J. Dairy Sci. 98:1750–1758
http://dx.doi.org/10.3168/jds.2014-8565


# Comparison of rumination activity measured using rumination collars against direct visual observations and analysis of video recordings of dairy cows in commercial farm environments

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## ABSTRACT

Automated systems for monitoring the behavior of cows have become increasingly important for management routines and for monitoring health and welfare. In the past few decades, various devices that record rumination have been developed. The aim of the present study was to compare rumination activity measured with a commercially available rumination collar (RC) against that obtained by direct visual observations and analysis of video recordings in commercial dairy cows. Rumination time from video recordings was recorded by a trained observer. To assess observer reliability, data were recorded twice, and the duration of recorded behaviors was very similar and highly correlated between these 2 measurements (mean = 39 ± 4 and 38 ± 4 min/2 h). Measurements of rumination time obtained with RC when compared with analysis of video recordings and direct observations were variable: RC output was significantly positively related to observed rumination activity when dealing with animals housed indoors (trial 1 video recordings: slope = 1.02, 95% CI = 0.92–1.12), and the limits of agreement method (LoA) showed differences (in min per 2-h block) to be within −26.92 lower and 24.27 upper limits. Trial 1 direct observations: slope = 1.08, 95% CI = 0.62–1.55, and the LoA showed differences to be within −28.54 lower and 21.98 upper limits. Trial 2: slope = 0.93, 95% CI = 0.64–1.23, and the LoA showed differences to be within −32.56 lower and 19.84 upper limits. However, the results were poor when cows were outside grazing grass (trial 3: slope = 0.57, 95% CI = 0.13–1.02, and the LoA showed differences to be within wider limits −51.16 lower and 53.02 upper). Our results suggest that RC can determine rumination activity and are an alternative to visual observations when animals are housed indoors. However, they are not an alternative to direct observations with grazing animals on pasture and its use is not advisable until further research and validation are carried out.
**Key words:** dairy cow, rumination activity, validation, video recording, direct observation

## INTRODUCTION

Ruminants occupy an advantageous niche in the animal kingdom. Due to their digestive adaptations, ruminants are capable of converting fibrous, cellulose-rich plant material to energy sources (Van Wieren, 1996). These fibrous materials are first subject to pregastric fermentation, second regurgitated at frequent intervals, rechewed, and finally swallowed back for further degradation.

Rumination reduces the particle size of feedstuffs for rumen degradation, and initiates the process of extracting soluble contents from the feed (Van Soest, 1994). Furthermore, by stimulating saliva production, rumination aids in maintaining correct rumen function by keeping rumen pH within a suitable range for microbial cellulolytic activity (Beauchemin et al., 1989). A combination of factors influences rumination, including nutritional factors, physical and chemical characteristics of the food material, environmental stressors, and day length. For example, rations with fibrous feeds increase chewing activity, whereas high concentrate rations reduce rumination, which could lead to rumen acidosis.

Rumination has a significant effect on intake and forage utilization, which directly correlates to performance, health, and welfare. Therefore, it has been proposed that rumination activity could be used as an indicator of animal health and welfare (Weary et al., 2009). Changes in rumination time may be used as a proxy measure of illness or changes in health status (i.e., if detected, subtle changes in rumination activity could help in the detection of subclinical diseases before they progress and become a clinically apparent concern). To

Received July 3, 2014.
Accepted December 5, 2014.
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further investigate this possibility, accurate and precise methods to measure rumination time are required.

Visual observation is the standard and more reliable method to measure rumination. This can be done either through direct observations or by analysis of video recordings; however, it presents some disadvantages (e.g., requires trained personnel and the number of animals that can be observed at a time is limited). Analysis of video recordings, on the other hand, allows observation of groups of animals and can be performed away from the study site. Video observation also has limitations because it requires trained personal and relies on expensive infrastructure.

To overcome the difficulties posed by monitoring and recording behavior, automated equipment to record feeding behavior (eating, ruminating, or both) have been developed. These devices can measure rumination by means of analyzing jaw movements (Beauchemin et al., 1989; Rutter et al., 1997; Kononoff et al., 2002; Umemura et al., 2009; Braun et al., 2013) or recording sounds of mastication (Laca and WallisDeVries, 2000; Schirmann et al., 2009; Clapham et al., 2011; Elischer et al., 2013; Goldhawk et al., 2013; Navon et al., 2013). Some of these devices have been evaluated in different experimental conditions and with variable results ($P < 0.05$; r = 0.41 to 0.96 and $R^2 = 0.86$ to 0.93).

Automatic recording systems present advantages over visual observations; however, these devices need to be tested and validated to ensure that the obtained data are reliable and accurate. In the past few years the rumination collar (**RC**; SCR Engineers, Netanya, Israel) has frequently been used in the literature (Adin et al., 2009; Gregorini et al., 2012; Soriani et al., 2012; Schirmann et al., 2013; Hart et al., 2013). The RC enables the recording of rumination time from sounds recorded by a microphone with a neck collar, which is positioned to hold the RC microphone on the left side of the cow's neck. The characteristic sounds of regurgitation and rumination are recorded, digitally stored, processed, and then data presented as rumination time either min/2 h or min/d (Bar and Solomon, 2010). Previous studies have evaluated the RC under experimental conditions (i.e., cows confined in individual pens that are not representative of group housing in farm commercial conditions) and cannot be extrapolated to different environments (Schirmann et al., 2009; Burfeind et al., 2011). When the RC were evaluated on other environments (under on-farm conditions), evaluation was either not performed against known rumination behavior (Byskov et al., 2014), or the evaluation showed the RC performance to be very poor and inconsistent (Elischer et al., 2013; Goldhawk et al., 2013). Furthermore, these previous evaluations of the RC did not use statistical analyses that took into account the repeated measures performed on individual cows.

Although the performance or output of the RC has been under scrutiny in the past years, the consensus seems to be that further evaluation and validation are needed (Schirmann et al., 2009; Burfeind et al., 2011; Elischer et al., 2013; Goldhawk et al., 2013). Therefore, the aim of the present study was to compare the rumination activity measured with the RC against that obtained from direct observation and by analysis of video recordings in commercial farm environments with both cubicle-housed and grazing dairy cows.

## MATERIALS AND METHODS

### *Animals*

Three trials were conducted at the University of Edinburgh at Langhill Farm, Roslin (Midlothian, Scotland, UK) during 2012 and 2013. The farm has a 240-cow Holstein milking herd. All procedures related to animals were approved by the Veterinary Ethical Review Committee (references: trial 1 VERC 2011–88, trial 2 VERC 30/12, and trial 3 VERC11/13) of the Royal (Dick) School of Veterinary Studies of the University of Edinburgh.

***Trial 1.*** January 2012: fourteen multiparous milking cows were selected and balanced for DIM (mean ± SEM 104 ± 12 d) and parity [median lactation number (**L**) = 4]. The cows were then randomly allocated to 2 different groups: group 1 (**G1**: DIM 103 ± 5.0 d, L = 5) and group 2 (**G2**: 105 ± 4.6 d, L = 4), with 7 cows in each group. Each group was housed in contiguous pens that share identical characteristics: area of feed and water troughs, cubicle/stalls with rubber mattresses top-dressed with sawdust 3 times a week.

Cows were offered a partial mixed ration (**PMR**; first cut grass silage 46.2% (fresh weight PMR proportion), whole-crop wheat silage 18.0%, crimped maize 6.7%, dairy meal 24.1%, and molasses 5.1%), with additional concentrate fed to yield in the milking parlor. Water was supplied ad libitum, and the cows were milked twice daily as per standard farm practice.

***Trial 2.*** January 2013: fourteen multiparous milking cows were selected and balanced for DIM (97 ± 4.3 d) and parity (L = 3). The cows were then randomly allocated to 2 different groups: G1 (DIM 96 ± 2.7 d and L = 3) and G2 (DIM 99 ± 9.2 d, L = 4), with 7 cows in each group. Each group was housed in contiguous pens that share identical characteristics: area of feed and water troughs, cubicle/stalls with rubber mattresses top-dressed with sawdust 3 times a week.

Cows were offered a PMR (first cut grass silage 44.9%, wholecrop wheat silage 17.6%, second cut grass