EFFECT OF COWS REMOVING ON THEIR MILK EFFICIENCY AND BEHAVIOURAL REACTIONS

Jan Broucek[1], Michal Uhrincat[1], Miloslav Soch[2], Jana Lendelova[3], Anton Hanus[1], Jana Stastna[2], Lubomir Botto[1]*

[1]Animal Production Research Centre Nitra, Slovakia
[2]University of South Bohemia in Ceske Budejovice, Czech Republic
[3]Slovak University of Agriculture in Nitra, Slovakia

Corresponding author: Assoc. Prof. Eng. Jan Broucek, DrSc.
Animal Production Research Centre Nitra, Hlohovská 2, 951 41 Lužianky, Slovak Republic
Phone: + 421 37 6546280; Fax: + 421 37 6546483; e-mail: broucek@cvzv.sk

Abstract. The purpose of this study was to investigate the effect of dairy cows removing from tie-stall building to cubicles on milk yield and behaviour. In the tie-stall housing barn cows were milked by pipeline milking system, after removing to a herringbone parlour. Decrease of milk was higher in not pregnant cows (8.08 kg vs. 6.38 kg, $P<0.05$), these cows showed higher increase of milk yield on the 14^{th} day (11.12 kg vs. 5.81 kg, $P<0.05$). Cows on the second lactation demonstrated higher milk yield before the move (35.31 kg vs. 25.42 kg, $P<0.001$), after removing (25.79 kg vs. 21.15 kg, $P<0.05$), and also on the 14^{th} day (36.63 kg vs. 26.44 kg, $P<0.01$). Milk production differed significantly in the stage of pregnancy; the highest decrease after removing was found in cows in the second stage (9.49 kg) and the lowest decrease in cows in the third stage (4.04 kg) of pregnancy. The increase of the amount of milk on the fourteenth day was the greatest in non-pregnant cows (11.11 kg) and the lowest in cows in the third stage of pregnancy (3.40 kg, $P<0.01$). There were no differences in behavioural parameters, order at milking, preference in side at milking, and social index. These results indicate that removing influences the milk yield but not behaviour at milking.

Keywords: cow, milk, behaviour

Introduction. Many of the high-yielding cows continue to be housed and milked in labour-intensive barns. The new technologies and techniques used in dairy cattle farming can result in increases of milk production (Bencsik et al., 2006a; Cubon et al., 2008). The replacement of old barns with new housing has brought with it a change in the life style of the dairy cattle (Broucek et al., 2008; Kulpys et al., 2010). These trends have been accepted by producers without adequate data on the long-term influence of such confinement on the comfort, welfare, and milk production (Soch et al., 1997; Kartal et al., 2011). The multiple stressors associated with the removing of cows can lead to changes in endocrine hormones and milk efficiency (Falkenberg et al., 2013). Broucek et al. (2012) investigated the effects of housing change on cows during 48 hours. The duration of lying and ruminating increased whereas the time of standing decreased. The longest time of lying occurred in the lactation stage from 101st to 200th day. Replacing and introducing individuals change the structure and ranking order of the herd. After mixing, cattle typically have a period of social instability while dominance relations are established (Kondo and Hurnik, 1990; Broucek et al., 2011a). Also, the physical restrictions given by the size, use and the design of different parts of the barn have a major impact on the behaviour of housed cattle.

Transition to a new way of milking significantly alters the behaviour of cows. Dairy cows have a firm position in the hierarchic steps within the group and respect an order also for entry to milking. Adamczyk et al. (2011) recorded significant positive correlations of succession between the cows during individual milking. Some studies have shown that milking order may be influenced by social hierarchy (Reinhardt and Reinhardt, 1981). Hopster et al. (1998) wrote that some cows were very consistent in the choice of one side of the milking parlour. Inability to voluntarily enter into preferred side of the entrance deteriorates cow comfort and cows milked in the non-preferred side decreased milk yield. Gadbury (1975) found that 39.5 % of cows from the total of 200 heads showed high consistency in preferring one side in the milking parlour. Tanner et al. (1994) recorded 46.3% of strong side preferences.

The objective of this study was to investigate how factors of pregnancy, lactation order, and stage of pregnancy affected cow's milk yield, order, and side at milking after removing from tie-stall building to cubicles.

Materials and methods. We assessed 41 Holstein cows. They were removed from the old barn with tie-stall housing into the new barn with cubicles housing. In the tie-stall housing barn cows were milked by pipeline milking system twice a day. All cows were fed with total mixed ration throughout the study. The last two individual milk yields were recorded during the evening and morning milking on the day before removing (DBR). The first milking after relocation was in the evening and the second one next morning on the first and second days after removing (DAR1) respectively. Decrease of the amount of milk on the first day DDAR (compared DBR and DAR) and increase the amount of milk on the fourteenth day ID14 (compared DAR and D14) was calculated.

Cows were milked in a 2 x 5 herringbone parlour. Individual milk yields (25 days), used order (from 1 to 10), and side (left=1 or right=2) were recorded electronically at each morning and evening milking (totally 22 milkings). In addition, identification of the milking stall of cows also was monitored visually. The behaviour of a cow was recorded by continuous observation, from entering the parlour until milking had started. The means of side choices were calculated from the sums for sessions at morning and for sessions at evening milkings.

The social dominance rank was determined by recording herd mate encounters during 1 h feeding on access to limited amounts of feed (three consecutive days, from 25th to 27th days after removing). The social index was calculated by dividing the number of win duels by the number of total duels.

The data were analyzed using a General Linear Model ANOVA by the statistical package STATISTIX, Version 9.0. There were evaluated factors of pregnancy (pregnant, N = 21; not pregnant, N = 20), lactation order (first lactation, N = 18; second lactation, N = 23), and stage of pregnancy (non-pregnant, N = 20; pregnant from the 21st day to 150th day, N = 9; pregnant from 151th day to 240 days, N = 12). The dependent variables included all measures of milk yield, order at milking (from 1 to 10), and side at milking (left, right). The normality of data distribution was evaluated by the Wilk-Shapiro/Rankin Plot procedure.

The normality of data distribution was evaluated by the Wilk-Shapiro/Rankin Plot procedure. Significant differences between groups were tested by Comparisons of Mean Ranks. Values are expressed as means ± SD. The comparison between left and right side were calculated by the paired t test. The correlations between behaviour and milk yield were calculated using the Spearman rank correlation coefficient.

Results. Milk yields before and after removing according to the observed factors is shown in Fig. 1–3. It is obvious that cows decreased production in all recorded groups in comparison of DBR and DAR. Significant effect of pregnancy was calculated in variables DDAR and ID14. Decrease of milk was higher in not pregnant cows (8.08 ± 7.37 kg vs. 6.38 ± 5.00 kg, P<0.05). Similarly, these cows showed higher increase of milk yield on the 14^{th} day; ID14 significantly differed (11.12 ± 7.84 kg vs. 5.81 ± 5.53 kg, P<0.05) (Table 1).

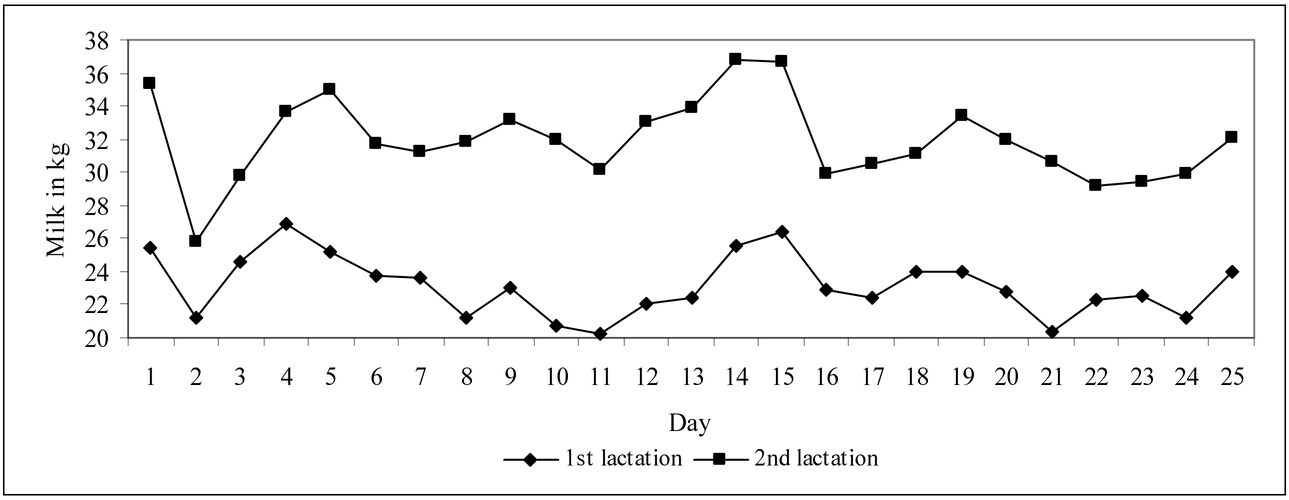

Fig. 1. **Milk yield before and after removing according to lactation order**
0 = last day before relocation; 1 = first day after relocation; Parity: 1 (N=18), 2 (N=23);

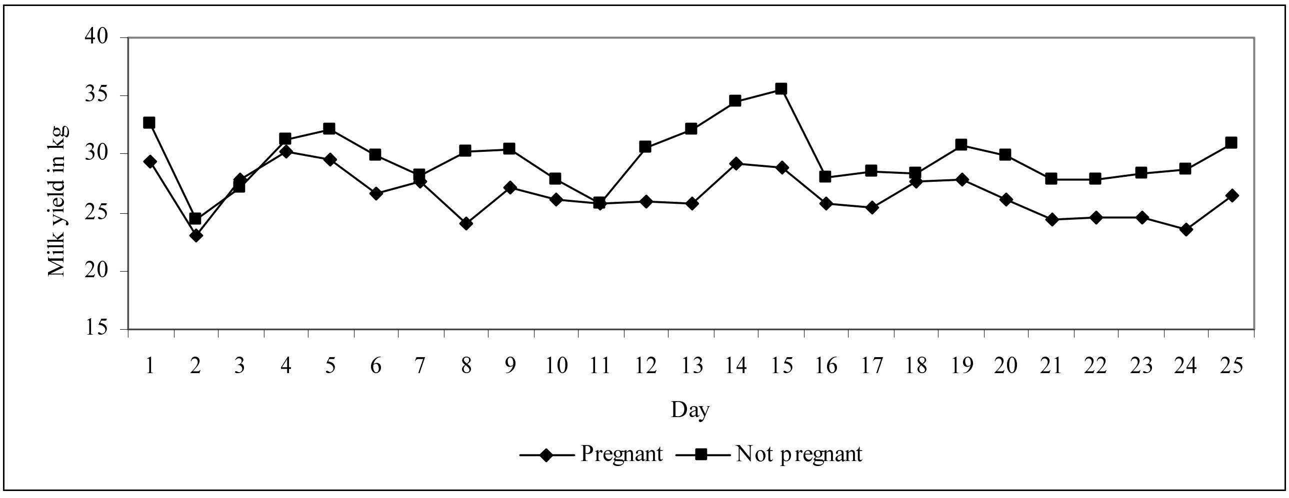

Fig. 2. **Milk yield before and after removing according to pregnancy**

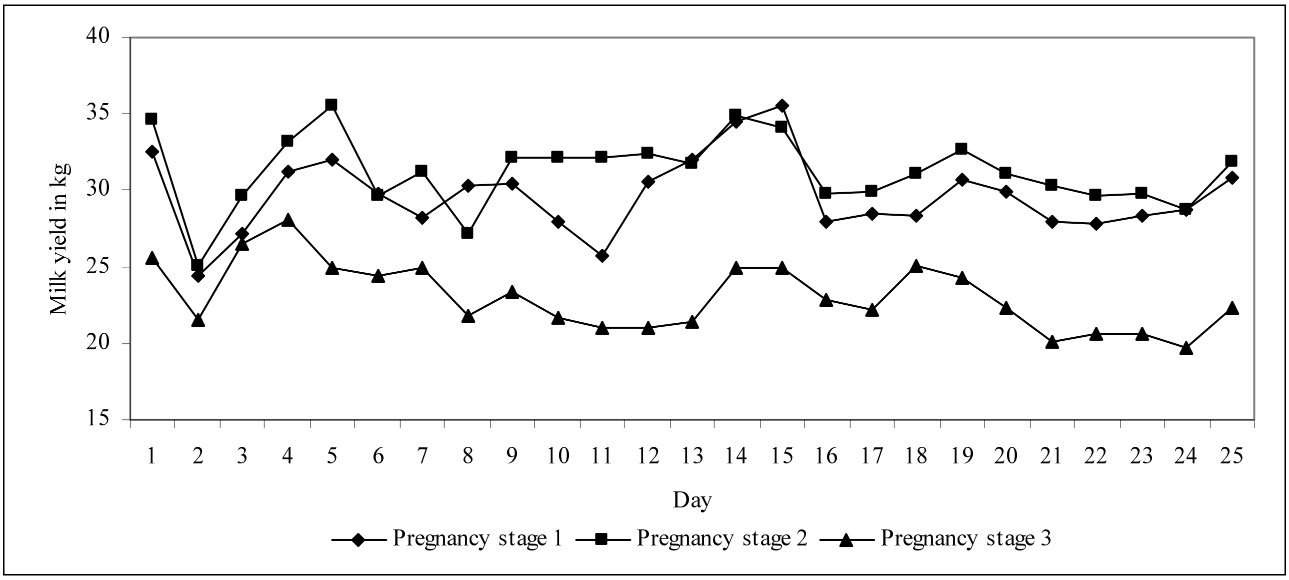

Fig. 3. **Milk yield before and after removing according to pregnancy stage**
0 = last day before removing (DBR); 1 = first day after removing (DAR); Stages (1 = non pregnant, N = 20; 2 = pregnant from the 21st day to 150 th day, N = 9; 3 = pregnant from 151th day to 240 days, N = 12)

Table 1. **Milk yield according to pregnancy** (kg)

Measuring parameter	1 $\bar{x} \pm SD$	2 $\bar{x} \pm SD$	Significance
DBR	29.45 ± 7.10	32.56 ± 7.26	NS
DAR	23.07 ± 5.36	24.48 ± 8.83	NS
D14	28.88 ± 7.83	35.59 ± 8.77	NS
DDAR (DBR – DAR)	6.38 ± 5.00	8.08 ± 7.37	*
ID14 (D14 – DAR)	5.81 ± 5.53	11.12 ± 7.84	*
Pregnancy (1 = pregnant, N = 21; 2 = not pregnant, N = 20); DBR (last day before removing), DAR (first day after removing), DDAR (decrease the amount of milk in the first day), D14 (fourteenth day after removing), ID14 (increase the amount of milk on the fourteenth day); *P<0.05; SD = standard deviation; NS = non-significant			

Cows on second lactation demonstrated higher milk yield not only before the move (DBR), but also after removing (DAR) (35.31 ± 6.14 kg vs. 25.42 ± 4.15 kg, P<0.001; 25.79 ± 8.20 kg vs. 21.15 ± 4.73 kg, P<0.05), and on the 14th day (D14) (36.63 ± 7.79 kg vs. 26.44 ± 6.71, P<0.01), respectively. Decrease of milk immediately after removing (DDAR) was significantly lower in primiparous cows (4.26 ± 3.74 kg vs. 9.51 ± 6.89 kg, P<0.01), but increase on the 14th day (ID14) was also lower than in second lactation cows (5.29 ± 6.45 kg vs. 10.83 ± 6.92 kg, P<0.05) (Table 2).

Table 2. **Milk yield according to lactation order** (kg)

Measuring parameter	1 $\bar{x} \pm SD$	2 $\bar{x} \pm SD$	Significance
DBR	25.42 ± 4.15	35.31 ± 6.14	***
DAR	21.15 ± 4.73	25.79 ± 8.20	*
D14	26.44 ± 6.71	36.63 ± 7.79	**
DDAR (DBR – DAR)	4.26 ± 3.74	9.51 ± 6.89	**
ID14 (D14 – DAR)	5.29 ± 6.45	10.83 ± 6.92	*
Lactation order (1 = first lactation, N = 18; 2 = second lactation, N = 23); DBR (last day before removing), DAR (first day after removing), DDAR (decrease the amount of milk in the first day), D14 (fourteenth day after removing), ID14 (increase the amount of milk on the fourteenth day); *P<0.05; **P<0.01; ***P<0.001; SD = standard deviation			

Milk production differed significantly also in the stage of pregnancy (Table 3). The highest decrease after removing (DDAR) was found in cows in the second stage (9.49 ± 4.30 kg) and the lowest decrease in cows in the third stage (4.04 ± 4.25 kg) of pregnancy. The increase of the amount of milk on the fourteenth day (ID14) was the greatest in non-pregnant cows (11.11 ± 7.85 kg) and the lowest in cows on the third stage of pregnancy (3.40 ± 5.72 kg, P<0.01). Close relationships were calculated between DDAR and ID14 (r = 0.6870***), also between DDAR and D14 (r = 0.3306*).

There were no differences in behavioural parameters, order at milking, preference in side at milking, and social index. However, significant relationships were found between changes in milk (DDAR) and behaviour at milking (order and preference), between milk change (DDAR) and social index (Table 4).

Table 3. **Milk yield according to stage of pregnancy** (kg)

Measuring parameter	1 $\bar{x} \pm SD$	2 $\bar{x} \pm SD$	3 $\bar{x} \pm SD$	Significance	
DBR	32.56 ± 7.26	34.61 ± 7.33	25.57 ± 3.80	**	2:3** 1:3**
DAR	24.48 ± 8.83	25.12 ± 6.86	21.53 ± 3.46	NS	N.S.
D14	35.59 ± 8.77	34.15 ± 7.04	24.93 ± 5.97	NS	N.S.
DDAR (DBR – DAR)	8.08 ± 7.37	9.49 ± 4.30	4.04 ± 4.25	**	1:3** 2:3*
ID14 (D14 – DAR)	11.11 ± 7.85	9.03 ± 3.35	3.40 ± 5.72	**	1:3**
Stage of pregnancy (1 = non pregnant, N = 20; 2 = pregnant from the 21st day to 150th day, N = 9; 3 = pregnant from 151st day to 240 days, N = 12); DBR (last day before removing), DAR (first day after removing), DDAR (decrease the amount of milk in the first day), D14 (fourteenth day after removing), ID14 (increase the amount of milk on the fourteenth day); *P<0.05; **P<0.01; SD = standard deviation					

Table 4. **Relationships between DDAR and other parameters**

Activity	Correlation coefficient
Order at all milkings	0.9000**
Order at evening milkings	0.9747***
Side preference at all milkings	0.4745**
Side preference at evening milkings	0.5565**
Social index	0.3156*
*P<0.05; **P<0.01; ***P<0.001	

Activities order at all milkings and evening milkings correlated with DDAR positive and mostly was high (r = 0.9000**, r = 0.9747**). Similarly, choices of side in parlour during all milkings and at evening milkings also were positive and significant (r = 0.4745**, r = 0.5565**). A significant relationship between social index and decrease of the amount of milk on the first day (DDAR) was found (r = 0.3156*).

Discussion. In the present study, significant decrease of milk production was found immediately after removing. However, the loss of performance did not last long, milk yield showed a significant increase on day 14, but later it decreased as lactation advanced. Ask ourselves why the yield quickly settled? The used Holstein breed of cows is very adaptable (Soch, 2005; Marsalek et al., 2008). High-yielding herd must be able to quickly adapt to change of environment (Appleby and Hughes, 1997; Mihina et al., 2012; Adamczyk et al., 2013). According to Broucek et al. (2011b) and Bencsik et al. (2006b), farm animals are learning constantly about their environment, feeding schedules, and the movements required of them. Technological systems with loose housing require well learned and tolerant animals with good orientation ability (Grandin, 1999; Koolhaas et al., 1999). This is related to positive and significant relationships between DDAR and ID14, also between DDAR and D14. The higher was the decrease in milk yield, the greater was its increase on the 14th day. Removing did create a prolonged stress, but overall, cows quickly adapted to the new facility.

We compared milk yield of cows on the basis of three factors, especially on decrease of milk on the first day after removing and increase of milk on the fourteenth day. The decrease of milk was higher in not pregnant cows. Actually, these cows were in early lactation, they yielded the most and removing had them greater influence. As expected, milk yield was greater from the second lactation cows than from the first lactation cows. Soch et al. (1997) and Pence et al. (2005) found that milk yield was significantly reduced in subordinate cows following relocation. Immediately after removing, overcrowding of cows can cause a decrease in animal welfare, since cows are forced to spend more time in the alleys rather than in free stalls. Milk yield changes indicated that subordinate cows, and they could account for the majority of cows, did not adapt to relocation as well as dominant cows. Regrouping affected the dominance ranking (Cote, 2000; Gonzales et al., 2003; Tongel and Broucek, 2010).

Significant differences between groups were especially obvious in animals in the first and third pregnancy stages. The lowest production was found in the third stage of lactation. This is in harmony with prolonged lactation. Milk yield changes depending on the stage of pregnancy. Our results are indirectly supported by previous results showing that cows in the early and late stages of pregnancy may be more susceptible (Marsalek et al., 2008; Micinski et al., 2010; Antanaitis et al., 2010; Proudfoot et al., 2013).

There were no differences in behaviour during milking between treatments. Although in dairy herds a considerable number of cows express a clear preference for the side of the milking parlour. We suppose that milking order is closely connected with social dominance. Although the relationship between order and lactation number was not significant, other authors (Arave and Albright, 1975; Johansson et al., 1999; Grandin, 2003) reported that at the beginning of lactation, some of the first lactation females are usually forced onto a platform to be milked and the cows are allowed to stay there for some time, since they have excellent long-term memories of handling procedures. In such cases, parlour training would facilitate entry for milking and would lead to a more well-being state during milking (Villagra et al., 2007). It would be very detrimental for milk production if a cow becomes afraid of the milking parloru. It is essential that the first experience of a primiparous cow in the milking parlour is good. The first experiences make a big impression on animals. If a cow falls down the first time she enters the parlour she may develop a fear memory that is associated with the parlour. If an animal has a painful or scary experience the first time it enters a new place, then the fear memory is associated with the new place (Grandin, 1998).

The significant correlation coefficients between decrease of the amount of milk on the first day (DDAR) and behavioural activities during milking proved that cows' milk yield is related to their order of entry into the milking parlour and choice of side. However, it is not clear whether the milking order is manifested also during the second half of lactation or the third stage of pregnancy, when less milk is produced (Margetinova et al., 2003). No correlations were found between cows' social index and the order of entry into the milking parlour. However, positive and significant relationships were recorded between the decrease of milk on the first day (DDAR) and social index.

Conclusions. Relocation to a new facility had a negative effect on milk yield by cows. Returning to the hypotheses posed at the beginning of this study, it is now possible to state that factors of pregnancy, lactation order, and pregnancy stage have a significant effect on milk production after removing to a new barn alone. The treatment was not manifested significantly in the behaviour at the milking.

We concluded also that the mixing of multi- and uniparous cows can cause disruption to their maintenance and social behaviour, which results in a reduction of milk yield. The evidence from this study suggests that lack of housing comfort and developed stress are apparent in reduced lying time. It is unconditionally necessary to improve the practical procedures that may disturb cows entering the milking parlour.

Acknowledgement. This work was supported by the Slovak Research and Development Agency under contract No. APVV-0632-10.

References

1. Adamczyk K., Slania A., Gil Z., Felenczak A., Bulla J. Relationships between milk performance and behaviour of cows under loose housing conditions. Annals Animal Science. 2011. 11. P. 283–293.

2. Adamczyk K., Pokorska J., Makulska J., Earley B., Mazurek M. Genetic analysis and evaluation of behavioural traits in cattle. Livestock Science. 2013. 154. P. 1–12.

3. Antanaitis R., Žilaitis V., Juozaitienė V., Žiogas V. Impact of health status of cows, season and stages of lactacion on daily walking activity, milk yields, conductivity and body weight. Veterinarija ir Zootechnika. 2010. 49(71). P. 3–7.

4. Appleby M.C., Hughes B.O. Animal welfare. CAB International, Wallingford, Oxon, UK. 1997. 316 p.

5. Arave C. W., Albright J. L. Social rank and physiological traits of dairy cows as influenced by changing group membership, J. Dairy Sci. 1976. 59. P. 974–981.

6. Bencsik I., Păcală N., Dronca D., Stanculet J., Telea A. The study of the genetic correlation between the daily milk productions and milking speed at cows from Holstein-Frieze breed. Animal Science and Biotechnologies. Timisoara. 2006a. 39. P. 147–150.

7. Bencsik I., Păcală N., Acatincăi S., Dronca D., Stanculet J., Telea A. Comparative study regarding the milking speed and the milk quantitity attained from the Holstein Frisian cows using two types of pulsators. Lucrari Stiintifice Journal. Seria Zootehnie Iasi. 2006b. 49. P. 621–624.

8. Broucek J., Uhrincat M., Soch M., Kisac P. Genetics of behaviour in cattle. Slovak Journal of Animal Science. 2008. 41. P. 166–172.

9. Broucek J., Uhrincat M., Hanus A. Maintenance and competitive behaviour study in dairy calves. Slovak J. Anim. Sci. 2011a. 44. P. 28–33.

10. Broucek J., Uhrincat M., Hanus A. Learning and locomotor behaviour study of dairy calves kept in group housing. Slovak J. Anim. Sci. 2011b. 44. P. 72–77.

11. Broucek J., Uhrincat M., Hanus A. Effects of stage of pregnancy and lactation on maintenance behaviour of dairy cows after housing change. Slovak Journal of Animal Science. 2012. 45. P. 48–52.

12. Cote S. D. Dominance hierarchies in female mountain goats: stability, aggressiveness and determinants of rank Behaviour. 2000. 137. P. 1541–1566.

13. Cubon J., Foltys V., Hascik P., Kacaniova M., Ubreziova I., Kracmar S. The raw milk quality from organic and conventional agriculture. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis. 2008. 56. P. 25-30.

14. Falkenberg S. M., Carroll J. A., Keisler D. H., Sartin J. L., Elsasser T. H., Buntyn J. O., Broadway P.R., Schmidt T. B. Evaluation of the endocrine response of cattle during the relocation process. Livestock Science.

2013. 151. P. 203–212.

15. Gadbury J. C. Some preliminary field observations on the order of entry of cows into herringbone parlous. Applied Animal Ethology. 1975. 1. P. 275–281.

16. González M., Yobuta A. K., Galindo F. Behaviour and adrenal activity of first parturition and multiparous cows under a competitive situation. Applied Animal Behaviour Science. 2003. 83. P. 259–266.

17. Grandin T. Handling methods and facilities to reduce stress in cattle. Vet. Clin. North Am. Food Anim. Pract. 1998. 14. P. 325–341.

18. Grandin T. Safe handling of large animals (cattle and horses). Occupational Medicine: State of the Art Reviews. 1999. 14. P. 195–212.

19. 19. Grandin T. Transferring results of behavioral research to industry to improve animal welfare on the farm, ranch and the slaughter plant. Applied Animal Behaviour Science. 2003. 81. P. 215–228.

20. Hopster H., van der Werf J. T. N., Blokhuis H. J. Side preference of dairy cows in the milking parlour and its effects on behaviour and heart rate during milking. Applied Animal Behaviour Science. 1998. 55. P. 213–229.

21. Johansson B., Redbo I., Svennersten-Sjaunja K. Effect of feeding before, during and after milking on dairy cow behaviour and the hormone cortisol. Animal Science. 1999. 68. P. 597–604.

22. Kartal T. Z., Yanar M. Effect of floor types on the growth performance and some behavioural traits of brown Swiss calves. Veterinarija ir Zootechnika. 2011. 55(77). P. 20–24.

23. Kondo S., Hurnik J. F. Stabilization of social hierarchy in dairy cows. Applied Animal Behaviour Science. 1990. 27. P. 287–297.

24. Koolhaas J. M., Korte S. M., De Boer S. F., Van der Vegt B. J., Van Reenen C. G., Hopster H., De Jong I. C., Ruis M. A., Blokhuis H. J. Coping styles in animals: Current status in behaviour and stress physiology. Neurosci. Biobehav. Rev. 1999. 23. P. 925– 935.

25. Kulpys J., Januškevičius A., Černauskienė J. Investigation of a new raising technology feeding calves on milk. Veterinarija ir Zootechnika. 2010. 50(72). P. 48–53.

26. Margetinova J., Broucek J., Apolen D., Mihina S. Relationship between age, milk production and order of goats during automatic milking. Czech Journal Animal Science. 2003. 48. P. 257–264.

27. Marsalek M., Zednikova J., Pesta V., Kubesova M. Holstein cattle reproduction in relation on milk yield and body condition score– Journal of Central Evropean Agriculture. 2008. 9. P. 624–628.

28. Micinski J., Zwierchowski G., Baranski W., Golebiowska M., Marsalek M. Locomotor activity and daily milk yield of dairy cows during the perioestrous period in successive lactations. J. Agrobiol. 2010. 27. P. 111–119.

29. Mihina S., Kazimirova V., Copland T. A. Technology for farm animal husbandry. 1st Issue. Nitra. Slovak Agricultural University. 2012. 99 p. ISBN 978-80-552-0934-0.

30. Pence K. J., Knowlton K. F., Gwazdauskas F. C., Pearson R. E., Wilson C. S., Harris L., Wilkes C..O., Hill S. R., Hurt A. M. The effect of social hierarchy on lactating cows during relocation. Journal of Animal Science. 2005. 83, Suppl. 1/Journal of Dairy Science. 2005. 88. Suppl. 1. P. 256–257.

31. Proudfoot K. L., Jensen M. B., Heegaard P. M. H., von Keyserlingk M. A. G. Effect of moving dairy cows at different stages of labor on behavior during parturition. Journal of Dairy Science. 2013. 96. P. 1638–1646.

32. Reinhardt V., Reinhardt A. Cohesive relationships in a cattle herd (Bos indicus). Behavior. 1981. 77. P. 121–151.

33. Soch M., Kolarova P., Rehout V., Kosvanec K., Hajic F., Citek J. Effect of dairy cows moving from tie-stall to loose housing system on their production and behaviour. Sbornik ZF JU Ceske Budejovice - zootechnicka rada. 1997. 14. P. 77–86.

34. Soch M. Effect of environment on selected indices of cattle welfare, University of South Bohemia, Ceske Budejovice, Czech Republic. 2005. P. 288.

35. Tanner M., Grandin T., Cattell M., Deesing M.J. The relationship between facial hair whorls and milking parlor side preferences. Journal of Animal Science. 1994. 72, Suppl. 1/ Journal of Dairy Science. 1994. 77, Suppl. 1. P. 207.

36. Tongel P., Broucek J. Influence of hygienic condition on prevalence of mastitis and lameness in dairy cows. Slovak Journal of Animal Science. 2010. 43. P. 95–99.

37. Villagra A., Balasch S., Peris C., Torres A., Fernandez N. Order of sheep entry into the milking parlour and its relationship with their milkability. Applied Animal Behaviour Science. 2007. 108. P. 58–67.

Received 5 August 2013
Accepted 6 November 2013