energy source which produces more growth rate per unit cost (Tallentire *et al*., 2018). Nowadays, animal fat is widely used in broiler rations as an energy source due to its availability, high energy content and low cost. But the addition of animal fat may result in fat depositions undesirable to the health-conscious consumers and lipid oxidation which causes quality deterioration in meat (Lawlor *et al*., 2003). This could be avoided by inclusion of feed additives in broiler diets containing animal fat (Cakir and Yadav, 2007).

Carnitine (β-hydroxy γ-trimethylaminobutyrate) is a water-soluble quaternary amine compound which is available in two types of stereo-isomeric forms, L and D (Zeyner *et al*., 1999). L-carnitine helps in the transfer of long-chain fatty acids from the cytoplasm to mitochondria for β-oxidation and energy production. Thus it reduces long-chain fatty acid availability for esterification

to triacylglycerols and storage in adipose tissue. (Ardekani *et al*., 2012). It also acts as an antioxidant by increasing the level and activity of enzymes like superoxide dismutase, lipid peroxidase and reduced glutathione (Neuman *et al*., 2002). Keeping in view the key role of L-carnitine in lipid metabolism and antioxidant properties, the present study was undertaken with the objective to evaluate the effects of L-carnitine supplementation in animal fat-rich diet on serum lipid profile and antioxidant status in broiler birds.

MATERIALS AND METHODS

The experiment was carried out in accordance to the National regulations on animal welfare and necessary approval for conducting the study was obtained from the Institutional Animal Ethical Committee. The study was conducted in the Department of Animal Nutrition, College of Veterinary and Animal Sciences, Mannuthy (Kerala) for a period of 42 days on eighty days old straight run 'VenCobb' broiler chicks. The chicks were randomly divided into two treatment groups with four replicates of ten chicks each. The birds were grown under a deep litter system. The dietary treatments were control group fed with basal broiler ration (BIS, 1992) with 5% animal fat while the second treatment group was additionally supplemented with L-carnitine @ 900 mg kg^{-1} in diet containing 5% animal fat. The composition of basal broiler starter and basal finisher rations (per 100 g) were:
Basal broiler starter ration: Maize - 40 g, soybean meal - 41.4 g, wheat bran - 9.0 g, animal fat - 5.0 g, dicalcium phosphate 2.0 - g, calcite - 1.79 g, DL-methionine - 0.14 g, choline chloride - 0.1 g, trace mineral mixture - 0.01 g, feed supplement - 0.31 g and salt - 0.25 g.
Basal broiler finisher ration: Maize - 48.5 g, soybean meal - 32.89 g, wheat bran - 9.0 g, animal fat - 5.0 g, dicalcium phosphate - 2.1 g, calcite - 1.80 g, DL-methionine - 0.04 g, choline chloride - 0.1 g, trace mineral mixture - 0.01 g, feed supplement - 0.31 g and salt - 0.25 g.
The feed supplements included vitamins, toxin binder, liver supplement & coccidostat. Lab grade L-carnitine procured from Carniking ® (Lonza Group Ltd, Muenchensteinerstrasse, Switzerland) was used.

Broiler starter ration was fed to birds up to 4 weeks and finisher ration followed thereafter up to 6 weeks of age. Throughout the experimental period, *ad libitum* feed and clean drinking water were provided and birds were reared under identical management conditions. The chemical composition of experimental rations was determined as per the standard procedures (AOAC, 2012). At the end of the experimental period of 42 days, five birds from each treatment were fasted overnight, slaughtered and dressed as per the standard procedure (BIS, 1973). Blood samples were collected to estimate serum triglycerides (GPO-POD method), total cholesterol (enzymatic colorimetric method), HDL cholesterol (PT.MG. acetate method), LDL cholesterol and VLDL cholesterol using kits supplied by Agappe Diagnostics, India. The serum reduced glutathione was determined by the method of Moron *et al.* (1979) and serum superoxide dismutase (SOD) was assayed as per the method of Minami and Yoshikawa (1979). Data collected on various parameters were statistically analyzed (Snedecor and Cochran, 1994) using SPSS 16.0 (2008) by following the independent samples t-test.

RESULTS AND DISCUSSION

The chemical composition of broiler starter and finisher rations are depicted in Table 1. The crude protein content of starter and finisher rations were 23.2 and 20.2%, respectively. The serum lipid profiles of two groups are presented in Table 2. The study revealed no significant difference ($P>0.05$) in serum triglycerides, HDL cholesterol and VLDL cholesterol levels between the groups. Khoshkhoo

Table 1: Chemical composition (on dry matter basis) of broiler diets*

Parameters	Broiler starter ration	Broiler finisher ration
Dry matter (%)	86.83	87.10
Crude protein (%)	23.25	20.14
Ether extract (%)	5.48	5.73
Crude fibre, %	4.38	4.16
Total ash, %	9.42	7.88
Acid insoluble ash, %	1.90	1.25
Calculated values[#]		
Metabolizable energy (kcal kg^{-1})	2805.20	2900.19
Lysine, %	1.27	1.07
Methionine, %	0.34	0.31

[#]calculated from ingredients reference value (NRC, 1994)

et al. (2006) and Koksal *et al.* (2011) have also reported that L-carnitine supplementation does not have any effect on serum triglyceride level in broilers. However, the total cholesterol and LDL cholesterol level of birds supplemented with L-carnitine was significantly lower ($P<0.05$) than control group. In line with our result, Wang *et al.* (2003) noticed a lowered serum total cholesterol level by dietary L-carnitine supplementation (100 ppm). Similarly, Parsaeimehr *et al*. (2012) reported that the supplementation of L-carnitine at 300 ppm in diet (having 5%animal fat) reduced cholesterol level and LDL cholesterol level in blood as compared to the control group. Contrary to this, Corduk *et al.* (2007) did not observe any significant effect on serum total cholesterol levels in broilers fed with basal diet (containing sunflower oil) supplemented with L-carnitine. Similar results were reported by Koksal *et al.* (2011). Reduction in serum total cholesterol by L-carnitine supplementation may be due to the usage of L-carnitine as a substrate by the enzyme carnitine palmitoyltransferase, which catalyzes the rate-limiting reaction in the transfer of fatty acid into mitochondria (Kuhajda and Ronnett, 2007). Augustyniak and Skrzydlewska (2009) have pointed out that the reduction of total cholesterol levels in blood due to L-carnitine is mostly via a decrease in cholesteryl esters rather than by decrease in free cholesterol and it would increase in biliary sterol excretion or an increase in the conversion of cholesterol to bile acids.

The serum reduced glutathione (GSH) and superoxide dismutase (SOD (µg mL^{-1}) levels of experimental birds (Table 2). The GSH and SOD levels in was significantly higher ($P<0.01$) in treatment group as compared to that of control group. In agreement with our results, increased serum GSH levels were observed in rats given L carnitine intraperitoneally (Kalaiselvi and Panneerselvam, 1998) and through feed (Augustyniak and Skrzydlewska, 2009) and in Japanese quails (Citil *et al.*, 2005). An increase in glutathione level upon carnitine supplementation may be due to increased NADPH generation through increased fatty acid metabolism, which is be used as cofactor by enzyme glutathione reductase which catalyzes the recycling of GSH from GSSH (oxidized glutathione)

Table 2: Serum lipid profile and antioxidant level of broilers supplemented with L-carnitine

Parameters	Control*	Treated group*	P value
	Serum lipid profile[†] (mg dL^{-1})		
Triglycerides	62.51 ± 1.86	57.81 ± 3.38	0.25
Total cholesterol	131.51 ± 3.25[a]	111.22 ± 1.51[b]	0.00
HDL cholesterol	46.56 ± 2.56	54.67 ± 3.38	0.09
LDL cholesterol	84.94 ± 3.77[a]	56.55 ± 2.42[b]	0.00
VLDL cholesterol	12.50 ± 0.37	11.56 ± 0.68	0.25
	Antioxidants level[†] (µg mL^{-1})		
GSH	0.11 ± 0.002[a]	0.13 ± 0.003[b]	0.007
SOD	0.39 ± 0.007[a]	0.44 ± 0.00[b]	0.00

The values bearing same superscripts within the same row do not differ significantly from each other at $P<0.01$.

[†]Mean of five values with SE

(Kumaran *et al*., 2004). Wang *et al.* (2013) found a significant increase in total SOD and GSH in broilers supplemented with L-carnitine.

Carnitine and its esters protect cells from ROS damage both by inhibiting free radical propagation and by contributing to the repair of oxidized membrane phospholipid (Arduini, 1992). Carnitine supplementation increases the overall antioxidant enzyme status by decreasing the levels of free radicals available for lipid peroxidation. Besides, carnitine can also act as a chelator by reducing the concentration of cytosolic iron, which plays a major role in free radical production (Resnik *et al*. 1992).

Conclusion: The study indicated that the supplementation of L-carnitine @ 900 mg kg^{-1} in animal fat-rich diet reduced the total cholesterol and LDL cholesterol levels and improved the antioxidant levels in terms of improved serum reduced glutathione and superoxide dismutase levels in broiler birds.

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Ethical statement: The experiment was carried out in accordance with the National regulations on animal welfare and necessary permission from the Institutional Animal Ethical Committee was obtained prior to the experimentation.

Competing interests: The authors declare that they have no competing interests.

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