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The Relation between Reticulorumen and Vaginal Acidity and Temperature and Rectal Temperature of Dairy Cows after Calving

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Abstract : ***Introduction: the objective of the research was to determine the relation of the reticulorumen and vaginal temperature and pH, and rectal temperature during the period after calving. Materials and methods:The pH and temperature of the contents of cows reticulorumens and uterus were measured using specific smaXtec boluses manufactured for animal care. The data of 40 cows were taken 10 days, three times a day (9 AM, 12 AM and 9 PM). Results: with an increasing reticulorumen content temperature, the rectal and vaginal tmperatures increases as well. With an increasing of the reticulorumen content pH, the vaginal pH increases as well. Conclusion: the computerized measurement of reticulorumen temperature allows the evaluation of temperature changes in the rectum and the vagina. Reticulorumen pH may indicate changes in the pH of the vagina.***

Key words. Cow, reticulorumen, ph, temperature.

INTRODUCTION

One of the most critical periods in respect to the physiology of a cow is its postpartum period. For cows, this period lasts until the next insemination i.e., for 2–3 months. The sum of postpartum-specific disorders normally occurs in the first 10 days after calving (Ingvartsen et al., 2003). Dairy cattle have diets containing a higher proportion of concentrates at the beginning of lactation to offset a negative energy balance. The feeding of high concentrate diets can lead to a decrease the reticuloruminal pH and an increase the risk of developing subacute ruminal acidosis (SARA) (Hook et al., 2011). The cause of SARA is a build-up of organic acids in the rumen and reduced rumen buffering. Important uterine pH values required for the embrionic development of cattle were reported to be affected by factors such as the applied anesthesia options, the animal's diet sexual cycle days (3,4). The development of productive livestock after calving is often disrupted. The main reason for the health disorders of cows in large milk farms is various types of endometritis. The frequent incidence of endometritis in cows is a pressing problem in many countries throughout the world (5,6). A change in feed intake is caused by changes in meal frequency, meal duration, and eating rate (7), which suggests feeding behaviour changes during SARA. Recent studies suggested that changes in feeding behaviour can be used to identify risk of cattle metritis (9). The mean rectal temperature of multiparous cows during the first 10 DIM was 38.7 ± 0.01°C, with an upper normal limit of 39.5°C. The rectal temperature (RT) of dairy cattle during the first 10 DIM was associated with parity, month of calving, and an infectious disease diagnosis, particularly the diagnosis of metritis. The normal RT of dairy cattle in the immediate postpartum period, during the warm summer months, is potentially higher than that generally reported (8). Ruminal temperatures have been effectively used to predict rectal temperatures in cattle (8). Bewley et al. (9) concluded that reticular temperatures of dairy cows are highly correlated to rectal temperatures, indicating that reticular temperature has usable applications as a method of predicting rectal temperature. However, reticular temperatures observed by Bewley et al. (9) were more variable than rectal temperatures. The radiotelemetry has the potential to improve the detection of SARA and fever on farm (10).

The objective of the research was to determine the relation of the reticulorumen and vaginal temperature and pH, and rectal temperature during the period after calving.

MATERIALS AND METHODS

Location, animals, and experimental design. The research was performed on 40 secondlactation dairy Lithuanian Black and White cows (up to 1 day after calving). The herd consisted of 400 dairy cows in total. The cows were kept in a loose housing system, and were fed a feed ration throughout the year at the same time, balanced according to their physiological needs, (Table 1). Cow feeding took place every day at 06:00 and 18:00.

Measurements. The pH and temperature of the contents of cows reticulorumens and uterus were measured using specific smaXtec boluses manufactured for animal care. SmaXtec animal care technology® enables the continuous real-time display of data such as ruminal pH and temperature. According to the directions of the manufacturer, the boluses were inserted into the reticulorumens of the cows investigated with the help of a specific tool. Immediately after calving, boluses were inserted into the vagina of cows and captured in basal part of the vagina. The data was measured with the help of specific antennas (smaXtec animal care technology®). For monitoring the reticuloruminal pH, an indwelling and wireless data transmitting system (smaXtec animal care GmbH, Graz, Austria) was used. The system was controlled by a microprocessor. The data (pH, temperature) was collected by means of an analogue to digital converter (A/D converter) and stored in an external memory chip. Due to its dimensions (length: 12cm; width: 3.5cm; weight: 210g), this indwelling system can be orally administered to an adult cow, and it is shock-proof and resistant to rumen fluid. Calibration of the pH-probes was performed using pH 4 and pH 7 buffer solutions at the beginning of the experiment. The rectal temperature was measured according to the clinical study plan rules. The data of 40 cows were taken 10 days, three times a day (9 AM, 12 AM and 9 PM). In total, 1200 measurements were performed. All data was obtained by smaXtec messenger® computer software.

Data analysis and statistics. The test data were processed using an SPSS statistical package (SPSS for Windows 15.0, SPSS Inc., Chicago, IL, USA, 2006). The data was considered reliable from a statistical point of view, where $p < 0.05$.

RESULTS AND DISCSUSSION

The correlation results of the analysed indicators are presented in Tab. 1. During the study, the average vaginal pH was 6.48 (± 0.17) and ranged from 6.22 to 7.06. The average vaginal temperature was 39.77 ºC (± 0.65) and ranged from 38.65 ºC to 41.33 ºC. The average reticulorumen temperature during the study was 39.65 ºC (± 1.50) and ranged from 30.89 ºC to 41.79 ºC (tab. 2).The examination of the relation between the vaginal and rectal temperatures revealed a positive (r = 0.352), statistically significant (p <0.001) correlation. With an increasing of the vagina temperature, the rectal temperature increases as well (Fig. 1). A similar relation was found between the reticulorumen content temperature and the rectal temperature. With an increasing reticulorumen content temperature, the rectal temperature increases as well (r=0.257), (p<0.0001) (Fig. 2). A positive (r = 0.253), statistically reliable (p <0.0001) correlation between the vaginal temperature and pH was found. With an increasing of the vaginal temperature, the pH increases as well (Fig. 3). A positive (r = 0.277), statistically reliable (p <0.0001) correlation between the reticulorumen content pH and vaginal pH was found. With an increasing of the reticulorumen content pH, the vaginal pH increases as well (Fig. 4). A positive (r = 0.385), statistically reliable (p <0.0001) correlation between the reticulorumen content temperature and vaginal temperature was found. With an increasing of the reticulorumen temperature, the vaginal cavity temperature increases as well (Fig. 5).

During the study, the average vaginal pH was 6.48 (± 0.17) (2 tabl.) and ranged from 6.22 to 7.06. According to a review of the literature, the measured range of vaginal pH was from is 5.52 to 8.60. In 400 cows the vaginal pH near the cervix was between 5.52 and 8, while nearly 50% of these measurements were in the range of 6.51 to 7 and 93.5% were in the range of 6.01 to 7.50. A mean uterine pH value of 6.62 was recorded post mortem in cows at interestrus intervals (10). The uterine pH value was not statistically affected in heifers fed diets containing different proportions of protein and showed an alteration of pH values in heifers ranging from 7.00-7.05 (10). The average pH of the reticulorumen content during the study was 6.99 (± 0.24) and ranged from 6.16 to 7.63. Both SARA challenges reduced the average daily rumen pH and increased the daily time of the rumen pH below 6.0, 5.8, and 5.6, as well as increased the daily area below pH 6.0, 5.8 and 5.6 (11). Recent findings also suggest that high grain diets and SARA may be associated with increased permeability of the rumen epithelium through reduced organization and thickness of this epithelium, even in the absence of visible tissue damage (12).

The average vaginal temperature was 39.77 ºC (± 0.65) (2 tabl.) and ranged from 38.65 ºC to 41.33 ºC. Recently studies have used microprocessor-controlled data loggers inserted into the vaginal cavity to test the effects of milking frequency (30), low ambient temperatures and wind (50), high ambient temperatures (13).

The average reticulorumen temperature during the study was 39.65 ºC (±1.50) (2 tabl.) and ranged from 30.89 ºC to 41.79 ºC.AlZahal et al. (10) reported a significant increase of rumen temperature due to feeding high amounts of grain in comparison to a mixed hay diet. Such effects may depend on the amount of concentrate fed as in a study of Gasteiner et al. (19) differences in rumen temperature of steers were not significant between a 100 % hay and a 50 % concentrate diet. The postprandial development of a temperature gradient in the rumen of dairy cows with an increased dorsal temperature due to feeding highconcentrate diets was coherent as, first, concentrate would be expected to be subjected to a faster ruminal degradation than forage and, secondly, the materials in the top stratum of the rumen digesta are recently ingested and are subjected to a higher fermentative activity than those contained in the middle and bottom strata of the rumen (14). Ruminal temperature decreased the day before parturition and increased at estrus in spring-calving beef cows and has potential use as a predictor of parturition and estrus (15).

The study found that with an increasing of the vagina temperature, the rectal temperature and the temperature of the reticulorumen content also increased.The most commonly used method to identify illness in dairy cows is measuring body temperature with a rectal thermometer (16). Daily evaluation of rectal temperature during the first 10 days in milk (DIM) is used to facilitate the early identification of postpartum complications, particularly metritis in dairy cows (17). The mean RT of multiparous cows during the first 10 DIM was 38.7±0.01°C, with an upper normal limit of 39.5°C(17).Body temperature of cows can be used in diagnosing not only pathological conditions but also some physiological conditions, such as estrus or parturition (18). Overall, body temperature increases in the afternoon and decreases during the early morning hours. Body temperature in cattle exhibits a circadian rhythm with a minimum temperature in the morning and a maximum temperature in the late afternoon (19). Several variables influence body temperature and the pattern of the circadian rhythm, such as windy and rainy weather conditions Recently, measurement of body temperature has been considered a useful method in systemic diagnosis of metritis in early postpartum cows as the disease is often accompanied by fever (20). In cows with diagnosis of metritis and fever, the RT began to increase from 72 to 48 h before the diagnosis and continued to increase to 39.7 °C (± 0.09). Nonetheless, cows fever had no daily increases of RT before diagnosis of metritis.Vaginal temperatures were associated with rectal measures, and provided the advantage of capturing diurnal changes in body temperature (20). A close correlation (r = 0.65) between reticulum temperature measured by an indwelling probe and rectal temperature of intact dairy cows was observed by Bewley et al. (21) and based on a large amount of paired samples which were taken during several seasons. Possible that changes of hindgut fermentation resulting from SARA have a negative impact on feed intake (22). A change in feed intake is caused by changes in meal frequency, meal duration, and eating rate (2), which suggests feeding behaviour changes during SARA. Recent studies suggested that changes in feeding behaviour can be used to identify cattle at risk of metritis (39, 9), ketosis and acute

locomotion disorders (2). AlZahal et al. (10) reported an r of 0.45 between time below ruminal pH of 5.6 and time above ruminal temperature of 39.4°C in dairy cows experiencing acidosis. The ruminal temperature may have potential to predict ruminal pH and thus aid in the diagnosis of SARA (3). Therefore regular measurement of body temperature could be part of a routine systemic monitoring in cattle farms (23). The relationships among puerperal metritis, suppression of neutrophil function and fever in cows were described by Hammon et al. (24). But limits of increased temperatures which are useful for diagnosis of puerperal metritis are not unified. Temperatures of 39.2°C (43), 39.5°C (36) or 39.7°C (25) were described. No significant difference in RT was found for cows diagnosed with lameness or metritis. Therefore, continuous vaginal temperature monitoring with temperature loggers can be used as a measure of body temperature in dairy cows (25). Vaginal temperature before estrus (d 11 and 12) was slightly (0.1°C) higher compared with the post-ovulation period (25).

It was found that with an increasing of the reticulorumen content pH, the vaginal content pH increased as well. The low ruminal pH was associated with dystocia, metritis and lameness (24). Disturbances of metabolism during the transition may have direct or indirect influences on fertility, and difficult transitions have negative impacts on subsequent reproduction (11). Clinical signs of SARA can include decreased dry matter intake (DMI), laminitis, rumenitis, liver abscesses, and pulmonary bacterial emboli (25), and others like abomasal displacement, mastitis and metritis (25). Determining physiological pH values in cow genital organs is important to develop new therapeutic approaches (26). According to the research, there has been only one study performed detecting uterine pH values during interestrus phase and factors producing in interestrus interval in cattle (26) nevertheless, there have been no studies conducted in cases of pregnancy and metritis in cows. Physicochemical factors, for example pH or temperature, have a dramatic effect on the production of bacteriocins; the optimal pH values and temperatures for maximum bacteriocin production rarely coincide with the best conditions for the growth of the bacteria (27). With the continuous measurement of many cow feeding variables, a more complete understanding of the dietary effects on their digestive function and performance is possible (28). According to literature, the ruminal pH nadir had a negative relationship with its corresponding ruminal temperature. Therefore, the ruminal temperature may have the potential to predict the ruminal pH and thus, aid in the diagnosis of SARA (2).

Conclusion

It can be stated that the computerized measurement of reticulorumen temperature allows the evaluation of temperature changes in the rectum and the vagina. By measuring the reticulorumen pH, which may indicate changes in the pH of the vagina.

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Table 1. Correlations of analysed indicators.

	Vaginal pH	Vaginal temperature	Rectal temperature
Vaginal content temperature	0.253*		0.352*
Reticulorumen content pH	0.277*		
Reticulorumen content temperature		0.385*	0.257*

* p<0.0001

Table 2. Average indicator values and standard deviations

	Vaginal pH	Reticulorumen content pH	Vaginal temperature	Reticulorumen content temperature	Rectal temperature
Average	6.48	6,99	39.77	39.65	40.13
SD ±	0.17	0.24	0.65	1.50	0.54
Min.	6.22	6.16	38.65	30.89	39.16
Max.	7.06	7.63	41.33	41.79	41.82

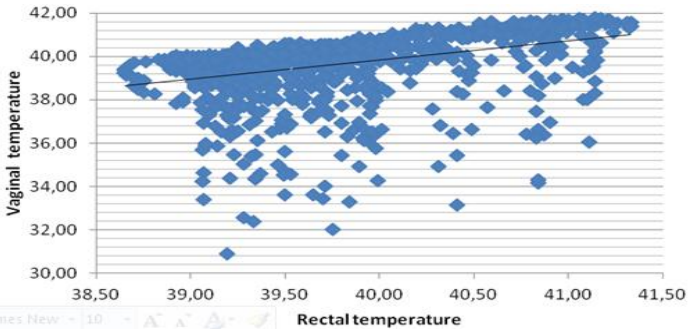

Figure 1. Relation between the vaginal temperature and rectal temperature

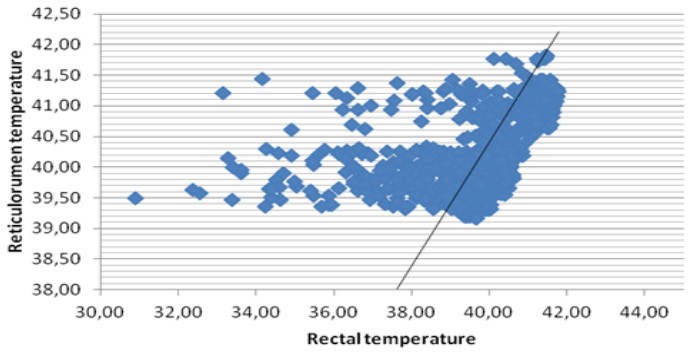

Figure 2. Relation between the reticulorumen content temperature and rectal temperature

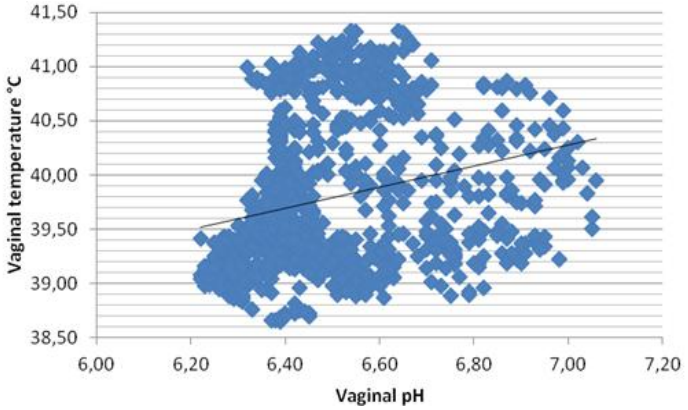

Figure 3. Relation between the vaginal pH and temperature

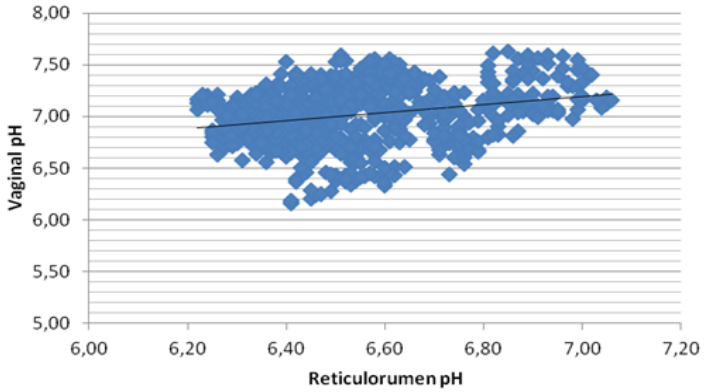

Figure 4. Relation between the reticulorumen content pH and vaginal pH

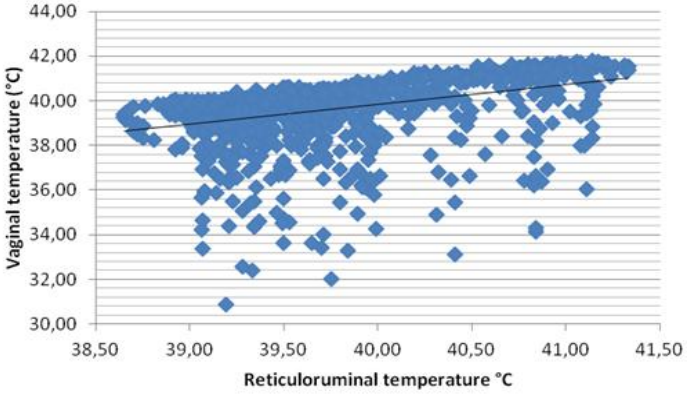

Figure 5. Relation between the reticulorumen content temperature and vaginal content temperature