Effects of mild heat stress periods on milk production, milking frequency and rumination time of grazing dairy cows milked by a mobile automatic system

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Abstract

Grazing dairy cows milked by an automatic system (AS) experienced mild heat stress (HS) periods twice during the summer. The daily temperature humidity index (THI) during these periods were higher than 72. Milk production, as well as milking frequency, rumination time and milk fat to protein ratio (F/P) during these periods were compared with adjacent periods with mean THI of 61. The daily milking frequency, the total number of visits to the AS, and milk production were significantly higher in HS periods (2.12 vs. 1.97, 2.99 vs. 2.69, and 19.7 vs. 18.5 kg milk per cow, respectively). There were significant interactions between times and periods for milking frequency and number of visits, whereas the daily rumination time was significantly lower (339 vs. 419 min) and the F/P in milk tended to be decreased (1.17 vs. 1.23). These results could be explained by changes in cow behaviour during HS periods.

Keywords: dairy cows, grazing, automatic milking system, heat stress, rumination

Introduction

Cows milked by automatic systems (AS) are most often confined indoors or have access to pasture only during the day in summer. However, grazing allows reduced feeding costs and it improves animal health and welfare. A mobile AS, as described by Dufrasne *et al.* (2010), allowing grazing of dairy cows in fragmented areas is thus advantageous for animals. At grazing, the cows can move more than when in the barn and they are exposed to the environmental conditions. During heat stress periods, it is known that feed intake can be reduced, especially when temperatures are above 25 or 26 °C (Rhoads *et al*., 2013). Little information exists on the effects of heat stress on grazing dairy cows milked by an AS. The aim of this study was to determine the effects of heat stress periods on the milk yield, milking frequency, fat to protein ratio in milk (F/P) and rumination time (RT) of grazing dairy cows milked by an AS located on the pasture.

Materials and methods

This study was carried out at the Experimental Farm of the University of Liège (Belgium). A herd of about 50 dairy cows grazed on 18 ha of permanent pastures and was milked by an AS Lely A3 next®. The grazing period began in April and ended in October. The cows grazed by strip grazing and two allocations per day were provided. The gate of the AS was manually changed twice per day, at 6:00 h and 16:00 h, to guide the cows on to the next allocation. The cows had to pass in the AS in order to benefit from the new allocation. In practice, they were fetched for the morning milking, allowing a daily survey of the animals by the herdsman. They came freely to access the AS when the gate was changed at the afternoon. Furthermore, they had free access to the AS at day and night times. The temperature humidity indexes (THI) were calculated according to Ingraham *et al*. (1979) and were used to define, *post hoc*, mild heat stress periods (HS) according to Armstrong (1994). Consequently, a period of 4 and 7 consecutive days were identified in July (J) and in August (A), respectively. These periods were characterized by a THI >72 during the day and 23.1 °C mean temperature. These two heat stress periods were compared to corresponding normal periods chosen close before and after

the period of heat stress - less than 9 days - for their similarity regarding the distance from the AMS and the availability in water in the grazed paddock. During normal periods, maximum THI was < 68 and mean temperature 16.3 °C. Water was always available near the AS in a tin (1000 L) and available in some grazed paddocks in individual bowls. Only animals present from the beginning till the end of these periods were taken into account. The total number of lactating cows was 45 in J and 47 in A. The lactation number and days in milk during the normal and HS periods were similar (Table 1). The pastures consisted mainly of perennial ryegrass and white clover. The grass heights were measured by an INRA rising plate meter at each entry and exit in the paddocks. Grass yield was measured with a mower, cutting strips of 10 meters long. Grass was sampled at each entry in order to determine chemical composition. Each cow received an amount of concentrate determined with respect to lactation stage. The cows were equipped with a HR-Tag neck collar recording rumination parameters and cow activity (SCR, Israel). The temperature, THI, distance from the paddock to the AMS, days in milk and lactation number were analysed according to a GLM by using THI conditions (normal and HS) and periods (J and A). Data electronically captured by the AS, i.e. milk production, milking frequency, milking visits (result of the sum of milkings, failed and refused milkings), F/P and RT (991 data) were analysed according a mixed model (SAS, 1999) including THI conditions, periods, lactation number, stages of lactation as fixed effects, and allowing an type 1 autoregressive covariance structure for measurements performed on each animal within THI conditions and periods.

Results and discussion

THI and temperature were significantly different and there was no interaction between THI conditions and periods for environmental parameters (Table 1).

Table1. Some environmental and animal characteristics during periods of normal and heat stress conditions in lactating cows at pasture (mean and standard deviation)

	Temperature (°C)	THI	Distance (m)	Days in milk	Lactation number
Normal	16.3±0.9	60.8± 1.4	190.5 ±79.1	183.5± 89.4	2.83± 1.78
Heat stress	23.1± 2.3	70.5± 2.9	187.8 ±40.6	182.9± 89.5	2.84 ±1.77
P value	<0.0001	<0.0001	NS	NS	NS

The grass composition in terms of crude protein, neutral detergent fibre, acid detergent fibre, water soluble carbohydrate (% in DM) and grass digestibility (%) were 16.3, 47.8, 27.3 and 79.7 in J, and 19.2, 49.6, 26.2 and 80.6 in A. The grass heights were 10.1 and 8.5 cm at entry and 3.1 and 3.1 cm at the exit, respectively in J and A respectively. The grass yield was 1509 and 1437 kg DM ha^{-1} in J and A respectively, the calculated sward availability was 14 kg DM per day and per cow. On average, the cows received 1.9 kg and 2.0 kg concentrate per day during normal and HS periods. Milking frequency and visits were significantly higher in HS (Table 2). There were significant interactions between THI conditions and periods, the longest periods in A showing no difference between N and HS (1.90 vs 1.98 milking per day and 2.67 vs. 2.51 milking visits respectively). The higher milk production in HS periods can be explained by the increased milking frequency. The cows were attracted to the AS to drink water from a large trough located near the AS during HS periods (unpublished observations). These observations did not confirm those of Spörndly and Wredle (2005) who reported no significant difference in milk yield, milking frequency or water intake between a group of cows with unlimited access to water and a group that had access to water only in the barn. In the present study, with an increase in THI, this behaviour probably increased the number of milking visits and milking frequency. The daily RT was considerably decreased in HS. A reduction of the RT

in cows suffering from mild to moderate heat stress in the barn was reported by Soriani *et al.* (2013).

Table 2. Daily parameters recorded in cows exposed to normal and mild heat stress at pasture (mean and standard error).

	Milking frequency	Milking visit	Milk prod. (kg day-1)	Rumination (min day-1)	Milk F/P
Normal	1.97±0.04	2.69±0.09	18.5±0.3	418.9± 8.7	1.23± 0.01
Heat stress	2.12± 0.04	2.99±0.09	19.7±0.4	339.2± 9.5	1.17 ±0.01
P value	<0.01	<0.05	<0.01	<0.0001	<0.10

Decrease in RT is often associated to a reduction in dry matter intake. It seems that, within the conditions of this trial, this was not observed as the milk yield in HS cows was not reduced, and was even increased. F/P tended to be lower in HS. This can be related to a diminution in pH rumen explained by a decrease in saliva production resulting from RT reduction. Such a decrease in ruminal pH when environmental temperature was increased was also described by Mishra *et al*. (1970).

Conclusion

It appears from these results that rumination, milking frequency and milk performance of cows milked by an automatic system are affected by a mild heat stress at pasture. More studies are needed to study the impact of the length of HS on these parameters.

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