Journal of Animal and Feed Sciences, 10, Suppl. 2, 2001, 97 – 101

The effects of different amounts and types of fat on rumen microbial protein synthesis in sheep*

M. Szumacher-Strabel[1], A. Cieślak[1], A. Potkański[1], J. Kowalczyk[2] and M. Czauderna[2]

[1]Department of Animal Nutrition and Feed Management, August Cieszkowski Agricultural University Wołyńska 33, 60-637 Poznań, Poland
[2] The Kielanowski Institute of Animal Physiology and Nutrition, Polish Academy of Sciences 05-11- Jabłonna, Poland

ABSTRACT

The experiments were carried out on 4 rams of 40±5 kg body weight fitted with permanent rumen and duodenal cannulas in a 4 x 4 Latin square design to determine the effects of fat source on rumen microbial biosynthesis. The basic ration for the control group consisted of meadow hay and concentrate (60:40) and for the experimental groups, the ration was supplemented with vegetable fat as rape seed oil, hydrogenated rape seed oil or linseed oil at a level of 0 (control), 4, 8 and 10% in dry matter of the diet. The concentration of 2,6-diamonopimelic acid in duodenal digesta was analyzed as a marker of bacterial protein content. There were no statistically significant differences in DAPA and protein concentration, nevertheless the source and level of fat addition.

KEY WORDS: sheep, fat, microbial biosynthesis, DAPA

INTRODUCTION

Digesta entering the small intestine of ruminants contains protein originating from different sources, i.e. microbial protein synthesized in the rumen, feed protein that has avoided degradation in the rumen, and endogenous protein in the form of abomasal secretions, desquamated epithelial cells and recycled nitrogen

* Supported by State Committee for Scientific Research, Grant No. 5 PO6E 025 16

compounds (Siddons et al., 1982). Of these three sources, microbial protein constitutes the major part of the protein used by ruminants. According to Johnson et al. (1988) ruminants meet 50 to 100% of their total protein requirements ruminal microbial synthesis. Changes in the ration fed to ruminants can have different and significant effects on rumen microbiota. For example, feeding fat in ruminant rations, which increases the energy density of the diet by increasing total energy intake, by generating ATP more efficiently (ATP/unit energy expended) than volatile fatty acids or protein, and by direct incorporation into product (Palmquist, 1994) can modify the bacterial population or its metabolic activity, and thus influence the extent of rumen protein synthesis. However, energy from fat is not utilized directly for microbial synthesis and a high level of fat in the diet may negatively affect bacterial growth and other rumen fermentation processes.

The objective of this study was to determine the effects of fat sources differing in fatty acid content and concentration on microbial protein synthesis in the rumen of sheep.

MATERIAL AND METHODS

Animals and diets

The experiments were carried out on 4 rams of 40±5 kg body weight fitted with permanent rumen and duodenal cannulas in a 4 x 4 Latin square design to determine the effects of fat source on rumen microbial biosynthesis. Experiments consisted of four 16-day trials, 14 days of adaptation to the diet and the last two for sample collection. The basic ration for the control group consisted of meadow hay and concentrate (60:40) and for the experimental groups, the ration was supplemented with vegetable fat of rape seed oil, hydrogenated rape seed oil or linseed oil at a level of 0 (control), 4, 8 and 10% in dry matter of the diet. The energy value of the rations was 5.06 MJ EN/kg, whereas the crude protein content was 118 g/kg. The daily ration was divided into two equal portions and fed at 08.00 and 18.00 h. Drinking water was available *ad libitum* throughout the experiment.

Sampling and analysis

During the two-day sample collection time, samples of duodenal digesta representing 10% of total digesta passage were collected continuously from sheep. Composed samples were thawed, homogenized and lyophilized for analysis. The concentration of 2,6-diamonopimelic acid (DAPA) of duodenal digesta was analyzed as a marker of bacterial protein content according to Czauderna and Kowalczyk (1999) using an HPLC method with pre-column derivatization.

Statistical analysis

All data were analyzed using SAS procedures (User's Guide, 1990).

RESULTS

The concentration of DAPA, a marker of bacterial protein content in duodenal digesta, is presented in Table 1. There were no significant differences in DAPA and protein concentration regardless of the source and level of fat addition. Although the tendencies to decrease microbial synthesis were observed in sheep receiving rape seed oil in diet, and to increase it when the diets were supplemented with hydrogenated rape seed and linseed oils, these differences were not significant (P>0.05).

TABLE 1

Concentration of 2,6-diaminopimelic acid (DAPA), g/100 g AA and protein content in duodenal digesta, %

Fat in diet, %	0		4		8		10	
	mean	CV	mean	CV	mean	CV	mean	CV
Rape seed oil								
DAPA	0.99	25.7	0.69	27.6	0.52	40.9	0.67	34.5
protein	0.96	25.6	0.65	29.1	0.47	29.8	0.72	16.8
Hydrogenated rape seed oil								
DAPA	0.45	44.6	0.50	23.8	0.55	20.2	0.48	32.2
Protein	0.51	21.3	0.56	12.8	0.62	22.3	0.56	15.6
Linseed oil								
DAPA	0.48	33.5	0.53	27.3	0.43	43.0	0.64	48.1
protein	0.51	27.7	0.49	36.3	0.46	35.9	0.49	51.5

DISCUSSION

The reported yields of microbial nitrogen range from 14 to 49 g of microbial nitrogen/kg of OM apparently digested in the rumen (Chen et al., 1991) and depend mostly of the type of diet given. Pantoja et al. (1994) reported that dietary unsaturated fatty acids inhibit microbe growth and decrease fibre digestion. According to Wu and Palmquist (1991) supplemental fat usually does not decrease

microbial N flow to the duodenum. In the present experiment, addition of fat with different contents of unsaturated fatty acids to the diet for sheep had no effect on microbial protein synthesis determined using DAPA as a marker. Also Oldick and Firkins (2000) found that supplemental fat differing in the level of saturation (4.85%) partially hydrogenated tallow, tallow or animal-vegetable origin fat did not affect intake or flows of N to the duodenum. This is also in agreement with studies of Stern et al. (1994). Murphy et al. (1987) described a positive correlation between the amount of fat added and net microbial protein synthesis when milking cows were fed rape seeds. The results obtained by Hussein et al. (1995) indicate that fat supplementation from canola seed (at 5% of dietary DM), in either whole or crushed seed form, had no effects on ruminal metabolism or flows of AA to the duodenum and suggest that alkaline H_2O_2-treated whole canola seed may stimulate ruminal bacterial synthesis. Fat in oil seeds is more inert in the rumen when fed whole than when crushed or as free oil (Oldick and Firkins, 2000), but there is no evidence that fat added as free oils even in high amounts, even more than 4%, affects microbial synthesis in the rumen. Feeding fat to ruminant diets with optimal level of fibre, which minimizes the potential for its negative effects on rumen metabolic processes according to Grant and Weidner (1992), similarly as found in our experiment, does not depress microbial protein synthesis in the rumen.

REFERENCES

Chen X.B., Chen Y.K., Franklin M.F., Ørskov E.R., Shand W.J., 1991. The effect of feed intake and body weight on purine derivative excretion and microbial protein supply in sheep. J. Anim. Sci. 70, 1534-1542

Czauderna M., Kowalczyk J., 1999. Determination of 2,6-diaminopimelic acid in bacteria, ruminal and duodenal digesta using HPLC with fluorescence or UV detection. J. Anim. Feed Sci. 8, 273-288

Grant R.J., Weidner S., 1992. Effect of fat from whole soybeans on performance of dairy cows fed rations differing in fiber level and particle size. J. Dairy Sci. 75, 2742-2751

Hussein H.S., Merchen M.R., Fahey C.C. Jr., 1995. Effects of forage level and canola seed supplementation on site and extent of digestion of organic matter, carbohydrates, and energy by steers. J. Dairy Sci. 73, 2458-2468

Johnson L.M., Harrison J.H., Riley R.E., 1998. Estimation of the flow of microbial nitrogen to the duodenum using urinary uric acid or allantoin. J. Dairy Sci. 81, 2408-2420

Murphy M., Uden P., Palmquist D.L., Wiktorsson H., 1987. Rumen and total diet digestibility in lactating cows fed diets containing fullfat rapeseed. J. Dairy Sci. 70, 1572-1582

Oldick B.S., Firkins J.L., 2000. Effects of degree of fat saturation on fiber digestion and microbial protein synthesis when diets are fed twelve times daily. J. Anim. Sci. 78, 2412-2420

Palmqiust D.L., 1994. The role of the dietary fats in efficiency of ruminants. J. Nutr. 124, S1377-S1382

Pantoja J., Firkins J.L., Eastridge M.L., Hull B.L., 1994. Effects of fat saturation and source of fiber on site of nutrient digestion and milk production by lactating dairy cows. J. Dairy Sci. 77, 2341-2356

SAS®, 1990. SAS/STAT Users Guide (Release 6.03). SAS Institute Inc., Cary, NC (USA)

Siddons R.C., Beever D.E., Nolan J.V., 1982. A comparison of methods for the estimation of microbial nitrogen in duodenal digesta of sheep. Brit. J. Nutr. 48, 377-388

Stern M.D., Varga G.A., Clark J.H., Firkins L., Huber J.T., Palmquist D.L., 1994. Evaluation of chemical and physical properties of feeds that affect protein metabolism in the rumen. J. Dairy Sci. 77, 2763-2786

Wu Z., Palmquist D.L., 1991. Synthesis and biohydrogenation of fatty acids by ruminal microorganisms in vitro. J. Dairy Sci. 74, 3035-3046

STRESZCZENIE

Wpływ dodatku tłuszczu na syntezę białka mikroorganizmów w żwaczu owiec

Doświadczenie, którego celem było określenie wpływu źródła i poziomu tłuszczu w diecie na rozmiar syntezy białka bakteryjnego w żwaczu, przeprowadzono w układzie kwadratu łacińskiego 4 x 4 na czterech trykach o masie ciała 40±5 kg z trwałymi kaniulami żwaczowymi i dwunastniczymi. Podstawowa dawka pokarmowa dla grupy kontrolnej, składająca się z siana łąkowego i paszy treściwej (60:40), była uzupełniana dla zwierząt grup doświadczalnych tłuszczem oleju rzepakowego, uwodornionego oleju rzepakowego lub oleju lnianego podawanych w ilości 4, 8 i 10% suchej masy dawki. W próbach treści dwunastnicy zbieranej przez dwa dni po 14 dniowym okresie wstępnym oznaczano kwas 2,6-dwuaminopimelinowy (DAPA) jako wskaźnik zawartości białka bakteryjnego w treści dwunastnicy, a tym samym jego syntezy w żwaczu. Zawartość DAPA w treści dwunastnicy nie różniła się istotnie w zależności od rodzaju tłuszczu i jego poziomu w dawce ($P>0,05$).