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Crowding of dairy cows in a cubicle barn during the hot summer months

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Abstract

This study was carried out on a commercial dairy farm located in the South-Moravian region of the Czech Republic. Two video cameras (IP7330 and PZ6122, Vivotek Technology), located over cubicles below the ceiling, provided video recordings, which were taken in 15-min intervals from 02.00 to 08.00 (Period 1 - morning) and from 10.00 to 19.30 (Period 2 - afternoon) one day per week (i.e. on Thursday) from 2 July (week 27) to 15 October (week 42). Air temperatures and humidity were measured every fifteen minutes during the days of behavioural observations using three HOBO data loggers. In order to determine the spatial distribution of dairy cows, the research barn was visually divided into three sectors of equal size: A - closest to the middle of the barn, B - between and C - the edge of the stable. Inside the barn, air temperatures predominantly ranged between 22 °C and 30 °C during Period 2, while in Period 1 they were lower by 5 °C to 11 °C. During Period 1, dairy cows were distributed quite evenly among sectors. Since week 29, however, the number of cows in sector A began to increase in Period 2 and did not return to the normal distribution pattern before week 42. Interestingly, the crowding was observed only during Period 2 and not in Period 1. Crowding began to appear when average daily temperatures increased to 20 °C.

Keywords: crowding, dairy cows, behaviour, summer

Introduction

This study was carried out to examine claims of cow breeders in Southern Czech Republic which noticed crowding behaviour of cows in cubicle and loose housing barns during the warm summer period. In this period the cows were gathered in the central part of a barn without obvious reason. The observed phenomenon was described as follows: on hot days, dairy cows moved into one section of the cubicle barn and they apparently became more intense as temperatures increased. Visits to eight dairy farms situated in the South-Moravian region (and also in other parts of the Czech Republic) confirmed the same crowding phenomenon. Hurnik *et al.* (1995) defined it as »...an unusually high spatial density of animals which may cause discomfort to some or all animals in the group but does not result in a serious deprivation and/or injury«.

According to some authors, this crowding can be caused by restricted access to some important resources such as food and water (e.g. Huzzey *et al.* 2006, Hill *et al.* 2009) or to lying places (e.g. Friend *et al.* 1979). However, crowding can also be a thermoregulatory behaviour, which enables organisms to reduce heat losses at low ambient temperatures, above all in pigs (Boon 1981, Andersen *et al.* 2000) but also in sheep (Bøe 1990). The studies of Tapkı & Şahin (2006) showed that in cattle exposed to high environmental temperatures, the total time spent for eating and rumination decreased while the time for standing increased.

Erbez *et al.* (2010a) found that crowding of dairy cows could contribute to decrease in milk production due to less favourable environmental conditions and disturbed social relations. In the same study, they also created and applied a scale enabling them to categorise the crowding behaviour on the basis of space available for individual animals.

The aim of this study was to study the crowding behaviour of dairy cows in cubicle housing systems during the summer. In this study our hypothesis was that dairy cows should be evenly distributed in all parts of the barn during the day.

Material and methods

This study was carried out on a commercial dairy farm located in the South-Moravian region of the Czech Republic, namely in the village of Říčany (49° 12′ 32.12", 16° 23′ 43.05") at the altitude of 351 m. The experiment started on 2 July (week 27) and ended on 15 October (week 42).

Housing

Dairy cows were housed in a three-year-old naturally ventilated cubicle barn with open side walls. Cows were separated into four equal pens with approximately 100 cubicles in each of them. Total available space in the research pen was 628.28 m^2 (i.e. alleys + cubicles) (Figure 1). There were 64 head to head cubicles +1 headed to a water trough, and 38 cubicles situated on one side of the barn, all with open front lunge space. There were around 1.1 cubicles per cow. The cubicles were approximately 1.2 m wide, 2.5 m long and 1.25-1.3 m high (the height of the neck rail from bedding surface). As bedding, pressed and dried liquid manure was used in cubicles and in alleys there was a concrete slatted floor. The feeding barrier provided approximately 0.46 m of feeding space per cow. Water troughs were located on both ends and in the middle of the research pen (Figure 1). The pen was oriented to the south-east. Dimensions presented in this figure are in centimetres.

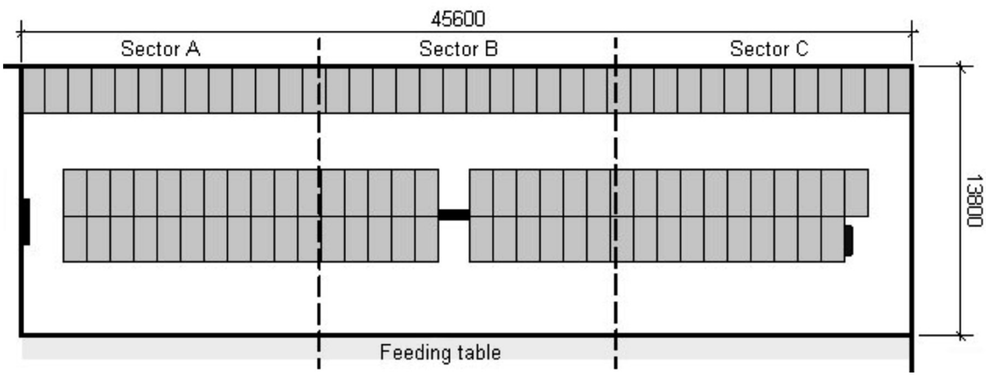

Figure 1
The lay-out of the experimental section of the barn

Animals and feeding

All dairy cows observed in this study were of the dual purpose Czech Fleckvieh breed of cattle (Hanuš *et al.* 2011). All animals were dehorned. Cows were on the 2nd to the 7th lactation but approximately 85 % of all were on the 2nd to the 4th lactation. The number of cows kept in research section of the barn ranged from 98-101. The cows were milked two times per day (viz. from 08.00 to 10.00 and from 19.30 to 21.00) in an adjacent milking parlour. They received ca 9 kg of DM in form of a total mixed ration (TMR) two times a day (approximately at 04.30 and 16.00).

Behavioural observations

In order to determine the spatial distribution of dairy cows, the research pen was visually divided into three sectors of equal size (A, B and C, see Figure 1). The area of each sector was approximately 209 m^2. Two video cameras (IP7330 and PZ6122, Vivotek Technology, New Taipei City, Taiwan), located over cubicles below the ceiling (Figure 1), provided video recordings, which were taken in 15-min intervals from 02.00 to 08.00 (Period 1 - morning) and from 10.00 to 19.30 (Period 2 - afternoon) always one day per week (i.e. on Thursday) from 2 July (week 27) to 15 October (week 42). Cameras were placed about 7 m above the stall floor. Due to other aims of research two observation days had to be removed (week 31 and week 34). Hence the final dataset have included 14 observation days.

Numbers of dairy cows present in each sector (A, B and C) were scored according to the video images. Observation on animal behaviour was made through 4 characteristics that we focused on: feeding (overhead feeding table), standing in alleys, lying in cubicles and standing in cubicles (with at least two legs in the cubicle).

Climatic conditions

In order to quantify the heat load that the cows were exposed to inside the building, air temperature and air humidity were measured every fifteen minutes on the days of behavioural observations. For this monitoring, three HOBO data loggers were used (H08-007-02, Onset Computer Corporation, Bourne, MA, USA). Loggers were located approximately 1.40 m above the floor at three different locations inside the barn. Using the recorded data, the mean air temperatures in Period 1 (02.00-08.00 morning) and Period 2 (10.00-19.30 afternoon) were calculated for each of the observation days. A temperature-humidity index (THI) was also calculated using the formula:

$$THI = 0.72\ (W+D) + 40.6 \qquad (1)$$

where W is the wet bulb, D is the dry bulb temperature (in °C).

Statistical analysis

Correlations existing between ambient air temperatures in the room (mean for the afternoon Period) and numbers of dairy cows present in sector A in the afternoon, as well as correlations between crowding (% of cows in sector A) and numbers of cows standing or feeding, were calculated using Pearson‘s formula.

Results

Climatic conditions

Inside the building, air temperatures ranged mostly between 22 °C and 30 °C during the Period 2 (afternoon), while in Period 1 (morning) they were lower by 5 °C to 11 °C (Figure 2). After week 38, air temperatures decreased and the heat load imposed on dairy cows was reduced. Until week 38, THI values were generally higher than 70 in Period 2 on all observation days.

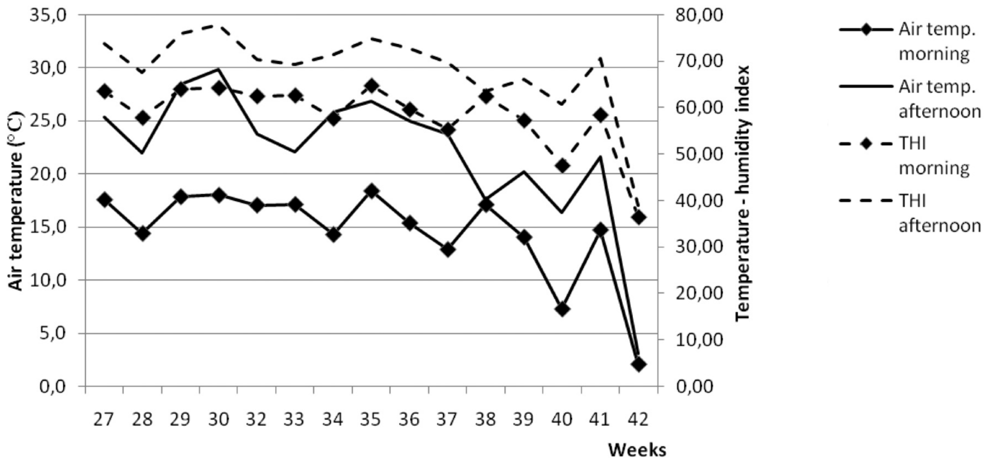

Figure 2
Air temperature and THI-index in Periods 1 (morning) and 2 (afternoon)

Crowding behaviour

During Period 1, cows were distributed quite evenly among sectors A, B and C (Figure 1). In the course of Period 2, the number of cows in sector A began to increase in week 29 and did not return to the normal level before week 42 (Figure 3). In weeks 32 and 33, actually more than 73 % of all cows were present in sector A during the Period 2. An overall maximum was reached at 13.30 in week 32; on the day of measuring, 89.01 % of all cows were present in sector A (about 90 cows were crowded on an area of mere 209 m^2). There was no significant correlation between the average ambient air temperature in the barn and the percentage of dairy cows present in sector A in Period 2 ($r=0.47$, $P=0.09$).

At the beginning of this study (week 27) only about 8 % of dairy cows were observed standing during Period 2 (Figure 4). The proportion of cows standing in Period 2 thereafter gradually increased and reached its maximum of nearly 44 % in week 32. It was observed that most of the cows that were standing in the crowded area oriented their heads to the back of other cows in the group. There was a highly significant correlation between crowding (% of cows in sector A) and numbers of standing cows ($r=0.97$, $P<0.001$). However, increased crowding did not affect the time spent for eating ($r=0.44$, $P>0.10$). A percentage of dairy cows standing in the cubicle dropped from 17.48 % in week 27 to 4.68 % in week 33 and started to increase again towards the end of crowding period. However, this was caused, above all, by an increase in numbers of cows present in sector A. The crowding behaviour of dairy cows had a similar effect on the time spent for lying.

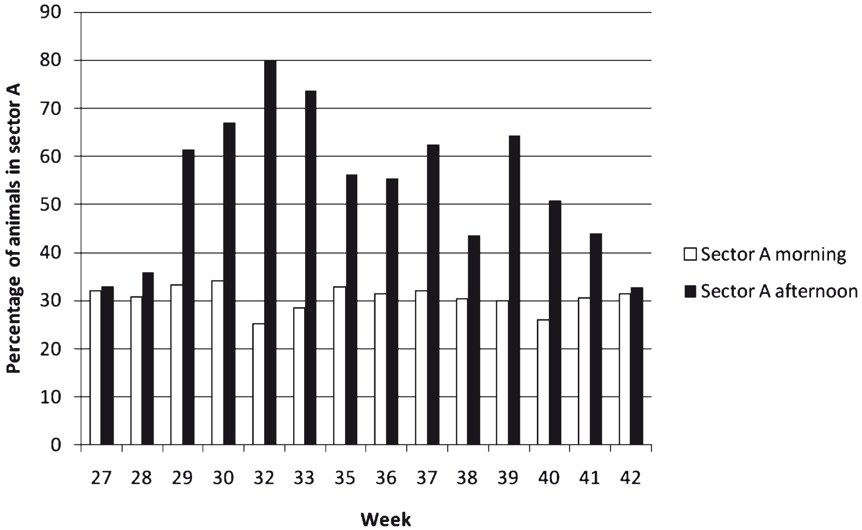

Figure 3
Percentages of cows present in sector A in Periods 1 (morning) and 2 (afternoon)

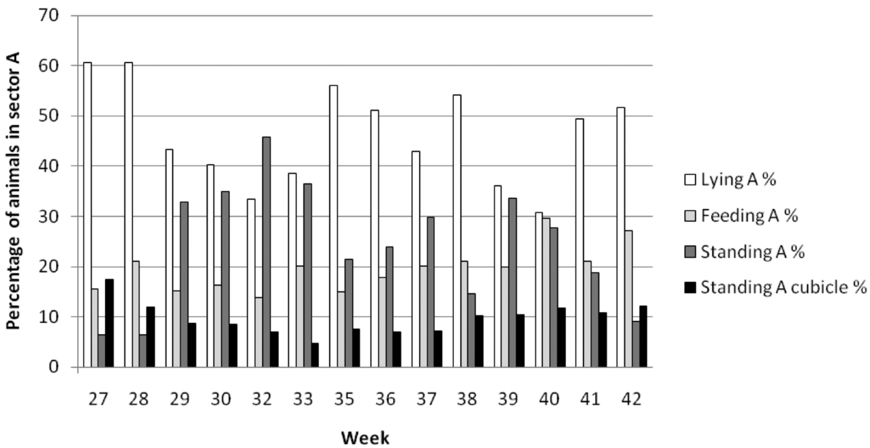

Figure 4
Percentage of cows lying, feeding, standing and standing in cubicles in sector A

Discussion

Results of this study confirmed observations of farmers that in cubicle housing systems, dairy cows crowded together on warm summer days. Interestingly, the crowding was observed only during Period 2 and not in Period 1. The air temperature inside the barn was naturally higher in Period 2 than in Period 1 and the afternoon values of the THI-index were higher than 70 for all observation days until week 38. According to some authors, these THI values are stressful and could affect heat stress for cows in lactation (e.g. Kadzere *et al.* 2002). It was rather strange that animals exposed to the heat stress showed the crowding behaviour, as observed in this study. When crowding, the heat load of animals further increases, and it is quite clear that for heat-stressed animals crowding is very disadvantageous. Studies performed with pigs showed that animals actually reduced their negative heat stress by lying closer to each other and that they reduced huddling (Boon 1981, Ekkel *et al.* 2003, Vasdal *et al.* 2009). Simultaneously with the crowding, the time dairy cows spent standing increased as well. When a high number of animals were gathered in sector A, the access to cubicles was rather limited but the more frequent standing position was also a strategy for how to reduce the discomfort which came from the heat stress (Tapkı & Şahin 2006, Cook *et al.* 2007). Shortened periods of lying may negatively affect performance of dairy cows, as few studies demonstrated that a reduced lying time impaired the milk yield (Metcalf *et al.* 1992, Rulquin & Caudal 1992). In our experiment, crowding actually did not affect the time spent for eating. As the feed was evenly distributed along the feed barrier, we excluded it as a potential cause of crowding. Moreover, feeds in parts where cows did not crowd, during crowding time, were almost »untouched«. However, Erbez *et al.* (2010b) observed a more intense competition for position in stall during the crowding period, where group of cows tending to stand in feeding alley produced more milk, then those in the group standing in dung channel.

Why those cows preferred to clump together in sector A and not in sectors B or C, is a question difficult to answer and explain. Also, cows in the other sections of the barn crowded in the sector nearest to the centre of the barn. One of the factors that may explain this crowding phenomenon is a reduction of irritation from insects. It seems reasonable to suggest that by crowding the animals reduce the body surface area that is exposed to insects. Most of the cows that were standing in the crowded area oriented their heads to the back of other cows, possibly because they aimed to protect the head zone (eyes and nostrils) as very vulnerable parts of a cow's body. Since the animals in the present study were willing to increase the heat load further although they were already under heat stress, the irritation of the insects must be considerable as a crowding trigger. Correspondingly, King & Gurnell (2010) observed that during the warmer hours of the day in warm months Przewalski horses moved up to higher, bare places with lack of pasture, most likely to escape from flies. This could be explained by the fact that horses chose to eat less than to be irritated by flies.

However, since the problem of irritation by insects was not a subject of our research study, this possibility stands as just one possible explanation.

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