J. Dairy Sci. 97:3635–3647
http://dx.doi.org/10.3168/jds.2013-7709

Rumination time around calving: An early signal to detect cows at greater risk of disease

L. Calamari,*[1] N. Soriani,* G. Panella,† F. Petrera,‡ A. Minuti,* and E. Trevisi*
*Istituto di Zootecnica, Università Cattolica del Sacro Cuore, Via Emilia Parmense, 84, 29122 Piacenza, Italy
†Azienda Sperimentale "Vittorio Tadini," 29027 Gariga di Podenzano, Piacenza, Italy
‡ Consiglio per la Ricerca e la sperimentazione in Agricoltura (Centro di Ricerca per le Produzioni Foraggere e Lattiero-Casearie), sede di Cremona, via Porcellasco 7, 26100 Cremona, Italy

ABSTRACT

The main objective of this experiment was to evaluate the use of rumination time (RT) during the peripartum period as a tool for early disease detection. The study was carried out in an experimental freestall barn and involved 23 Italian Friesian cows (9 primiparous and 14 multiparous). The RT was continuously recorded by using an automatic system (Hr-Tag, SCR Engineers Ltd., Netanya, Israel), and data were summarized in 2-h intervals. Blood samples were collected from 30 d before calving to 42 d in milk (DIM) to assess biochemical indicators related to energy, protein, and mineral metabolism, as well as markers of inflammation and some enzyme activities. The liver functionality index, which includes some negative acute-phase proteins and related parameters (albumin, cholesterol, and bilirubin), was used to evaluate the severity of inflammatory conditions occurring around calving. The cows were retrospectively categorized according to RT observed between 3 and 6 DIM into those with the lowest (L) and highest (H) RT. The average RT before calving (−20 to −2 d) was 479 min/d (range 264 to 599), reached a minimum value at calving (30% of RT before calving), and was nearly stable after 15 DIM (on average 452 min/d). Milk yield in early lactation (on average 26.8 kg/d) was positively correlated with RT (r = 0.33). After calving, compared with H cows, the L cows had higher values of haptoglobin (0.61 and 0.34 g/L at 10 DIM in L and H, respectively) for a longer time, had a greater increase in total bilirubin (9.5 and 5.7 μmol/L at 5 DIM in L and H), had greater reductions of albumin (31.2 and 33.5 g/L at 10 DIM in L and H) and paraoxonase (54 and 76 U/mL at 10 DIM in L and H), and had a slower increase of total cholesterol (2.7 and 3.2 mmol/L at 20 DIM in L and H). Furthermore, a lower average value of liver functionality index was observed in L (−6.97) compared with H (−1.91) cows. These results suggest that severe inflammation around parturition is associated with a slower increase of RT after calving. Furthermore, more than 90% of the cows in the L group had clinical diseases in early lactation compared with 42% of the H cows. Overall, our results demonstrate the utility of monitoring RT around calving, and in particular during the first week of lactation, as a way to identify in a timely fashion those cows at a greater risk of developing a disease in early lactation.

Key words: rumination time, dairy cow, metabolic disease, transition period

INTRODUCTION

Rumination is a cyclical process characterized by regurgitation, remastication, and reswallowing (Beauchemin, 1991). This process is variable and influenced by many factors including acute stress (Herskin et al., 2004), disease (Welch, 1982; Hansen et al., 2003), diet composition and forage quality (Welch and Smith, 1970), and management errors (Grant and Albright, 2006). Variability in rumination is caused by ethological behavior, reproduction status, production level, climatic condition, and health status. The recent introduction of indirect methods to measure rumination time, based on analysis of vocal signs (Hr-Tag rumination monitoring system, SCR Engineers Ltd., Netanya, Israel), allows automatic measurement of rumination time and analysis of daily pattern in rumination time (**RT**).

Our recent study (Soriani et al., 2012) using this new system during the peripartum period uncovered differences in RT between healthy and sick cows. In particular, a lower RT during the first 10 DIM was observed in cows with health disorders compared with healthy cows (Soriani et al., 2012). Furthermore, cows with lower RT in early lactation were characterized by a greater increase of plasma positive acute-phase proteins after calving, as well as a slower increase of negative acute-phase proteins, indicative of a marked inflammatory status around calving. These alterations were highlighted by indices based on several negative

Received November 12, 2013.
Accepted February 26, 2014.
[1]Corresponding author: luigi.calamari@unicatt.it

acute-phase proteins proposed by Bertoni et al. (2008), Trevisi et al. (2012a), and Bertoni and Trevisi (2013).

Timely therapies are required to improve welfare and performance during the transition period, when the incidence of diseases is highest (Lewis, 1997; Trevisi et al., 2011, 2012a). Together, the results available to date seem to support the use of RT measurement around calving as a tool for early detection of sick cows or cows with a higher probability of developing health disorders around calving. Therefore, the objective of this study was to examine the possibility of early detection of health problems in dairy cows during the peripartum period by recording their RT and daily rumination behaviors. In addition, the RT data were used to assess relationships to the incidence of clinical symptoms of diseases and metabolic-inflammatory indices in the blood.

MATERIALS AND METHODS

Animal and Management

The research protocol and animal care were in accordance with Directive 2010/63/EU of the European Parliament and of the Council of September 22, 2010, on the protection of animals used for scientific purposes.

The study involved 23 Italian Friesian dairy cows (14 primiparous: **PR**; and 9 multiparous: **MP**) from the last month of pregnancy through wk 6 of lactation. All cows calved within a period of 2 mo (from July 4 to September 6, 2011); most cows (18) calved between July 20 and August 20. Each cow in the study was examined daily and records of all health-related problems as well as trauma and pharmacological treatments that occurred throughout the study were recorded.

The animals involved in this study were housed in a freestall barn at the experimental farm "Vittorio Tadini," located near Piacenza, Italy (45°01′N, 9°40′E; 68 m above sea level). Dry cows and early lactating cows were kept in 2 separate pens. Dry cows were housed in a pen with straw-bedded pack as resting area; the individual area available for each animal was 8 m^2. The cows were moved from a far-off dry-period pen to a late-pregnancy pen 1 mo before expected calving day, and the heifers were moved 2 mo before their expected calving day. Cows were allowed to calve in the pen holding late-pregnant cows. After calving, the cows were housed in the pen (cubicles as resting area) for early lactating cows until 40 d postpartum. Fresh water was available ad libitum within each pen. Each pen was equipped with axial-flow fans installed along the feed driveway. Sprinklers were placed perpendicular to the air flow of the fans along the feed alley. Fans and sprinklers were thermostatically controlled: fans were switched on at 23°C and sprinklers at 27°C. Constant managerial conditions (operators, similar batches of feed, milking frequency, and working routine) were maintained during the experimental period.

Cows were milked twice daily (0330 and 1500 h), and milk yield (**MY**) at each milking was recorded electronically (Alpro, DeLaval, Tumba, Sweden). An automatic weighing system (Alpro, DeLaval) was installed at the exit of the milking parlor to measure BW. Cows of each pen were fed a specific TMR ad libitum once daily at 0730 h. To ensure that cows had ad libitum access to the TMR, the amount offered was assessed daily with the aim of producing 3 to 8% refusals.

Measurements and Analyses

Microclimatic Conditions. Temperature and relative humidity of the inside barn were recorded daily during the study period using 2 electronic probes (Gemini Data Logger, Chichester, UK) connected to a data logger programmed to record every 30 min. Mean daily temperature and humidity and daily minimum and maximum temperatures and humidity were calculated from temperature and relative humidity data recorded throughout the study. Data were used to compute a composite climatic welfare index—temperature-humidity index (**THI**)—according to the formula of Kelly and Bond (1971), as reported by Ingraham et al. (1979). Mean daily THI, daily minimum THI, and daily maximum THI were also calculated throughout the study. Furthermore, the average of the mean daily THI observed during the first week of lactation was calculated for each cow.

Feed and Diets. Representative samples of forages, concentrate mixtures, and TMR were collected twice monthly. All samples were pooled monthly for analyses. Chemical composition (moisture, fat, CP, crude fiber, NDF, ADF, ADL, starch, and ash) was determined using standard procedures, and nutritive values were calculated according to NRC (2001). The chemical and nutritive characteristics of the diet of dry and lactating cows were calculated monthly. Furthermore, the particle size distribution of the TMR was determined with the New Penn State Forage Particle Separator (**PSPS**) system (Kononoff et al., 2003).

Rumination Time. Rumination time was measured using the Hr-Tag rumination monitoring system (SCR Engineers Ltd.). The system consisted of rumination loggers, stationary readers, and software for processing the electronic data (Data Flow software, SCR Engineers Ltd.). A neck collar positioned the logger on the left side of the neck. The logger contained a microphone