Evaluation of the ruminal function of Belgian dairy cows suspected of subacute ruminal acidosis

Evaluatie van de ruminale functie bij Belgische melkkoeien verdacht van subacute pensacidose

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ABSTRACT

Subacute ruminal acidosis (SARA) has been considered a major pathology in high producing dairy herds for years. These findings were corroborated by several studies in Europe. However, different feeding practices and herds' production levels are found in Southern Belgium. This study aimed to ascertain whether dairy cows of several herds from the south of Belgium (Wallonia) with a suspicion of SARA really did present too low ruminal pH values. Twenty-four herds were visited and 172 cows were sampled using an oropharyngeal device to collect ruminal fluid, i.e. Geishauser probe. On the samples, three tests were performed: pH measurement, methylene blue reduction test and microscopic evaluation of protozoa vitality. Based on these analyses, no cows demonstrated pH values lower than 5.5 and, only ten cows could be considered at risk for SARA. By contrast, in eightteen cows, pH values higher than 7.0 were measured and ruminal inactivity was suspected. In this study, ruminal alkalosis appeared to be more frequently observed than SARA.

SAMENVATTING

Sinds jaren wordt subacute pensacidose (SARA) beschouwd als een belangrijk probleem op hoogproductieve melkveebedrijven. Meerdere studies uitgevoerd in Europa bevestigen dit. Er zijn echter belangrijke verschillen in de productie en de voeding van melkvee in Wallonië. Het doel van deze studie is na te gaan of de melkkoeien op Waalse bedrijven verdacht van SARA, werkelijk een te lage zuurtegraad (pH) van de pensinhoud hebben.

Vierentwintig melkveebedrijven werden bezocht en van 172 koeien werd pensvocht afgenomen via een slokdarmsonde, i.e. sonde van Geishauser. Van elk staal werd de pH-waarde bepaald, de methyleenblauw-reductietest werd uitgevoerd en de beweeglijkheid van de protozoa werd microscopisch beoordeeld. Gebaseerd op die analyses had geen enkele geteste melkkoe een penspH lager dan 5,5. Slechts tien melkkoeien konden in aanmerking komen als risicodieren voor SARA. Daarentegen werd bij achttien dieren vastgesteld dat de pH hoger was dan 7,0 en dat hun pensflora onvoldoende actief was. Uit deze studie blijkt dat pensalkalose meer voorkomt dan SARA op hedendaagse Waalse melkveebedrijven.

INTRODUCTION

For years, subacute ruminal acidosis (SARA) has been considered a major disease affecting high producing dairy herds. Nevertheless, this concept has been more and more questioned with the help of new technologies, which continuously record the ruminal pH (Kleen and Denwood, 2013). Diagnosis is based on pH determination on ruminal fluid usually obtained by rumenocentesis. Yet, ruminal pH varies during the day due to ruminal fermentation (Oetzel, 2007; Plaizier et al., 2008). As a consequence, diagnosis levels are controversial (Nordlund, 2003; Enemark et al., 2004) and several authors consider a long duration drop under 5.8 or 5.5 more important than a low pH value of short duration (Gozho et al., 2005; Al Zahal et al., 2007). On the other hand, field investigations cannot apprehend drop duration, so they consider SARA evidence when ruminal pH value is lower than 5.5, whatever the duration might be. Between 5.5 and 5.8, animals are considered at risk. Many studies have been published to assess SARA prevalence. In high producing herds, which receive high concentrate diets, SARA prevalence can reach 40% in one third of the studied herds in the United States (Garrett et al.,1997). In another study of Oetzel (2004), 20% of the sampled cows were detected as acidotic and 23% were considered being at risk. However, it must be kept in mind that feeding practices, which differ from one country to another, have a key impact on SARA development. In intensive dairy cattle industry in Italy, out of ten herds with a total of 3.490 cows producing more than 10,000 kg milk /year, three herds were considered to be demonstrating SARA and five other ones were diagnosed at risk (Morgante et al., 2007). These herds received a totally mixed ration (TMR), of which the composition was in compliance with NRC (2001) recommendations for crude protein, NDF and ADF concentrations. In a Dutch study based on 197 cows of 18 dairy herds producing 10,000 kg milk/year, 13.6% of the sampled cows demonstrated pH values < 5.5 while 16.8% had pH values between 5.5 and 5.8 (Kleen et al., 2009). Those herds received a TMR composed of grass silage, maize silage and concentrates, providing nutrients in proportion considered secure regarding SARA. In only one herd, 38% of the animals was positive for SARA. In Ireland, ruminal fluid sampling was performed on 114 grazing cows, of which the average yearly milk production was 8,114 kg: 11 % demonstrated pH values lower than 5.5, while 42% had ruminal pH values between 5.5 and 5.8 (O'Grady et al., 2008). These cows were mainly fed spring grass supplemented 2 kg of concentrates maximum. In Southern Belgium, feeding practices and milk production are different from these published results; however, up till now, no study has been conducted to quantify SARA prevalence in Belgium. Despite this fact, in Belgium, it is very common to blindly complement dairy cows' diet with sodium bicarbonate to prevent ruminal acidosis. In this context, the present study aimed to verify whether dairy cows of several herds from the South of Belgium (Wallonia), where SARA was suspected, really did present low ruminal pH values indicating SARA, and whether sodium bicarbonate addition in their diet was really advisable.

MATERIALS AND METHODS

Farm selection and cow production data

Twenty-four farms were investigated in Wallonia at the request of the farmers and/or the veterinarians who expected a potential risk of SARA based on lameness prevalence, poor milk production, low fat and low fat-to-protein ratio in milk. The milk yield on a 305-day basis was 8,898 ± 1,044 kg (mean ± SD) with 95 ± 43 cows per exploitation. Seven farms were equipped with an automatic milking system. Production, days in milk (DIM), milk yield (MY; kg), milk fat % (F), milk protein % (P), F/P ratio (F/P) and performances were obtained by the National Dairy Herd Improvement.

Ruminal fluid collection and analysis

Out of the 24 investigated farms, 172 cows (162 Holstein and 10 Brown Swiss) were sampled from 2011 to 2012 for evaluation of the ruminal function. At least five cows per herd were selected on basis of DIM (< 150), or low F (< 3.2%), or F/P ≤ 1 or at the farmer's request.

As the duration of low pH is impossible to estimate in field conditions, the pH determinations were completed with the Methylene Blue Reduction Time (MBRT) test and with the examination of rumen protozoa easily performed in farms. Furthermore, milk production and milk composition were recorded on the tested cows.

Ruminal fluid was sampled four to eight hours after the distribution of the TMR using a Geishauser oropharyngeal probe, preventing saliva contamination. The pH was immediately measured by a portable pH Meter (VWR, pH100, Liège, Belgium), and the values were reduced by 0.35 as proposed by Duffield et al. (2004) because of higher pH values in reticulum sampling than with rumenocentesis. The redox potential was evaluated by MBRT as described by Rosenberger (1981). The results were classified in three categories: discoloration within less than three minutes: high redox potential; three to six minutes: medium redox potential and low redox potential for discoloration taking more than six minutes. The protozoa number and mobility were assessed by optical microscopy. For standardization, it was decided to grade the microscopy results from 1 to 5 as detailed in Table 1.

Clinical Scoring

As SARA is usually considered a herd level pathology, health scores were assessed on several animals of the same herd.

The health scores were determined as described by Edmonson et al. (1989) for body condition (BCS) and by Zaaijer and Noordhuizen (2003) for ruminal fill (RF), fecal consistency (FC) and undigested fraction in feces (UF) in producing dairy cows. The locomotion scores (LS) were recorded according to Sprecher's grading scale (Sprecher, 1997) from 1 (normal gait) to 5 (severe lameness). All evaluations were made by the same operator.

Table 1. Criteria for grading microscopic examination of rumen protozoa following grid following Kleen et al. (2009). Mobility: was estimated by the strength of protozoa movement and by the length of their track. Good: rapid movement from one side to the other of the microscopic field. Poor: slow or no motion from one side to the other, only low oscillatory motion observed.

Grade	Size	Number	Mobility
1	LMS	++	Good
2	LMS	++	Poor
3	L/ MS	+/++	Poor
4	MS	+	Poor
5	S	+	Poor

LMS: grading size for protozoa: L- large, M: medium, S: small. Number: ++: protozoa clearly visible in the sample. +: few protozoa visible in the sample.

Feed

The composition of the TMR allocated to the cows was transcribed from the balance on the feeder wagon. The concentrates allocated at milking were added. The composition of the feeds provided on the day of the visit was collected. The nutritional values based on NIRS analysis were compared to the production needs. Dutch units (VEM, DVE and OEB) were used to assess nutritional values. Silages were examined regarding their preservation (absence or presence of macroscopic moulds and temperature in the depth of the silage). The length of fibers was assessed using the Penn State Particle Separator (PSPS) as described by Kononoff and Heinrichs (2003). It was not possible to use the PSPS when liquid feeds were added to the TMR (nine farms).

Statistical Analysis

All results are presented as means ± SD. Descriptive statistical analysis (proc univariate) and t-test were performed using the SAS program (version 9.1-SAS Institute). The description of fed rations include mean ± SD, minimum and maximum values observed in the studied herds.

The t-test was used to compare the mean values of group 1 presenting pH values < 5.8 with group 2, of which the pH values were > 5.8. A second t-test was performed to evaluate the effect of adding bicarbonate by comparing farms using bicarbonate (BF) to prevent SARA and farms, which did not use it (NBF). A Chi-square test was performed to test the equality of distribution of MBRT values classified as normal (reduction time <6 minutes) and high (reduction time >6 minutes) in BF and NBF.

RESULTS

The mean characteristics of the rations are exposed in Table 2. The cows received 20.5 kg DM daily (minimum: 17.5 kg – maximum: 25.4 kg) on average. Rations were mainly composed of forages including maize silage (mean: 6.5 kg DM/day, minimum: 0 kg; maximum: 9 kg), grass silage (mean: 5.6 kg DM/day; minimum: 0 kg; maximum: 8.7 kg) and beet pulp silage (mean: 2.4 kg DM/day; minimum: 0 kg; maximum: 3.5 kg) representing 14.5 kg DM. The rest of the diet was composed of concentrates (commercial mixtures, cereals, dry pulps, brewers, by-products). One farm (herd 17) did not include maize silage and another one (herd 8) did not include grass silage. The forage percentage in the TMR was calculated on all farms, considering the physical structure of the feed, e.g. brewers and dried beet pulps were recorded as concentrates, while fodder beets were recorded as forage. Based on this classification, the mean forage proportion was 70% with a minimum of 46% in herd 17 and a maximum of 82% in herd 13. An average quantity of concentrates of 6.4 kg (minimum: 3.6 kg – maximum: 11.2 kg) completed the diet. The average proportions of fibers evaluated by PSPS were the following: 53% in the first sieve (fiber length > 19 mm), 22% in the second one (fiber length > 8 mm) and 25% in the pan. Sodium bicarbonate (150 g per cow) was added to the ration of five herds (H2, 5, 9, 10 and 15).

Health scores were evaluated on average on 40% of the animals in each herd. The average production of the scored animals (DIM: 116 ± 77) was 30.4 ± 6.0 kg/cow/day, F%: 3.9 ± 0.6 and P%: 3.4 ± 0.2 (Table 3). The mean BCS, RF, CF, UF and LS were respectively 2.6 ± 0.4, 2.8 ± 0.4, 2.7 ± 0.3, 1.5 ± 0.4 and 2.0 ± 0.6 and were put in relationship with their production level. Of 24 herds, five (21%) recorded mean BCS >3 and four herds included overweight cows with a BCS higher than three despite DIM below 170 days. One herd showed BCS of 3.2 for DIM > 212. On the contrary, insufficient body condition was noticed in five farms with mean BCS < 2.5. In one herd, the animals were really lean (BCS = 1.6 ± 1.2) and produced 36.0 ± 7.6 kg milk, while receiving a TMR with nutritional characteristics allowing a production of 32 kg milk. Relative ruminal impaction was detected in eight herds (33 %) with RF > 3; poor fiber digestion was detected in ten herds (42%) with UF > 2 and lameness was detected in 14 farms with LS > 2.

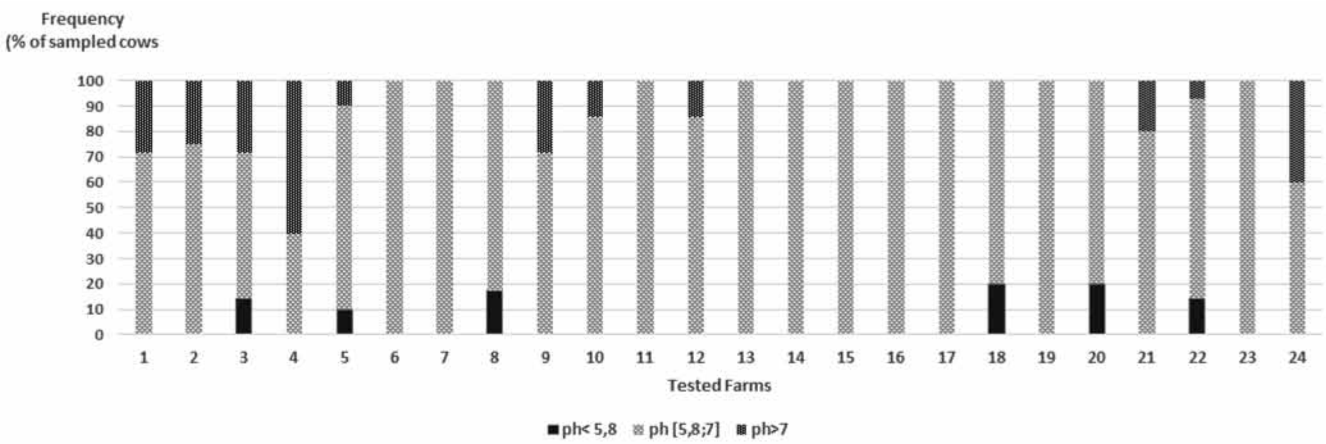

Figure 1. Distribution of low (<5.8), normal (5.8-7) and high (>7) ruminal pH within the 24 herds.

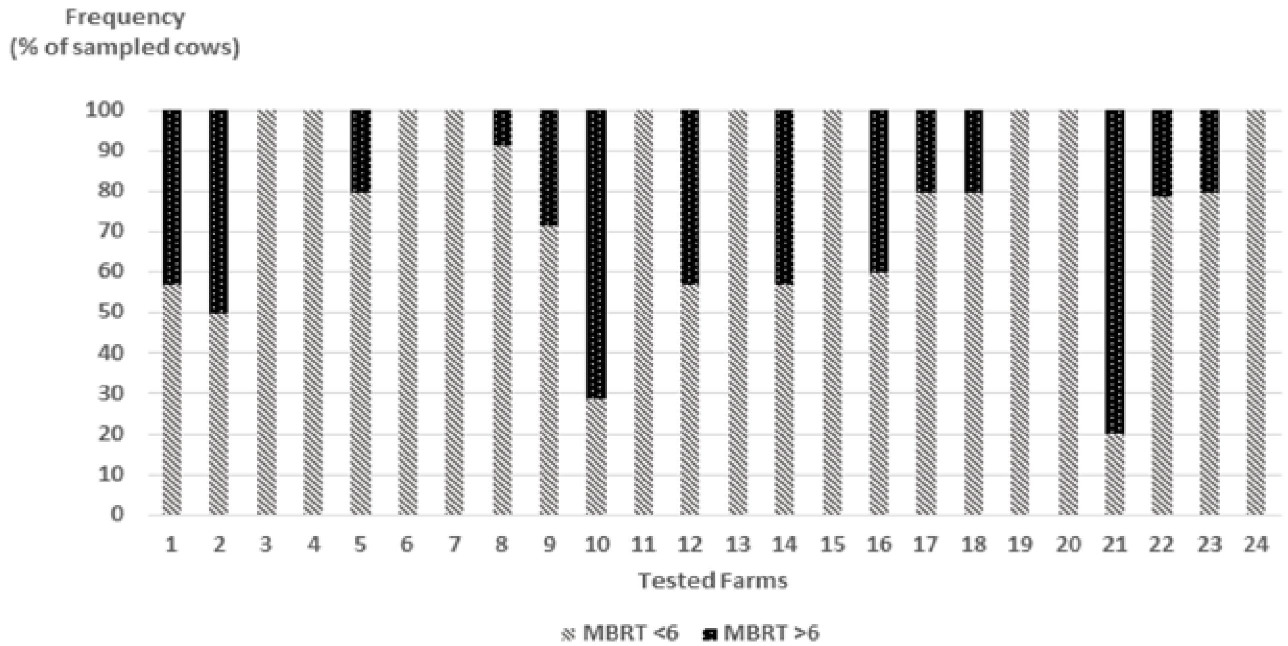

Figure 2. Distribution of normal (reduction time < 6 minutes) and high (reduction time > 6 minutes) methylene blue reduction time in the 24 tested herds.

The results of the individual samplings are presented in Table 4. Among the sampled animals, MY, F% and P% were 33.3 ± 8.9 kg, 3.5 ± 0.7 % and 3.3 ± 0.3%, respectively. The F/P ratio was 1.1 ± 0.2. The mean DIM and BCS were 106 ± 84 and 2.6 ± 0.6, respectively.

The mean ruminal pH value was 6.5 ± 0.4. Ten animals on 172 (5.8 %) had a pH < 5.8. No result was < 5.5. The distribution of low pH values was the following: 1/5 sampled animals in H18 and H20, 4/23 in H8, 1/7 in H3, 2/14 in H22 and 1/10 in H5. In other herds, no pH value lower than 5.8 was measured. Considering a herd positive for SARA when 25% of the cows presented ruminal pH < 5.5 or at risk for pH values < 5.8, no herd was positive or at risk. On the contrary, in 18 cows (10%), pH was higher than 7. In four out of the five herds supplemented with sodium bicarbonate, ruminal alkalosis (pH > 7) was reported in 25% of the sampled cows in H2, 10% in H5, 29% in H9 and 14% in H10. The relative proportions of low and high pH values within the herds are shown in Figure 1. The mean MBRT was 4.1 ± 3.0 minutes. In five out of 172 cows (3%), a value < 1 minute indicated a highly active bacterial flora. In 23 samples (14%), no reduction of MB occurred, demonstrating a relative bacterial inactivity. Results of MBRT were categorized in two classes: class 1 included values of MBRT <6 minutes while class 2 involved values of MBRT > 6 minutes. The relative distribution of MBRT within the herds is shown in Figure 2.

The mean microscopic score (MSc) was 1.35 ± 0.70. The disappearance of large protozoa was observed in seven samples (five samples from H8, one from H11 and one from H22).

In H8, on 23 sampled animals, abnormal findings in ruminal fluid were detected in nine animals (41%): four with low pH values (one combining low pH and high MSc, one low pH and no discoloration), one with no discoloration of MB and four cows with MSc equal to four and more.

In herds supplemented with sodium bicarbonate, the milk P % and the milk urea were significantly higher (3.5 ± 0.2 in BF vs 3.2 ± 0.3 in NBF; $p<0.001$; 270 ± 62 mg/L in BF vs 241 ± 71 mg/L in NBF; $p<0.05$). The discoloration of MB was slower in BF (5.7 ± 3.3 minutes versus 3.8 ± 2.9 minutes in NBF). A Chi-square test was performed to test the equality of the distribution of MBRT values classified as normal (reduction time <6 minutes) and high (reduction time >6 minutes) in BF and NBF. High MBRT-values were more frequent on BF-farms ($p<0.01$) (Figure 2). The pH also tended to be higher (6.60 ±0.46 in BF versus 6.47 ± 0.40 in NBF; $p<0.1$).

DISCUSSION

In this study, the evaluation of the ruminal function was required by the farmer or the veterinarian on the basis of suspected SARA. Low MY, low F% and low F/P in milk may be linked to SARA (Nocek, 1997; Enemark et al., 2004; Enjalbert, 2006; Mulligan et al., 2006; Toni et al., 2011). The sampled cows were selected on the basis of these criteria but no pH value was lower than 5.5. Ruminal acidosis could not be diagnosed in any herd. Only ten animals (5.8%) presented values between 5.5 and 5.8 and could be considered at risk for SARA.

Low milk yield was the usual complaint of the visited farmers. This relative lack of production could be due to several factors. The observed health scores suggest management failures. The body condition scores were not optimal for MY in eleven farms (in five farms: score > 3 and in six farms: score < 2.5). Ruminal impaction likely due to the long fiber proportion was observed in 33% of the visited farms. Poor digestion was noticed on ten farms out of 24. The high pH (> 7) largely observed in the sampled cows was probably linked to impaired digestion and ruminal dysfunction (Mouriño et al., 2001; Kozloski et al., 2008). Moreover, a poor silage quality regarding conservation and nutritional values was reported in five out of 24 farms and might have reduced the nutritional value of the diet. Lameness was a major problem as more than half of the herds presented high LS (LS > 2). This factor has been reported as impacting the productivity of animals (Juarez et al, 2003; Archer et al., 2010). The housing of the animals was therefore examined: the cowsheds demonstrated discomfort inducing competition between animals in some farms. Abnormal eating and rumination behavior are well-known to be related to lameness and discomfort, and to influence ruminal fermentations and pH and hence, the production levels (Stone, 2004).

On the other hand, the addition of sodium bicarbonate influenced ruminal fermentation inducing a relative increase in pH and slowing down MBRT. High ruminal pH observed in the sampled cows could

Table 2. Main nutritional characteristics of the diet of the tested herds.

Herd	TMR	% Forages	KVEM	DVE	OEB	MY expected
1	18.2	74	17.1	1773	46	26.0
2	19.1	86	17.2	1355	415	26.1/25
3	19.9	57	18.8	1543	-15	29.2/28
4	17.5	82	16.8	1501	228	25.4
5	20.7	69	20.2	2048	336	32.4
6	21.0	74	19.6	1662	704	31
7	21.0	76	19.0	1565	609	30/28.5
8	19.4	68	16.6	1487	517	25.0
9	19.5	71	18.4	1652	165	28.5
10	18.0	70	16.9	1546	111	25.6
11	20.7	71	19.1	1841	284	30.2
12	17.5	68	15.0	1354	176	21.6
13	20.8	82	19.2	1503	244	30.3/28
14	21.1	56	19.4	1933	425	30.5
15	23.0	68	22.2	2122	648	36.4
16	22.2	72	21.5	1994	429	34.9
17	22.3	46	20.5	2027	302	32.8
18	22.1	67	20.0	1833	589	32
19	24.4	74	22.0	2172	658	36
20	25.4	76	23.8	2340	363	39.5
21	21.4	63	20.1	1792	490	32.1
22	20.7	62	19.6	1684	104	31
23	21.1	63	20.5	2078	471	33
24	21.5	65	20.0	1877	268	32

TMR: totally mixed ration (kg DM). DM: dry matter. KVEM: net energy (Dutch system), DVE and OEB respectively intestine and ruminal degradable proteins (Dutch system). MY expected: milk yield expected regarding the energy provided by the ration. Should the protein supply be the limiting factor, the milk yield based on the protein supply is indicated as a second figure.

Table 3. Production values and health scores of the tested herds.

Herd	MY	F%	P%	DIM	BCS	RF	FC	UF	LS
1	27.0 ± 9.4	4.1 ± 0,9	3.6 ± 0.3	188 ± 133	2.8 ± 0.7	2.4 ± 0.8	2.7 ± 0.6	2.0 ± 0.8	2.8 ± 0.7
2	27.4 ± 7.6	3.9 ± 0.6	3.6 ± 0.4	156 ± 119	2.4 ± 0.7	2.9 ± 0.7	2.5 ± 0.5	1.7 ± 0.5	2.7 ± 0.7
3	30.5 ± 7.6	3.7 ± 08	3.3 ±0.3	144 ± 91	3.3 ± 0.7	3.3 ± 0.7	2.4 ± 0.5	2.4 ± 0.5	1.8 ± 0.6
4	25.4 ± 5.9	4.3 ± 0.6	3.6 ± 0.5	169 ± 119	2.9 ± 0.5	2.9 ± 0.6	3.0 ± 0.3	1.9 ± 0.3	2.0 ± 0.9
5	34.8 ± 11.3	3.8 ± 0.6	3.6 ± 0.5	209 ± 147	2.8 ± 0.6	2.6 ± 0.7	2.5 ± 0.6	2.3 ± 0.5	2.4 ± 0.8
6	28.2 ± 7.7	4.1 ± 0.6	3.6 ± 0.3	154 ± 121	3.1 ± 0.8	3.0 ± 0.6	2.9 ± 0.4	1.8 ± 0.5	2.5 ± 1.1
7	26.2 ± 8.0	4.3 ± 0.5	3.6 ± 0.4	165 ± 138	3.1 ± 0.5	3.2 ± 0.7	2.5 ± 0.6	2.5 ± 0.6	2.6 ± 0.8
8	26.8 ± 8.2	3.8 ± 2.7	3.2 ±0.3	212 ± 159	3.2 ± 0.6	2.6 ± 0.7	2.6 ± 0.6	2.0 ± 0.0	2.6 ± 1.3
9	35.0 ± 7.3	3.8 ± 0.4	3.3 ± 0.3	143 ± 121	2.8 ± 0.6	2.8 ± 0.4	2.4 ± 0.6	MD	1.5
10	26.0 ± 7.8	4.0 ± 0.6	3.5 ± 0.4	156 ± 139	3.0 ± 0.5	3.6 ± 0.5	2.3 ± 0.5	1.0 ± 0.0	2.0 ± 0.7
11	29.3 ± 7.7	4.0 ± 0.5	3.3 ± 0.3	150 ± 100	2.7 ± 0.7	3.0 ± 0.7	3.0 ± 0.6	2.7 ± 0.6	1.9 ± 0.8
12	28.5 ± 8.1	3.4 ± 0.6	3.3 ± 0.3	175 ± 98	2.5 ± 0.7	3.2 ± 0.7	2.4 ± 0.5	3.5 ± 0.6	2.3 ± 0.8
13	26.7 ± 8.2	3.0 ± 0.6	3.2 ± 0.4	170 ± 123	2.3 ± 0.7	2.6 ± 0.8	2.5 ± 0.5	2.2 ± 0.2	2.0 ± 0.8
14	23.5 ± 8.6	4.8 ± 0.7	3.5 ± 0.3	189 ± 124	2.7 ± 0.6	3.0 ± 0.7	2.8 ± 0.4	2.0 ± 0.6	2.4 ± 0.8
15	30.2 ± 7.7	3.7 ± 0.6	3.3 ± 0.3	86 ± 95	2.9 ± 0.3	3.2 ± 0.4	2.5 ± 0.7	MD	1.4 ± 0.5
16	33.4 ± 7.2	3.7 ± 0.5	3.2 ± 0.3	102 ± 50	2.4 ± 0.4	3.0 ± 0.4	3.1 ± 0.2	3.9 ± 0.3	2.0 ± 0.8
17	36.0 ± 7.6	3.3 ± 0.5	3.3 ± 0.2	102 ± 55	1.6 ± 0.2	2.6 ± 0.5	2.9 ± 0.3	3.0 ± 0.3	3.0 ± 0.7
18	38.0 ± 6.0	3.6 ± 0.6	3.2 ± 0.2	85 ± 29	2.8 ± 0.6	2.5 ± 0.5	2.5 ± 0.5	1.8 ± 0.5	1.8 ± 0.8
19	29.4 ± 8.2	3.9 ± 0.7	3.2 ± 0.5	92 ± 48	2.8 ± 0.5	2.6 ± 0.5	2.4 ± 0.5	1.7 ± 0.5	1.8 ± 0.6
20	37.5 ± 9.9	3.7 ± 0.6	3.2 ± 0.4	121 ± 52	2.5 ± 0.6	2.6 ± 0.5	2.4 ± 0.4	1.4 ± 0.5	2.4 ± 1.0
21	33.2 ± 5.1	3.9 ± 0.5	3.4 ± 0.2	148 ± 47	2.7 ± 0.6	2.5 ± 0.5	2.7 ± 0.5	1.8 ± 0.4	1.9 ± 0.8
22	26.1 ± 12.1	3.9 ± 0.6	3.5 ± 0.4	210 ± 143	2.4 ± 0.7	2.7 ± 0.5	2.8 ± 0.3	1.6 ± 0.4	1.4 ± 0.6
23	34.7 ± 11.0	3.8 ± 0.5	3.4 ± 0.3	102 ± 72	2.6 ± 0.5	2.7 ± 0.4	3.0 ± 0.4	3.1 ± 0.5	2.5 ± 1.0
24	29.7 ± 5.5	4.0 ± 0.3	3.6 ± 0.3	101 ± 45	3.1 ± 0.5	2.7 ± 0.5	3.0 ± 0.0	1.7 ± 0.5	2.0 ± 0.9

Values are means ± SD. Production values (MY: milk yield, F%: milk fat percentage, P%: milk protein percentage, DIM: days in milk) were reported by the Herd National Improvement at the time of the sampling. Health scores (BCS: body condition score, RF: ruminal fill, FC: fecal consistency, UF: undigested fraction and LS: locomotion score) were determined in each herd by the same operator. MD: missing data.

alter the ruminal function and impair the performance of the cows. An increase in P% was noticed in the BF. Similar effects of sodium bicarbonate supplementation on P% have not been reported in the literature (Erdman et al., 1982; Kennelly et al., 1999; Khorasani and Kennelly, 2001). However, in compliance with the results of this study, the association of high concentrate and buffer supplementation has been described as influencing ruminal fermentation pattern causing a decline in (acetate + butyrate) to propionate ratio (Khorasani and Kennelly, 2001). According to these authors, adding high concentrate and buffer supplementation has a moderate impact on lactose production, but also has an impact on the amino-acid production, which is privileged by the increased propionate concentration to the detriment of gluconeogenesis. As a result, the milk protein % is increased. A similar process could be incriminated in the present study. The high urea level recorded on BF farms was possibly linked to the shift in bacterial population reflected by the high MBRT.

The herds involved could be considered efficient as their average milk yield (8,898 ±1,044 kg) was higher than the mean registered in Southern Belgium (7,638 kg per cow on a 305 days basis). Despite the high nutritional requirements linked to this production level, the feed was mainly composed of forages. Grass silage was included in all the rations but one (herd 8) and maize silage was another major component. A high proportion of fibers in the rations was confirmed by the results of PSPS with a majority of fibers (53%) measuring > 19 mm. Long fibers were mainly provided by grass silage. The concentrate level (on average 31%, minimum: 14% - maximum: 52%) was within the recommendations of NRC (2001) (maximum: 65%) in all the exploitations. These feeding practices prevent SARA (Stone, 2004; Mulligan et al., 2006). Therefore, the systematic addition of sodium bicarbonate in the cows' diet appeared inappropriate on the examined herds.

To improve the productivity of the visited herds, the main advice could be to improve the forage quality and to detect lame cows more efficiently. Introducing highly fermentable carbohydrates in the cows' diet could help improving ruminal fermentation.

CONCLUSION

Regarding these results, ruminal evaluation did not confirm SARA suspicion, while on the opposite, relative ruminal flora inactivity and high ruminal pH seemed far more common.

No relation could be demonstrated between F% or F/P ratio and ruminal pH values. Systematically linking low fat syndrome and SARA is hazardous.

Table 4. Ruminal parameters and body condition scores of sampled cows from the 24 tested herds.

Herd	N	DIM	LN	BCS	pH	MBRT	MS
1	7	112 ± 85	2.3 ± 1.0	2.8 ± 0.9	6.8 ± 0.3	7.8 ± 4.3	1.1 ± 0.4
2	8	174 ± 86	2.6 ± 1.7	2.3 ± 0.4	6.9 ± 0.5	6.8 ± 3.1	1.1 ± 0.4
3	7	112 ± 85	3.7 ± 1.8	3.0 ± 0.0	6.6 ± 0.5	1.1 ± 0.4	1.3 ± 0.8
4	5	145 ± 88	3.6 ± 2.1	3,0 ± 0.0	7.0 ± 0.4	4,0 ± 1.1	2.0 ± 0.0
5	10	145 ± 109	3.2 ± 1.2	2.8 ± 0.2	6.3 ± 0.4	4.3 ± 2.8	1.8 ± 0.4
6	7	69 ± 41	2.4 ± 0.7	1.3 ± 0.5	6.3 ± 0.2	3.0 ± 0.4	1.4 ± 0.8
7	11	52 ± 37	2.3 ± 0.3	2.9 ± 05.3	6.3 ± 0.3	3.1 ± 2.5	1.0 ± 0.0
8	23	111 ± 73	2.4 ± 0.9	2.9 ± 0,5	6.4 ± 0.5	3.6 ± 2.0	2.1 ± 1.3
9	9	143 ± 120	2.9 ± 1.7	MD	6.9 ± 0.3	5.8 ± 2.6	1.0 ± 0.0
10	7	82 ± 37	1.3 ± 0.6	2.8 ± 0.3	6.7 ± 0.2	8.5 ± 2.7	1.9 ± 0.4
11	6	111 ± 115	3.5 ± 0.8	3.2 ± 0.8	6.4 ± 0.3	2.3 ± 0.8	1.7 ± 1.6
12	7	119 ± 63	4.8 ± 1.7	2.3 ± 0.5	6.7 ± 0.4	5.3 ± 3.6	1.0 ± 0.0
13	5	111 ± 159	2.8 ± 1.8	2.3 ± 0.4	6.7 ± 0.3	2.0 ± 0.9	1.0 ± 0.0
14	7	177 ± 202	2.8 ± 1.8	MD	6.5 ± 0.3	5.9 ± 3.7	1.0 ± 0.0
15	5	22 ± 25	2.8 ± 1.5	2.6 ± 0.1	6.0 ± 0.2	1.4 ± 0.5	1.0 ± 0.0
16	5	60 ± 31	2.4 ± 0.8	2.5 ± 0.3	6.3 ± 0.4	4.1 ± 4.2	1.0 ± 0.0
17	5	86 ± 44	2.6 ± 1.5	1.6 ± 0.2	6.2 ± 0.3	4.6 ± 1.5	1.0 ± 0.0
18	5	62 ± 34	2.4 ± 0.9	2.7 ± 0.4	6.4 ± 0.5	3.1 ± 1.9	1.2 ± 0.4
19	5	62 ± 14	2.8 ± 1.6	2.5 ± 0.7	6.2 ± 0.1	1.6 ± 0.5	1.0 ± 0.0
20	5	86 ± 36	1.8 ± 1.1	1.8 ± 0.4	6.3 ± 0.3	1.8 ± 0.5	1.0 ± 0.0
21	5	106 ± 49	3.2 ± 1.3	2.3 ± 0.4	6.6 ± 0.4	8.2 ± 4.1	1.0 ± 0.0
22	14	107 ± 37	2.0 ± 1.1	2.0 ± 0.6	6.3 ± 0.4	4.3 ± 3.8	1.4 ± 1.2
23	5	95 ± 62	3.6 ± 2.3	2.3 ± 0.4	6.4 ± 0.2	3.1 ± 2.1	1.0 ± 0.0
24	5	99 ± 32	2.6 ± 2.3	2.9 ± 0.6	6.7 ± 0.4	2.9 ± 1.3	1.0 ± 0.0

Values ± SD. Abbreviations: N: number of sampled cows. DIM: days in milk; LN: lactation number, BCS: body condition score; MBRT: methylene blue reduction time; MS: ruminal microscopic score; MD: missing data.

According to this study, the regular use of sodium bicarbonate in Walloon dairy farms is questioned. In case of low production or low fat syndrome, more attention should be paid to silage and housing quality as well as to the detection, prevention and treatment of lame cows.

REFERENCES

Al Zahal, O., Kebreab, E., France, J., McBride, B.W. (2007). A mathematical approach to predicting biological values from ruminal pH measurements. *Journal of Dairy Science 90*, 3777-3785.

Archer, S C, Green, M J, Huxley, J.N. (2010). Association between milk yield and serial locomotion score assessments in UK dairy cows. *Journal of Dairy Science 93*, 4045-4053.

Duffield, T., Plaizier, J.C., Fairfield, A., Bagg, R., Vessie, G., Dick, P., Wilson, J., Aramini, J., McBride, B. (2004). Comparison of techniques for measurement of rumen pH in lactating dairy cows. *Journal of Dairy Science 87*, 59-66.

Edmonson, A.J., Lean, I.J., Weaver, L.D., Farver, T., Webster, G. (1989). A body condition scoring chart for Holstein dairy cows. *Journal of Dairy Science 72*, 68-78.

Enemark, J.M.D., Jørgensen, R.J., Kristensen, N.B. (2004). An evaluation of parameters for the detection of subclinical rumen acidosis in dairy herds. *Veterinary Research Communications 28*, 687-709.

Enjalbert, F. (2006). Assessment of nutritional adequacy in dairy cows through diet characteristics and animal responses. Twenty-fourth World Buiatrics Congress, Nice, France, 15-19 October, 2006, 180-190.

Erdman R.A., Hemken R.W., Bull L.S. (1982). Dietary sodium bicarbonate and magnesium oxide for early postpartum lactating dairy cows: effects of production, acid-based metabolism, and digestion *Journal of Dairy Science 65*, 712-731.

Garrett, E.F., Nordlund, K.V., Goodger, W.J., Oetzel, G.R. (1997). A cross-sectional field study investigating the effect of periparturient dietary management on ruminal pH in early lactation dairy cows. *Journal of Dairy Science 80* (Suppl. 1), 169.

Gozho, G.N., Plaizier, J.C., Krause, D.O., Kennedy, A.D., Wittenberg, K.M. (2005). Subacute ruminal acidosis induces ruminal lipopolysaccharide endotoxin release and triggers an inflammatory response. *Journal of Dairy Science 88*, 1399-1403.

Juarez S.T, Robinson P.H., De Peters E.J., Price E.O. (2003). Impact of lameness on behavior and productivity of lactating Holstein cows. *Applied Animal Behaviour Science 83*, 1–14.

Kennelly, J.J., Robinson, B., Khorasani, G.R. (1999). Influence of carbohydrate source and buffer on rumen fermentation characteristics, milk yield, and milk composition in early-lactation holstein cows. *Journal of Dairy Science 82*, 2486-2496.

Khorasani, G.R., Kennelly, J.J. (2001). Influence of carbohydrate source and buffer on rumen fermentation characteristics, milk yield, and milk composition in latelactation holstein cows. *Journal of Dairy Science 84*, 1707-1716.

Kleen, J.L., Hooijer, G.A., Rehage, J., Noordhuizen, J.P.T.M. (2009). Subacute ruminal acidosis in Dutch dairy herds. *Veterinary Record 164*, 681-684.

Kleen, J.L., Denwood M. (2013). Analysis of ruminal variation in a group of dairy cows recorded by indwelling ruminal pH probes. In: Göran Dalin (editor). *Uppsala. ICPD Book of Abstracts*, 26.

Kononoff, P.J., Heinrichs, A.J. (2003). The effect of reducing alfalfa haylage particle size on cows in early lactation. *Journal of Dairy Science 86*, 1445-1457.

Kozloski, G.V., Lima, L.D., Cadorin Jr R. L., Bonnecarrère Sanchez, L.M., Senger, C.C.D., Fiorentini, G., Härter, C.J. (2008). Microbial colonization and degradation of forage samples incubated in vitro at different initial pH. *Animal Feed Science and Technology 141*, 356-367.

Morgante, M., Stelletta, C., Berzaghi, P., Gianesella, M., Andrighetto, I. (2007). Subacute rumen acidosis in lactating cows: An investigation in intensive Italian dairy herds. *Journal of Animal Physiology and Animal Nutrition 91*, 226-234.

Mouriño, F., Akkarawongsa, R., Weimer, P.J. (2001). Initial pH as a determinant of cellulose digestion rate by mixed ruminal microorganisms in vitro. *Journal of Dairy Science 84*, 848-859.

Mulligan, F.T., O'Grady, L., Rice, D.A., Doherty, M.L. (2006). A herd health approach to dairy cow nutrition and production diseases of the transition cow. *Animal Reproduction Science 96*, 331-353.

National Research Council (2001). Nutrient requirements of dairy cattle. Seventh[t] revised edition, National Academy ofScience, Washington DC.

Nocek, J.E. (1997). Bovine acidosis: implications on laminitis. *Journal of Dairy Science 80*, 1005-1028.

Nordlund, K.V. (2003). Herd-based diagnosis of subacute ruminal acidosis. Preconvention seminar 7: dairy herd problem investigation strategies. In: *Proceedings of the 36th Annual Conference of the American Association of Bovine Practitioners*. Columbus, OH, USA.

Oetzel, G.R. (2004). Monitoring and testing dairy herds for metabolic disease. *The Veterinary Clinics of North America. Food Animal Practice 20*, 651-674.

Oetzel, G.R. (2007). Subacute ruminal acidosis in dairy herds: physiology, pathophysiology, milk fat responses, and nutritional management. *American Association of Bovine Practitioners, 40th Annual Conference*. University of Winconsin, Vancouver BC, Canada, 89-119.

O'Grady, L., Doherty, M.L., Mulligan, F.J. (2008). Subacute ruminal acidosis (SARA) in grazing Irish dairy cows. *The Veterinary Journal 176*, 44-49.

Plaizier, J.C., Krause, D.O., Gozho, G.N., McBride, B.W. (2008). Subacute ruminal acidosis in dairy cows: The physiological causes, incidence and consequences. *The Veterinary Journal 176*, 21-31.

Rosenberger G. (1981). *Clinical Examination of Cattle*. Parey/WB Saunders, Berlin, 453.

Stone W.C. (2004). Nutritional approaches to minimize subacute ruminal acidosis and laminitis in dairy cattle. *Journal of Dairy Science 87*, 13-26.

Sprecher, D.J., Hostetler, D.E., Kaneene, J.B. (1997). A lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. *Theriogenology 47*, 1179-1187.

Toni, F., Vincenti, L., Grigoletto, L., Ricci, A., Schukken, Y.H. (2011). Early lactation ratio of fat and protein percentage in milk is associated with health, milk production, and survival. *Journal of Dairy Science 94*, 1772-1783.

Zaaijer, D., Noordhuizen, J.P.T.M. (2003). A novel scoring system for monitoring the relationship between nutritional efficiency and fertility in dairy cows. *Irish Veterinary Journal 56*, 145-156.