The effect of group housing on behaviour, growth performance, and health of dairy calves

Gabriela Malá[1], Pavel Novák[1], Josef Prášek[2], Luboš Zábranský[3]

[1]Institute of Animal Science, Livestock Technology and Management, Prague-Uhříněves, Czech Republic
[2]University of Veterinary Science Brno, Faculty of Veterinary Medicine, Section of Large Animal Diseases, Ruminant and Swine Clinic, Brno, Czech Republic
[3]Univesity of South Bohemia in České Budějovice, Faculty of Agriculture, České Budějovice, Czech Republic

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Abstract

The aim of this study was to evaluate the effect of the housing system on the behaviour, performance, and health of dairy calves. The two-year study was conducted on 56 Holstein bull calves (from birth to 60 days of age) that were placed in individual hutches immediately after their birth. At the age of 31 days, 28 bull calves were moved to group hutches by four. The calves were weighed at birth, at 30 days, and at 60 days of age. The starter intake and health were recorded once a day. The behavioural activities of calves (lying, standing and cross-sucking, etc.) were analysed in 24-h cycles at 38 days and 53 days of age. The results showed that group-housed calves spent less time lying and resting ($P < 0.01$) and more time standing ($P < 0.01$), receiving the starter ($P < 0.05$), drinking ($P < 0.01$), cross-sucking ($P < 0.01$), and social playing ($P < 0.01$) compared to individually housed calves. Conversely, calves from individually housing spent more time licking the housing surfaces ($P < 0.05$) and individual playing ($P < 0.05$). Bull calves housed from day 31 of age in the group hutches achieved a non-significantly higher body weight at weaning (by +3.0 kg), weight gain (by +2.8 kg), and a significantly higher ($P < 0.05$) starter intake (by +7.9 kg) compared to the individually housed calves. These results showed that housing in small groups allowed for the natural behaviour of calves and improved their growth without having adverse effects on their health.

Cattle rearing, weight gain, starter intake, diarrhoea, respiratory disease

Dairy calves are raised under a wide variety of housing systems, defined by the facilities (number of calf pens, group size) and their use at different ages. Most dairy calves in Europe are housed individually during their early life (Marcé et al. 2010). Individual housing affects animal welfare because it significantly reduces their physical activity and "manifestations of natural behaviour", such as limiting the space for resting, feeding, and water drinking, while protecting them from adverse climatic conditions and diseases (Abeni and Bertoni 2009).

The housing of milk-fed calves in pairs or groups has been gaining popularity, mainly because of the potential of reducing labour requirements per head. The development of automated feeding systems for calves is accelerating the adoption of group housing of dairy calves, particularly for larger dairy farms. Social housing can also provide animal welfare benefits, as it allows calves to perform social behaviours and can provide calves more useable space (Jensen et al. 1997; Færevik et al. 2006).

Calves reared in groups are more socialized, they can better manage new situations and adapt to a new environment, establish contact with unfamiliar calves more quickly, and learn faster compared to calves reared individually (Bøe and Færevik 2003; De Paula Vieira et al. 2010; Gaillard et al. al. 2014; Meagher et al. 2015). Early social contact affects the well-being of calves not only during their own rearing, but also during their merging with the group and subsequently also in adulthood (Costa et al. 2016).

Address for correspondence:
MVDr. Josef Prášek
Department of Infectious Diseases and Microbiology
Faculty of Veterinary Medicine
University of Veterinary and Pharmaceutical Sciences Brno
Palackého tř. 1-3, 612 42 Brno, Czech Republic
E-mail: josef.prasek@gmail.com
http://actavet.vfu.cz/

On the other hand, mutual contact between calves increases the risk of spreading infectious diseases (Gulliksen et al. 2009). Hänninen et al. (2003) and Maatje et al. (1993) describe a higher occurrence of diarrhoea and respiratory diseases in calves housed in groups compared to calves housed individually.

The aim of this study was to evaluate the effect of the housing system on the behaviour, performance, and health of dairy calves.

Materials and Methods

General methodology and treatments

The experiment was carried out on one of the experimental farms of the Netluky Institute of Animal Science in Prague, Czech Republic, from February 2020 to February 2022. Fifty-six Holstein bull calves were enrolled at birth. Calves were fed at least 6 l of colostrum (with > 50 g/l of IgG) by bottle and separated from their dam within 12 h of birth. All calves were weighed after birth (mean = 43.7 ± 3.7 kg of body weight) and moved to plastic individual hutches on straw bedding (available space of 2.0 m^2) with runs (surface of 1.7 m^2). A control group of 28 bull calves was reared in plastic individual hutches (IH) throughout the milk-feeding period (from birth to 60 days). These calves could maintain visual contact with calves housed next to and across from them throughout their housing in individual hutches. In contrast, the experimental group of 28 bull calves was moved to plastic group hutches (GH) at the age of about 31 days where they were housed in fours until weaning. The total area of the group hutch was 6.1 m^2 and the total area of the run was 5.6 m^2. The calves for group housing were selected randomly. Both IH and GH were made of HDPE polyethylene with a smooth surface. Both groups of hutches had the same exposure to the cardinal points. In both group-housing treatments, calves were provided milk and water and solid feed buckets in the same pen system as the individually raised calves.

Milk delivery, solid feeding, and litter bedding

All calves were fed natural whole milk from buckets twice per day. From 0 to 55 d of age, calves in all treatments received 6 l/d of whole milk, divided into 2 feedings, administered at 06:00 and 18:00 h. From d 56 to d 60, milk was reduced by 20%/d for 5 d until calves were completely weaned at d 61. Calves were enrolled in the experiment until d 60. All calves had *ad libitum* access to water and calf starter [TELSTART molasses GMO free – alfalfa pellets with molasses mixture of a two types of protein supplements, oat grain, corn grain and corn flakes; Zeas Sedmihorky LLC, Czech Republic, with an overall dry matter (DM) of 90%; chemical composition shown as percent of DM; total protein (TP) 19.2%, Ca 0.6%, P 0.5%, vitamin A 15 000 I.U.; vitamin D3 1 500 I.U.; vitamin E 46 mg/kg] during the experimental period. Fresh feed and water were delivered daily at approximately 08:30 h and feed refusals were removed before the new feed was delivered. Daily (24 h) calf starter intakes were determined each morning by disappearance. The depth of the straw bedding was 30 cm before the calves were housed in individual and group hutches. The hutches from both treatments were littered with a long, clean, and dry straw at the amount of 5 kg per calf at approximately 09:30 h every other day.

Performance, behaviour and health

Calves were weighed at birth, at 30 days of age (i.e. before moving to the experimental group), and at weaning at 60 days of age. The weight gain is defined as the difference between the body weight at weaning and the birth weight of the calf. The starter intake was determined from the difference between the starter administered and consumed once a day.

The behavioural activities of calves (lying and resting, standing, feeding, drinking, cross-sucking and licking, comfort behaviour, individual and social play) were analysed at 5 min intervals over 24 h at 38 days and 53 days of age. Definitions of calf behaviour were modified according to Jensen et al. (1998) and Stěhulová et al. (2008). Drinking included both milk intake and water drinking.

Comfort behaviour was expressed as caring for their own body and included licking (self-grooming) or scratching their own or foreign body, rubbing against the fence of the run or the wall of the hutch. Individual play involved running and jumping or playing with an object (bedding straw, bucket, ear tag of another calf). Social play involved butting (frontal pushing and butting head to head or head to body contact) and mounting (front legs were on the back of another calf).

Health indicators were recorded once a day. We followed the health indicators relevant to calf morbidity on our farm: diarrhoea, coughing, ocular discharge, and nasal discharge. The calves' health state was also monitored by farm staff and treated by a veterinarian if the farm manager considered it necessary. The occurrence of diarrhoea and respiratory disease were quantified by the number of days.

Statistical analysis

All analyses were performed with TIBCO Statistica™ (version 13.5.0.17; TIBCO Software Inc., Palo Alto, CA, USA) using the calf as the experimental unit. The observed qualitative parameters (occurrence of diarhoea and respiratory diseases, number of episodes of diarrhoea) were evaluated by nonparametric tests (Kruskal-Wallis ANOVA), quantitative parameters (behaviour, live weight, weight gain, starter intake, first occurrence

of disease, duration of illness) using one-factor ANOVA in the Statistica 7 software package. Scheffe test was used to compare means between the test groups.

Results

The evaluated individual elements of dairy calves' behaviour depending on the housing system are presented in Table 1.

Calves of both groups spent most of the daily time by lying and resting. Group housed calves were lying down and resting a significantly shorter time (by 4.0%) compared to calves reared individually (Table 1). Calves in group housing were standing a significantly longer time (by 3.3%) compared to the individually housed calves (Table 1). The significantly longer time of the starter intake is related to a larger amount of it consumed and, in connection with that, the need for a larger amount of water and a therefore, significanly longer drinking time (by 0.4%).

Regarding the manifestation of negative behaviour, the calves housed in group hutches by four spent 0.5% of their time per day sucking on other individuals in the group (Table 1). By contrast, the individually housed calves spent significantly more time (by 0.8%) licking the hutch surfaces, paddocks or buckets compared to the group-housed calves.

A non-significant difference in comfort behaviour was demonstrated between experimental (GH) and control (IH) groups of calves. Calves housed in groups spent significantly shorter time (by 0.3%) by individual playing compared to the individually housed calves (Table 1). Calves reared in groups were involved in social play a significantly longer time (0.8%) compared to calves in individual housing, where this behaviour is not possible (Table 1).

Table 1. Calf behaviour depending on the type of housing (mean ± SD).

	Housing system		
Behaviour during the day (%)	GH	IH	*P*
Laying and resting	62.9 ± 5.0	66.9 ± 4.6	0.004
Standing	24.2 ± 4.3	20.9 ± 3.2	0.002
Starter intake	2.7 ± 1.3	2.4 ± 1.2	0.051
Drinking	2.0 ± 0.8	1.6 ± 0.4	0.027
Licking of housing surfaces	2.6 ± 1.2	3.4 ± 1.0	0.018
Cross-sucking	0.5 ± 0.3	0.0 ± 0.0	0.001
Comfort behaviour	3.9 ± 1.2	4.1 ± 1.3	0.725
Individual play	0.4 ± 0.3	0.7 ± 0.5	0.051
Social play	0.8 ± 0.5	0.0 ± 0.0	0.001

SD – standard deviation, GH – group hutch, IH – individual hutch

The mean values of body weight (at birth, at 30 days of age before moving to a group housing, at 60 days of age at weaning), weight gain, and starter intake are presented in Table 2.

The birth weight of calves ranged between 42.1 and 51.7 kg. Calves allotted for rearing in groups had a non-significantly (P = 0.830) higher birth weight compared to calves housed individually. The body weight of calves at 30 days of age, i.e. before grouping, ranged from 56.7 to 66.9 kg, identically for both groups of calves (Table 2).

The weaning weight of calves at 60 days of age ranged from 83.0 to 99.2 kg. Calves housed in group hutches from day 31 of age had a non-significantly (P = 0.159) higher weaning body weight by 3.0 kg than calves reared in individal hutches. The weight gain of calves was in the range of 36.6 to 50.6 kg. Calves that moved from individual to group housing

on day 31 of age had a non-significantly higher weight gain by 2.8 kg in consequence of a higher intake of starter (by 7.9 kg) than calves housed in individual hutches. The starter intake varied from 25.8 kg to 43.2 kg. Significant differences ($P < 0.01$) in the start intake were found between the experimental and control group of calves (Table 2).

Table 2. The body weight of calves and starter intake depending on type of housing (mean ± SD).

Housing system	Birth weight (kg)	Body weight before grouping (kg)	Body weight at weaning (kg)	Weight gain (kg)	Starter intake (kg)
GH	47.2 ± 3.0	61.4 ± 4.4	91.8 ± 7.4	44.7 ± 5.9	38.9 ± 4.3 [a]
IH	46.9 ± 4.8	61.8 ± 5.1	88.8 ± 5.8	41.9 ± 5.3	31.0 ± 5.2 [b]

[a,b] Values with various superscripts within columns are significantly different ($P < 0.05$)
IH – individual hutch, GH – group hutch, SD – standard deviation

Occurrence of diarrhoea was observed in 66.7% of calves up to 30 days of age. From day 31 of age, diarrhoea was diagnosed in 35.7% of individually housed calves and in 38.5% of calves housed in groups. The group-housed calves had non-significantly higher (by 2.7%, $P = 0.237$) occurrence of diarrhoea compared to the calves reared individually. The first occurrence of diarrhoeal diseases was detected at the age 7.2 ± 8.9 days. Diarrhoea occurred in a maximum of two episodes of varying length and its duration was 5.0 ± 4.6 days.

Respiratory disease was detected in 25.9% of calves reared individually up to day 30 of age. From 31 days of age, the occurrence of respiratory diseases was reported in 50.0% of calves housed individually and in 53.8% of calves housed in groups. Calves housed in groups from day 31 of age had non-significantly ($P = 0.845$) higher occurrence (by 3.8%) of respiratory disease compared to individually reared calves. The first occurrence of respiratory diseases was found in calves aged 22.7 ± 22.5 days. Duration of respiratory diseases was 5.0 ± 3.4 days.

Discussion

The behaviour of calves often varies quite significantly depending on the level of the breeding environment, housing, feeding, management and health status (Brouček et al. 2002; Whalin et al. 2021). The possibility of resting and sleeping is a necessary indicator of the level of calf welfare. The length of resting and sleeping of the calves was shorter than found by Hänninnen (2007) and Camiloti et al. (2012) who reported that calves spent about 70–80% of the day, i.e. 17–19 h, lying down. The total lying time of calves depends not only on the depth of bedding but also on its moisture.

Calves reared in GH were more active compared to individually housed calves. Our finding was consistent with the study of Jensen et al. (1998) who found that calves housed individually were less active than calves housed in groups.

The higher starter intake in the group-housed calves may be attributed to social facilitation. Our results are consistent with previous studies (Babu et al. 2004; Hepola et al. 2006; De Paula Vieira et al. 2010), which noted increased starter and water intake in the group-housed calves during the milk feeding period.

Cross-sucking and licking the surfaces of hutches or buckets and tongue rolling are abnormal behaviours exhibited by calves Veissier et al. (1997), Jensen (2003), and Lidfors and Isberg (2003) have argued that expression of abnormal oral behaviours is likely caused by poor milk-feeding practices (e.g., low milk allowance, bucket feeding, abrupt weaning). Cross-sucking is defined as non-nutritive sucking directed to the body of another calf. Calves suck most often on the mouth, ears, navel, scrotum, prepuce

or udder (Jensen 2003). The sucking motivation is stimulated by ingestion of milk and declines spontaneously within approximately 10 min (Lidfors 1993; de Passillé 2001). This behaviour is carried over into the cow's adulthood and is associated with various udder deformations, mastitis, and milk loss (Lidfors and Isberg 2003). Some studies have reported high levels of cross-sucking in group-housed calves (e.g. Lidfors and Isberg 2003) but other studies have reported little or none (e.g., Chua et al. 2002; Mattiello et al. 2002), suggesting that the problem can be managed. Although individual housing prevents cross-sucking, individually housed calves engage in other forms of abnormal oral behaviours, including excessive licking of their own bodies and walls and fixtures of the environment (Bokkers and Koene 2001). Our results are inconsistent with Babu et al. (2004) who found that the time spent licking inanimate objects and abnormal cross-sucking were higher in group-housed than in individually housed calves.

Comfort behaviour may be a means of satisfying the need for socialization. Higher incidence of comfort behaviours was observed in individually housed calves as a response to the moderate or higher stress they faced compared to group-housed calves (Babu et al. 2004; Liu et al. 2020). According to Reinhardt (1980), every animal in a herd prefers a partner, and social licking is a means by which animals of all orders within the herd develop a social bond of friendship.

Our results regarding playing are consistent with some authors (Jensen et al. 1998; Tapki 2007) who found that group-housed calves played more than calves reared individually. Play was noticed in the form of locomotor activity such as jumping and social activity such as pushing and butting each other. Calves show spontaneous play for only a few minutes per day (Jensen et al. 2015) at irregular intervals (Fraser and Duncan 1998). According to Babu et al. (2004), play was observed in calves mainly during the time both before and after milk feeding. Play was stimulated in dairy calves by spatious environment. Calves in small individual pens performed less locomotor activity, they could not gallop, and rarely performed elements involving elevation of the hind legs (Jensen et al. 1998).

We found a tendency for raising body weight and weight gains of group housed calves during the milk feeding periods. Previous studies that reported increased weight gains for group housed calves (e.g. Chua et al. 2002; Tapki 2007; De Paula Vieira et al. 2010; Costa et al. 2015; Pempek et al. 2016) varied in management practices and experimental design (e.g. feeding frequency, number of animals, milk volume, duration of the feeding period, and health state). However, the current study of Bučková et al. (2021) found no significant effect of pair housing on solid feed intake or growth, despite feeding calves 7 l of milk per day and *ad libitum*, respectively.

Animal health is an important part of its welfare which is always poorer when an animal is diseased (Broom and Corke 2002). The most common diseases affecting calves during the milk feeding period are diarrhoea and respiratory diseases (Cho et al. 2014). Diarrhoea is the most common disease in calves younger than 30 days of age and pneumonia is the biggest problem of calves over 30 days of age (Svensson et al. 2006). Our results agree with those of Svensson et al. (2003) and Svensson and Liberg (2006), who proved that the highest occurrence of diarrhoeal diseases is during the first two weeks of the calf's life. The risk of spreading enteric disease in the first few weeks of life and increase of respiratory disease during first grouping are the primary factors for delaying group housing (Svensson et al. 2003). Curtis et al. (2016) reported that the group housing of calves during the first three weeks of life can significantly increase the risk of diarrhoeal diseases due to increased transmission of pathogens. In contrast, studies by Bolt et al. (2017) and Abdelfattah et al. (2018) showed that age does not affect the health status of calves in the group housing. Studies by Maatje et al. (1993) and Cobb et al. (2014) described a higher occurrence of respiratory diseases in pair and group-housed calves compared to individually housed calves. In agreement with Chua et al. (2002), Jensen

and Larsen (2014), Bolt et al. (2017) and Bučková et al. (2021), our results showed no significant differences in disease incidence between various calf housings. In contrast, Hänninen et al. (2003) and Babu et al. (2009) found a lower occurrence of disease in group-housed calves compared to individually housed calves.

In conclusion, calf behaviour is a very important indicator of the animals' welfare and health, directly depending on its housing system. A suitable calf housing system is one that creates conditions that allow natural behaviours, sufficient time to rest and feed, providing the basis for maintaining an adequate level of welfare. Rearing dairy calves in small groups (of up to 4 calves) ensures that their needs for social behaviour are met and improves their performance without significantly worsening their health.

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