

# Indicators of subacute ruminal acidosis (SARA) in early lactating dairy cows in commercial farms

M. ZSCHIESCHE, A. MENSCHING, A.R. SHARIFI, H.M. JANSEN, D. ALBERS, AND J. HUMMEL

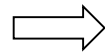


Grant number: 2817905815

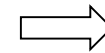


Rapidly fermentable  
carbohydrates ↑

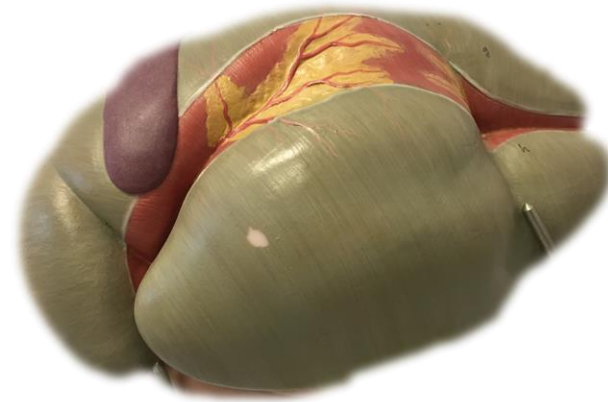
Properly balanced  
physically effective NDF ↓



Volatile fatty acids (VFA) ↑  
Lactate ↑



Ruminal pH ↓



[NOCEK, 1997]

## Ventral rumen

- Daily mean pH < 6.16
- pH < 5.8 for > 5.24 h/d
- Increased daily fluctuation

[ZEBELI ET AL. 2008]

[NOCEK ET AL. 2002]

## Reticulum

- pH < 6.04 for > 5.24 h/d

[NEUBAUER ET AL. 2016]

## Milk:

- Milk fat depression  
[HARVATINE ET AL., 2009; SUTTON, 1989]
- Fat:protein ratio (FPR) < 1.0  
[BRINKMANN ET AL., 2016]
- Further potential indicators:  
urea concentration ↓ ; lactose concentration ↑

[ENEMARK, 2002]

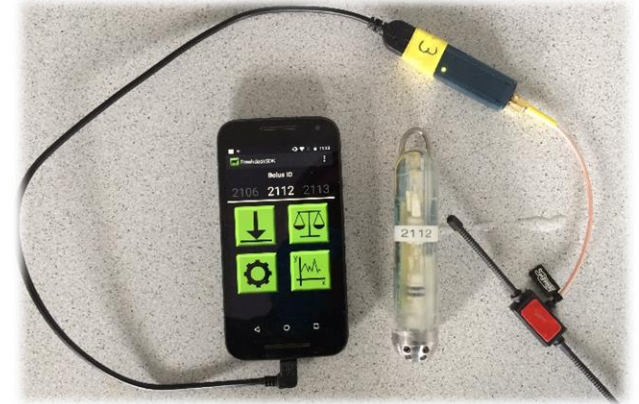


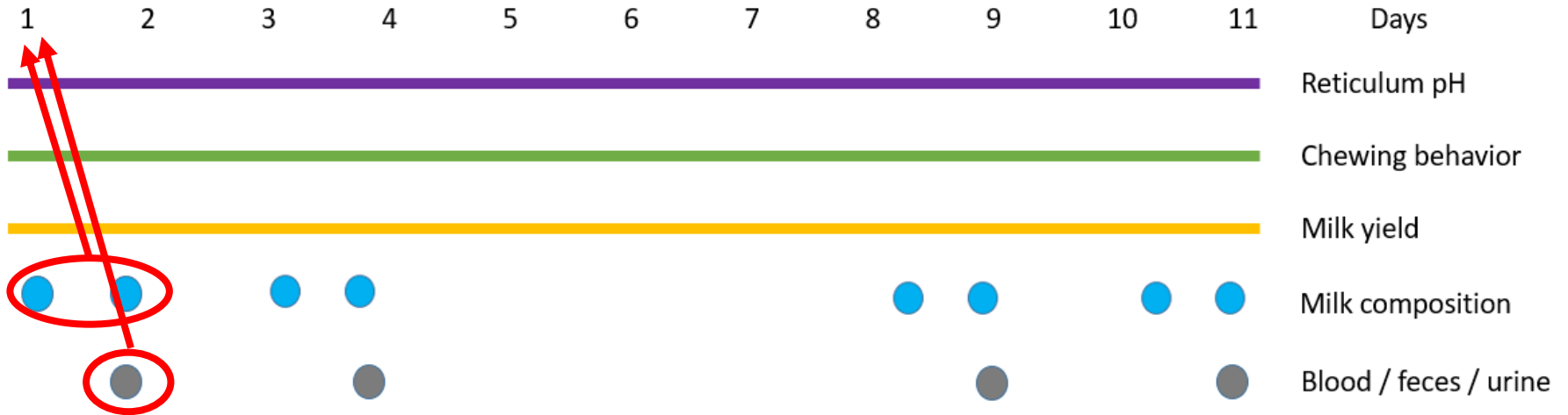
## Chewing behavior:

- Rumination time ↓  
[YANG ET AL., 2009]
- Number of rumination chews ↓  
[YANG ET AL., 2009]
- Feed intake time ↓  
[JIANG ET AL., 2017]



- 10 commercial dairy farms
- 100 dairy cows ( $20 \pm 4$  days in milk)
- Milk yield:  $37.3 \pm 8.9$  kg/d
- Data collection: 11 consecutive days per farm
- Reticular pH measurement: eCow logger





	Mean $\pm$ SD	Minimum	Maximum
DM (TMR), %	40.2 $\pm$ 4.4	35.2	51.1
Neutral-Detergent-Fiber, % DM	38.0 $\pm$ 2.3	34.8	42.0
Crude Protein, % DM	16.7 $\pm$ 1.6	14.3	19.6
Starch, % DM	18.9 $\pm$ 3.8	14.4	26.2
Sugar, % DM	3.2 $\pm$ 1.0	2.0	5.1
Ether Extract, % DM	3.8 $\pm$ 0.5	3.2	4.5
NEL, MJ NEL/kg DM	6.8 $\pm$ 0.2	6.5	7.3



## Chewing behavior:

rumination time,  
feed intake time,  
rumination boluses,  
rumination chews per bolus

Reticulum pH values:  
daily mean  
daily standard deviation (SD)

## Feces:

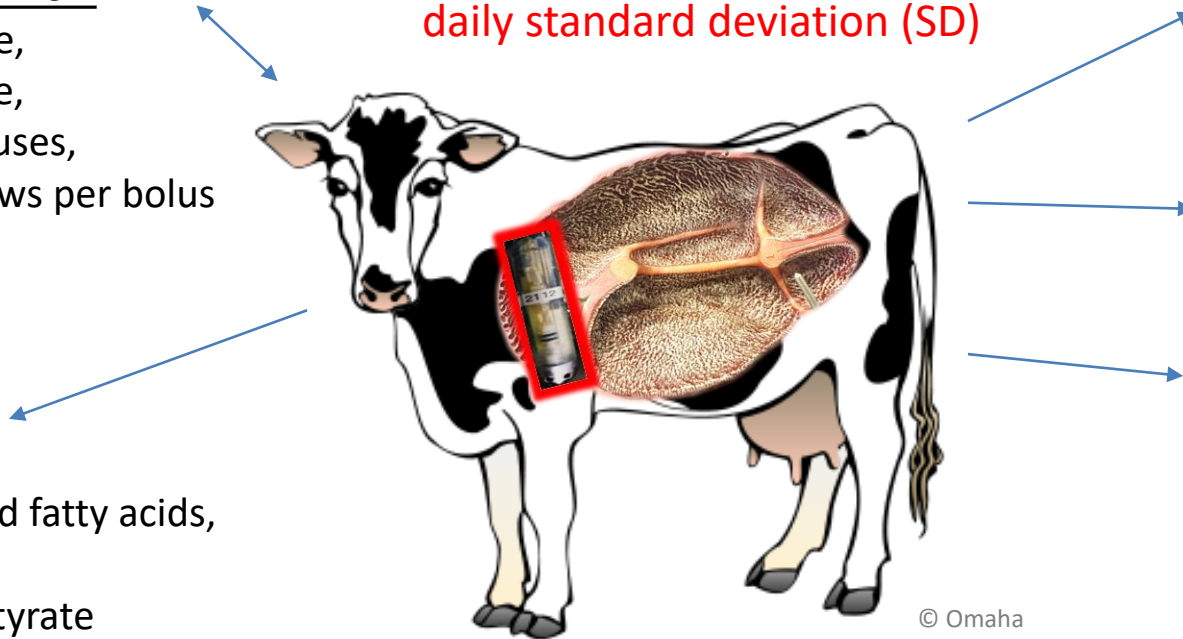
pH, aNDF<sub>om</sub>,  
dry matter

## Urine:

pH, net acid base  
excretion

## Milk:

yield, fat, protein,  
fat:protein ratio,  
lactose, milk urea



© Omaha

$$y_{ijk} = \beta_0 + \beta_1 x_{ijk,1} + \text{farm}_j + \text{cow}_k + e_{ijk}$$

$y_{ijk}$  ... pH values: daily mean or SD pH (independent variable)

$x_{ijk}$  ... indicators (1 to 18); days in milk; parity class (fixed effects)

1) Linear mixed models → single indicators

2) Multiple linear mixed models (backward selection) → indicator index

- Prevalence: 31%** (used threshold: pH <6.04 for more than 5.24 hours/day)

[NEUBAUER ET AL., 2018]

Milk parameter	Estimates	<i>P</i> -value	R <sup>2</sup> <sub>marginal</sub>	R <sup>2</sup> <sub>conditional</sub>
Yield, kg	-0.002	**	0.03	0.74
Fat, %	0.043	***	0.06	0.74
Protein, %	0.006	n.s.	0.02	0.70
Fat:protein ratio	0.103	***	0.05	0.74
Lactose, %	0.063	n.s.	0.03	0.70
Urea, mg/l	0.0004	**	0.04	0.72

\**P*-value < 0.05; \*\**P*-value < 0.01; \*\*\**P*-value < 0.001

Chewing behavior parameter	Estimates	<i>P</i> -value	R <sup>2</sup> <sub>marginal</sub>	R <sup>2</sup> <sub>conditional</sub>
Rumination time, h/d	-0.019	***	0.05	0.74
Feed intake time, h/d	-0.021	***	0.04	0.72
Rumination boluses, N/d	-0.0003	***	0.03	0.73
Rumination chews, N/Bolus	-0.002	***	0.03	0.71

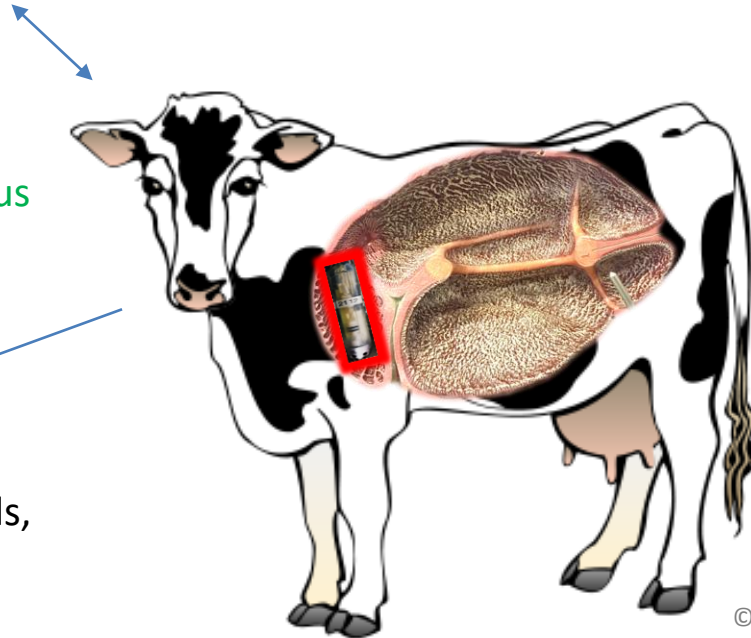
\**P*-value < 0.05; \*\**P*-value < 0.01; \*\*\**P*-value < 0.001

## Chewing behavior:

rumination time,  
feed intake time,  
rumination boluses,  
rumination chews per bolus

## Blood:

non-esterified fatty acids,  
glucose,  
 $\beta$ -hydroxybutyrate



## Feces:

pH,  $\text{aNDF}_{\text{om}}$ ,  
dry matter

## Urine:

pH, net acid base  
excretion

## Milk:

yield, fat, protein,  
fat:protein ratio,  
lactose, milk urea

© Omaha

Indicators	Daily mean pH	Daily SD pH
		days in milk
Milk	fat, fat:protein ratio, lactose	fat, protein, fat:protein ratio
Chewing behavior	rumination time, feed intake time, rumination boluses	rumination boluses, feed intake time
Blood	$\beta$ -hydroxybutyrate	$\beta$ -hydroxybutyrate
Feces	pH	pH

## Model characteristics

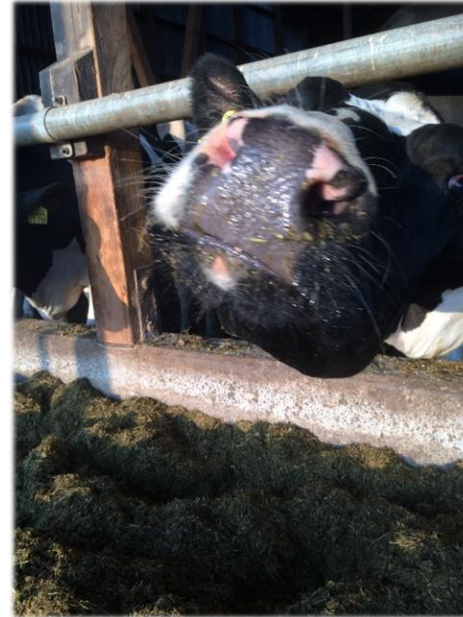
	$R^2_{\text{marginal}}$	$R^2_{\text{conditional}}$	$R^2_{\text{marginal}}$	$R^2_{\text{conditional}}$
	14 %	77 %	30 %	60 %

- Daily mean reticular pH and daily standard deviation of the reticular pH are not easy to predict
- Large farm- and animal-specific variance
  - general inter-farm thresholds of the indicators can not be recommended
- Indicators may be also impacted by negative energy balance
  - however, blood  $\beta$ -hydroxybutyrate was lower in SARA-risk cows

# Thank you for your attention.

This study was done within the project  
“Evaluation of animal welfare in dairy  
farming – metabolic and feeding  
indicators” (**IndiKuh**)

**Grant number: 2817905815**



With support from



Federal Ministry  
of Food  
and Agriculture

by decision of the  
German Bundestag





Tab. 1: Descriptive statistics pH values

pH value	Mean	SD	Min	Max
Daily mean pH	6.19	0.16	5.29	6.71
Daily SD pH	0.18	0.06	0.02	0.58

Tab. 2: Descriptive statistics milk indicators

Milk indicators	Mean	SD	Min	Max
Yield, kg	37.58	8.09	10.40	63.80
Fat, %	4.43	0.76	2.73	7.71
Protein, %	3.24	0.31	1.90	4.31
Fat:protein ratio	1.38	0.28	0.85	3.29
Urea, mg/l	194.91	55.76	69.23	384.11
Lactose, %	4.75	0.21	3.85	5.36

Tab. 3: Descriptive statistics chewing behavior

Chewing behavior indicators	Mean	SD	Min	Max
Rumination time, h/d	9.32	1.41	0.82	12.47
Feed intake time, h/d	5.33	1.37	1.40	11.72
Rumination boluses, N/d	581.31	98.79	47.00	838.00
Rumination chews, N/bolus	60.04	9.29	12.55	84.52

Tab. 4: Descriptive statistics blood, feces and urine samples

Item		Mean	SD	Min	Max
Blood	BHB, mmol/l	0.95	0.63	0.27	5.13
	Glucose, mg/dl	56.87	8.96	8.90	79.20
	NEFA, mmol/l	0.38	0.24	0.00	1.89
Feces	NDF, g/kg DM	491.11	54.51	325.79	645.58
	DM, %	14.14	1.74	8.70	21.41
	pH	7.01	0.37	5.30	8.94
Urine	pH	8.30	0.15	7.62	8.74
	NABE, mmol/l	149.23	61.64	17.9	300.75

Tab. 5: Significant single indicators for reticular daily mean pH and SD pH

Indicator	Daily mean pH	SD pH
Milk	yield, fat, fat:protein ratio, urea	yield, protein, fat:protein ratio, lactose
Chewing behavior	rumination time, feed intake time, rumination boluses, rumination chews per bolus	rumination time, feed intake time, rumination boluses, rumination chews per bolus
Blood	BHB	BHB, NEFA, glucose
Feces	pH	/
Urine	/	/