

EFFECT OF SULPHUR DEFICIENCY ON FERMENTATION OF DIFFERENT CARBOHYDRATE SOURCES IN AN ARTIFICIAL RUMEN (RUSITEC)

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Introduction

In a recent review on the assessment of rumen microbe requirement for sulphur (S), Durand and Komisarczuk (1988) suggested that about 2.5-2.8 g S/kg organic matter fermented in the rumen (OMF) should be available. However, it has not yet been demonstrated whether microbial needs for both degradative and synthetic processes are similar whatever the carbohydrate source. The aim of the present study was to compare the effect of two S levels associated with three types of polysaccharides on fermentation end-products and ATP concentrations in a semi-continuous fermentor (Rusitec).

Materials and Methods

The Rusitec system and the analytical procedures were mainly run as described by Durand et al. (1988). The substrates used in each experiment were: 1) sodium hydroxide treated straw, 2) pure apple pectin with 72% degree of methylation (Unipectine, France), 3) pure soluble starch (Prolabo). The two former products (15 g DM daily) were enclosed within nylon bags. The bags of pectin were soaked in buffer before introduction into the vessels. The starch powder (15 g daily) was solubilised in buffer and injected into the vessels at 2 intervals (0 and 8 h) during the 24 h cycle. With soluble substrates a bag of pre-digested straw (solid matrix) was left inside the vessels throughout the experiments. The buffer, supplemented with urea in order to get an $\text{NH}_3\text{-N}$ concentration of above 130 mg/l in the fermentor, was infused at a rate of 1 l/d/vessel. Four 1-vessels were used, two were infused with a low S buffer (-S) and two with a high S buffer (control) (+S) as indicated in table 1. The control level was higher for strach and pectin than for straw because they were more extensively fermented. S from substrates was 21 mg/d for straw and null for the other two. Volatile fatty acids (VFA) and gas

production and ATP concentrations in the liquid phase of fermentors (Komisarczuk et al., 1987) were determined on 3 different days (n=6) after 8 to 10 days of equilibration.

Results and Discussion

In S-deficient vessels, the amount of available S (S_a) in terms of OMF (calculated from VFA production, Durand et al., 1988) (table 1) was well under the above suggested requirements. Indeed, with straw, S-deficiency induced a decrease in both output of end-products (table 1) and ATP concentration (fig. 1). On the other hand, with starch, only ATP concentrations were negatively affected, whereas with pectin a change in fermentation pattern was observed with an increase in CH_4 production.

In vivo, positive responses of OM or crude fibre digestibility were noted when S was added to low quality forages which are often S deficient (Durand and Komisarczuk, 1988). Our results on straw fermentability corroborate these observations. These effects of S-deficiency may be the result of a decrease in the number of cellulolytic bacteria and (or) in cellulase activity. In the present work, microbial protein synthesis measured by ^{15}N incorporation (unpublished results) and cellulase activity (Stevani et al., 1988) were both reduced by S-deficiency. A reduction in microbial catabolic activity as well as in the size of biomass can cause the decrease in ATP concentrations. With straw, both factors were involved whereas with starch the fall of ATP reflected only a decrease in the microbial population.

In conclusion, these results emphasize that for lignocellulose substrates more S is needed to optimize the degradative processes than for pectin and starch. However, whatever the type of substrates S-deficiency affects the fermentation balance in a way which is detrimental to the energy supply to the host.

(Key Words: Sulphur, Carbohydrates, Rumen)

TABLE 1. EFFECT OF S-LEVEL ON OUTPUT OF END-PRODUCTS

	Treated straw		Pectin		Starch		SEM
	-S	+S	-S	+S	-S	+S	
S addition (mg/d)	0.6	16.4	5.7	41.2	5.7	41.2	
Sa/OMF (g/kg)	1.9	6.5	0.8	5.7	0.6	4.7	
VFA production							
Total (mmol/d)	50.9 ^a	65.0 ^c	82.2 ^b	83.5 ^b	101.4 ^a	98.5 ^a	3.0
Molar %							
Acetate	71.0 ^b	71.8 ^b	75.4 ^a	71.1 ^b	57.1 ^c	56.1 ^c	1.3
Propionate	20.9 ^b	21.4 ^b	18.8 ^c	22.7 ^b	33.3 ^a	33.2 ^a	1.0
GAS							
CO ₂ (ml/d)	512 ^c	829 ^b	2123 ^a	2085 ^a	2087 ^a	2002 ^a	127
CH ₄ (ml/d)	290 ^d	399 ^c	673 ^a	570 ^b	556 ^b	503 ^b	29
CH ₄ /VFA (mol/mol)	0.25 ^c	0.28 ^{bc}	0.37 ^a	0.30 ^b	0.25 ^c	0.23 ^c	0.01

Within a row: a = b = c = d, p at least <0.05 (test of Newman-Keuls)

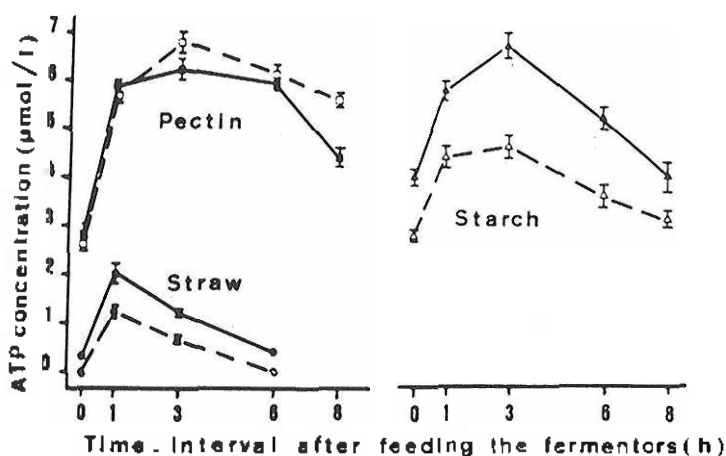


Figure 1. Effects of S level on ATP concentrations in fermentors. Symbols: —●—, straw + S; ---○---, straw -S; —■—, pectin +S; ---□---, pectin -S; —▲—, starch +S; ---△---, starch -S.

Literature Cited

- Durand, M., C. Dumay, P. Beaumatin and M.T. Morel. 1988. Use of the rumen simulation technique (RUSITEC) to compare microbial digestion of various by-products. *Anim. Feed Sci. Technol.* 21:197-204.
- Durand, M. and S. Komisarczuk. 1988. Influence of major minerals on rumen microbiota. *J. Nutr.* 118:249-260.
- Komisarczuk, S., M. Durand, P. Beaumatin and G. Hannequart. 1987. Effects of phosphorus deficiency on rumen activity associated with the solid and liquid phases of a fermentor (RUSITEC). *Reprod. Nutr. Develop.* 27:907-919.
- Stevani, J., P. Beaumatin, C. Dumay, G. Hannequart and M. Durand. 1988. Etude en fermenteur semi-continu de l'influence de l'addition de sulfate sur la degradation des constituants parietaux d'une paille non traitée ou traitée à la soude. *Reprod. Nutr. Develop.* 28 (in press).