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The effect of fat type and L-carnitine administration on growth, feed digestibility and blood metabolites of growing Afshari lambs

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ABSTRACT

This study was conducted to evaluate the effect of fat type and L-carnitine supplementation on feed intake, nutrient digestibility, growth, and blood metabolites in growing Afshari lambs. Twenty-four-male lambs with an initial body weight of 16 ± 0.4 kg were used in a completely randomized design with a 2 × 2 factorial arrangement of fat type with or without supplemental carnitine in an 84-day feeding period. The diets were isoenergetic and isonitrogenous. Soybean oil or a commercial Ca-protected fat were included at 4% of the DM of diet, each with or without 100 mg L-carnitine top dressed per kg of diet. Initial weight was equalized across treatments. At the end of experiment, blood was sampled from each lamb and concentrations of serum glucose, BUN, total protein, triglyceride, total cholesterol, HDL, and LDL were determined. There was no interaction between fat type and carnitine administration on feed intake, nutrient digestibility and growth. Fat type did not affect feed intake, but lambs fed soybean oil had greater DM and EE digestibility ($P < 0.05$), and tended to have higher CP digestibility. Supplemental L-carnitine did not affect feed intake, but improved EE digestibility ($P < 0.01$) and tended to improve CP digestibility ($P = 0.10$). Although fat type did not affect growth of lambs, L-carnitine administration tended ($P = 0.13$) to improve body weight and ADG, thus improving FCR ($P < 0.05$). Fat type interacted with L-carnitine administration for cholesterol and LDL concentration in blood; L-carnitine administration significantly decreased them only for the soybean oil diet ($P < 0.05$). Lambs fed with soybean oil, compared with Ca-protected fat, had more ($P < 0.05$) total protein and BUN and tended ($P = 0.11$) to have lower triglyceride concentrations in the blood. Under conditions of the current study L-carnitine might improve growth, dietary fat digestibility, and blood metabolites of lambs fed diets with supplemented fat. Supplementing different fat types had a minimal effect on responses of lambs.

1. Introduction

Fats have been fed to livestock to formulate highly digestible diets for animals with high nutrient requirements. Also, fat prevent ruminal acidosis, facilitate absorption of liposoluble nutrients and minimize dustiness during mixing

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and handling of feed (Perez et al., 2002; Manso et al., 2006). However, at high levels, due to suppression of rumen function, unsaturated fat may decrease fiber digestibility (by 50%) and feed intake in ruminant (Jenkins and Palmquist, 1984). Thus, Ca-protected fat currently is used in commercial diets for dairy cows. Also, it has been shown that palm oil (PO) fatty acids as calcium soaps avoided the negative effects on fiber digestibility when 41 g PO/kg were added to the diet (Manso et al., 2006).

Carnitine facilitates transport of medium- and long-chain fatty acids (LCFA) across the mitochondrial membrane for β-oxidation (White et al., 2002) and appears to be involved in nitrogen metabolism. Carnitine is essential for mitochondrial β-oxidation of LCFA. L-carnitine has several other functions such as altering the acetyl-CoA: CoA ratio, transporting medium- and short-chain fatty acid from peroxisomes to mitochondria, and modulating flux of intermediates through pathways associated with fatty acid, glucose, and nitrogen metabolism (Chapa et al., 2001; Greenwood et al., 2001; Carlson et al., 2007). The growth rates of weaned calves and growing cattle have been improved by including carnitine in the diet (Hill et al., 1995; White et al., 2001).

Despite some studies considering effects of fat supplementation and type on growth of lambs, it is not clear whether replacing soybean oil with commercial Ca-protected fat would interact with L-carnitine administration. We hypothesized that replacing soybean oil with commercial Ca-protected fat would improve nutrient digestibility and growth of finishing lambs and that, with administration of L-carnitine, fat supplementation would improve feed intake, growth and blood metabolites. Therefore, the objective was to determine the effects of fat type and carnitine administration on feed intake, nutrient digestibility, growth, and blood metabolites in Afshari growing lambs.

2. Materials and methods

2.1. Animals and dietary treatments

Twenty-four Afshari ram lambs, approximately 70 days old and averaging 16 ± 0.4 kg (BW $\pm$ SD) were used in a completely randomized 2×2 factorial arrangement of diets for an 84-day feeding period. Lambs were assigned randomly to either soybean oil or Ca-protected fat at 4% of the dietary DM, with or without 0.11 g/d of L-carnitine. Fatty acid composition of soybean oil (Naz Vegetable Oil Company, Ifahan, Iran) and Ca-protected fat (Energizer GOLD, IFFCO, Malaysia) as reported by commercial producers are presented in Table 1. Initial weight was stratified across diets. Diets were formulated to be isoenergetic (2.8 Mcal ME/kg of diet DM) and isonitrogenous (16.5% crude protein). Ingredients and chemical compositions of the diets are presented in Table 2.

During the experiment, lambs were housed in individual pens (1.2×0.9 m^2) in a well-ventilated barn. There were 14 days of adaptation and 70 days of data collection. Lambs were switched gradually from the basal TMR to one of the 4 experimental diets. Week 1 was for adaptation to the pens and to high concentrate diets, and for estimation of feed consumption. Week 2 was for adaptation to diets.

Table 1
The fatty acid profile of fat supplements (g/100 g of FA).

	Soybean oil	Ca-protected
C12:0	0.1	0.2
C14:0	0.1	1.2
C16:0	10.8	47.0
C18:0	3.7	5.0
C18:1	22.9	38.0
C18:2	54.4	8.0
C18:3	6.5	Not reported
Others	1.5	0.6

Table 2
Ingredient and chemical composition of completely mixed diets fed to growing lambs.

L-carnitine, g/d:	Fat type:			
	Soybean oil		Ca-protected fat	
	0	0.11	0	0.11
Ingredient, %				
Alfalfa	33.5	33.5	29.9	29.9
Wheat barn	9.8	9.8	9.8	9.8
Barley	35.3	35.3	39.3	39.3
Soybean meal	7.8	7.8	7.8	7.8
Cottonseed meal	8	8	8.3	8.3
$CaCO_3$	1.2	1.2	0.5	0.5
Salt	0.4	0.4	0.4	0.4
Soybean oil	4	4	–	–
Ca-protected fat	–	–	4	4
L-carnitine, g/day	–	0.6	–	0.6
Chemical composition[a]				
ME, mcal/kg	2.8	2.8	2.8	2.8
CP, g/kg	165	165	165	165
Ca, g/kg	9.6	9.6	9.8	9.8
P, g/kg	4.8	4.8	4.9	4.9
NDF, g/kg	320	320	299	299
EE, g/kg	79	79	77	77

[a] ME = metabolizable energy, CP = crude protein, NDF = neutral detergent fiber, ADF = acid detergent fiber, EE = ether extract.

Lambs received water ad libitum and had ad libitum access to feed offered twice daily in equal proportions at 08:00 and 15:00 h.

2.2. Sampling and chemical analysis

Samples of each diet were analyzed chemically for dry matter, crude protein, ash, ether extract, calcium, and phosphorus (Association of Official Analytical Chemists, 2002. Neutral detergent fiber (NDF) was measured according to Van Soest et al. (1991).

2.3. Growth and blood analysis

Dry matter intake (DMI), average daily gain (ADG) and feed conversion ratio (FCR) were calculated for each individual lamb. Lambs were weighed biweekly in the morning before feeding to determine ADG and feed to gain ratio.