FERMENTATION OF THREE TYPES OF SILAGES WITH DIFFERENT CARBOHYDRATE SUPPLEMENTS IN CONTINUOUS CULTURES

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Introduction

Owing to differencies in the nitrogenous and non-nitrogenous composition of silages, various types of concentrates may be needed in order to obtain optimum rumen fermentation and microbial growth (Thomas and Rae, 1988). The purpose of this study was to examine the effect of the type of carbohydrate supplement on rumen fermentation with three types of silages in continuous cultures.

Materials and Methods

The continuous culture system described by Miettinen and Setala (1988) containing three fermenters (V=700ml) was used in replicated 3x3 latin square design to study the effect of replacing half of the cereal (oats: barley, 75:25) concentrate with wheymix (wheypowder 60 %, delactosed wheypowder 40 %) or with wheymix and unmolassed sugarbeet pulp (SBP) (cereal: wheymix: SBP, 50:25:25). The composition of the silages and concentrates used is given in table 1. The diets consisted of 50 % freeze dried grass silage and 50 % concentrate. The feeds were ground through 1 mm screen and fed 22 g DM/d in two equal portions. The incubations lasted for 5 days and the mean values for days 3 and 4 are presented as results. The flow rate from the fermenters was adjusted to be on average 5.55 %/h and the pH was held constantly above 6 with Na_2CO_3. The rumen inoculum was taken from the dairy cow given grass silage-grain diet.

Results

The only statistically significant ($p < 0.05$)

TABLE 1. THE COMPOSITION OF THE SILAGES AND CONCENTRATES USED

	Silages[a]			Concentrates[b]		
	1	2	3	A	B	C
DM, %	15.9	20.3	19.4	94.1	94.0	93.2
(% in DM)						
Ash	8.9	8.2	7.6	3.1	9.0	6.1
Crude fibre	30.3	33.9	26.7	10.2	5.3	10.4
Crude protein	15.7	16.0	14.3	13.7	15.0	13.9
Sugars	0.19	1.11	3.76	3.30	20.5	12.3
Lactic acid	11.7	4.83	11.2			
Butyric acid	0.32	0.0	0.0			
Acetic acid	2.86	1.69	1.12			
pH	3.97	3.87	3.69			
NH_3, g/l						
press juice	0.64	0.44	0.12			

[a]1=no additive, 2=AIV II (80 % formic acid), 3=inoculant + enzyme (L. plantarum + cellulase);
[b]=cerela, B=cereal + wheymix, C=cereal + wheymix + SBP.

differences between silages in the rumen fermentation were those in the ammonia concentration (9.7, 7.9 and 4.0 mmol/l) and on the proportion of valeric acid when measured from the effluent (2.89, 2.35 and 2.82 mol % with silages 1,2 and 3, respectively). There was also a tendency ($p < 0.10$) for a higher proportion of acetic acid with the formic acid treated silage when measured from the outflow effluent.

Substituting half of the cereal concentrate with wheymix increased the amount of organic matter fermented and the total VFA concentration in the effluent (table 2). The molar proportions and production of butyric and valeric acids together with the ammonia concentration and the microbial N production were increased. The proportion and production of propionic acid and the concentration of lactic acid were decreased.

Replacing half of the wheymix (25 % of the concentrate) with SBP increased the proportion of propionic acid and decreased the production and proportion of butyric acid in the fermenters.

The mean protozoa numbers in the fermenters on the last day of incubation were 25, 31 and 35x 10^3/ml for concentrate diets A, B and C, respectively

TABLE 2. FERMENTATION CHARACTERISTICS OF DIFFERENT CONCENTRATES WITH SILAGES IN CONTINUOUS CULTURES

	Concentrates[1]			Stat.signif.[2]
	A	B	C	A/B/C
VFA,				
Total conc. (mmol/l)	81.5	84.7	80.8	NS
Proportions of mol%				
Acetic acid	60.7	61.6	62.7	NS
Propionic acid	22.9^{a}	20.3^{b}	21.2^{ab}	**
Butyric acid	13.7^{ab}	15.1^{a}	13.6^{b}	**
Valeric acid	2.62	3.01	2.57	*
Prod. of, (mmol/gDDM)	10.8	11.3	11.0	NS
Lactic acid, (mmol/l)	0.38^{a}	0.14^{b}	0.18^{b}	***
Ammonia, (mmol/l)	5.9^{b}	8.9^{a}	6.8^{b}	***
DM digested (%)	41.7	40.9	41.9	NS
OMF (%)[3]	43.4^{a}	47.5^{b}	45.7^{ab}	**
Microbial N (mg/d)	360	403	379	*
g/kg OMF	41.2	42.1	40.7	NS

[1] see for Table 1;
[2] NS ($P > 0.05$), * ($P < 0.05$), ** ($P < 0.01$), *** ($P < 0.001$);
[3] organic matter fermented, calculated from the VFA data; means with different letter differ significantly ($P < 0.05$) (Tukey's test)

Discussion

The higher rumen ammonia concentration with the untreated silage may be a consequence of the higher degree of protein degradation (see table 1) in this silage.

Increases in the molar proportion of butyrate, and decreases in the molar proportion of propionate in the rumen fluid when dried whole whey are added to the rations have also been observed *in vivo* (Windschild and Schingoethe, 1984) or *in vitro* (Czerkawski and Breckenridge, 1979). This indicates that the lactose component of whey does not favor the production of propionate in the rumen when the pH is maintained above 6. The microbial protein synthesis is usually increased and the rumen ammonia concentration decreased when whey (or soluble sugars) are added in the diets (Windschild and Schingoethe, 1984) Replacing grain with wheymix increased the microbial protein synthesis also in this study. The improvement was relatively greatest with the silage ensiled using the biological additive. The reasons for this improvement may be besides an increased supply of energy for the microbial growth also an increased supply of total N and of specific nitrogenous compounds, like amino acids and peptides, for rumen microbes (Rooke and Armstrong, 1989). However, in this study also the ammonia concentration in the fermenters was increased when cereals were replaced by wheymix. This indicates that only part of the ammonia released in wheydiet was used for the increased microbial protein synthesis. This may be a consequence of the higher protein content (16 % DM) of the wheymix compared to dried whey.

Replacing half of the wheymix with SBP changed the fermentation towards cereal type of fermentation.

It is concluded that the replacement of cereal concentrate with dried whey increased the microbial protein synthesis in fermenters fed silage based diets. The increase was greatest with the fermented silage with low protein content. How-

ever, only minor changes in the rumen fermentation were found when cereals were replaced with dried whey and sugar beet pulp.

(Key Words: Silage, Whey, Continuous Culture)

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