Animal Feed Science and Technology 172 (2012) 4–8

Contents lists available at SciVerse ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Incidence, prevalence and impact of SARA in dairy herds☆

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ARTICLE INFO

Keywords:
SARA
Feed efficiency
Metabolism
Dairy cattle

ABSTRACT

Whilst the exact definition of subacute ruminal acidosis (SARA) remains debatable, it is certain that SARA is present in a large number of dairy herds, affecting a limited proportion of animals. It is uncertain, however, what the exact consequences in the individual animal within a herd are. Based on the current knowledge, it appears fair to assume that not SARA in itself has negative consequences in the individual as well as in the herd, but that these are arising simultaneously with other pathologic alterations.

The challenge for the future is to describe the impact of SARA on herd level. Detrimental effect on feed efficiency described seems to be the most important economic consequence. Furthermore, research may focus on the question whether SARA has to be understood as a signal differentiating optimal from suboptimal management in dairy herds.

1. Introduction – definition of subacute ruminal acidosis

Beginning in the 1990s, subacute ruminal acidosis (SARA) has been differentiated from acute or lactic acidosis (Garrett et al., 1999). SARA is usually differentiated from acute ruminal acidosis by its transient character and the limited pH drop down to pH values of around 5.5, thus not leading to massive growth of lactate-producing bacteria such as *Streptococcus bovis* (Kleen et al., 2003). However, SARA is characterized by a drop of ruminal pH to non-physiological levels. This is caused either by a lack of structural fibre or an excess of concentrates, generally rapidly fermentable carbohydrates, or both. This leads to an accumulation of volatile fatty acids (VFA) within the rumen.

A narrow definition of SARA appears difficult: Firstly, it remains debatable what the threshold of a physiological ruminal pH would be. Various values between pH 5.5 and 6.0 have been advocated, often the pH values of 5.5 and 5.8 are used to define individuals or groups experiencing SARA or being at risk for SARA, respectively (Kleen et al., 2003; Plaizier et al., 2008). Secondly, there is uncertainty on how pH values have to be interpreted correctly in order to justify the diagnosis of SARA and whether they are indeed detrimental to the animal's health (Plaizier et al., 2008; Zebeli et al., 2008). A study by Garrett et al. (1999) is so far the only one suggesting a scheme for SARA diagnosis on herd level. According to their study, SARA is present in a herd if three out of twelve cows would be found with a ruminal pH of 5.5 or less. It is important to understand, however, that in this study the pH threshold of 5.5 was chosen for statistical, not physiological reasons and it has to be measured by means of rumenocentesis (Duffield et al., 2004). As the reticulo-ruminal compartment is not maintaining a steady pH, the pH 5.5 is

Abbreviations: CLA, conjugated linoleic acid; DMI, dry matter intake; MFD, milk fat depression; NDF, neutral detergent fibre; NEB, negative energy balance; PUFA, polyunsaturated fatty acids; SARA, subacute ruminal acidosis; peNDF, physically effective neutral detergent fibre; TMR, total mixed ration; VFA, volatile fatty acids.

☆ This paper is part of the special issue entitled: Rumen Health: A 360° Analysis, Guest Edited by A. Van Vuuren, S. Calsamiglia and Editor for Animal Feed Science and Technology, P. Udén.

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doi:10.1016/j.anifeedsci.2011.12.003

to be understood as the lowest threshold of a functioning amylolytic biosystem. It is usually measured 2–8 h post feeding, depending on feeding technique. Below pH 5.5, lactate production will increase rapidly, microbial protein metabolism will be impaired and the microbial ability to ferment structural carbohydrates will decrease significantly (Kaufmann, 1976; Bach et al., 2005; Jouany, 2006).

Its transient character differentiates SARA from acute acidosis; its dynamics have been described in models. Duffield et al. (2004) used 16 lactating dairy cows on a standard lactating cow ration for description of ruminal pH dynamics. Independently of SARA being prevalent, ruminal pH was found to be at or below 5.5 for 1 h per day on average, however, with a huge variation between 0 h and 6 h and a standard deviation of almost 2 h. Penner et al. (2009) showed variation in VFA uptake in sheep possibly explaining individual variation of pH-dynamics. Dohme et al. (2008) were able to show an increasing severity in terms of pH nadir and length of acidosis episodes over three subsequent periods with a challenge for SARA. Whilst the time with pH 5.5 or below increased to up to 6 h, the nadir of pH decreased down to 5.1 during the third of the SARA episodes. SARA is therefore likely to be present in just a small proportion of individuals in a herd at a time and may intensify.

2. Prevalence and incidence of SARA

Diagnosis of SARA is difficult as clinical signs are subtle and proxy parameters like faecal pH or net-acid-base-excretion are not suitable for diagnosis (Enemark, 2008). A definite diagnosis therefore generally requires the sampling of ruminal fluid. Whilst rumen-fistulated cows are frequently used in clinical trials, the puncture of the rumen (rumenocentesis) is regularly used in field trials and is tolerated well by sampled animals (Kleen et al., 2004). The sampling of ruminal fluid by ways of this method gives however only a mere snapshot of the actual ruminal environment. Research has been done on the development of devices, measuring ruminal or, respectively, reticular pH continuously (Schneider et al., 2010). The use of these devices will allow a more precise determination of prevalence and incidence by showing pH fluctuations during the day and for a longer time.

The prevalence describes what proportion of animals within a herd or a group are experiencing SARA at any given point of time. Determining prevalence therefore demands for a detection method and a valid definition of the condition. Few field studies have so far determined the prevalence of SARA on herd level and on dairy cows population level. In Europe, Morgante et al. (2007) investigated SARA in 10 Italian herds and found three herds having more than 33% of individuals with a pH of 5.5 or less. Kleen et al. (2009) found an overall prevalence of 13.8% in 18 Dutch dairy herds with stage of lactation having no detectable influence on SARA prevalence. O'Grady et al. (2008) described SARA in grazing Irish dairy cows and reported a prevalence of 11%. An Iranian study determined an overall prevalence of 27.6% in 10 dairy herds (Tajik et al., 2009). In these field studies generally the pH thresholds of 5.5 and 5.8 are used, whilst rumenocentesis is used as method for sampling of ruminal fluid. Although different risk periods in the course of lactation have been defined (Kleen et al., 2003), no study has so far shown an influence of stage of lactation on the prevalence of SARA. The studies show that animals with a pH of 5.5 or below can be found in very different production systems, independently from production level or stage of lactation. However, it has also been shown that in similar production systems the prevalence of SARA can vary among herds. Kleen et al. (2009), for example, found prevalences ranging from 0% and close to 40% in very similarly managed herds.

Whilst the prevalence is related to a fixed point of time, incidence describes how many animals would enter a period of experiencing SARA within a given period of time, e.g. per day. The incidence of SARA is therefore difficult to determine, as it would require the use of a system that monitors ruminal pH continuously or at defined intervals. Studies reporting on the incidence are therefore all based on models in a limited number of animals and so far no field data are available. In a study conducted by Zebeli et al. (2008) it has been stated that the incidence of SARA could be minimized by maintaining a level of 300–330 g/kg DM of physically effective NDF (peNDF) in the ration fed.

The question remains what the incidence of SARA within herds would be. As stated above, it appears likely that individual cows are experiencing SARA repeatedly and for a longer time rather than whole herds do for only a limited period of time. Therefore, in herds experiencing SARA its incidence will be low for a defined time, independently of its prevalence. The abovementioned system using internal probes will certainly aid in understanding the incidence of SARA and deliver sound data.

In summary it has to be stated that general feeding management seems to be decisive in explaining SARA prevalence and possibly its incidence. As shown by Morgante et al. (2007), the influence of management seems to contribute significantly to the incidence of SARA, independently from chemical composition of the ration like peNDF or proportion of fermentable carbohydrates. Examples for factors contributing are severe NEB due to management mistakes in late lactation, time of mixing in a feeder wagon for TMR, ability of animals to sort against certain components, feeding space at the feed trough, frequency of feeding or social stress within groups.

3. Impact of SARA

The potential consequences of SARA like laminitis, milk fat depression, poor body condition and others have been reviewed thoroughly (Kleen et al., 2003; Plaizier et al., 2008; Enemark, 2008). It has to be stated, however, that the evidence base for the frequently cited consequences of SARA is to a very large extent not supported by observations from the field or from experiments. Reasons for this are various: obviously consequences from SARA would arise with a certain delay from the initial insult and it is difficult to relate them to actual rumen status. Laminitis, for example, is regularly mentioned as resulting