EFFECTS OF RUMEN PROTOZOA ON ENERGY UTILIZATION BY WETHERS OF TWO DIETS BASED ON AMMONIA-TREATED STRAW SUPPLEMENTED OR NOT WITH MAIZE

M. Vermorel and J.P. Jouany

INRA Centre de Recherches de Clermont-Theix, 63122 Ceyrat, France

Introduction

Although many studies have been carried out in the last twenty years, the importance of protozoa in ruminant digestion in still debated. Contradictory effects of defaunation on growth of young animals have been obtained (Jouany et al., 1988). The fact that defaunation improves nitrogen utilization by ruminants fed low-protein diets is now well established. However, the effects of defaunation on energy utilization remain unclear for lack of coherent data. According to Kreuzer and Kirchgessner (1989) utilization of metabolizable energy (ME) depends on the nature of energy sources (cellulose vs starch). Ushida et al. (unpubl. data) also showed that the positive effect of protozoa on organic matter and cell wall carbohydrate digestion, is greater when diets based on low digestible roughage (ammonia-treated straw) are supplemented with starch. On this basis, the objectives of the present experiment were to characterize the effects of defaunation on the energy utilization by sheep of a forage based diet supplemented or not with maize.

Materials and Methods

Four Texel wethers (47.2 ± 2.3 kg), fitted with a rumen cannula were defaunated according to the method of Jouany and Senaud (1979) and fed successively each of two diets R1 and R2 in a different sequence. They were then refaunated and fed the same diets in the opposite sequence. Diet R1 was composed of 89.0 % ammonia-treated straw, 6.2 % fish meal, 3.1 % mineral supplement and 1.7 % ammonium sulfate on a dry matter (DM) basis. In diet R2 18 % pelleted maize was substituted for 18 % ammonia-treated straw. The rations were distributed in two meals per day, close to maintenance (872 g DM/day).

After a 2-week-adaptation period of wethers to each of the experimental diets, faeces and urine were collected over a 6-day-period. Heat production was determined by indirect calorimetry. Wethers were adapted to the open-circuit respiration chambers before the beginning of the experiment. Gas exchanges were measured during four consecutive days after a 3-day adaptation period. Statistical evaluation was done with analysis of variance on paired data and Student's test.

Results and Discussion

Defaunation did not alter significantly energy and nitrogen digestibilities of both diets (table 1). This result was in agreement with most data obtained in different ruminant species fed various diets, in spite of contradictory results (Kreuzer and Kirchgessner, 1989). The lesser degradation of organic matter in the rumen of defaunated wethers may be compensated for by a better digestion in the large intestine (Jouany et al., 1988). Methane production was not significantly affected by defaunation with diet R1, but tended to be lower with diet R2 which allowed a 3.8 times greater ruminal protozoal population than diet R1 (Jouany et al., unpubl. data). This tendency agreed with all the published data. Conversely, urinary energy tended to be higher in the defaunated wethers fed ration R1. Consequently, energy metabolizability of both diets was not significantly altered by defaunation.

Energy retention was obtained by subtracting total heat production from ME intake. However, gross energy GE and ME intakes of each wether were slightly different when it was defaunated or refaunated. Therefore, energy retention for each pair of data was adjusted for similar GE or ME intakes, assuming that the efficiencies of ME utilization for mainteinance and fattening (k_m = 0.68 and k_f = 0.44) were the same as those obtained with sheep fed similar diets (Vermorel et al., 1987). For the same GE or ME intakes refaunated (table 1). This result was supported by

TABLE 1. DIET DIGESTIBILITY AND METABOLIZABILITY, AND ENERGY RETENTION (RE) ADJUSTED FOR SIMILAR GROSS ENERGY (IE) OR METABOLIZABLE ENERGY (ME) INTAKES (kJ/kg $W^{.75}$) IN DEFAUNATED (DF) AND REFAUNATED (RF) WETHERS

Diet	R1		R2		SEM	Statistical
Treatment	DF	RF	DF	RD		significance
E. digestibility (%)	51.4[a]	49.6[a]	57.0[b]	57.4[b]	1.3	NS
N. digestibility (%)	59.9[a]	62.2[a]	65.5[b]	66.4[b]	2.3	NS
Methane E % IE	5.8[ab]	5.8[ab]	5.4[a]	6.1[b]	0.3	$P < 0.20$
Urinary E % IE	4.4[a]	3.7[b]	3.9[ab]	3.8[ab]	0.3	$P < 0.20$
ME % IE	41.1[a]	40.1[a]	47.6[b]	47.5[b]	1.2	NS
Mean IE intake	792	792	818	818	33	–
Adjusted RE	5[a]	19[b]	18[b]	62[c]	15	$P < 0.01$
Mean ME intake	317	317	381	381	17	–
Adjusted RE	−10[a]	9[b]	30[c]	54[d]	15	$P < 0.01$
Respiratory quotient	1.036[a]	1.049[ab]	1.025[a]	1.062[b]	0.009	$P < 0.02$

the higher respiratory quotient of refaunated wethers ($p < 0.02$).

The production of CO_2 of digestive origin, estimated from the CO_2/CH_4 ratio in the rumen gases determined by Jouany et al. (unpublish. data) was similar in defaunated and refaunated wethers. The remaining CO_2, assumed to be of metabolic origin, was 2.3 and 5.6 % lower in the refaunated wethers fed the R1 and R2 diets, respectively. Furthermore, for the same ME intake, O_2 consumption of refaunated animals was 6.4 and 8.5 % lower with R1 and R2 diets, respectively. Consequently, the "metabolic" respiratory quotient was increased by 4.7 and 3.3 % in the refaunated wethers.

This improvement of ME utilization in the refaunated animals could result from both lower acetate, and higher propionate molar proportions in rumen VFA (*Jouany et al., unpubl. data*) and a likely lower acetate production in the large intestine. However, it should be reminded that, on the one hand, the study was carried out on a small number of animals and that, on the other hand, measurements of gas exchanges were made first in defaunated, and then in refaunated animals. Thus, the lower heat production of the latter might also arise from a better adaptation to the respiration chambers.

The skilled technical aid of Y. Anglaret, S. De Smet, F. Duboisset, M. Fabre, S. Gasnet, C. Leoty, L. L'Hotelier, R. Souchet and J. Vernet is heartly acknowledged.

(Key Words: Protozoa, Sheep, Energy Utilization)

Literature Cited

Jouany, J.P., D.I. Demeyer and J. Grain. 1988. Effect of defaunating the rumen. Anim. Fed. Sci. Technol. 21:229-265.

Jouany, J.P. and J. Senaud. 1979. Défaunation du rumen de mouton. Ann. Biol. Anim. Bioch. Biophys. 19:619-624.

Kreuzer, M. and M. Kirchgessner. 1989. Effect of rumen protozoa on metabolism and retention in ruminants, with special reference to diet characteristics. In "The Role of Protozoa and Fungi in Ruminant Digestion" (Ed. by R.A. Leng and J.V. Nolan). OECD/UNE International Seminar. September 1988. Armidale. Australia (in press).

Vermorel, M., J.P. Dulphy and J.C. Bouvier. 1987. Energy utilization of sodium hydroxide treated or untreated straw supplemented with protein or concentrates by adult sheep. Arch. Anim. Nutr. 37:805-821.