Estimation of the prevalence of subacute ruminal acidosis in dairy herds

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Abstract

Subacute ruminal acidosis (SARA) is a nutritional disorder encountered in the high-producing dairy cows. This disease appears in cases of high nutrient density diets including an increase in the proportion of concentrates and a decrease of the forage particle size. The consequences of SARA include a reduction of milk production (milk yield, milk fat, milk protein) and an increase of associated pathologies (laminitis, rumenitis, diarrhea, liver abscesses…). French milk recording organizations set up a study in order to: - developed knowledge on SARA on field conditions based on farms located in the west of France - to validate risk factors described in the literature - and to assess the sensitivity of milk fat and protein contents as an indicator of SARA. The experimental plan was articulated in two parts. In the first part, prevalence of SARA has been estimated on commercial farms. 144 dairy cows from 12 dairy herds were investigated in the West of France. In each herds, pH measurements were made on 12 selected cows using a ruminal fluid sample collected with an oro-ruminal probe. Additional measurements were: rumen fill, body condition score (BCS), faeces consistency, counting undigested maize grain and the composition of the diet. Individual milk records associated to these measurements were also collected (milk yield, milk fat and protein contents, somatic cell count). In the second part, assessment of the reliability of milk fat and protein contents as predictor of SARA was conducted using a population database with more than 350,000 dairy cows. In the surveyed farms, the prevalence of SARA is 2.1% with a pH threshold of 6.2 to define SARA. Symptoms associated with SARA in the literature were not significantly related to ruminal pH in our study. Calculated prevalence on the population database according to indicators [fat / protein<1], [0<fat-protein<3] and [fat<35] are respectively 4.60%, 8.70% and 27.10%. Indicators derived from milk fat and protein contents are not sensible and specific enough to detect low pH values.

Keywords: subacute ruminal acidosis, SARA, dairy cow, oro-ruminal probe, pH, milk fat, milk protein.

Introduction

Subacute ruminal acidosis (SARA) is currently considered as a major nutritional disease for high-producing dairy cows (Plaizier *et al.*, 2009). SARA is associated with high nutrient density diets, most of the time made of a larger proportion of concentrates and a reduced forage particle size compared to regular diets (Peyraud *et al.*, 2006). Other risk factors of SARA according to the literature are: high quantity of concentrate per meals, high-producing cows (big capacity of ingestion), first lactation heifers (competition for feed) and difficulty for getting access to feedbunk (Garrett *et al.*, 2007). SARA has no specific clinical sign but is associated with a decrease of dry mater intake (DMI), milk yield and milk fat content

(Krause *et al.*, 2005). Worldwide, 8 to 28% of cows could be affected by SARA (Kleen *et al.*, 2012). In France, few studies have estimated the prevalence of SARA in commercial dairy farms, about 1.8% according to Mannessiez (2009). Current definitions of SARA are based on the pH of rumen fluid. The various technique used to measure rumen pH (rumenocentesis / oro-ruminal probe / indwelling electrode / ruminal cannulation) can affect the pH values and make difficult a scientist consensus for a pH threshold significant of SARA (Tajik *et al.*, 2011; Plaizier *et al.*, 2009). These difficulties to diagnostic SARA induce a lack of knowledge on the disease. The objectives of this study are 1) developed new knowledge on this disease on field conditions based on farms located in the west of France, 2) to validate risk factors described in the literature, 3) to assess the sensitivity of fat to protein ratio as an indicator of SARA.

Material and methods

The experimental plan was articulated in two parts.

Part 1: Prevalence of SARA has been estimated on commercial farms deriving the methodology from Garrett *et al.* (1999). Farms were selected according to 3 conditions: the existence or suspicion of SARA risk factors (according to the farm nutritionist), the presence of head-lockers in the farm and the agreement of the farmer. In each herd, pH measurements were made on 12 selected cows. Samples of ruminal fluid have been collected with an oro-ruminal probe (LPG). Cows were selected according to the risk they were affected by SARA. If the farm used a total mixed ration (TMR), cows between 100 and 150 days in milk (DIM) were selected because they have a high intake capacity. If the farm made an individual distribution of concentrates, cows between 5 and 50 DIM were selected because some of them receive high quantity of concentrates. Ruminal fluid was collected when pH values were suspected to be the lowest: between 5 to 8 hours after feeding if the diet is a TMR or 2 to 5 hours after individual concentrate feeding. About 0.5 L of rumen fluid was thrown before performing pH determination using an electronic pH meter (Hanna HI 8424 model). Additional measurements were: rumen fill, body condition score (BCS), faeces consistency, counting undigested maize grains and the composition of the diet. Individual milk records associated to these measurements were collected and consisted of milk yield, fat and protein contents and somatic cell count.

Part 2: Assessment of the reliability of fat and protein contents as predictor of SARA was conducted. A population database with more than 350,000 dairy cows from 8 to 120 DIM was built. This database contains results of individual milk records: milk yield, milk fat and protein contents, somatic cell count, days in milk and rank of lactation. Using the population database, three indicators were tested to diagnose cows affected by SARA: 1) a fat to protein ratio below 1 [fat / protein<1], 2) a difference between fat content and protein content are between 0 and 3 [0<fat-protein<3], and 3) a fat content below 35 g / kg of milk [fat<35] (Sauvant *et al.*, 1999; Sauvant *et al.*, 2010; Herman, 2012).

Statistical analysis: Descriptive analysis and ANOVA (lm procedure) were performed using the R 3.0.0 statistical package. Difference were considered significant at $P<0.05$ (***<0.001; **<0.01; *<0.05).

Results and discussion

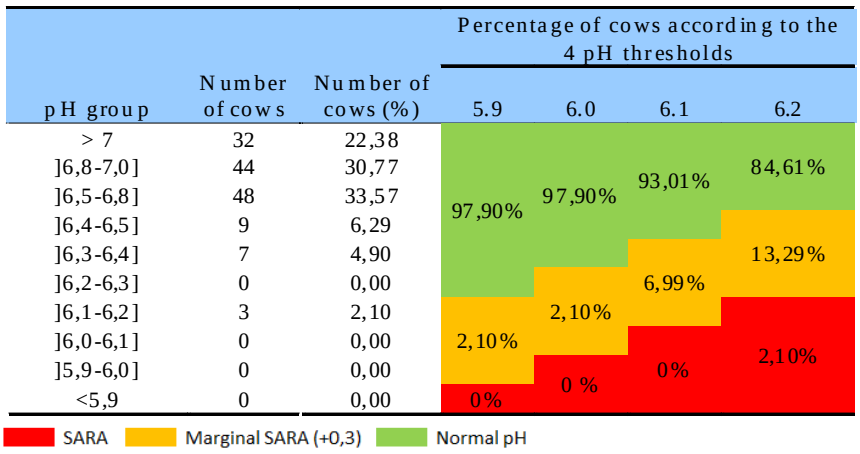
In total, 143 pH measurements were collected. The average ruminal pH was 6.81. No cow had a ruminal pH below the threshold of 5.9. Only 3 cows (2.1% of the studied population), had a ruminal pH below 6.2. Sixteen cows had a ruminal pH between 6.2 and 6.5, and 124 cows have a ruminal pH above 6.5. Values of ruminal pH were classified in 6 groups with a constant pH-interval [<6.2], [6.2-6.4], [6.4-6.6], [6.6-6.8], [6.8-7.0] and [>7]. Anova performed on milk parameters (milk yield, fat and protein contents, somatic cell count) and on farm measurements (rumen fill, BCS, faeces consistency, counting undigested maize grains and the composition of the diet) according to the 6 pH groups did not present significant

differences. However, significant correlations were found between ruminal pH and rumen fill (-0.24**), ruminal pH and herd milk yield (-0.17*) and ruminal pH and quantity of concentrate per day (-0.23**).

Rumen fluid pH thresholds, of samples collected by rumenocentesis, used to diagnose SARA are below 5.5 (Garrett *et al.*, 1999). However, there is no scientific consensus on a pH threshold for the rumen fluid samples obtained by the oro-ruminal probe method. The use of an oro-ruminal probe induces a contamination of ruminal fluid by saliva which can increase the pH. An adaptation of the interpretation thresholds is needed. Duffield *et al.* (2004) report a difference between oro-ruminal probe method and rumenocentesis of +0.35 pH points. Among the literature, the adjusted threshold to detect SARA in ruminal fluid sampled through oro-ruminal probe vary from 5.9 to 6.2 (Duffield *et al.*, 2004; Hofirek *et al.*, 2001).In this study, 4 different thresholds of pH were tested: 5.9, 6.0, 6.1 and 6.2 Depending on thresholds used, prevalence of SARA was ranged from 0 and 2.1% (table 1). This is a low prevalence in comparison to others studies conducted in different countries (Kleen *et al.*, 2012), however, this is in agreement with a French study conducted in 2008 which reports - with the rumenocentesis method - a prevalence of 1.8% in 52 Brittany dairy herds (Mannessiez, 2009).

Table 1. Distribution of cows according to the pH groups and percentage of cows with SARA, marginal SARA and normal pH according to the 4 pH thresholds: 5.9, 6.0, 6.1 and 6.2.

			Percentage of cows according to the 4 pH thresholds			
pH group	Number of cows	Number of cows (%)	5.9	6.0	6.1	6.2
> 7	32	22,38				
]6,8-7,0]	44	30,77				
]6,5-6,8]	48	33,57				
]6,4-6,5]	9	6,29				
]6,3-6,4]	7	4,90				
]6,2-6,3]	0	0,00				
]6,1-6,2]	3	2,10				
]6,0-6,1]	0	0,00				
]5,9-6,0]	0	0,00				
<5,9	0	0,00				



When using the methodology based on fat and protein contents, prevalence of SARA was 4.6% using the fat / protein ratio, 8.7% using fat-protein contents and 27.1% using a threshold for fat content (figure 1). These results are in accordance with the results of Herman (2012) who calculates an annual prevalence of 5.5%, 9.3% and 15.56% in France with the same indicators. However, the estimated prevalence really differs according to the indicator used. The comparison between pH values and milk fat and protein contents shows that milk fat and protein contents are not relevant to identify cows with lowest ruminal pH values. With the threshold of ruminal pH value of 6.2 + 0.3 pH points which corresponds to "marginal SARA" (cows which could develop SARA in the future - Duffield *et al.*, 2004; O'Grady *et al.*, 2008), the sensitivity (capacity to detect cows with lower pH values than 6.5) and specificity (capacity to detect cows with a pH value above 6.5) are presented in the table 2.

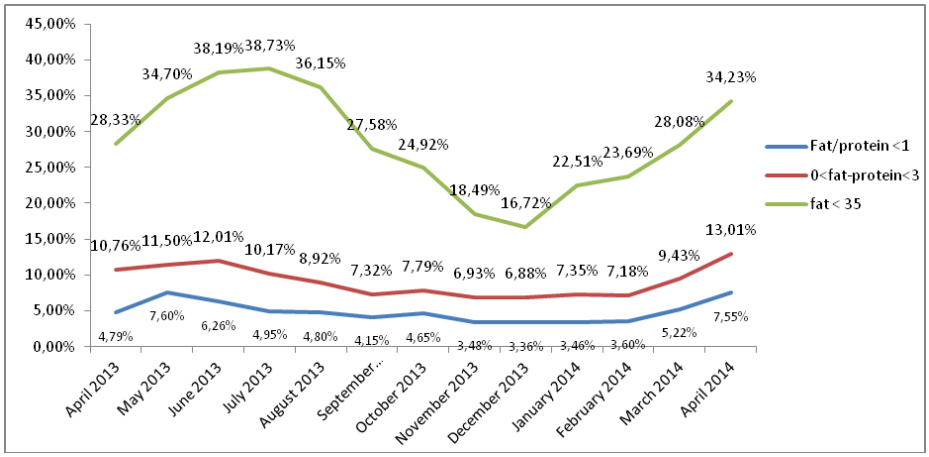


Figure 1. Monthly prevalence according to the three indicators tested (April 2013 - April 2014).

Table 2. Calculation of sensitivity and specificity of 3 indicators derived from milk fat and protein contents to detect low ruminal pH (pH threshold: 6.5).

		pH threshold (6.5) > = 6,5	Predictive quality < 6,5 = SARA	Sensitivity	Specificity
Indicator 1	Fat/protein ? 1	116	16		
	Fat/protein < 1	10	1	6%	92%
Indicator 2	0 ? fat – protein ? 3	106	13		
	0 < fat – protein < 3	20	4	24%	84%
Indicator 3	Fat ? 35	77	10		
	Fat < 35	49	7	41%	61%
	Total	126	17	143 cows	

Conclusions

Samples of ruminal fluid were collected with the oro-ruminal probe. Because of saliva contamination, the pH threshold of 6.2 was selected to define a SARA. In the surveyed farms, the prevalence of SARA is 2.1%. This prevalence of SARA is lower than the prevalence reported in other European countries. Symptoms associated with SARA described in the literature were not significantly related to ruminal pH in our study. Indicators derived from milk fat and protein contents are not sensible and specific enough to detect low pH values. Further studies are needed to determine a threshold for ruminal fluid collected through oro-ruminal probes in order to diagnose SARA.

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