Applied Animal Behaviour Science 165 (2015) 25–32

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

Daily grazing time of dairy cows is recorded accurately using the Lifecorder Plus device

Rémy Delagarde[a,b,*], Philippe Lamberton[a,b]

[a] INRA, UMR1348, Physiologie, Environnement et Génétique pour l'Animal et les Systèmes d'Elevage (PEGASE), F-35590 Saint-Gilles, France
[b] Agrocampus Ouest, UMR1348, PEGASE, F-35000 Rennes, France

ARTICLE INFO

Article history:
Accepted 18 January 2015
Available online 29 January 2015

Keywords:
Grazing time
Dairy cow
Methodology
Accelerometer

ABSTRACT

Accurate estimation of daily grazing time and nycthemeral grazing pattern in ruminant nutrition research may result in a better understanding of sward–animal interactions and of the behavioural constraints affecting daily intake at pasture. Portable devices which automatically record grazing activities are needed. The Kenz Lifecorder Plus device (LCP, Suzuken Co. Ltd., Nagoya, Japan), originally developed for measuring human daily activity level, has been used recently to record daily grazing time and pattern in dairy cows. The aim of this validation study was to compare grazing activity duration as recorded simultaneously by the Lifecorder Plus fitted on the cow neck and by trained observers. A total of 250 h of visual observations on six grazing cows over 12 days were performed. The relative prediction error averaged 0.12, 0.07, 0.05, and 0.03 of actual grazing time when accuracy was investigated per hour, per sequence of observation (approx. 5 h), per day (approx. 21 h), and per cow (approx. 41 h), respectively. Error was mainly random, the proportion of mean square prediction error related to mean bias or line bias being always very small. This high accuracy shows no overall confusion between grazing and other activities, such as rumination, when cows were at pasture. No activity was detected when cows were ruminating. Walking time to and from the milking parlour was detected as activity due to much greater speed than while grazing. This can be easily filtered out when the raw data are processed so as not to over-estimate grazing time, particularly if some cows are fitted additionnally with Lifecorder on the leg to identify these periods. In conclusion, the high accuracy of the Lifecorder Plus to detect grazing activities when cows are at pasture, particularly at the day scale or when comparing cows over several days, as well as its robustness and simplicity in use, make it a very suitable device for recording the grazing time and pattern of dairy cows at pasture.

1. Introduction

One of the main objectives of recording some components of the feeding behaviour of grazing ruminants is to improve understanding of the sward–animal relationships and their potential effect on daily pasture intake. Daily grazing and rumination times and their nycthemeral pattern are the main components of feeding behaviour that may be recorded automatically using portable devices. When measured simultaneously with daily pasture DM intake, grazing time allows an average daily pasture intake rate to be estimated, providing a better understanding of sward–animal relationships and of the role of behavioural

* Corresponding author at: INRA, UMR1348, PEGASE, F-35590 Saint-Gilles, France. Tel.: +33 0223485096; fax: +33 0223485080.
E-mail address: remy.delagarde@rennes.inra.fr (R. Delagarde).

http://dx.doi.org/10.1016/j.applanim.2015.01.014
0168-1591/

constraints on daily DM intake (Pérez-Prieto et al., 2013). Portable devices obviate the need for manual recording, which is time-consuming and difficult at night, particularly in the case of large herds.

Many devices have been developed for monitoring grazing ruminants for research purposes over the years, primarily by research teams. The most recent devices are based on sensors, such as silicone-tube nosebands recording electrical resistance (Rutter et al., 1997), microphones for both intake (Delagarde et al., 1999; Galli et al., 2011; Nadin et al., 2012) and rumination (Reith and Hoy, 2012), mercury switches (Scheibe et al., 1998; Delagarde et al., 1999), and uniaxial, biaxial or tri-axial accelerometers (Scheibe et al., 1998; Nielsen, 2013; Umemura, 2013; Oudshoorn et al., 2013). The relative advantages of these devices depend on the number of variables recorded (including rumination time and bite frequency), their simplicity and robustness in use, specificity and accuracy of grazing-activity detection, method of transferring the data to a computer, degree of automation for data-processing, and financial cost and commercial availability.

The most promising sensors in the near future are likely to be accelerometers, as a number of affordable devices for on-farm dairy herd management are under development or already commercially available. They might not be sufficiently accurate for scientific use, however, because ruminant nutrition research requires a greater level of precision at short- or medium-time scale. Recently, a portable device called Lifecorder (Ex version, LCP, Suzuken Co. Ltd., Nagoya, Japan), originally designed for human health improvement, has been suggested by Ueda et al. (2011) as a potentially useful device for recording the grazing behaviour of dairy cows at pasture. Lifecorder is based on an uniaxial accelerometer that records physical activity level (range 1–9) for each 4-s period. More recently, Yoshitoshi et al. (2013) validated the use of the Lifecorder Ex version for recording the grazing time of steers on a hilly pasture from data recorded at 4-s intervals. Lifecorder Ex can be used for long term behaviour recording because its battery capacity is of 3 months and its memory capacity is of 1 month. The large volume of data recorded, however, requires that the data be processed on a per cow basis before estimating periods of grazing activities, through linear discriminant analysis (Yoshitoshi et al., 2013). Several versions of the Lifecorder device are commercially available (Suzuken Co. Ltd., Nagoya, Japan). The Lifecorder Plus version is available in English and records and compiles information on the average or most representative level of physical activity for each 2-min period, which means that less data needs to be processed by the user.

Following the work of Ueda et al. (2011) and Yoshitoshi et al. (2013), the objective of this experiment is to determine the accuracy of the Lifecorder Plus device in recording the grazing activity periods of dairy cows at pasture more extensively. The novel aspects of this study are based on (1) the use of the Plus version of the Lifecorder that potentially does not require preliminary data processing to identify grazing activity periods, contrary to the Ex version, (2) the duration of the validation period, of more than 200 h compared to the 11-h validation period by Ueda et al. (2011) and to the 15-h validation period by Yoshitoshi et al. (2013), and (3) the comparison of activity levels recorded when the device is placed either on the neck or on the leg.

2. Materials and methods

2.1. Experimental site, animals and management

The validation study was conducted at the INRA experimental farm of Méjusseaume (1.71° W, 48.11° N, Le Rheu, Brittany, France) over 12 non-consecutive days between October 10 and October 31, 2012. Six Prim'Holstein dairy cows in late lactation were used. They were rotationally grazed as a single herd on temporary pastures consisting mainly of perennial ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.). The front fence was moved once every 3–4 days to provide fresh pasture. Each day, four of the six cows were fitted with the Lifecorder Plus device after morning milking, before to access grazing. The device was placed in a small waterproof plastic box (90 mm × 60 mm × 55 mm), and cushioned with plastic foam. The box was attached to the cow's neck by means of a simple collar. After preliminary observations, the Lifecorder Plus was placed in a standard horizontal position within the box, ensuring that it was in a semi-vertical position when the cow was grazing in a head-down position, with the objective of maximising activity-level amplitude. The collar was not tightly attached in order to maximise free movement of the box while the cow was grazing, with a space of approximately 5 cm between collar and neck when the cow was in a head-up position.

2.2. Measurements

Actual feeding activities were recorded by trained operators continuously observing the cows for a total of 48 validation sequences (12 days × 4 cows). Validation sequences generally started in the morning (between 09:00 h and 11:00 h) and ended in the afternoon (between 12:00 h and 17:00 h). Three main activities were defined: grazing (biting, searching, and/or chewing during a meal), ruminating, and "other activities" (drinking, walking without biting or searching, resting, social interaction). Times spent performing these three activities were recorded manually for each cow min by min in each of the validation sequences, taking into account only the predominant activity within each min period. For instance, a 20-s walking sequence included in a grazing sequence was not considered. Short intra-meal intervals of more than 30–45 s devoted to activities other than eating, such as drinking, walking or social activities, were considered as "other activities" and were excluded from grazing activity recorded (Gibb, 1998). The operators' clocks were synchronised with those of the Lifecorder Plus devices so that the validation process could be performed on a short-term scale.

During evening milking time, the Lifecorder Plus devices were removed from the boxes and connected to a computer for data transfer via a USB cable. The data were then downloaded using the Physical Activity Analysis Software Lifestyle Coach v1.2 (Kenz, Suzuken Company Limited, Nagoya, Japan), which offers two options: most