Transabdominal Ultrasonography of the Rumen Mucosa as a Potential Diagnostic Tool to Diagnose Subacute Rumen Acidosis (SARA) in Adult Dairy Bulls

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Introduction

Subacute rumen acidosis (SARA) is frequently encountered in ruminants on high-concentrate rations. The diagnosis of this condition in practice has proven difficult because of the lack of pathognomonic symptoms. Rumen fluid collection either orally by stomach tube or transcutaneously via rumenocentesis has to this day not become routine procedure in veterinary practice because the former is considered as too time consuming and the latter is often perceived as too invasive by animal owners and veterinarians alike.

Since marked morphological changes of the rumen mucosa in response to changes in volatile fatty acid (VFA) concentration and rumen fluid pH in cattle are well established we hypothesized that transabdominal ultrasonographic evaluation of the rumen mucosa would be a suitable noninvasive diagnostic procedure to identify tissue reactions of the rumen mucosa caused by SARA in adult cattle.

The objective of the present study was accordingly to assess the feasibility and suitability of transabdominal ultrasonography of the rumen wall to diagnose SARA and, if successful, to identify the most suitable location and best cut-off value for rumen mucosal diameter to diagnose SARA in cattle.

Material and methods

Five adult rumen canulated dairy bulls previously adjusted to a roughage based ration were switched in 10-day intervals to rations with increasing concentrate content. Seven rations with a concentrate content ranging from 5 (ration 1) to 95% (ration 7) were fed. At the end of each 10-day feeding period rumen fluid was obtained through the rumen cannula at 4 hours after the morning feeding to determine the rumen fluid pH.

Ultrasonographic examination of the rumen wall was conducted over the entire left flank extending from the ventral midline to the left transversal process of L3 using an 8 MHz linear transducer (Pie medical Scanner 100LC). The studied section of the rumen wall was divided into acoustic windows of 7 cm width starting at ventral midline (Window 1) upward.

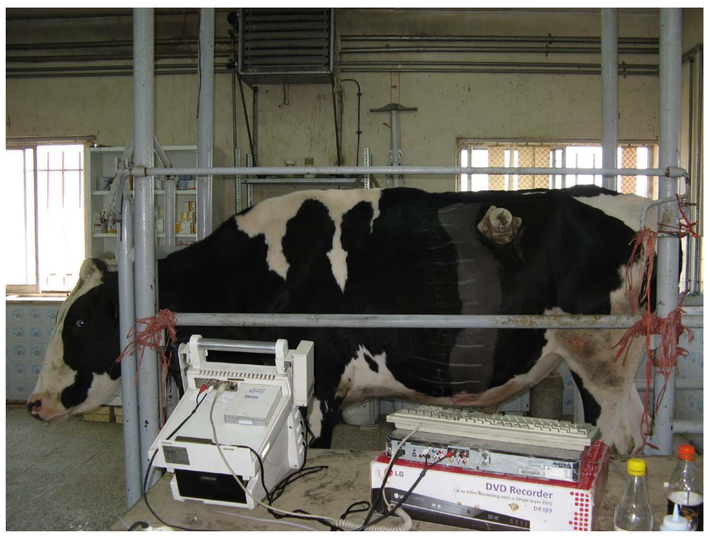

Figure 1: Setup for transabdominal ultrasonography of the rumen wall in a dairy bull

In 4 bulls a total of 12 and in one bull (due to smaller size) 11 acoustic windows of the rumen wall were obtained. For each acoustic window the best suited picture to identify the different layers of the rumen wall was used to measure the thickness of the rumen mucosa 3 times on different locations of the same image The average value was then computed for each acoustic window.

Repeated *measures* analysis of variance was used to detect differences in measured parameters between treatment groups and over time. Regression analyses where performed with thickness of the rumen mucosa as dependent and rumen pH measured 4 h after feeding as independent variables. Goodness of fit of the obtained regressive functions for each acoustic window were compared with each other. A multiples stepwise regression analysis was conducted. For the acoustic windows yielding the regressive function with the best goodness of fit Receiver Operating Characteristics (ROC) analyses were conducted to identify a suitable cut-off value for the thickness of the rumen mucosa at an arbitrarily determined rumen pH (pH=5.5).

Results

Thickness of the rumen mucosa stratified by feeding group are presented in figure 3 for each acoustic window. Examples of ultrasonographic images obtained in one animal on ration 1 and on ration 7 at the height of the acoustic window 6 are presented in figure 2. A numerical increase in thickness of the rumen mucosa with decreasing rumen fluid pH was apparent in all acoustic windows. Most pronounced effects on rumen mucosal thickness were observed in acoustic windows 3, 4 and 8 (Figure 3). Smallest effects were determined in windows 11 and 12 (Figure 3). Regression analyses conducted to identify the window most suitable to accurately predict the feeding group and thereby indirectly the rumen fluid pH revealed the best goodness of fit for the regression model including windows 5 and 6. With the pillar between dorsal and ventral rumen sac located in either window 6 or 7, depending on the size of the animal, windows 5 and 6 were located in the upper ventral rumen sac.

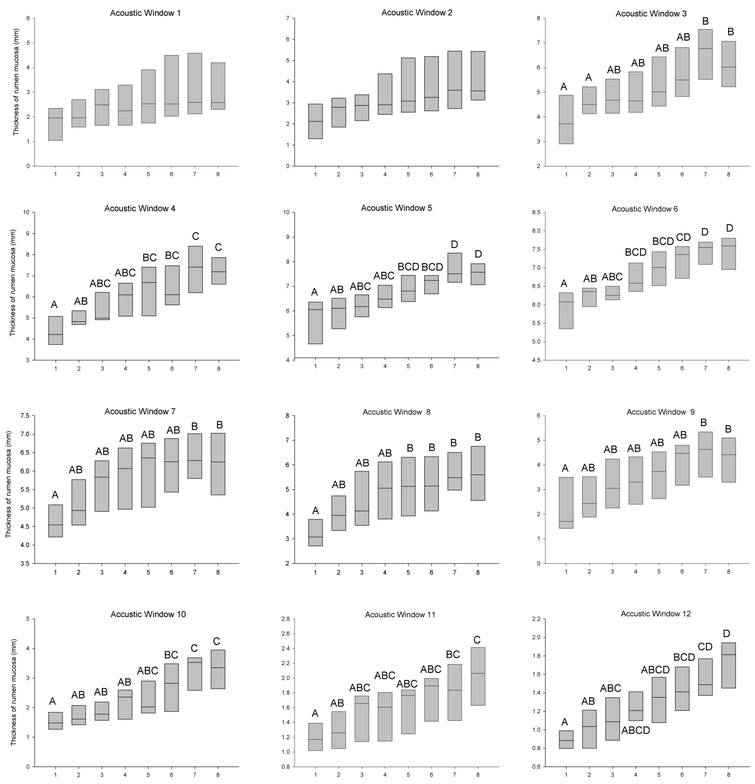

Figure 3; Rumen mucosal thickness (in mm) stratified by feeding group for 12 acoustic windows. Rumen mucosal thickness for rations marked with different capital letters differ significantly from each other (P < 0.05, bonferroni corrected).

The Receiver Operating Characteristics (ROC) analysis revealed that a cut-off values forthe mucosal thickness of 7.3 mm at the height of acoustic window 5 had a sensitivity of 0.80 and a specificity of 0.87 to identify a bull with a rumen fluid pH<5.5 at 4 h post feeding.

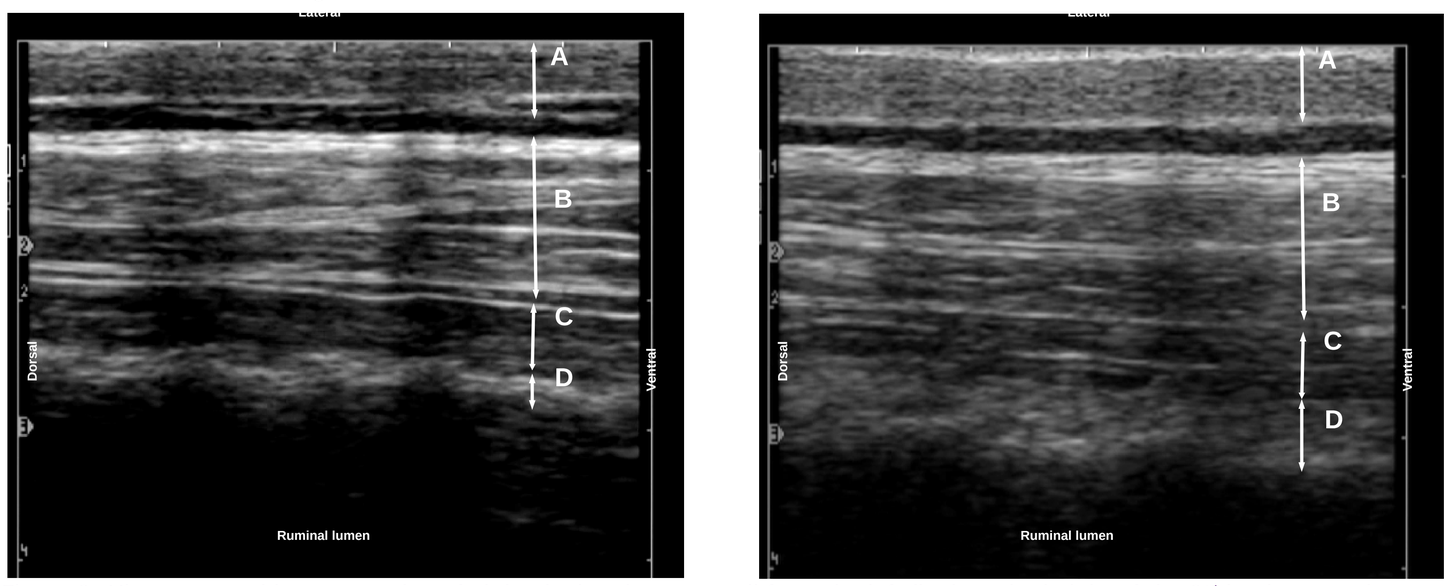

Figure 2: Ultrasonographic presentation of abdominal and rumen wall from the left flank at the height of the 3rd lumbar vertebra (8.0 MHz, linear probe) of acoustic window 6 for one animal on ration 1 (5% concentrate, left panel) and the same animal on ration 7 (95% concentrate, right panel). From top to bottom the skin (A), the muscles of the abdominal wall (B), the muscularis layer of the rumen wall (C) as well as mucosa and submucosa of the rumen wall (D) can be identified.

Discussion and Conclusion

The intersection of an horizontal line going through the costochondral junction and a vertical line coming from the 3rd lumbar vertebra was found to be most suitable to identify animals with rumen pH<5.5 at 4h post feeding. Transabdominal ultrasonography of the rumen mucosa has the potential to be a suitable diagnostic tool to identify adult ruminants with SARA. This study provides encouraging preliminary data warranting further examination in adult dairy cows.