Livestock Science 158 (2013) 151–156

Contents lists available at ScienceDirect

Livestock Science

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

Short communication

A note on rumination behavior of dairy cows under intensive grazing systems

P. Gregorini*, B. Dela Rue, M. Pourau, C. Glassey, J. Jago

DairyNZ, Ltd., Farm Systems/Modelling, Cnr Ruakura & Morrinsville Roads, Newstead, Private Bag 3221, Hamilton, New Zealand

ARTICLE INFO

Article history:
Received 3 March 2013
Received in revised form
18 September 2013
Accepted 6 October 2013

Keywords:
Dairy cow
Rumination
Behavior

ABSTRACT

Rumination is an important aspect of rumen function and animal welfare. However, there is a paucity of information regarding rumination behavior and diurnal patterns among grazing dairy cows of different breeds, genetic merits and ages managed under intensive grazing systems. An observational study was conducted to explore these potential associations and highlight possible behavioral adaptations to compensate for variations in rumination time. Three hundred and twenty lactating dairy cows were fitted with HR Tag™ rumination collars from day 30 to day 240 in milk (DIM), to record daily rumination activity (min per day and min every 2 h), mastication rhythm (seconds between ruminative chews) and interval between regurgitation of bolus (s). The group of cows consisted of a mix of two breeds (Friesian and Jersey) and their crossbreeds (Friesian12 × Jersey4 and Friesian8 × Jersey8) with ages of 2 (heifers), 3 and older than 4 yr old. The results indicate no relationships among age, breed, genetic merit and daily rumination time, but a differential diurnal pattern of rumination activity. Age and breed were also associated with mastication rhythm and interval between regurgitation of bolus. The older the cow and the greater the Friesian pedigree, the larger the interval between rumination chews. The total number and time of mastications per bolus appeared to increase with cow age. Increments in Friesian pedigree were associated with fewer regurgitations of bolus per day, a longer time of mastication per bolus and more chews per bolus. The number of regurgitations of bolus per day decreased with the age of the cow. If daily rumination time is controlled by feeding management, these associations possibly highlight underlying compensatory mechanisms, for example to reductions of chewing efficiency as cows age. Therefore, specific feeding managements to manipulate rumination behavior could be designed based on age and breed. Due to the observational nature of the present study, results should be interpreted with caution. At the same time, such observations open up challenging questions for future controlled and detailed experiments.

1. Introduction

Rumination has been considered as a key component of digestion and intake by ruminants and has a significant effect in the chemical composition of milk (Mertens, 1997; Murphy et al., 1983), as well as an important role in animal welfare (Krawczel and Grant, 2009). Rumination has the primary function of facilitating clearance of digesta from the rumen by reduction of particle size (Kennedy, 2005). Clearance of digesta from the rumen allows more room and stimulates feeding (Gregorini et al., 2007). Reduction of particle size also facilitates microbial colonization and thereby digestion of forage particles. Due to the direct relationship between rumination and salivation, reductions of rumination lessen the input of buffer to the rumen. This, in turn, reduces the rumen acetogenic fermentation pattern

* Corresponding author. Tel.: +64 7 858 3750; fax: +64 7 858 3751.
E-mail address: Pablo.Gregorini@dairynz.co.nz (P. Gregorini).

1871-1413/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.livsci.2013.10.012

and depresses milk fat content (Mertens, 1997). Severe impediments of rumination can lead to ruminal acidosis (Owens et al., 1998).

The diurnal pattern of rumination is circadian but flexible, modulated by feeding frequency, physical and chemical characteristics of the diet (Welch and Smith, 1969), feeding time, fasting, photoperiod (Gordon and McAllister; 1970; Pearce, 1965a,b; Schirmann et al., 2012) and grazing management (Gregorini et al., 2012). For example, grazing dairy cows reduce rumination as a compensatory mechanism to increase effective grazing when time at pasture is restricted (Gregorini et al., 2012). Moreover, mastication rhythm (a.k.a. chewing rate) during rumination varies with type of animal (Weston et al., 1989). Although few studies have compared and evaluated the rumination time of grazing dairy cows as affected by breed (Prendiville et al., 2010) and genetic merit (McCarthy et al., 2007; Sheahan et al., 2011), there are very little data on the relationships between these traits, including age, and rumination behavior. More data and a better understanding of these relationships will assist the design of specific and strategic feeding management to increase herbage intake and enhance rumen digestion. Thus, in order to understand more about relationships between rumination behavior and its diurnal pattern among grazing dairy cows of different breeds, genetic merits and ages, an observational study was conducted to explore associations and highlight possible, underlying compensatory mechanisms.

2. Materials and methods

2.1. Research site and experimental procedures

This study was conducted from September 2010 to April 2011 at the Lincoln University Dairy Farm, Lincoln, New Zealand. Key features of this farm were the high stocking rate of 4.15 cows/ha, the mean cow genetic merit of BW=92 (breeding worth), the high milk solids production of 414 kg/cow/yr and a mean lactation length of 266 d. The population breakdown according to cows' breed, age, and genetic merit is presented in Table 1. The cows strip-grazed pastures from a sward dominated by *Lolium perenne* (~80%) and *Trifolium repens* (~20%) with mean pre- and post-grazing herbage masses of 3000 and 1500 kg DM/ha, respectively (~4 mm sward surface height). Nitrogen fertilizer was applied to the pastures at a rate of 200 kg N/ha/yr. No concentrates were fed. The total herbage harvested (consumed) by the study cows was 16.8 t DM/ha. The BW is an index that measures the expected ability of the cow to breed replacements which are efficient converters of feed into profit. The BW is based mainly on the performance of close relatives. For example, a BW of 68 indicates that the cow is expected to pass onto her progeny an extra $34 (she passes on half of her genes to her daughters) net farm income per year (per 4.5 t of feed on a dry matter basis) compared to daughters of a 0 BW cow (New Zealand Animal Evaluation, http://www.nzael.co.nz/).

2.2. Measurements and calculations

Three hundred and twenty lactating dairy cows were fitted with HR Tag™ rumination collars (SCR Engineering Ltd., Netanya, Israel) from day 30 to day 240 in milk (DIM), to measure rumination activity through the sound of mastication and regurgitation of the digesta bolus during rumination (Bar and Solomon, 2011). The collar has a microphone incorporated in a plastic case, which is located adjacent to the dorsal aspect of the neck on the left side. The sounds are analyzed using a bioacoustic algorithm. The device stores rumination data in 2 h intervals for periods of 24 h. This information is automatically downloaded every time the cow enters the milking parlor. The collars have shown good agreement between the automated data and visual observations, providing confidence in their use and application (Schirmann et al., 2009).

Table 1
Number of cows according to genetic merit, age and breed.

Genetic merit	Breed Age[a]	F	F 12 × J4	F 8 × J8	J	Total
BW1 NZ$66–59.5	Heifer	0	1	0	0	1
	3 yr	0	0	3	4	7
	≥ 4 yr	17	20	24	11	72
	Total	17	21	27	15	80
BW2 NZ$59.5–98	Heifer	1	6	3	6	16
	3 yr	1	2	8	18	29
	≥ 4 yr	10	14	4	6	34
	Total	12	22	15	30	79
BW3 NZ$98–130	Heifer	0	13	7	21	41
	3 yr	0	1	1	2	5
	≥ 4 yr	13	13	2	4	32
	Total	13	27	11	27	78
BW4 NZ$130–188	Heifer	0	6	3	11	20
	3 yr	0	5	9	17	31
	≥ 4 yr	3	20	3	6	32
	Total	3	31	15	34	83
Total	Heifer	1	26	13	38	78
	3 yr	1	8	22	41	72
	≥ 4 yr	43	67	33	27	170
	Total	45	101	68	106	320

[a] F, 100% Friesian pedigree; F12 × J4, 66% Friesian pedigree; F8 × J8, 50% Friesian pedigree; and J, 100% Jersey pedigree.

2.3. Statistical analysis

Data were split into four quartiles according to genetic merit (BW1, BW2, BW3, and BW4) and grouped by age (heifer, 3 yr and ≥ 4 yr old) and breed (Friesian, F; Jersey, J; F12 × J4 and F8 × J8; Table 1). Daily rumination time (min/d), daily mean interval between rumination boli (time in seconds between bolus) and mean mastication rhythm (time in seconds between two ruminative chews) were explored for the entire measurement period as repeated measurements through time (milking date, ~days in milk) with a mixed model using compound symmetry for the covariance structure for the within-cow repeated measurements. Milking date, groups (age, breed, and genetic merit) and their interactions were included as fixed effects and cow was included as a random effect in the model. Residual maximum likelihood (REML) in GenStat 12.1 was used to fit these models. The analysis of daily rumination time showed no significant interactions among the three factors, so a model including only Milking date and the main effect of each group was