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Original study

Effect of relocation and sire lineage on behaviour and milk yield of dairy cows

Jan Broucek[1], Michal Uhrincat[1], Zuzana Palkovicova[1], Vladimir Tancin[1,2] and Anton Hanus[1]

[1]Animal Production Research Centre Nitra, Nitra, Slovakia, [2]Slovak University of Agriculture in Nitra, Nitra, Slovakia

Abstract

The objective of the present study was to analyse the maintenance behaviour of cows after shift from tie-stall barn to free-stall barn. The activities were analysed in relation to the time of moving of the cows. Forty-one Holstein cows were used. Cows were observed for three 24-h (first, second and tenth day) periods after moving into the new barn with free-stall housing. The shortest times of lying and ruminating were recorded at the first day after relocation (336.3 min, 628.0 min, 756.1 min, $P<0.001$; 318.0 min, 325.0 min, 440.5 min, $P<0.001$). The longest time was recorded for the duration of standing (1 103.7 min, 811.9 min, 683.9 min, $P<0.001$). The period's number of lying and ruminating were the lowest at the first day and highest at the tenth day after relocation (7.34, 14.07, 16.34, 14.32, 15.75, 18.58, $P<0.001$). The opposite trend was found in the period's number of feeding and standing (17.46, 12.73, 9.54 and 24.93, 18.19 and 12.41; $P<0.001$). Sires progeny was significantly manifested in times of total lying, standing ($P<0.05$) and feeding ($P<0.01$) as well as in the number of lying periods ($P<0.05$). Cows produced significantly less milk at the first day after removing than the last day before (23.76 kg vs. 30.97 kg, $P<0.001$). Milk yield returned towards basal levels at the 13th day (31.82 kg). Milk production was different among sires.

Keywords: cow, behaviour, milk, tie-stall, free-stall, sire

Introduction

Relocation of dairy cows in group-housing systems is common management practice, which induces agonistic interactions resulting in social stress and inconvenience. This intervention

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Corresponding author:
Jan Broucek; email: broucek@cvzv.sk
Animal Production Research Centre Nitra, Hlohovecka 2, 941 51 Luzianky, Slovakia

may change the welfare and milk yield of cows for a long time. Soch *et al.* (1997) and Novak *et al.* (2000) suggested that the welfare worsening could be attributed to transition cows being regrouped and overstocked in modern dairy systems. Changing density at regrouping may have suppressive effects on the immune system by restricting their access to feed and water troughs and also by increasing competition over these resources. Feeding and lying times can be decreased also (Nordlund *et al.* 2006).

Effects on the lying behaviour due to different housing and bedding conditions have been measured to identify comfortable systems and preference testing (Tucker *et al.* 2004, Kremer *et al.* 2006). Recent studies of the lying time of cows housed in free-stalls have reported daily average lying times ranging from 11.4 to 14.7 h (Cook *et al.* 2004, Drissler *et al.* 2005).

The lying behaviour clearly provides valuable information about barn comfort, but health should also be an integral part of assessing cow comfort. Reduced lying times can place cattle at greater risk of lameness (Cook 2007, Ito *et al.* 2010). The lying time is also associated with rumination. Cows spend most of the time ruminating while lying down (Cooper *et al.* 2007, Steensels *et al.* 2012).

Heifers reduced their lying time when moved from the loose housing to free-stall housing, suggesting that cattle are not able to adapt immediately to the new conditions (von Keyserlingk *et al.* 2011). The smaller lying area of the free-stall compared with that available on the bedded pack may have made it more difficult for animals to lie down (Faerevik *et al.* 2008, Micinski *et al.* 2010). When provided a choice between free-stalls and an open lying area, cows spend more time lying and standing fully in an open lying area (Fregonesi *et al.* 2009). Welfare in free-stall barns is affected by design, stall surface and size, management factors and stocking density (Tucker *et al.* 2003, Fregonesi *et al.* 2004, DeVries & von Keyserlingk 2005, Cubon *et al.* 2008, Tongel & Broucek 2010, Sawa & Bogucki 2011, Heinz *et al.* 2011).

The relocation, different type of housing and changing of how the cows are milked can depress the milk performance (Izumi *et al.* 2003). The average milk production in regrouped primipare cows decreased significantly compared with the milk yield before exchange (Hasegawa *et al.* 1997). According to von Keyserlingk *et al.* (2008), milk production declined from 43.4±1.5 kg/d to 39.7±1.5 kg/d on the day of regrouping. Tancin *et al.* (2004) found reduction of milk yield in primiparous cows after moving from free-stall housing to tie-stall housing. The milk yield one day before relocation was 19.7 kg. On the first day after change the milk yield was slightly reduced (19.1 kg) but significantly increased on the fifth day (21.1 kg). Weiss *et al.* (2004) found a decreased milk yield of 69 % relative to previous parlour yield during the first milking in an automated milking system.

Material and methods

We hypothesized that the effects of regrouping and habituation to a new type of housing would be different according to time after relocation of the used cows. In order to evaluate the adaptability after relocation to a new housing type, we used 41 Holstein cows with an average age of 1 260 days (from 36 to 46 months). The cows originated from 3 sires (Sire 1, n=20; Sire 2, n=11; Sire 3, n=10). Cows were observed for three 24-h (first, second and tenth day) periods after moving into the new barn with free-stall housing. Behavioural observations were recorded at 10-min intervals. Cows were monitored for time spent lying, standing

(including time spent in milking parlour), feeding and ruminating (ruminating while standing plus ruminating while lying). The number of activity bouts was also calculated.

The cows were moved into the new barn from the old barn with tie-stall housing. Free-stalls (1.15×2.0 m) were bedded with straw. Cows were kept in a two pens (movement area 7.4 m^2 per animal). The average daily air temperature and relative humidity in the housing facility were 15.1 °C and 80.2 % during three 24-h observations. The cows were fed a mixed ration. Feeding was allowed throughout the 24-h period, except during milking. In the tie-stall housing cows were milked by pipeline milking system. The last two individual milk yields were recorded during the evening and morning milking (Day 0). After removing to the free-stall housing barn, the cows were milked in a herringbone parlour (2×5) with a vacuum level of 50 kPa, a pulsation rate of 55 cycles per min and a pulsation ratio of 60:40. The cows were milked twice a day at 5.00 and 16.00. First milking after relocation was at the evening milking and the second one on the next morning (Day 1). Yields were recorded electronically at each milking.

The data were analysed using a General Linear Model ANOVA of the statistical package STATISTIX 9 (Analytical Software, Tallahasee, FL, USA). There were evaluated factors of day (first, second, tenth day in behaviour and nought, first, second, tenth and thirteenth day) and sire lineage. The normality of data distribution was evaluated by the Wilk-Shapiro/Rankin Plot procedure. All data conformed to a normal distribution. Significant differences between groups were tested by Comparisons of Mean Ranks. Values are expressed as means±SD.

Results

After relocation and housing change the times of lying increased gradually from the first to the third observation on the tenth day (336.3±171.1 min, 628.0±181.2 min, 756.1±140.3 min; $P<0.001$) (Figure 1). A similar course was found at rumination time (318.0±58.7 min, 325.4±74.1 min, 440.5±77.4 min; $P<0.001$). No significant differences were found among individual observation days in comparison to the duration of the feeding time (Figure 2). The total time of standing decreased (1 103.7±171.1 min, 811.9±181.2 min, 683.9±140.3; $P<0.001$) from the first day to the third day after relocation (Figure 1).

The number of periods of total lying (1st day 7.34±4.54, 2nd day 14.07±4.72, 3rd day 16.34±4.41; 1:2,3***) and ruminating (14.32±2.83, 15.75±2.95, 18.58±4.32) were increasing ($P<0.001$) during the experiment. The converse trend ($P<0.001$) was shown in the variables of feeding (17.46±3.56, 12.73±3.48, 9.54±2.86) and total standing (24.93±4.51, 18.19±4.44, 12.41±3.56; $P<0.001$) (Figure 3).

Cows originated from Sire 2 showed the longest time of lying (678.2±230.4 min; $P<0.05$) and the shortest time of standing (761.0±230.4 min; $P<0.05$). Time of feeding was the longest for cows from Sire 1 (324.0±91.4 min; $P<0.01$) (Table 1). The genotype of Sire 2 was also significantly manifested in the highest numbers of total lying periods (15.42±5.77; $P<0.05$) (Table 2).

Relocation had significant effects on daily milk yield (Table 3). Cows produced significantly less milk at the first day after removing (D1) than at the last day before (D0) (23.76±7.20 kg vs. 30.97±7.26 kg; $P<0.001$). There was an increase (27.53±8.09 kg) in the second day of relocation (D2), but at the tenth day (D10) a decrease was recorded (25.74±8.46 kg). These values returned towards basal levels till day 13 (31.82±8.96 kg).

Milk production was different among sires. The highest yields were recorded in cows originated from Sire 2. Significant differences were found in sire lineages assessment as early as during the D0 (27.17±6.56 kg, 34.72±7.37 kg, 31.03±4.91 kg; $P<0.01$).

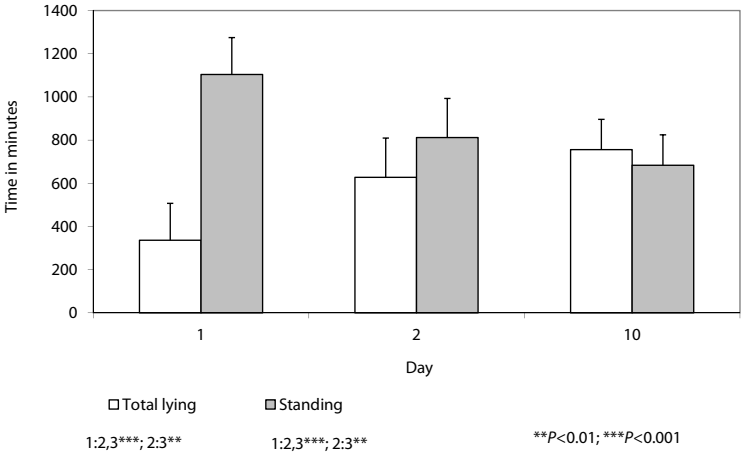

Figure 1
Duration of lying and standing times in observed days (x±SD)

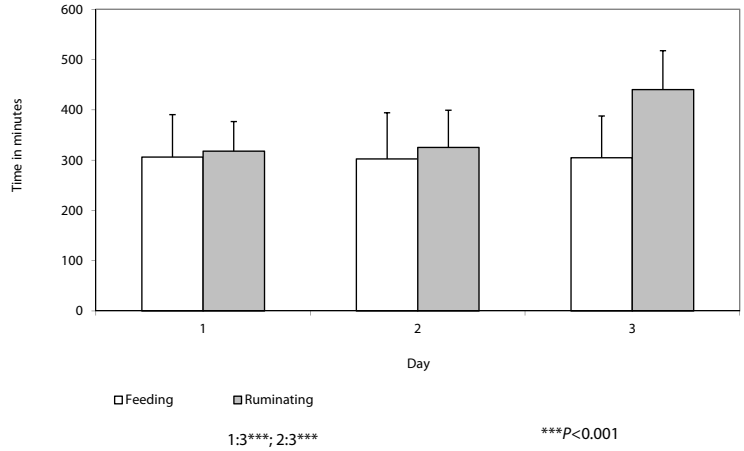

Figure 2
Duration of feeding and rumination times in observed days (x±SD)

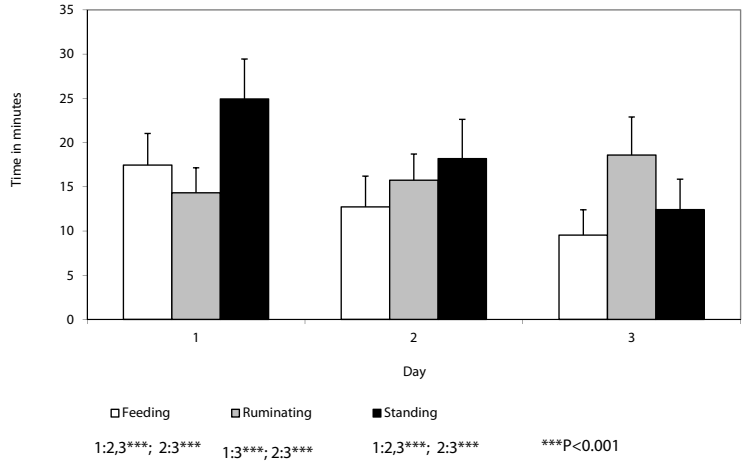

Figure 3
Number of periods of feeding, rumination and standing in observed days (x±SD)

Table 1
Times of maintenance behaviour according to sire

	Sire			*P*	Significance
	1 (n=20) x̄±SD	2 (n=11) x̄±SD	3 (n=10) x̄±SD		
Total lying	535.8±230.7	678.2±230.4	533.6±244.7	0.0313*	1:2*
Feeding	324.0±91.4	263.0±82.5	311.0±61.3	0.0035**	1:2**
Total ruminating	358.3±95.8	384.8±71.4	341.3±92.4	0.0996	ns
Total standing	904.2±230.7	761.0±230.4	906.3±244.7	0.0129*	1:2*

*P<0.05, **P<0.01, ***P<0.001, SD: standard deviation, ns: not significant

Table 2
Periods of maintenance behaviour according to sire

	Sire			*P*	Significance
	1 (n=20) x̄±SD	2 (n=11) x̄±SD	3 (n=10) x̄±SD		
Total lying	11.25±5.31	15.42±5.77	12.13±6.35	0.0273*	1 : 2*
Total ruminating	15.92±3.79	17.21±3.80	15.73±3.90	0.3706	ns
Total standing	18.88±6.26	16.51±6.08	19.97±7.41	0.1021	ns
Total eating	13.80±4.47	11.94±4.58	13.57±4.89	0.1640	ns

*P<0.05, **P<0.01, ***P<0.001, SD: standard deviation, ns: not significant

Table 3
Milk yield before and after relocation according to days and sires

Day	Milk yield, kg	Sire			*P*	Significance among sires
		1 (n=20) x̄±SD	2 (n=11) x̄±SD	3 (n=10) x̄±SD		
D0	30.97±7.26	27.17±6.56	34.72±7.37	31.03±4.91	0.0097**	1:2**
D1	23.76±7.20	22.20±5.66	26.98±7.66	20.78±7.34	0.0604	ns
D2	27.53±8.09	25.71±6.43	31.45±8.22	23.80±8.36	0.0349*	*
D10	25.74±8.46	21.82±7.68	28.86±8.53	27.18±7.67	0.0495*	*
D13	31.82±8.96					
	D0 : D1***					
	D1 : D13***					
	D10 : D13**					
	D0 : D10*	27.56±6.84	36.57±9.99	30.94±6.66	0.0129*	1:2*

D0: last day before relocation, D1: first day after relocation, D2: second day after relocation, D10: tenth day after relocation, D13: thirteenth day after relocation, *P<0.05, **P<0.01, ***P<0.001, SD: standard deviation, ns: not significant

Discussion

The time spent times and period numbers of maintenance behaviour were consistent with the findings of Overton *et al.* (2002), Tucker *et al.* (2004) and Gibbons *et al.* (2012). The lowest times of lying and ruminating were recorded at the first day after relocation. On the contrary, the highest times were found in duration of standing. After regrouping, dairy cows must establish their position in the new hierarchy of the new group. It can be assumed that regrouping is likely a stressful event (Macuhova *et al.* 2008). Lying times declined when cows

were first introduced to free-stalls. However, according to von Keyserlingk *et al.* (2008) no significant difference in lying time after regrouping was observed.

Moreover, the effects of combining stressors may cause aggravated welfare, especially the adaptation to a distinct type of housing. Cows in the present study decreased their lying times directly after removing on the first day but partially returned to usual levels the following day. Overcrowding could contribute to a high variation in individual lying bouts (Fregonesi *et al.* 2007). Rumination times reached the lowest values on the day of regrouping and removing. Probably, the decreased rumination times may have been due to the distress during moving, regrouping and housing change (Bristow & Holmes 2007).

The relocation did not affect the time of feeding. At the present work, the number of visits to the feed trough was observed. However, contrary to our expectations, no effect of relocation on the feeding time was found. The period's number of lying and ruminating were the lowest at the first day and highest at the tenth day after relocation. The opposite trend was found in the period's number of standing. The number of bouts declined from 24.9 to 12.4.

Relocation and mixing of unfamiliar cows resulted in modification of behaviour immediately following the change. The lying time was reduced, an increase in time spent standing was apparent. However, these modifications were clearly evident only during the first day after moving and change of housing type. Group size is also an important factor for welfare of cows. Stable social relationships, especially dominance relationships, can be difficult to maintain in very large groups, potentially reducing the disruptive effects of regrouping for large groups (Soch 2005, Estevez *et al.* 2007, Broucek *et al.* 2011).

Comparing the behaviour of cows according to sires we have found that the genotype was significantly manifested in times of total lying, standing and feeding. Sires progeny was also realized on the number of lying periods. Activity ruminating was not affected by the factor of sire lineage. Also, treatment had no effect on the numbers of lying, standing and ruminating. As nobody has probably dealt with this problem except for us, there is a lack of sources.

The majority of articles devoted to adaptation of dairy cows to environmental changes was directed to regrouping. Our results indicated that relocation disrupts the social hierarchy and had a negative effect on the milk yield of cows. Pence *et al.* (2005) found that milk yield was significantly reduced following relocation of subordinate cows. Changes in post-move milk yield indicated that subordinate cows did not adapt to relocation as well as dominant cows. At the present study, the cows introduced to the new group increase frequency of feeding, especially in the hour after feed delivery when competition for food is typically. Newly relocated cows could be displaced also from the feeder by dominant cows. All these disruptions decrease milk production. Each regrouping exposes the cow to new individuals or new combinations of individuals (Cook & Nordlund 2004, von Keyserlingk *et al.* 2008). Also milking in an unknown parlour can induce a stress reaction (Wilkes *et al.* 2005).

In conclusion, dairy cows changed their lying and standing behaviour when introduced from tie-stalls to free-stalls, but they did not change their time of feeding. These results suggest that cattle may have some difficulty when first introduced to free-stalls. This study shows that relocation with regrouping and housing type changing can disrupt not only behaviour but also milk production in the days following change. Future work is required to document changes in behaviour and production associated with relocation and housing change.

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