Rumination activity

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Introduction

The daily rumination pattern in cattle is influenced by different factors such as feeding frequency, physical and chemical characteristics of the diet, feeding time, fasting, photoperiod and grazing management [1], [2], [3], [4], [5]. Studies have observed an apparent decrease in rumination activity in ruminal acidosis or mastitis challenged dairy cattle [6], [7]. Social and physical environment can also affect cattle's rumination behaviour [8]. Manual observation of eating and rumination in individual animal is time-consuming and labour intensive. Therefore, the need for developing innovative and non-intrusive techniques to assess rumination behaviour is important. The IGER behaviour recorder was the first commercially available tool, initially introduced by Penning [9], and further developed via integrating microcomputer-based systems for the digital recording of jaw movements [10]. The IGER system has some limitations, such as feasibility for longer experiments or difficulties when interpreting acquired data. The Hi-Tag system is a neck-collar based rumination monitoring tool, which records data based on acoustic biotelemetry [11], [12]. The applicability of this system has been proven, however the accuracy of the collected data relies on the correct positioning of the collar on the animal's body [13]. The recently developed RumiWatch system combines data from a built-in pressure sensor and a triaxle accelerometer to track different behavioural characteristics in cattle. This system has been validated in dairy cows under different housing management systems [14], [15].

Prerequisites

This guideline provides key steps on conducting individual rumination assessment in cows. This document was written based on the presumption that rumination in experimental units is monitored automatically, either via acoustic sound or pressure sensors (RumiWatch System (RWS); Itin and Hoch GmbH, Liestal, Switzerland). The points mentioned below will be applicable to experimental units with pasture or intensive-housing systems. The Animal Trait Ontology for Livestock (ATOL) numbers linked with rumination are: **ATOL_0000779, ATOL_0002150, ATOL_0000811, ATOL_0001062, AHOL_0005008** and **EOL_000706** (for complete list of ATOL and EOL, please visit https://www.atol-ontology.com/en/erter-2/).

A – Assessing rumination in cattle

1. The operator should be well informed of various factors, such as metabolic issues (as a consequence of feeding deficiencies), diseases, hot weather (temperature-humidity index >75), overcrowded stalls, and the period around calving or oestrus, which can alter the rumination activity of cattle (unless the design of experiment is to evaluate the impact of these factors).
2. Operators should be aware that rumination sequences in a healthy cow occurs 15–20 times per day, for roughly 20–30 min, and mostly when the animal is in a lying position. Eating should be considered as when a cow takes feed into its mouth, chews and swallows it. Rumination should

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be considered as the period from when regurgitation takes place, i.e. when a bolus comes up the oesophagus and reaches the mouth, including the following period (about 1 min) of regular chewing of the bolus and then ending with re-swallowing.

3. If the experimental design dictates a ration change, cattle rumination should be carefully observed to determine any abnormal feeding behaviour due to the new ration offered to the animals (when there is no intention to determine the impact of dietary change or particular feedstuff inclusion on feeding behaviour). An adaptation period to diet change of 14–21 d is recommended before rumination observations are made.
4. Rumination activity of primiparous and multiparous animals should be considered separately due to evident behavioural differences and competition for feeding [6].

B – Acoustic sound monitoring of jaw movement

1. The wireless microphone (when combined with a video recording system) should be protected by a rubber foam cover and attached to the animal's forehead by an elastic band fastened to a halter.
2. The chosen dairy cow should be carefully restrained in a specific place during recording and placed back into the barn after data acquisition is complete.
3. Sound files should be aurally analysed, independent of the video recordings.
4. The operator should be aware that 'bite' refers to a ripping sound while 'chew' refers to a grinding sound. Also, 'chew-bite' corresponds to an intermediate between the chew and bite sound [10].
5. The operator who aurally analyses the acoustic sound data, must be experienced enough and trained appropriately to differentiate 'bite', 'chew' and 'chew-bite sounds'. Results obtained from less experienced operators, should be cross-checked with analysis of the same data by an experienced operator. In the case of significant between-observer differences, an operator with expertise in aural analysis should re-train the inexperienced operators.
6. During analysis, operator must be aware of background noises, particularly where the experiment is conducted outdoors.
7. When using an automatic system, the microphone, microprocessor and the transponder should be checked to ensure they are functioning properly.
8. Rumination data from the loggers should be validated with the direct-observational method as a reference. Expected errors during visual observation, e.g. inability to precisely detect the start and finish of each rumination bout or discriminate jaw movements as eating versus ruminating (especially when the animal's head is in the feed bin) must be taken into consideration when interpreting potential variances between the methods [1].
9. Rumination loggers should be positioned roughly 20 cm behind the left ear and 5–10 cm down the left side of the neck.
10. The algorithm used for processing acoustic signals from the rumination loggers should be clearly stated.

C – The RumiWatch System (RWS)

1. Validating the sensitivity, specificity and accuracy of the RWS and its convertor software should be done as described by Zehner [14]. If the system will be used in the experimental unit for a different purpose from that described in the literature, the operator must validate the acquired data from the RWS against visual observation (directly or via video recording).
2. The operator must ensure that the pressure sensor and triaxial accelerometer, along with the data logger, are functioning properly before use. To test, the operator can manually apply pressure on the sensors whilst tilting the halter and then check whether the appropriate signals are detectable by the software.
3. For optimal jaw movement detection by the pressure sensor, roughly 3–5 cm of free space should be left between the belt, which surrounds the nose and the lower jaw, to the nose bridge. Additionally, the belt should be positioned between 11 and 16 cm behind the nasal tip.
4. The battery status of the apparatus should be checked to be above the threshold level described by the manufacturer (as long as the RWS Manager software displays a voltage >3.0 V on the on-screen voltmeter, the RWS may be used without any concerns). If the battery charge falls below 2.8 V, the SD-memory card of the system could be damaged, and all collected and saved data on the SD-card will be lost.
5. The pressure tube of the RWS must be checked for any leakage or malfunction prior to the trial.
6. Animals should be adapted to wearing the RWS halter 1–3 d prior to actual measurement

collection.

7. Experimental units engaging the RWS with grazing cattle should be aware of and utilise the updated version of the software (RWS Converter 0.3.11) for processing the raw data regarding eating chews, rumination chews, pretension bites, and the duration of these activities [3].

References

1. Welch JG, Smith AM. Influence of forage quality on rumination time in sheep. Anim Sci J. 1969;28(6):813-8. DOI: 10.2527/jas1969.286813x
2. Gordon, JG, McAllister IK. The circadian rhythm of rumination. J Agric Sci. 1970;74(9):291-7. DOI: 10.1017/S0021859600022905
3. Gregorini P, DelaRue B, McLeod K, Clark CEF, Glassey CB, Jago J. Rumination behavior of grazing dairy cows in response to restricted time at pasture. Livest Sci. 2012;146(1):95-98. DOI: 10.1016/j.livsci.2012.02.020
4. Schirmann K, Chapinal N, Weary DM, Heuwieser W, von Keyserlingk MAG. Rumination and its relationship to feeding and lying behavior in Holstein dairy cows. J Dairy Sci. 2012;95(6):3212-7. DOI: 10.3168/jds.2011-4741
5. Beauchemin, KA. Invited review: Current perspectives on eating and rumination activity in dairy cows. J Dairy Sci. 2018;101(4):4762-84. DOI: 10.3168/jds.2017-13706
6. DeVries, TJ, Beauchemin KA, Dohme F, Schwartzkopf-Genswein KS. Repeated ruminal acidosis challenges in lactating dairy cows at high and low risk for developing acidosis: feeding, ruminating, and lying behavior. J Dairy Sci. 2009;92(10):5067-78. DOI: 10.3168/jds.2009-2102
7. Fogsgaard KK, Rontved CM, Sorensen P, Herskin MS. Sickness behavior in dairy cows during Escherichia coli mastitis. J Dairy Sci. 2012;95(2):630-8. DOI: 10.3168/jds.2011-4350
8. Thorup VM, Nielsen BL, Robert PE, Giger-Reverdin S, Konka J, Michie, C, Friggens NC. Lameness Affects Cow Feeding But Not Rumination Behavior as Characterized from Sensor Data. Front Vet Sci. 2016;3:37. DOI: 10.3389/fvets.2016.00037
9. Penning PD, Steel GL, Johnson RH. Further development and use of an automatic recording system in sheep grazing studies. Grass Forage Sci. 1984;39:345-51
10. Ungar ED, Rutter SM. Classifying cattle jaw movements: Comparing IGER Behaviour Recorder and acoustic techniques. Appl Anim Behav Sci. 2006;98(1-2):11-27. DOI: 10.1016/j.applanim.2005.08.011
11. Schirmann K, von Keyserlingk MAG, Weary DM, Veira DM, Heuwieser W. Technical note: Validation of a system for monitoring rumination in dairy cows. J Dairy Sci. 2009;92(12):6052-5. DOI: 10.3168/jds.2009-2361
12. Soriani N, Trevisi E, Calamari L. Relationships between rumination time, metabolic conditions, and health status in dairy cows during the transition period1. Anim Sci J. 2012;90(12):4544-54. DOI: 10.2527/jas.2011-5064
13. Burfeind O, Schirmann K, von Keyserlingk MAG, Veira DM, Weary DM, Heuwieser W. Evaluation of a system for monitoring rumination in heifers and calves. J Dairy Sci. 2011;94(1):426-30. DOI: 10.3168/jds.2010-3239
14. Zehner N, Umstätter C, Niederhauser JJ, Schick M. System specification and validation of a noseband pressure sensor for measurement of ruminating and eating behavior in stable-fed cows. Comput Electron Agric. 2017;136:31-41. DOI: 10.1016/j.compag.2017.02.021
15. Rombach M, Munger A, Niederhauser J, Südekum KH, Schori F. Evaluation and validation of an automatic jaw movement recorder (RumiWatch) for ingestive and rumination behaviors of dairy cows during grazing and supplementation. J Dairy Sci. 2018;101(3):2463-75. DOI: 10.3168/jds.2016-12305

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