Effect of sesame oil feeding on performance, plasma lipids and ruminal fermentation of growing lambs

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Abstract:

BACKGROUND: In recent years, dietary fat supplementation has become a common practice and fat supplemented diets have had variable effects on animal performance and carcass characteristics. **OBJECTIVES:** This study was conducted to determine the effect of increasing the levels of sesame oil on performance, rumen parameters and plasma lipid profile in finishing Chal lambs. **METHODS:** Eighteen male lambs were fed with control (C; without sesame oil) and the diets contained low level (LSO; 2.5%) and high level (HSO; 5%) of sesame oil. **RESULTS:** The addition of fat had no effect on dry matter intake (DMI), average daily gain (ADG), feed conversion ratio (FCR) and carcass weight. Treatments with sesame oil had no effect on rumen ammonia concentration and total protozoal count. Ruminal pH was numerically smaller (p=0.14) for control compared to lambs fed diets containing 2.5 and 5% sesame oil. Treatments had no effect on total VFA, acetate, butyrate, valerate and isovalerate concentrations. The propionate concentration decreased (p=0.04) by supplementation of sesame oil compared with the control. Total cholesterol (TC) and HDL increased and the tendency for VLDL and triglyceride (p=0.13) to increase was observed by treatment groups when compared with the control. Glucose concentration and LDL were not affected by treatment. **CONCLUSIONS:** Sesame oil had no effect on the performance and carcass weight of lambs but there was decrease in blood cholesterol concentration.

Introduction

As in many other countries, cereal grains are commonly used in ruminant diets in Iran, but feeding costs are largely determined by the cost of grains. Thus, finding alternative high energy feeds has been of great advantage to local producers (Saqhir et al., 2012). Fat and oil supplementation became a common practice and are often included in diets to increase the dietary energy content. Recently, problems associated with the use of feedstuffs of animal origin in ruminant diets have increased interest in the use of vegetable-origin fats in intensive fattening rations (Castro et al., 2005). Several studies investigated the effects of different vegetable-origin fats such as sunflower and soybean oils in diets of beef cattle (Beaulieu et al., 2002; Duckett et al., 2002), fattening lambs (Castro et al., 2005; Manso et al., 2009)

and kids (Marinova et al., 2001; Saqhir et al., 2012). Based on existing literature, no research has studied the inclusion of sesame oil in diets of finishing lambs. Therefore, the objective of this research was to determine the effects of adding sesame oil (high in linoleic and oleic acids) to the diet of finishing lambs on rumen fermentation parameters, blood metabolite and performance.

Materials and Methods

Eighteen male Chal lambs (with initial body weight = 23.7±0.73 kg) were used in this experiment. Three groups of six lambs of the same average live weight were formed, and the animals were housed in separate pens. Alfalfa hay and barley straw, and three different concentrate supplements were offered separately ad libitum, and feed not consumed was removed daily, during the experimental period. The three concentrate supplements contained barley, wheat bran and canola meal, but varied according to their content of sesame oil; (C) control, concentrate without oil; low level (LSO) (2.5%) and high level (HSO) (5%) of sesame oil (Table 1). All diets were formulated to be iso-nitrogenous and iso-ME. Diets were fed as total mixed rations (TMR) twice daily at 09:00 and 18:00 h to fulfill the lambs' requirements according to the NRC (1985) recommendations, with free access to fresh water.

For each lamb, samples of TMR not consumed were collected daily, gathered at the end of the study, and saved (-20ºC) for later analysis of chemical composition. Feed samples were analyzed for dry matter (DM), ether extract (EE) and crude protein (CP) contents according to the AOAC (1990) procedures. The acid detergent fiber (ADF) and the neutral detergent fiber (NDF) contents of feed samples were also measured according to the procedure described by Van Soest et al. (1991).

The duration of the experiment was 84 days. During the experiment, lambs were observed for health problems and their body weight was recorded at 2-week intervals before the morning feedings.

Blood samples were collected at the start, middle, and end of the experiment from the jugular vein of each animal. Blood was stored with ice after collection, until centrifuged at 3000×g for 20 min to obtain plasma. Plasma was stored at -20°C until analyzed for glucose, total cholesterol (TC), high density lipoproteins (HDL) and the triglycerides (TG) using commercially assay kits (Pars Azmun, Iran). Very low density (VLDL) and low density (LDL) lipoproteins were measured using Friedewald et al. (1972) methods.

The content of rumen collected from each sheep was strained through a single layer of cheesecloth and the pH was measured immediately using a digital pH meter (WTW pH 330, WTW, Weinheim, Germany). Total protozoa were counted as described by Sulu et al. (1988). In addition, the contents of volatile fatty acids (Ottenstein and Batley, 1971) and ammonia-N (Conway, 1962) were also determined.

Data were subjected to analysis of variance using the GLM procedure of SAS (2002).

Results

Increase in the level of sesame oil had no significant effect on ADG, DMI, FCR, final body weight and carcass weight (Table 2).

Treatments had no effect on rumen ammonia concentration and total protozoal count. The pH of rumen was numerically smaller (p=0.14) for the control compared with lambs fed diets containing 2.5 and 5% sesame oil (Table 3). Also, the treatment had no effect on total VFA, acetate, butyrate, valerate and isovalerate concentrations. The propionate concentration decreased (p=0.042) by both 2.5 and 5% treatments, compared with the control group. As a result of the decrease in propionate concentration, lambs fed diet containing sesa-

Table 1. Ingredients and chemical composition (%, DM basis) of diets fed to lambs. [a C)] Control, no oil added to the concentrate; (LSO) low level (2.5%) and (HSO) high level (5%) of sesame oil. [(b)] Each kg contained: vitamin A, 400,000 IU; vitamin D3, 100,000 IU; vitamin E, 200mg; Ca, 180 g; P, 70 g; Mg, 30 g; Na, 50 g; Mn, 5,000 mg; Zn, 3,000 mg; I, 100 mg; Fe, 3,000 mg; Cu, 300 mg; Co, 100 mg; Se, 20 mg plus 400 mg antioxidant.

Items	Diets a		
	C	LSO	HSO
Diet ingredients			
Alfalfa hay	25.00	27.00	28.00
Barley straw	6.00	7.00	7.00
Barley grain	46.50	39.00	35.00
Wheat bran	13.00	14.00	14.00
Canola meal	8.00	9.00	9.50
Sesame oil	0.00	2.50	5.00
Vitamin-mineral premix b	0.40	0.40	0.40
Salt	0.40	0.40	0.40
Sodium bicarbonate	0.40	0.40	0.40
Limestone	0.30	0.30	0.30
Diet composition			
Dry matter (%)	88.70	89.00	89.30
Crude protein (%)	14.66	14.70	14.59
Neutral detergent fibre (%)	34.69	35.86	35.74
Acid detergent fibre (%)	19.02	20.13	20.29
Ether extract (%)	2.39	4.88	7.32
Calcium (%)	0.58	0.61	0.63
Phosphorus (%)	0.50	0.50	0.50
Sodium (%)	0.33	0.34	0.34
ME (Mcal/ kg)	2.61	2.64	2.71

Table 2. Effects of sesame oil on animal performance and carcass weight. [a C)] Control, no oil added to the concentrate; (LSO) low level (2.5%) and (HSO) high level (5%) of sesame oil.

Items	Diets a			S.E.M.	P value
	C	LSO	HSO		
Average initial weight (kg)	23.7	23.7	23.7	0.31	NS
Average final weight (kg)	38.37	38.05	39.18	0.49	NS
Average daily gain (kg)	0.175	0.171	0.184	0.01	NS
Dry matter intake (kg)	1.147	1.142	1.182	0.03	NS
Feed conversion ratio	6.59	6.71	6.43	0.19	NS
Carcass weight (kg)	18.60	18.39	19.19	0.34	NS

me oil had higher (p=0.03) acetate: propionate ratio compared with the control group (Table 3).

Total cholesterol (TC) and HDL increased and VLDL and triglyceride tended (p=0.13) to increase by treatment groups compared with the control. Glucose concentration and LDL were not affected by the treatment (Table 4).

Discussion

DMI, ADG and FCR values in this study are comparable to those of other studies with lambs raised under similar conditions (Manso et al., 2006, 2009). Lack of change in DMI is consistent with the result of Kott et al. (2003) and Demirel et al. (2004), who reported no reduction in DMI when various vegetable fats were

Table 3. Effects of sesame oil on rumen fermentation parameters. [(a C)] Control, no oil added to the concentrate; (LSO) low level (2.5%) and (HSO) high level (5%) of sesame oil.

Items	Diet a			.SEM	P value
	C	LSO	HSO		
Rumen pH	6.96	7.10	7.06	0.045	0.14
Ammonia-N (mg/l)	128	133	131	3.513	0.65
Protozoa numbers ($\times 10^5 ml^{-1}$)	2.93	3.40	3.13	0.661	0.83
VFA concentration (mmol/l)					
Acetate	36.98	35.62	39.89	2.456	0.41
Propionate	11.99	9.95	10.48	0.486	0.04
Butyrate	7.17	6.89	7.45	0.384	0.61
Valerate	0.71	0.57	0.68	0.072	0.79
Isovalerate	0.85	0.82	0.99	0.110	0.38
Total VFA	57.69	53.83	59.50	2.887	0.66
Molar proportions (%)					
Acetate	63.83	65.93	66.90	1.290	0.11
Propionate	20.90	18.63	17.67	0.805	0.01
Butyrate	12.49	12.82	12.57	0.554	0.92
Valerate	1.25	1.05	1.16	0.140	0.66
Isovalerate	1.53	1.57	1.69	0.249	0.65
Acetate: propionate ratio	3.10	3.57	3.84	0.209	0.03

Table 4. Effects of sesame oil on blood lipid metabolites. [(a C)] Control, no oil added to the concentrate; (LSO) low level (2.5%) and (HSO) high level (5%) of sesame oil.

Metabolite (mg/dl)	Diet [a]			SEM	P value
	C	LSO	HSO		
Total cholesterol	45.83	51.50	56.50	2.701	0.01
HDL	24.33	27.83	32.50	1.623	0.01>
LDL	17.30	19.10	19.27	1.445	0.35
VLDL	4.20	4.57	4.73	0.232	0.13
Triglycerides	21.00	22.83	23.67	1.173	0.13
Glucose	66.33	68.17	67.67	1.782	0.60

included in lamb rations. In contrast, Haddad and Younis (2004) reported a decrease in DMI after adding 25 and 50g/kg of saturated fat to Awassi lamb diets. Lough et al. (1993) also observed a decrease in DMI when 100g/kg palm oil was included in the ration. However, diets compared by Haddad and Younis (2004) and Lough et al. (1993) were not iso-energetic and the lambs reached the same energy intake levels with reduced DM intake.

Lough et al. (1993) recorded lower feed conversion rates in lambs fed a dietary palm oil supplement. However, in agreement with the results of this research, Manso et al. (2009) also using isoenergetic and isonitrogenous diets, observed no changes in feed conversion ratios in lambs fed dietary supplements containing vegetable oils. Lack of differences between the FCR of lambs administered different levels of fat may be explained by the absence of important differences in the digestion of the diets. It has been proposed that the digestive processes in the hindgut compensated for the possible reduction in digestion in the rumen and results in a limited effect on whole tract digestion (Manso et al., 2009).

Some authors have noted that the addition of fat to fattening diets may increase carcass

yield due to greater carcass fatness (Zinn, 1989; Clinquart et al., 1995). No differences in the carcass yield were found in this study. Kott et al. (2003) and Manson et al. (2009) reported similar results after adding various fats to lamb diets. The levels of fat used in this study (up to 50g/kg) and the absence of significant differences in intake and weight gain between the different experimental treatments could explain the lack of differences in carcass yield. In addition, it should be noted that lambs in the present study were sacrificed at the early stage of maturity and if they had been sacrificed at later stages the treatment effects could have been different; since fatness normally occurs mostly during the late stages of growth.

Several studies reported that oil supplementation (such as coconut oil (5%), linseed oil (4%) and sunflower seed oil (6%)) decreased rumen protozoal count (Dohme et al., 1999; Ivan et al., 2001; Heristov et al., 2009). In a review, Doreau and Ferlay (1995) reported that linseed and coconut oils have a defaunating effect on the rumen fluids. Furthermore, Ueda et al. (2003) supplemented linseed oil (3%) into dairy cow diets and found no considerable change in total rumen protozoa population which is similar to the results of this study. The absence of a reasonable effect on the protozoa population in the present study is consistent with the absence of considerable changes in butyrate proportion (Table 3). The isocaloric substitution of sesame oil with barley grain caused a decrease in the concentration and molar ratio of ruminal propionate but increased the acetate: propionate ratio. The decrease in concentration and molar ratio of ruminal propionate in this study may be related to a reduced level of barley grain in the diet. This finding is supported by the pH value and ammonia-N concentration observed in this study. Protozoa exert a stabilizing effect on the pH of the rumen and ammonia-N production, which is probably due to the rapid ingestion and storage of starch by protozoa that prevents fermentation of bacteria (Ivan et al., 2001).

Dietary fats have been shown (Hodson et al., 2001; Sjogren et al., 2004) to increase the concentration of total cholesterol and HDL-cholesterol in plasma. Several researchers reported that cottonseed oil, soybean oil and palm oil are types of supplementations in diets which have the ability to increase blood cholesterol and triglyceride contents (Garcia et al., 2003; Hedvig et al., 2004; Hernandez et al., 1978). In this study, there was an increase in the total cholesterol and high-density lipoprotein concentration of the sesame oil supplemented groups. Total cholesterol represents the summation of all forms of cholesterol presented in the serum. The elevation in total cholesterol in lamb fed sesame oil containing diets was primarily due to an increase in HDL. In human medicine, an elevation in HDL is a desirable health related goal because HDL concentrations are negatively correlated with coronary atherosclerosis (Murray et al., 1993). Conversely, an elevation in serum LDL concentration is interpreted negatively because a positive correlation exists between serum LDL concentration and coronary atherosclerosis (Murray et al., 1993).

In conclusion, supplementing finishing lamb diets with sesame oil had no effect on DM intake, ADG, FCR and carcass weight but increased plasma total and HDL cholesterol. Treatments had no effect on rumen parameters except at the highest level of addition, at which the rumen fermentation shifted to reduce the propionate concentration.

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تأثیر تغذیه روغن کنجد بر عملکرد، فراسنجه‌های خون و تخمیر شکمبه‌ای بره‌های پرواری

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چکیده

زمینه مطالعه: در سالیان اخیر استفاده از مکمل‌های غذایی در جیره نشخوارکنندگان گسترش یافته است. در این زمینه استفاده از مکمل‌های چربی بر عملکرد تأثیرات متفاوتی داشته است. **هدف:** این مطالعه به منظور بررسی تأثیر سطوح مختلف روغن کنجد بر عملکرد، فراسنجه‌های خون و تخمیر شکمبه در بره‌های پرواری نژاد شال انجام شد. **روش کار:** هیجده رأس بره نر شال با سه جیره آزمایشی حاوی مقادیر صفر (شاهد)، ۲/۵ و ۵٪ روغن کنجد در طول دوره پروار تغذیه شدند. **نتایج:** افزودن مکمل چربی تأثیری بر میانگین خوراک مصرفی، میانگین افزایش وزن روزانه، ضریب تبدیل غذایی و وزن لاشه نداشت. همچنین اعمال تیمارهای آزمایشی تأثیری بر غلظت آمونیاک شکمبه و جمعیت پروتوزایی آن نداشت. افزودن روغن کنجد تأثیر معنی‌داری بر غلظت کل اسیدهای چرب فرار و همچنین غلظت اسیدهای چرب فرار استات، بوتیرات، والرات و ایزووالرات شکمبه نداشت. امام غلظت پروپیونات در جیره‌های حاوی روغن کنجد کمتر از تیمار شـاهد بود ($p=۰/۰۴$). غلظت کلسـترول و HDL در بره‌هایی که از جیره‌های حاوی روغن استفاده کردند، نسبت به بره‌های تیمار شاهد کمتر بود. غلظت گلوکز و LDL تحت تأثیر تیمارهای آزمایشی قرار نگرفت. **نتیجه‌گیری نهایی:** افزودن روغن کنجد تأثیری بر عملکرد و وزن لاشه بره‌های شال نداشت اما باعث کاهش معنی‌دار غلظت کلسترول خون شد.

واژه های کلیدی: عملکرد دام، کلسترول، بره پرواری، روغن کنجد، اسیدهای چرب فرار

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