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Linseed-based diets for sheep. 1. Nutrient digestibility, N retention and rumen fermentation*

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ABSTRACT

The effects of linseed-based diets for sheep on nutrient digestibility, N retention and some parameters in blood serum and rumen fluid were studied. Linseed-based diets contained more fat (%) and different fatty acid profiles. Inclusion of linseed increased crude fat digestibility from 68 to 80% ($P<0.05$), without significant effects on digestibility of other nutrients and N retention. Statistically significant differences ($P<0.05$) were found in the total cholesterol, triacylglyceride and total lipid contents in blood serum, and in the ammonia content of rumen fluid. The 10% addition of linseed to concentrate caused a decrease in VFA ($P<0.05$) in the rumen fluid.

KEY WORDS: linseed, sheep, rumen, digestibility

INTRODUCTION

The use of linseed in ruminant diets increases the fat content, which may decrease fibre digestibility in the rumen. On the other hand, addition of fat increases the energy concentration of the diet and helps to limit energy losses during fermentation by restricting the number of methane-producing bacteria, which may have a positive effect on the magnitude of microbiological protein synthesis (Machmüller et al., 2000). Supplemental linseed, containing fat rich in PUFA, may therefore alter the digestibility of dietary nutrients and influence the energy and protein metabolism in the body (Jenkins, 1993). The aim of the present study was to determine the effects of dietary linseed cultivars (two traditional and the new Linola) on nutrient digestibility, N retention and some parameters in blood serum and rumen fluid.

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MATERIAL AND METHODS

Twenty rams were randomly assigned to 4 groups and fed a diet containing meadow hay and concentrate. The control group (I_K) received concentrate with no supplemental linseed, whereas concentrates for groups II_{OP}, III_{OM} and IV_{LI} contained 10% crushed linseed cultivars Opal, Omega, or Linola^{TM947}, respectively. All diets were isonitrogenous and only slightly differed in energy value. The chemical composition of feeds and faeces were determined according to AOAC (1995) methods. Nutrient digestibility and N balance were determined using standard methods. Representative samples of blood and rumen fluid were taken for analysis (prior to feeding and 1.5, 3.0 and 4.5 h postprandially). Blood serum was assayed for glucose, urea, total lipids, triacylglycerides, total cholesterol and HDL (Biochemtest and Alpha Diagnostics KITs). Rumen fluid was analysed for pH, N-NH_3 (Conway method) and VFA (gas chromatography, Varian 3400 CX apparatus with FID detector and DB-FFAP column). The results were analysed statistically using one-way analysis of variance and Scheffe's multiple range test (SAS, 1995). Prior to analysis of variance, the data on ruminal fermentation were tested with the split plot procedure using the interaction between animals and the main experimental factor as an error category.

RESULTS

Inclusion of linseed increased the fat content of concentrates and changed their fatty acid profiles. Traditional linseed cultivars increased the content of $C_{18:3}$, while the Linola cultivar increased the content of $C_{18:2}$.

TABLE 1

Digestibility coefficients (%) and N retention

Item	Group				P	SEM
	I_K	II_{OP}	III_{OM}	IV_{LI}		
Dry matter	67.8	67.1	67.1	66.7	0.926	0.52
Organic matter	69.1	71.0	70.7	70.8	0.705	0.59
Crude protein	69.8	69.3	69.9	70.7	0.841	0.50
Ether extract	67.8^{C}	76.4^{B}	81.7^{AB}	82.3^{A}	0.000	1.60
Crude fibre	45.3	46.4	44.1	43.7	0.934	1.48
NDF	53.5	54.9	52.6	52.3	0.849	1.03
ADF	46.0	47.5	44.1	43.7	0.670	1.19
N-free extractives	74.5	76.8	76.4	77.0	0.608	0.64
Gross energy	68.9	67.4	67.5	68.6	0.759	0.56
N-retained, g d^{-1}	8.3	8.0	9.0	8.5	0.408	0.19
% of N-intake	31.1	29.6	32.5	30.5	0.533	0.69
% of N-digested	44.1	46.3	46.5	43.1	0.764	1.25

^{A,B} $P<0.01$

TABLE 2

Biochemical indicators of blood serum

Group	Glucose mmol/l	Urea mmol/l	Total lipids	Triacyl-glycerides	Total cholesterol	HDL	LDL
			mg/dl				
I_K	3.54	7.19^A	191.8^B	24.5^B	64.7^B	29.8^B	39.9
II_{OP}	3.58	6.46^{AB}	230.0^B	36.2^A	68.7^B	29.2^B	33.9
III_{OM}	3.60	5.93^B	239.8^{AB}	39.1^A	61.7^B	26.9^B	32.3
IV_{LL}	3.67	6.79^A	300.0^A	45.2^A	85.6^A	44.7^A	34.3
P	0.587	0.001	0.000	0.000	0.000	0.000	0.523
SEM	0.04	0.13	9.40	1.90	1.81	1.58	1.83

^{A,B} P<0.01

TABLE 3

Parameters of rumen fermentation (average of 4 samples)

Item	pH	N-NH_3	VFA, mmol/l				
		mg/dl	acetic	propionic	butyric	isobutyric	valeric
I_K	6.64^a	12.44^C	46.3	16.2	8.9^{AB}	0.7^a	1.0^A
II_{OP}	6.50^{ab}	15.53^B	42.7	15.1	8.2^B	0.6^{ab}	0.8^B
III_{OM}	6.58^{ab}	16.03^B	42.1	14.9	7.9^B	0.6^{ab}	0.8^B
IV_{LL}	6.44^b	17.61^A	44.5	15.7	9.4^A	0.5^b	0.8^B
P	0.022	0.000	0.150	0.408	0.002	0.024	0.006
SEM	0.04	0.56	0.86	0.50	0.22	0.02	0.04

^{A,B} P<0.01; ^{a,b} P<0.05

Except for fat digestibility, no significant effect of supplemental linseed on nutrient digestibility and N balance was found (Table 1). The highest fat digestibility was observed in groups IV_L and III_{OM}. Linseed had no effect on serum glucose but decreased urea and increased total lipids and triacylglycerides (P<0.05; Table 2). Total cholesterol and HDL were increased after supplementation with linseed, especially with the Linola cultivar. A slight decrease in pH of the ruminal fluid in linseed-fed rams was accompanied by a decreased content of VFA (Table 3), especially acetic acid, and by an increased content of N-NH_3 (P<0.05).

DISCUSSION

Linseed cultivars are a rich source of fat and PUFA. The increased content of polyunsaturated FA in linseed-based diets may cause a slight decrease in cellulolytic activity in the rumen, which was observed in the present study by the decrease of the VFA content. At the same time, an elevated ammonia content may be a sign of

higher protein degradability accompanied by decreased protein synthesis by ruminal microorganisms, which was probably caused by the limited energy supply (Herrera-Saldana et al., 2000). On the other hand, the lower content of urea in the blood serum of animals receiving linseed may suggest that ammonia formed in the rumen did not pass to the blood serum because of its fast utilization by rumen microorganisms. The higher proportion of UFA in linseed-based diets caused higher fat digestibility (shown in part 2 of the present study), which probably resulted in elevated lipid metabolism indicators ($P<0.01$), especially in animals receiving Linola.

CONCLUSIONS

A 10% supplement of linseed to concentrate can be recommended for adult sheep because it has no negative effect on nutrient digestibility, ruminal fermentation or the level of biochemical indicators of the blood.

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STRESZCZENIE

Nasiona lnu w dawkach pokarmowych dla owiec. 1. Strawność składników pokarmowych, bilans N oraz fermentacja w żwaczu

Badano wpływ udziału nasion lnu w dawkach pokarmowych owiec na strawność składników pokarmowych, retencję N oraz na wartość wskaźników biochemicznych w osoczu krwi i treści żwacza. Mieszanki z udziałem lnu (10%) zawierały więcej tłuszczu oraz miały inny profil kwasów tłuszczowych. W porównaniu z grupą kontrolną, spowodowało to zwiększenie strawności tłuszczu surowego, średnio z 68 do 80% ($P<0,05$), bez istotnego wpływu na strawność pozostałych składników pokarmowych oraz retencję N. Stwierdzono także statystycznie istotne różnice ($P<0,05$) w zawartości cholesterolu całkowitego, trójglicerydów i lipidów całkowitych w osoczu krwi oraz amoniaku w treści żwacza tryków. Zastosowanie nasion lnu w mieszankach uzupełniających w ilości 10% spowodowało zmniejszenie zawartości LKT w treści żwacza.