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Peripartal rumination dynamics and health status in cows calving in hot and cool seasons

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ABSTRACT

Our objective was to evaluate the effect of season of calving, associated with variable levels of heat stress, on the dynamics of rumination during the prepartum period and early lactation of cows that were healthy or affected by peripartal health disorders. Three weeks before the estimated due date, 210 multiparous Holstein cows at the University of Florida Dairy Unit were affixed with a neck collar containing rumination loggers, providing rumination time (RT) in 2-h periods. One blood sample was collected in a subpopulation of cows (n = 76) at 12 to 48 h postcalving to assess metabolic status by determining serum calcium, nonesterified fatty acid, and β-hydroxybutyrate concentrations. The occurrence of peripartal health disorders (dystocia, clinical ketosis, clinical hypocalcemia, metritis, and mastitis) was assessed by University of Florida veterinarians and trained farm personnel. We analyzed the dynamics of daily RT over ± 14 d relative to parturition in cows that were healthy or affected by specific health disorders by season of calving [hot season, June to September (n = 77); cool season, November to April (n = 118)] using repeated measures analysis and comparison of least squares means at different time points relative to calving. Rumination was consistently reduced on the day of calving in both healthy and sick cows in both the hot and cool seasons. Only hot-season calvings had shorter average daily RT prepartum and postpartum in cows affected by severe negative energy balance and subclinical ketosis. Dystocia during the hot season was associated with shorter daily RT prepartum; for cool-season calvings, cows with dystocia had reduced RT postpartum. We also observed reduced RT in cows with ketosis prepartum and postpartum in both the hot and cool seasons. Daily RT was reduced postpartum in cows with hypocalcemia and mastitis that calved during the cool season, and it was shorter in cows with metritis in both the hot and cool seasons. Our results indicated that the effect of heat stress on changes in rumination patterns around calving for sick cows depends on the specific health disorder or metabolic condition.
Key words: rumination, heat stress, disease

INTRODUCTION

Early detection of the signs of disease is key to successful health programs in dairy cows. An efficient health monitoring system is most crucial during the transition period, which is the most critical time for cow health and survival and for the profitability of the lactation. Endocrine changes at calving and drastic metabolic adjustments to support milk synthesis result in negative energy balance and immune suppression (Goff, 2004; Burton et al., 2005; Hammon et al., 2006). Consequently, a substantial proportion of cows are affected by disease around the time of calving, and most health disorders occur in the first 30 DIM (LeBlanc et al., 2006; LeBlanc, 2010; Vergara et al., 2014). In recent decades, the average US dairy herd size has been increasing consistently, resulting in less labor available per cow. Thus, the regular systematic evaluation of clinical parameters in animals at risk of disease is important to ensure herd health and select animals for clinical examination.

Rumination behavior has been suggested as an indicator of rumen condition and overall health (Welch and Smith, 1972; Herskin et al., 2004), although the process is influenced by many variables, including nutritional factors, such as digestibility of the feed, NDF intake, dietary composition, and forage quality (Welch and Smith, 1970; Beauchemin, 1991). Devices effective at measuring rumination by differentiating specific movements and sounds have been recently developed (Kononoff et al., 2002; Schirmann et al., 2009; Braun et al., 2013). The Hr-Tag rumination monitoring system (SCR Engineers Ltd., Netanya, Israel) provides output data for rumination time (**RT**), intervals between re-

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gurgitation of boluses, and chewing rate (Schirmann et al., 2009). The system has been validated in heifers, calves, and dairy cows (Schirmann et al., 2009; Burfeind et al., 2011), and associations between rumination behavior and calving events, peripartal metabolic status, and uterine diseases have been reported (Soriani et al., 2012; Calamari et al., 2014; Liboreiro et al., 2015). However, the effect of heat stress on the magnitude of changes in RT during the early stages of disease during the prepartum and early lactation periods has not been extensively explored. Summer heat is a significant stressor affecting dairy cows in the United States (St-Pierre et al., 2003), and direct negative effects on milk yield, health, and reproduction have been well documented (Jordan, 2003; West, 2003; de Vries and Risco, 2005). We were interested in the effect of heat stress on rumination dynamics around parturition in cows with peripartal health disorders. Our objective was to evaluate the effect of heat stress on RT during the prepartum and early lactation periods in cows that were healthy or affected by peripartal health disorders.

MATERIALS AND METHODS

Animals and Farm Management

The study was conducted in accordance with the guidelines for animal research and with the approval of the University of Florida Institutional Animal Care and Use Committee. The initial study population consisted of 210 multiparous Holstein cows enrolled 21 d before expected calving, from November 2013 to October 2014. From these, 205 cows successfully calved and completed the study. Cows were housed at the University of Florida Dairy Unit (Gainesville), which milked approximately 500 Holstein cows twice daily with a rolling herd average of approximately 10,000 kg/cow.

Dry cows were moved from a far-off dry-period pen to a prepartum pen 21 to 28 d before their expected calving. Prepartum housing consisted of a tunnel-ventilated barn with sprinklers over the feed bunk. The barn had a housing capacity of 12 cows (approximately 350 m^2 with sand bedding) and 9 m of feed bunk space. The diet fed during the prepartum study period is described in Table 1. Feed was delivered once a day at approximately 0830 h and was pushed up 4 times a day between feedings. Cows were monitored by farm employees every 2 h for signs of calving and were moved out of the prepartum pen within 3 h after calving.

From d 0 to 2 postpartum, cows were housed in a hospital barn, consisting of an open hospital facility on a deep sand-bedded pack, measuring approximately 560 m^2. An open-sided barn provided shade over 297 m^2 of the bedded pack, and shade cloth provided shade over the feed bunk and water troughs. Cooling was provided by fans over the bedded pack and by sprinklers and fans over the feed bunk and water troughs. Group size ranged from 11 to 31 cows, and there was 19.5 m of feed bunk space. Cows in the hospital barn were fed the postpartum TMR, which is described in Table 1.

At 3 d postpartum, healthy cows were moved to the main lactating herd and kept in 2-row sand-bedded freestall barns equipped with headlocks. Cows that were sick on d 3 postpartum were moved to the lac-

Table 1. Ingredient and nutrient composition of pre- and postpartum diets (DM basis)

Item	Diet	
	Prepartum	Postpartum
Ingredient (%)		
Grass hay	21.3	—
Corn-sorghum silage	52.2	—
Corn silage	—	35.7
Rye grass-triticale silage	—	9.5
Brewer's grains	13.0	9.5
Citrus pulp	6.1	7.1
Corn grain	—	11.9
Whole cottonseed	—	4.8
Canola meal	—	8.6
Soybean meal, 47% CP	—	7.1
StearoLac[1]	—	1.0
Postpartum mineral supplement	—	4.8
Prepartum mineral supplement	2.2	—
Bio-Chlor[2]	5.2	—
Nutrient profile		
NE_L[3] (Mcal/kg)	1.54	1.72
CP (%)	14.1	17.6
NDF (%)	44.1	33.6
ADF (%)	25.2	22.0
Starch (%)	19.3	24.0
Ether extract (%)	3.9	5.5
Ca (%)	0.63	0.79
P (%)	0.34	0.42
Mg (%)	0.44	0.41
K (%)	1.19	1.57
Na (%)	0.15	0.54
Cl (%)	0.87	0.55
S (%)	0.36	0.22
DCAD (mEq/kg)	−110	340
Fe (mg/kg)	143.26	165.20
Zn (mg/kg)	60.52	66.40
Cu (mg/kg)	14.11	13.72
Mn (mg/kg)	42.44	55.67
Se (mg/kg)	0.45	0.40
Co (mg/kg)	0.74	0.24
I (mg/kg)	0.50	0.67
Vitamin A (IU/kg)	10,560	7,040
Vitamin D (IU/kg)	3,300	1,320
Vitamin E (IU/kg)	191,400	62,260

[1]StereoLac energy supplement (Energy Feeds International, San Leandro, CA) contains hydrolyzed vegetable oil.

[2]Bio-Chlor (Arm & Hammer Animal Nutrition, Princeton, NJ) contains the following (DM basis): 48.6% CP, 13.5% starch, 2.07% Mg, 1.22% K, 1.49% Na, 3.60% S, and 9.09% Cl.

[3]Calculated at 11 and 19 kg of DM/d for the pre- and postpartum diets (CPM-Dairy version 3.0.8.1; https://cahpwww.vet.upenn.edu/doku.php/software:cpm:start).