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HEART RATE VARIABILITY OF HIGH PRODUCING COWS IN A PARALLEL MILKING SYSTEM

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Abstract

Stress response of milking cows (n=36) during the evening milking procedure in a parallel milking system were evaluated in this study. Changes in heart rate (HR) and heart rate variability (HRV) during early afternoon (reference period) were compared to those measured during the different parts of the evening milking: 1. before the evening milking, in the milking parlor, waiting for being milked, 2. during milking, 3. in the milking parlor after being let off from the milking stall. HR was significantly higher during the entire evening milking procedure compare to the reference period ($P<0.05$). HRV during milking did not differ significantly from the reference period, but lower HRV was found during waiting in the milking stall after milking ($HF_{norm}=33.7\pm23.5$) than during the reference period ($HF_{norm}=52.8\pm13.6$) also than during evening resting ($P<0.001$) but there were no significant differences between milking and resting in HRV. The results suggest that the evening milking was not really stressful for these animals. The greatest stress level was caused by the anticipation for getting out from the milking parlour. More research is needed for assess the stress-coping ability during milking.
Keywords: heart rate variability, dairy cow, milking, stress

Introduction

Certain welfare studies proved that for dairy cattle producing under intensive farm conditions the milking technology means such load that may cause stress for animals (*Rushen et al*, 2001; *Wenzel et al*, 2003). Physiological and mental stress causing the deterioration of the well-being of cows through the disturbance of the homeostasis (*Rushen et al*, 1999). Furthermore, stress during milking not only affects the welfare of the cows, but also has a negative influence on milk ejection, resulting in an increase in residual milk which also impair the animal's health. In the last decade it have been verified that effects of milking technology can be described not only by the behaviour of animals, but with physiological measures as well (*von Borell* 2001; *Möstl and Palme,* 2002; *Kovács et al*, 2012b). As an alternative for sympatho-adrenal measures, such as plasma cortisol and its metabolites (*Cole et al*, 1988; *Mitchell et al*, 1988) non-invasive techniques have also been investigated for assessing stress and welfare in dairy cattle (*Kahrer et al*, 2006; *Fukasawa et al*, 2008), but there are also some major disadvantages related to each (*Möstl and Palme,* 2002). These difficulties can be overcome with the indirect monitoring of the

ANS regulation by heart rate (HR) and heart rate variability (HRV) defined as the oscillation in the interval between consecutive heart beats (*von Borell et al*, 1996). Compared HR with certain parameters of HRV, the rapid oscillations in HR reflecting vagal activity can be assessed noninvasively and be used as a physiological measurement indicative for stress (*Porges*, 1995).

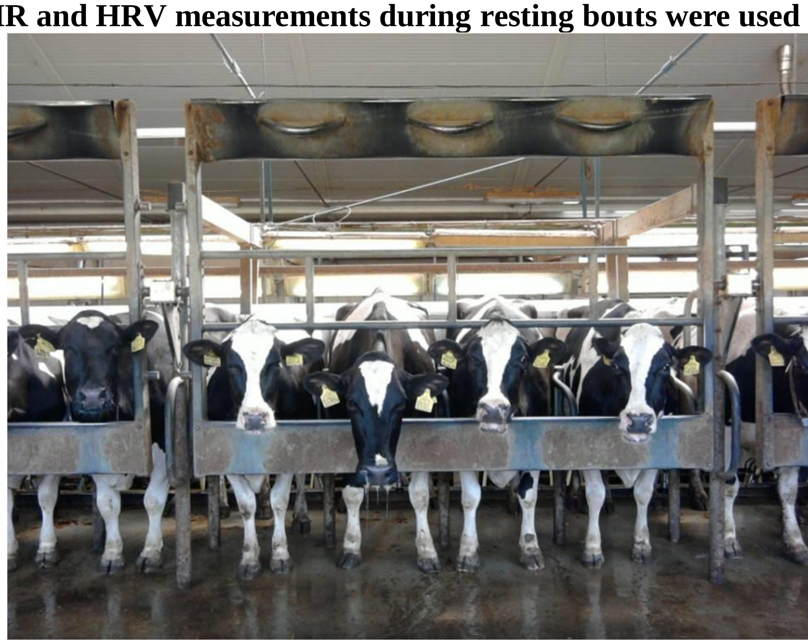
Changes in HR and HRV have previously been used to assess stress in dairy cows during milking mostly comparing automatic and conventional milking systems. Some studies found higher levels of stress in automatic milking system than in an auto-tandem milking parlour (*Wenzel et al,* 2003; *Gygax et al,* 2008), while others found no such differences (*Hopster et al,* 2002), or even noted less restlessness than in a herringbone parlour (*Hagen et al*, 2004, 2005).

We investigated HR and HRV as physiological measures of stress in cows milked in a parallel milking parlour on a Hungarian working farm. The aim of the study was to show cows stress response in a conventional milking system during the whole milking process.

Materials and methods

Measurements were carried out between 6:30 and 21:30 during a 1-week period in May 2012. The 36 focal cows were selected from among the healthy, trouble-free specimens so as to represent a good cross-section of the herd in terms of age (between 2 and 5 years), milk production (35±2.5 kg) and lactation stage (DIM: 150±10).
In line with other experimental approaches (*Hopster et al,* 2002; *Wenzel et al,* 2003; *Hagen et al,* 2004; *Gygax et al,* 2008), a combination of behavioural and physiological parameters was used. Data was obtained using video observations of the milkings and continuous heart-rate recordings (*Picture 1-2*).

Picture 1: **HR and HRV measurements during resting bouts were used as a baseline**



***Picture 2*: The behaviour during milking was video recorded**

Two video cameras were installed at the milking parlour and the entire barn area was simultaneously recorded on video, allowing for later matching of individuals' behaviour and HR recordings. Individuals' HRV values were evaluated for lying used as a baseline in the comparison with values during milking.

HR was recorded with a monitoring system that stored interbeat-intervals (IBIs) for about 15 h continuously (Polar Equine RS800 CX from Polar Electro Oy, Helsinki, Finland). Focal animals wore an electrode belt with two electrodes for the recording of IBIs. Transmitters and the electrodes were attached to an own designed girth made from cattle leather (Picture 3*)* and fitted to cows as earlier described by Kovács *et al,* (2012a). Prior to the study, cows were accustomed to wearing this equipment.

***Picture 3*: Polar Equine equipment and accessories fixed on the focal animals**

The IBI data were downloaded from the HR receiver onto a computer and inspected for measurement quality and artefacts using the Kubios HRV analysis software.

One HRV parameter was chosen for analysis: the high-frequency (HF) component of HRV, strongly reflects vagal tone (*Porges,* 1995) confirmed in cows (Hagen *et al,* 2005; Konold *et al,* 2011), thus highly correlated to other HRV measures. The HF component was calculated in normalized unit. with Fast Fourier Transformation (FFT).

In HRV analysis, we used generalised linear mixed-effects models in R 12.2.1 (*R Development Core Team,* 2005). For comparisons between lying and milking, individuals' mean values were calculated and compared with paired T-tests.

Results

Mean HR values after the midday milkings during resting were 98±14.2 beats per minute (bpm) and tended to be higher later in the day comparing the reference values. Higher HR values were found during every measured periods of milking (except for after being milked, waiting in the parlour) than during resting ($P<0.05$ in either case).

Mean HR differed averagely 13.8±29.8 bpm between resting and milking bouts and the end of the day (during evening resting) was the highest (108.5±27.0 bpm). HR values during 'waiting for being milked' and 'after being milked' as well as 'during evening resting' differed neither statistically.

Lower HRV was found during waiting in the milking stall after milking (HF_{norm}=33.7±23.5) than during the reference period (HF_{norm}=52.8±13.6) at afternoon resting ($P=0.009$) also than during evening resting ($P<0.001$) but there were no significant differences between milking and resting in HRV.

Discussion

During resting after midday milking considerable higher HR values (HR=92.8 bpm) were found comparing earlier results reported 67.3 bpm in Brows Swiss and Simmental cows (*Hagen et al,* 2004; *Schmied et al,* 2008) or 83 bpm in Holstein cows (*Hopster et al,* 1998; *Wenzel et al,* 2003) could be indicative of a breed difference related to differences in for example metabolic activity or temperament (*Hagen et al,* 2004).

Beyond the above mentioned facts, season (spring) could have an effect on HR, namely lower HR values were measured in experiments carried out in winter (*Hagen et al,* 2005; *Schmied et al,* 2008) or in summer (*Brosh et al,* 1998; *Hopster et al,* 1998).

High HR measured in early afternoon and late evening in this experiment can be caused by sudden temperature recovery as a result of an increased metabolic activity (*Brosh,* 2007) reported in earlier studies in the evening (*Wenzel et al,* 2003; *Janžekovič,* 2005).

Only slight effect of the milking procedure on HR was found during milking correspondingly other results (*Rushen et al,* 1999; *Hopser et al,* 2002; *Hagen et al,* 2005; *Gygax et al,* 2008) by about 10 bpm between resting/pre-milking and milking bouts. However, in this investigation, milking process had no effect on HRV itself. The determined vagal predominance during milking might be caused by the release of oxytocin during udder preparation, or the pleasant sense of the udder's emptying. In contrast, lower HF_{norm} was found in the post-milking phase, before being let off from the milking stall than during every measured period of the milking process representing decreased vagal tone reflecting higher level of stress. This can be a result of a commotion caused by the anticipation of feed and water, namely cows were fed only in the barn, not in the milking parlour.

Our results suggests that there was no acute stress during the milking process that reflected on the cardiovascular system, but after milking more restlessness was found with regard to stress during waiting for being let off the milking parlour detectable also in HRV.

Since HR indicating only a slightly increased stress level during milking, we believe that the absolute size of this difference is so minor that no serious impairment of the welfare of dairy cows milked by parallel milking system can be testified.

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