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Effect of dietary fat source on nutrient digestibility and rumen fermentation in sheep

A. Ćwiek and F. Borowiec[1]

Agricultural University of Cracow,
Department of Animal Nutrition
Al. Mickiewicza 24/26, 30-059 Kraków, Poland

ABSTRACT

The experiment was carried out on Polish Longwool Sheep wethers with rumen cannulas in a 4 × 4 Latin square design to determine the influence of fat source and amount in the ration on nutrient digestibility and rumen fermentation. The basic ration for the control group (C) consisted of meadow hay and concentrate. For the experimental groups, this ration was supplemented with linseed (L), linseed oil (OL) and Dunafett (D). Rumen fluid was taken from each animal 0; 1.5; 3.0 and 4.5 h after feeding. There was no influence of the type and amount of vegetable fat on rumen fermentation and digestibility of nutrients. There were, however, significant differences in the urine allantoin level among the groups.

KEY WORDS: sheep, fat, rumen, metabolism, allantoin

INTRODUCTION

Ruminant nutrition must not only satisfy the animals' requirements but also optimize conditions for growth and development of all ruminal microorganisms. Isoenergetic and isoproteinous diets for ruminants have a major influence on ensuring proper rumen fermentation processes (Szumacher-Strabel et al., 2001). The effect of fat supplementation in concentrate mixtures for ruminants on rumen fermentation and protein biosynthesis has been the subject of many studies (Borowiec et al., 2001). The purpose of this experiment was to determine the influence of supplementing fats linseed, linseed oil and protection fat (Dunafett) differing in their fatty acid profiles and their optimum share in concentrates on nutrient digestibility and rumen fermentation in sheep.

[1] Corresponding author: e-mail: borowiec@ar.krakow.pl

MATERIAL AND METHODS

The experiment was carried out in a 4×4 Latin square design on 4 wethers fitted with rumen cannulas divided into 4 groups: control and 3 experimental. Wethers were fed according to standards (INRA-98) with meadow hay (1 kg/d/animal) and concentrate mixture. The control group (C) received 0.7 kg/d/animal of concentrate without fat supplementation, the second group (L), 0.75 kg/d/animal of concentrate supplemented with 8% linseed, the third group (OL), 0.75 kg/d/animal of concentrate with 3.5% linseed oil, and the fourth group (D), 0.7 kg/d/animal of concentrate mixture with 3.5% Dunafett (Table 1). All of the diets were isoenergetic and isoproteinous. Digestibility of nutrients was estimated. The urinary allantoin level was estimated as an indicator of microbial biosynthesis. Rumen samples were collected (fasting; 1.5; 3.0 and 4.5 h after feeding) and assayed for pH, volatile fatty acids (VFA), ammonia ($N\text{-}NH_3$) and protein. The results were analysed statistically by means of one-way and two-way analysis of variance using SAS 1995 software and Duncan's test.

RESULTS

The energy supplements in the rations for sheep did not influence ($P>0.05$) nutrient digestibility (Table 1). The lowest nutrient coefficients were found in group D. There were significant differences in the allantoin nitrogen level excreted in urine between the control and experimental animals (Table 2). The highest allantoin nitrogen content per 1 g nitrogen intake was found in the control group (C). No significant differences ($P>0.05$) were found in the concentration of individual fatty acids between the animals (Table 3). Differences in total or protein N concentration in the rumen liquor between the groups were not significant ($P>0.05$); ammonia N concentration was the highest in the rumen liquor in the animals of group L and the lowest in group D ($P<0.05$).

DISCUSSION

The optimum fat concentration in rations for ruminants is 4-5% of dry matter. Overdose of fat is expected to have a negative influence on rumen fermentation (Szumacher-Strabel et al., 2001) and to decrease nutrient digestibility. Volatile fatty acids (VFA), produced in the rumen, as a result of fermentation induced by enzymes produced by bacteria, are the principal source of energy for ruminants. The findings of Potkański et al. (2001) indicate that supplemental fat in the diet adversely affects the production of acetic and propionic acids in the rumen. In

the present experiment there were no differences in VFA molar proportions in the rumen related to the dietary fat supplement as the levels of fat did not exceeded

Table 1. Fat content in diets (g) and nutrient digestibility, %

Items	Group			
	C	L	OL	D
Dry matter intake, g/day	1447.1	1489.3	1489.6	1449.2
Fat in diet, g	36.8	51.7	40.7	66.3
Digestibility, %				
dry matter	69.4	73.2	69.5	65.2
organic matter	71.4	75.3	71.6	67.4
crude protein	66.3	70.9	69.0	61.8
crude fat	76.1	83.2	78.7	83.7
crude fibre	53.1	59.2	53.5	48.0
NDF	53.1	60.4	54.6	49.3
ADF	45.0	50.9	44.7	38.3
N-free-extractives	78.1	81.4	78.3	74.5

Table 2. Allantoin excretives

Items	Group			
	C	L	OL	D
Dry matter intake/day	1447.08	1489.28	1489.58	1449.18
Organic matter intake/ day	1349.90	1394.08	1380.43	1330.58
N-allantoin excretion mg/day	1535.39^{A}	739.23^{B}	789.81^{B}	748.62^{B}
N-allantoin mg/100 g digestible DM intake	153.79^{A}	68.00^{B}	76.84^{B}	79.48^{B}
N-allantoin mg/100 g digestible OM intake	113.74^{A}	53.03^{B}	57.22^{B}	56.26^{B}
mg N-allantoin/1g N intake	62.62^{A}	28.65^{B}	30.26^{B}	30.10^{B}

Table 3. Physico-chemical indices of rumen liquid

Items	Group			
	C	L	OL	D
pH	6.09	6.07	6.09	5.91
$N\text{-}NH_3$, mg/dl	9.29^{AB}	11.67^{A}	10.43^{AB}	8.02^{B}
Acetic acid, mml/L	54.40	53.73	54.21	55.78
Propionic acid, mml/L	14.39	14.09	14.36	14.25
Butyric acid, mml/L	9.18	9.31	9.04	9.60
Isobutyric acid, mml/L	0.64	0.65	0.67	0.62
Valeric amid, mml/L	0.83	0.89	0.84	0.89
Isovaleric amid, mml/L	0.87	0.83	0.82	0.75
Total nitrogen, %	0.07	0.07	0.07	0.07
Protein nitrogen, %	0.05	0.06	0.05	0.06

critical level of 5%. It is noteworthy that fat supplementation in diets had no essential influence on the level of acetic and propionic acids in the rumen liquid. In the rumen it was shown, however, that fat supplements decreased urinary allantoin excretion, indicating a lower level of microbial protein synthesis in the rumen.

CONCLUSIONS

Five percent fat supplementation in concentrate mixtures had no influence on nutrient digestibility and did not change the VFA concentration in rumen fluid out differentiated supplement type, ammonia level among the fat.

Supplementary fat to rations decreased urinary allantoin excretion in sheep, indicating decreased microbial biosynthesis.

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STRESZCZENIE

Wpływ dodatków tłuszczowych w mieszankach treściwych dla owiec na strawność składników pokarmowych oraz przemiany w żwaczu

Doświadczenie przeprowadzono na trykach polskiej owcy długowełnistej z przetokami do żwacza, w układzie kwadratu łacińskiego 4×4, podzielonych na 4 grupy: kontrolną (C) i 3 doświadczalne. Zwierzęta żywiono sianem łąkowym oraz mieszanką treściwą, która w grupach doświadczalnych zawierała dodatek nasion lnu (L), oleju lnianego (OL) lub preparatu Dunafett (D). Dodatek tłuszczu w mieszankach nie miał istotnego wpływu na przebieg procesów fermentacyjnych w żwaczu i nie wpłynął na strawność składników pokarmowych dawek. Stwierdzono natomiast istotne różnice w wydalaniu alantoiny pomiędzy grupą kontrolną a doświadczalnymi.