Biomarkers for Rumen Health

Introduction

Subacute ruminal acidosis (SARA) is one of the major health problems in Dutch dairy cows. With a prevalence of almost 14%, SARA is defined as a long-term condition of low pH values in the rumen for several hours a day, which is mainly caused by ingesting large amounts of rapidly fermentable carbohydrates and low amounts of effective fibre. SARA affects overall animal health in many ways. It may increase the risk for digestive disorders and reduces feed efficiency. Digestive disorders inhibit nutrient uptake (feed intake, digestion and absorption) which is crucial in early lactation, because it will aggravate the negative energy balance thereby resulting in metabolic and immune related disorders. Reduced nutrient uptake will reduce animal performance and consequently the efficiency of nutrient utilisation (a relatively higher proportion used for maintenance instead of for milk production). In a North-American study, economic losses due to SARA were estimated on 1.12 US dollar per dairy cow per day. For the entire Dutch dairy sector, this would mean a loss of more than 60 million euro per year. Development of relatively simple and non-invasive tools for an effective detection of ruminal health disorders will help to adapt feeding management and apply treatments where needed, thus reducing the economic loss and improving animal health and welfare.

The objective of this project was to induce SARA in a feeding trial, collecting data and milk samples to assess the feasibility of a rumen health warning system based on milk analysis which can be used by dairy farmers and nutritionists to optimize their feeding management.

Material & Methods

The trial was performed with 8 rumen-cannulated dairy cows in 2 rounds of 4 cows each. Cows were milked twice daily and had unrestricted access to fresh drinking water. All diets were fed *ad libitum* as a TMR (totally mixed ration). Each cow received a control (CON) diet for 2 weeks, followed by a change-over in 4 days to one of two SARA induction rations which were continued throughout week 4.

One treatment aimed to induce SARA by increasing the level of concentrate over roughage, to reduce roughage scratch (RRS) and physically effective fibre content, thereby inducing reduced rumination and salivation activity. The RRS diet was equal to the CON diet, except for a relative increase of the compound concentrate over the other ration components.

The other treatment aimed to induce SARA by changing the concentrate composition from slowly degradable carbohydrates to Fast Degradable Carbohydrates (FDC). The FDC diet was equal to the CON diet except for the exchange of the compound concentrate for FDC concentrate. Diet composition is shown in Table 1.

Table 1

Relative ration composition of the different diets on a dry matter base (%)

	CON round 1&2	RRS round 1	FDC round 1	RRS round 2	FDC round 2
Grass silage	29.3	22.0	29.3	17.6	29.3
Maize silage	29.3	22.0	29.3	17.6	29.3
Rape meal	4.5	3.4	4.5	2.7	4.5
Soy bean meal	4.5	3.4	4.5	2.7	4.5
Wheat meal	4.5	3.4	4.5	2.7	4.5
Control concentrate	27.9	45.8	10.4	56.7	-
FDC concentrate	29.3	-	17.5	-	27.9

CON = control ration;
RRS = treatment ration with reduced roughage scratch (reduced physically effective NDF);
FDC = treatment ration with increased fast degradable carbohydrates.

This research project is a cooperation between Wageningen UR Livestock Research, Dairy Campus, Qlip N.V. and ForFarmers with a financial contribution from SNN (Samenwerkingsverband Noord-Nederland).

In week 5, cows returned to the CON diet for two weeks. In week 7 again a change-over took place to the other SARA induction ration, continued throughout week 8 after which the trial round ended. For the second round of 4 cows, the treatment diets were changed based on the preliminary results to reach larger differences in round 2. Milk production and dry matter intake were recorded daily throughout the entire trial. During week 2, 3, 4 and 6, 7, 8 of each round, rumen pH was measured continuously (every 2 minutes) with intraruminal pH data loggers. Various samples have been collected for later analysis (when relevant). Milk samples were taken of each milking, combined per cow per day and frozen. Each Tuesday and Thursday, rumen fluid was sampled (at 8h, 12h and 16h) and stored frozen; also blood samples were taken (at 12h) and plasma was frozen.

Results

On average, the rumen pH decreased during the RRS diet, but not during the FDC diet (Figure 1). If SARA was defined as a situation with rumen pH < 5.8 during >3 hours per day, cows on RRS diet reached SARA but cows on FDC diet did not (Figure 2). Feed intake was increased for cows on the RRS diet (Table 2) due to the increased concentrate to roughage ratio. The reduced rumen pH with the RRS diet did not seem to reduce feed intake. Cows on the FDC diet however showed a reduced feed intake and milk production (Table 2). In practice where rumen pH data are generally not available, these cows would have drawn SARA attention considering the "risk" diet and symptoms of reduced performance (reduced milk yield and reduced feed intake).

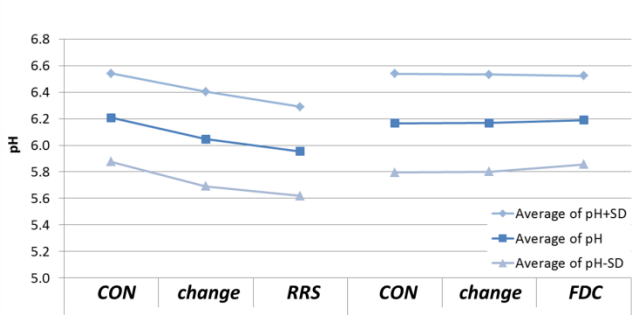

Figure 1 *Average rumen pH +/- standard deviation for each measurement week*

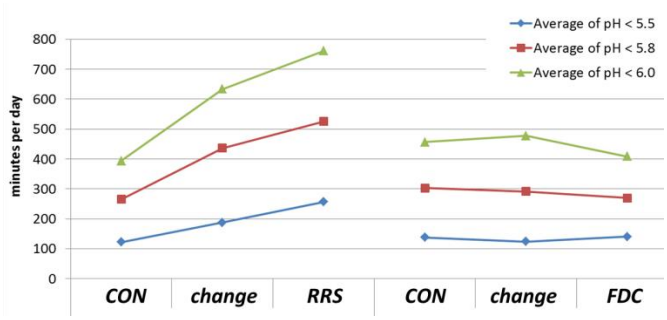

Figure 2 *Minutes per day below pH cut-off levels (green: pH 6.0, red: pH 5.8, blue: pH 5.5)*

Table 2

Average dry matter (DM) intake and milk yield per treatment group per measurement week

	RRS		FDC	
	DM intake (kg/d)	**Milk yield (kg/d)**	**DM intake (kg/d)**	**Milk yield (kg/d)**
Control diet week	21.4	26.4	22.6	30.7
Change-over week	23.4	25.4	21.1	28.2
Treatment week	**23.5**	**28.6**	**20.5**	**26.5**

RRS = treatment ration with reduced roughage scratch (reduced physically effective NDF);
FDC = treatment ration with increased fast degradable carbohydrates.

Conclusions

- Inducing reduced rumen pH in healthy dairy cows is not easily reached. Cows are able to regulate their rumen pH quite well, for example by adapting their daily dry matter intake.
- The diagnosis of SARA in practice (cows with reduced feed intake, reduced milk yield, decreased faecal consistency) and the true cases of SARA based on rumen pH measurements can vary widely.
- A rumen health warning system based on milk analysis can be very helpful for farmers and nutritionists, but needs more data and further research to define rumen health by other factors than only rumen pH.

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