Effect of pre-grazing herbage mass on behavioural characteristics of dairy cows

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Abstract

The purpose of this study was to validate a new RumiWatch converter (C31) which differentiates prehension bites from mastication chews during eating. Furthermore, the study investigated the effects of a low (LHM, 589 kg DM ha^{-1}) and high (HHM, 2288 kg DM ha^{-1}) pre-grazing herbage mass (PGHM) at similar herbage allowances (HA, 22 kg DM $animal^{-1}$ d^{-1}) on bite mass, DM intake (DMI), number of prehension bites and milk production. The C31 was validated in comparison with the previous RumiWatch converter (C11), and additionally, with visual observations of behavioural characteristics. A total of 24 Holstein cows were allotted pairwise to one of the two treatments. On average, LHM cows produced more energy-corrected milk, had the same herbage DMI (hDMI) and similar prehension bite mass. The eating time was longer and the rumination time shorter for LHM cows compared to HHM cows. Besides prehension bites and mastication chews during eating, C11 and C31 performed similarly well in identifying the various behavioural characteristics. Compared to visual observation, C31 showed a mean absolute percentage error (MAPE) for prehension bites of 12%. Only a small part of the herbage intake variability could be explained by the number of prehension bites.

Keywords: pre-grazing herbage mass, behaviour, dairy cow, pasture, RumiWatch

Introduction

In many respects, knowledge of individual herbage dry matter intake (hDMI) of grazing dairy cows is essential. This knowledge helps monitor nutritional status, feed efficiency as well as pasture and livestock management. As a step to the long-term objective of estimating hDMI, based partly or completely on individual behavioural characteristics, the subsequent experiment was carried out. During grazing, dairy cows perform prehension bites and mastication chews. As only prehension bites serve for hDMI, it may be important for a more accurate intake estimation to record these separately (Laca and WallisDeVries, 2000). A recent evaluation software, called converter (C31), of the RumiWatch System (RWS) enabled the detection of every single jaw movement and the differentiation of eating chews in prehension bites and mastication chews. Using this software, it might be possible to describe grazing events of dairy cows more precisely and to estimate hDMI more accurately. The first objective was to validate the C31 in comparison to the previous RumiWatch converter (C11), and additionally, with direct visual observations. Further, the effects of two different pre-grazing herbage masses (PGHM) at the same targeted herbage allowance (HA) on bite mass, hDMI, number of prehension bites and milk production were investigated.

Materials and methods

The study was carried out at the Agroscope experimental farm in Posieux (Switzerland) in September 2015. The experiment lasted three wk, with a 14 d adaptation and a seven d measurement period. Twenty four Holstein and Red-Holstein cows were allotted pairwise to one of two treatments based on body weight, milk yield, days in milk and lactation number. Cows grazed 19 h d^{-1}, had free access to water and were not supplemented in the barn. The treatments consisted of two different PGHM: either 589 kg DM ha^{-1} for LHM or 2288 kg DM ha^{-1} for HHM, but with the same targeted HA of 22 kg DM cow^{-1} d^{-1} above 3.4 cm (Jenquip rising plate meter, Feilding, New Zealand). New paddocks were offered to both groups twice per day after each milking. Recordings and evaluations of the behavioural characteristics were completed using the RWS, the RW Halter (version 6.0, Itin & Hoch GmbH, Liestal, Switzerland) as well as the C11 (Converter 0.7.3.11, Itin & Hoch GmbH) and the C31 (Converter 0.7.3.31, Itin & Hoch GmbH). Milk yield was measured twice daily and milk composition was analysed on d 2, 4, and 6 during the measurement week. To estimate individual hDMI on pasture, the *n*-alkane double indicator method was used, as described by Heublein *et al.* (2017). The direct observation, reference method for the validation of C11 and C31, was done on d 1, 3 and 5 during the measurement week for each cow. One trained observer performed all 72 observation sequences, each of which lasted 10 minutes. To indicate the accuracy of C11 and C31 compared to direct observations, the mean absolute percentage error (MAPE) was calculated. A linear mixed model (Systat 13, Systat Software, Chicago, USA) with a fixed effect treatment (PGHM) and a random effect cow pair was used for the statistical analyses for milk production, intake and behaviour variables.

Results and discussion

Post-grazing sward heights were similar between treatments, 3.8 cm for HHM and 3.9 cm for LHM. The pasture swards were composed of different grasses 720 (standard deviation (SD) 41) g kg^{-1} fresh matter, legumes 260 (SD 44) g kg^{-1} and forbs 20 (SD 6) g kg^{-1}. During the measurement period, the nutritive value of herbage DM was 6.3 MJ net energy for lactation (NEL), 218 g acid detergent fibre (ADF), and 184 g crude protein (CP) for HHM. For LHM, values were 6.6 MJ NEL, 188 g ADF, and 240 g CP.

The MAPE between C31 and direct observation was 6% (C11: 6%) for eating time, 11% (C11: 10%) for eating chews, 12% for prehension bites, 52% for mastication chews head down, 68% for mastication chews head up, 2% (C11: 2%) for rumination time, 4% (C11: 4%) for rumination chews, 9% (C11: 9%) for bolus count and 10% (C11: 12%) for chews per bolus.

Cows grazing on LHM produced more milk (25.4 vs 22.7 kg d^{-1}; $P = 0.008$) and more energy corrected milk (26.6 vs 24.1 kg d^{-1}; $P = 0.003$) and showed a trend for greater milk protein content (36 vs 34 g kg^{-1}; $P = 0.06$) compared to HHM. No treatment effects were seen on the milk fat content (44 vs 46 g kg^{-1}; $P = 0.22$), lactose content (46 vs 46 g kg^{-1}; $P = 0.63$), hDMI (15.6 vs 15.0 kg d^{-1}; $P = 0.33$), prehension bite mass (0.49 vs 0.47 g DM bite^{-1}; $P = 0.55$) and hDMI rate (26 vs 27 g min^{-1}; $P = 0.22$). Cows grazing on LHM had a longer grazing time (617 vs 559 min d^{-1}; $P = 0.004$), a lower eating frequency (70 vs 76 min^{-1}; $P = 0.002$), ruminated less (297 vs 365 min d^{-1}; $P < 0.001$), performed fewer rumination chews (18,436 vs 23,625 chews d^{-1}; $P = 0.001$) and regurgitated fewer boluses (365 vs 441 boli d^{-1}; $P = 0.005$) compared to HHM cows. No differences were seen between the two treatments for the number of eating chews (42950 vs 42220 chews d^{-1}; $P = 0.60$) and prehension bites (32,366 vs 32,244 d^{-1}; $P = 0.95$) as well as for the number of chews per bolus (51 vs 54 bolus^{-1}; $P = 0.15$) during rumination.

The coefficient of determination between eating chews or prehension bites and hDMI for the different treatment were low (0.05 to 0.3).

For grazing cows, the C11 had been extensively validated (Rombach *et al.*, 2018). Since the C31 is a further development of the C11, it is not surprising that behavioural characteristics such as eating time, eating chews, rumination time, rumination chews, bolus counts and number of chews per bolus were recognised equally well by both converters. In contrast to C11, C31 is able to identify prehension bites and is similar in accuracy to an acoustic measurement tool (Laca and WallisDeVries, 2000). For grazing dairy cows, the determination of mastication chews head up and down made by C31 are prone to errors.

Contrasting results are found in the literature in relation to the effect of HM on hDMI, milk production and behaviour at the same HA. According to Pérez-Prieto and Delagarde (2012), this has largely to do with the sward height above which the HA is measured. For a better ease of comparison, realistic HA might be calculated from a level similar to the defoliation limit of dairy cows, as in our experiment. Eating time and average intake rate per day in strip-grazing or rotationally grazing systems also depend on sward characteristics for reasons others than pre-grazing state. These include, but are not limited to post-grazing sward height, tear strength of different strata and duration of grazing periods (Pérez-Prieto and Delagarde, 2012). An increased eating time for LHM cows and similar numbers of prehension bites per day as HHM cows might show that LHM cows needed more time to select herbage compared to HHM cows. The increased fibre content might be the reason for longer rumination duration (Welch and Smith, 1970), more rumination chews and boluses. Pérez-Prieto *et al.* (2013) also observed a considerable increase in rumination duration when cows grazed on swards with increased HM.

Average prehension bites or eating chews per day explained only about 20% of the variation of hDMI. Consequently, prehension bites or eating chews alone did not enable an accurate hDMI prediction.

Conclusion

The evaluation software C31 identifies prehension bites relatively well (MAPE = 12%), but the detection of mastication chews during eating is prone to errors. Under the given conditions, HM had no influence on the number of prehension bites, hDMI or herbage bite mass averaged per day. Finally, the number of prehension bites explained only a small part of hDMI variation.

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