Effects of Pair Versus Individual Housing on the Behavior and Performance of Dairy Calves

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ABSTRACT

This study compared the health, performance, and behavior of individually and pair-housed calves fed milk ad libitum by artificial teats. Calves were separated from their dams within 24 h of birth and assigned to housing in either a single pen (10 calves) or a group pen (10 pairs of pair-housed calves). Calves were gradually weaned at approximately 5 wk of age and remained on the experiment until wk 8. Behavior was video recorded during wk 2 to 8. Before and after weaning, calves gained weight steadily with no differences between treatments. During the week of weaning, pair-housed calves continued to gain weight normally, but the individually housed calves experienced a growth check. There were no differences between groups in the amounts of milk, starter, or hay consumed, or in the incidence of scouring. There were also no differences in the amount of time spent self-grooming, sucking on the teat, or lying down. However, pair-housed calves spent more time standing inactive, more time moving, and less time with their head out of the pen than individually housed animals. Paired calves spent approximately 2% of the day in social contact, and the incidences of agonistic behavior and cross-sucking were very low. These results indicate that housing dairy calves in pairs allows benefits such as increased space for movement and social opportunities with no disadvantages in health and weight gains.

(Key words: calf housing, weight gain, social behavior, welfare)

INTRODUCTION

Calves are social animals that live in groups under natural or seminatural conditions. Under normal farm conditions, keeping dairy calves in groups may provide several advantages to both the producer and the calves. Specifically, group rearing allows for early social interactions that have been shown to be important in the development of normal social responses later in life (Jensen et al., 1997; Veissier et al., 1997). Group housing also provides improved access to space that, together with social contact, facilitates the expression of play behavior (Jensen et al., 1998). Grouping calves may also reduce the labor associated with cleaning calf pens and calf feeding (Kung et al., 1997).

Despite these apparent advantages of group housing, North American dairy calves are typically housed in individual pens or calf hutches and individual housing of calves is promoted in the industry (e.g., see Quigley, 1997). This preference for individual rearing may stem from studies showing that rearing calves individually results in higher weight gains (Maatje et al., 1993), a lower incidence of disease (Tomkins, 1991), and fewer behavioral problems such as cross-sucking (Van Putten, 1982). However, the success of a rearing system will depend on many factors, including the feeding method and the number of animals in the group. In some of the earlier studies, housing and feeding systems were confounded, usually by feeding individually housed calves milk by bucket twice a day and feeding grouped calves ad libitum milk by artificial teat (Maatje and Verhoeff, 1991; Thickett et al., 1983).

The aim of the present study was to compare the health, performance, and behavior of individually and pair-housed calves fed milk ad libitum by artificial teat. Calves were housed in pairs to provide more space and the opportunity for social contact while minimizing potential problems associated with larger groups such as competition for resources and disease transmission and detection. Calves were provided ad libitum milk by artificial teat to reduce the potential for cross-sucking, which sometimes occurs when group-housed calves do not have access to more appropriate objects to suck upon (Boe and Havrevoll, 1993; Hammel et al., 1988; Maatje et al., 1993).

MATERIALS AND METHODS

The experiment was conducted at the University of British Columbia Dairy Education and Research Centre, in Agassiz, British Columbia. Holstein calves (n =
30) were separated from their mothers within 24 h of birth, weighed, moved into individual pens, and fed 5 L of colostrum over two feedings. Calves were alternately assigned to housing in either single (1.2 × 1.7 m) or group pens (2.4 × 1.7 m). Pairs were of the same gender and within 8 d of age. Group pens were formed by removing the partition between alternate pairs of adjacent pens, such that the individual and paired pens were interspersed evenly throughout the calf barn. Pens had solid wooden sides, with openings in the front and rear to allow calves free access to a barley-based starter (87.1% DM and 21.6% CP), chopped fescue hay (80.4% DM and 18.7% CP), and water. Calves could also see calves in neighboring pens through these openings.

For each calf, an artificial teat was secured to the rear wall, approximately 53 cm above the floor. A clear plastic tube with a one-way valve was attached to the teat and the valve was suspended just above the bottom of the milk-filled pail. Milk was offered ad libitum and replenished twice daily. Gradual weaning began after noon on d 37. Milk was diluted with water at a rate of 10% per feeding such that no milk, only water, was provided by d 42. Water continued to be available from the teat from d 42 until d 50. The teat was removed on d 50 and on d 59 calves were removed from the experiment. This careful weaning method was used to reduce the variation in weight gains and solid food intake and, thus, provides a more sensitive test of the housing treatment than would be possible with abrupt weaning.

Milk consumption was recorded daily. BW and grain and hay consumption were measured twice a week. Any diarrhea (code 3 or 4 according to Larson et al., 1977) was noted daily, and type and duration of treatment were recorded.

Video cameras (Panasonic WV-BP330; Osaka, Japan) were positioned to record each pen. Output from the cameras was recorded with a time-lapse video-cassette recorder (Panasonic AG-6540) in 24-h mode and a digital video multiplexer (Panasonic WJ-FS216). Calves were taped for 24 h once a week for 7 wk starting at midnight on d 8. Behaviors were scored from the videotape by scan sampling 1 frame every 10 min, providing 144 observations per day and 1008 observations in total for each calf. This sampling method was adequately sensitive to detect treatment differences in behaviors that were observed during as few as 1% of observations.

We scored several types of behavior. Most important, for the paired calves we scored all social contact (specifically when one calf's head was in contact with any part of the other calf), including licking and sniffing of the other calf. We also recorded all occasions when the nose of one calf was under the abdominal area of the other calf (as would be consistent with cross-sucking of the navel, prepuce, or udder) and instances in which one calf displaced another from an artificial teat. Individually housed calves are occasionally observed engaged in apparently nonfunctional licking and sucking of objects in the pen. To determine the effect of treatment on this type of behavior, we also scored when calves (paired and individually housed) contacted the pen (i.e., sniffing, licking, or head contact with any part of the pen or pen fixtures). We also noted when they licked themselves (self-grooming) or sucked on the teat. To provide a general indication of the effect of the housing treatment on activity, we recorded if the calf was laying, standing inactive, or moving (at least one foot is lifted off the ground). Finally, individually housed calves are frequently observed with their heads extending through the openings in the pens, in an apparent attempt to remain in visual contact with other calves or farm workers. We therefore also scored whenever the calf extended its head out of the pen (such that at least one ear was outside the pen opening).

### Statistical Methods

Data for pairs of calves were averaged to give one value per pen. Pen values (10 individually housed calves and 10 pairs of pair-housed calves) were then used to generate treatment means and for statistical comparisons. Multiple observations over a single week (such as for weight gain, milk intake, starter intake, and hay intake) were averaged to generate weekly means. Treatment means were plotted against week and these plots were visually examined. For weight gain, the effect of treatment varied across week, so treatment was tested separately at each week. For the other variables, the effect of treatment did not vary across weeks, so treatments were compared by using the average values across all 8 wk. All inferential comparisons were by t-test with 18 degrees of freedom.

### RESULTS

#### Production

The mean (± SEM) BW of calves at birth was 41.1 (± 1.2) kg for individually housed calves and 40.1 (± 1.0) kg for paired calves (NS). Before and after weaning, calves gained weight rapidly and there was no difference in gains between treatment groups except during wk 6 (Figure 1a). During this week, when calves were being weaned, the pair-housed calves continued to gain weight at preweaning levels (approximately 1 kg/d), but calves housed alone gained at only half that rate (P < 0.01).
Figure 1. Mean (± SEM) daily a) weight gain, and intake of b) milk, c) calf starter, and d) hay, all measured as kilograms per day (kg/d). Values are shown separately for calves housed individually and in pairs from 1 to 8 wk of age.

There were no other significant differences between treatment groups. The amount of milk consumed increased steadily over the first 3 wk for both groups, reaching an average of approximately 8 kg/d during wk 3 and 4 before declining slightly during wk 5 (Figure 1b). Calves consumed a negligible amount of starter and hay over the first 2 wk (Figure 1c and d). Intake increased only very gradually over wk 3, 4, and 5, but a sharp rise was measured over wk 6, the week of weaning. For both treatment groups, starter intake continued to increase over wk 7 and 8, whereas hay intake appeared to plateau. Individually housed calves scour for an average of 3.7 ± 0.6 d and paired calves for 3.1 ± 0.7 d over the 58 d of the trial (NS).

Behavior

Paired calves engaged in social contact for approximately 2% of the day but were very rarely observed displacing one another from the teat or with their nose under the other calf’s abdomen (Table 1). Although cross-sucking could not be definitively identified by using video recordings, informal live observations indicated that cross-sucking did occur as a percentage of this behavior. One pair of bull calves was observed prepuce sucking and two pairs of heifers were observed navel sucking.

Table 1. Mean (± SEM) percentage of the day calves engaged in each of the behaviors measured.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Individual</th>
<th>Pair</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social contact</td>
<td>—</td>
<td>2.03 ± 0.21</td>
<td>—</td>
</tr>
<tr>
<td>Nipple displacement</td>
<td>—</td>
<td>0.05 ± 0.01</td>
<td>—</td>
</tr>
<tr>
<td>Nose under abdomen</td>
<td>—</td>
<td>0.15 ± 0.05</td>
<td>—</td>
</tr>
<tr>
<td>Contact with pen</td>
<td>4.46 ± 0.40</td>
<td>5.13 ± 0.40</td>
<td>&gt;0.1</td>
</tr>
<tr>
<td>Self-grooming</td>
<td>3.53 ± 0.31</td>
<td>3.07 ± 0.28</td>
<td>&gt;0.1</td>
</tr>
<tr>
<td>Sucking teat</td>
<td>3.43 ± 0.41</td>
<td>3.77 ± 0.34</td>
<td>&gt;0.1</td>
</tr>
<tr>
<td>Lying</td>
<td>71.91 ± 0.76</td>
<td>69.98 ± 0.87</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Standing</td>
<td>3.33 ± 0.40</td>
<td>4.77 ± 0.34</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Moves</td>
<td>0.64 ± 0.02</td>
<td>1.43 ± 0.19</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Head out of pen</td>
<td>12.63 ± 0.73</td>
<td>9.59 ± 0.37</td>
<td>&lt;0.002</td>
</tr>
</tbody>
</table>

1Results are shown separately for the calves housed individually (n = 10 calves) and those housed in pairs (n = 10 pairs). Values are averages over the 7 d that these behaviors were measured.

DISCUSSION

Production

One constraint on the adoption of group housing for preweaned calves has been the concern that grouping can have negative effects on calf health and performance (Maatje and Verhoeff 1991; Maatje et al., 1993; Tomkins, 1991). In the current study, we found that pair-housed calves remained healthy and gained weight rapidly before and after weaning. Indeed, we found no difference in weight gains between treatment groups except when calves were being weaned. During this week, individually penned calves gained less weight,
but the pair-housed calves continued to gain weight at preweaning levels. This difference in gains during wk 6 may be explained in part because paired calves consumed slightly more milk, starter, and hay during this week.

In our experiment, we observed no signs of disease other than diarrhea, and the level of this ailment was low and did not differ between the housing treatments. This lack of difference should not be surprising, because viral pathogens often cause enteric disease and the type of pen will have little effect on transmission of these organisms through aeroallergization (Wathes et al., 1988). In addition, oral and nasal contact of calves still occurs at the end or top of pens or through slatted partitions of individual pens, which allow fecal-oral transmission of microorganisms (Friend and Dellmeier, 1988). Fecal matter and urine can also serve as reservoirs for infectious organisms, so proper management of housing systems (cleanliness, adequate ventilation, and feeding), as well as calf immunity, may play a much more important role in disease susceptibility than penning system. Increased morbidity and mortality of calves in larger groups may also be fueled by the difficulty of detecting disease until it is advanced. The importance of these other factors may explain the variability in results of different studies; some have reported a higher incidence of calf scours in grouped animals (Maatje et al., 1993; Tomkins, 1991) and others have found lower rates (Thickett et al., 1983).

In human and veterinary medicine, social isolation is sometimes used to reduce transmission of disease, but normally only in health-care settings with immuno-compromised individuals (Hannan et al., 2000) or in settings with unusually virulent and zoonotic pathogens (Konkle et al., 1997). Efforts to eradicate specific pathogens and maintain a closed herd are likely to be more useful than changes in housing as a method of reducing disease (de Verdier Klingenberg et al., 1999).

Behavior

The overall frequency of cross-sucking in this study was low. Only three groups were observed cross-sucking and usually only one calf in each group exhibited the behavior. The feeding system used in this study may have contributed to the low frequency; several studies have suggested that cross-sucking occurs less frequently when calves are fed by teat than when fed from a bucket (Boe and Havrevoll, 1993; Hammel et al., 1988; Maatje et al., 1993). Also, one recent survey (Keil et al., 2000) indicated that increased access to food reduces the risk of cross-sucking. Feeding by nipple also allows calves to express their natural sucking reflex during feeding. Feeding calves ad libitum by teat also provides the calf with other benefits. Unlike conventional bucket feeding, where calves are fed two larger milk meals twice a day, animals are able to adjust their own milk intake and feeding frequency, much as they might do if left with their dam, and thus achieve much higher intakes and weight gains (Appleby et al., 2001). Nonnutritive sucking is also reduced when calves are fed through an artificial teat that prolongs the feeding period (Haley et al., 1998).

We found no differences between treatment groups in the amount of time spent in contact with the pen, self-grooming, or sucking on the teat. Calves in individual stalls spent more time with their head out of the pen, perhaps in an attempt to interact with other calves and barn workers. In a similar manner, Morgensen et al. (1999) observed that group-housed calves sought less human contact than calves housed in single pens.

In our study, calves were recorded as moving for only approximately 1% of the day. However, as Jensen et al. (1998) also discovered, paired calves were more active than individually housed calves. Calves spent most of the day resting, but individually penned animals spent slightly more time laying than did the grouped animals, a finding also reported by Warnick et al. (1977) and de Wilt (1986).

Increased activity by the paired calves likely relates in part to the increased space available. Space allowance appears to be an important determinant for expression of normal and naturally occurring locomotion. Confinement housing reduces the expression of highly active movement in calves and results in impaired locomotion characterized by stumbling and falling in open-field tests (Dellmeier et al., 1985), perhaps because of a lack of muscular development, coordination, or adequate circulation (Dellmeier et al., 1990). Sufficient space is also essential for the expression of play behavior in domestic calves. Play is generally regarded as a positive indicator of health and well-being, and play may have several developmental benefits for the animal (Spinka et al., 2001). An increase in the available space increases the occurrence as well as the quality of locomotory play in calves (Jensen and Kyn, 2000; Jensen et al., 1998), and play is more likely to occur when calves are kept in groups (Jensen et al., 1998).

Dairy cattle are ultimately housed in groups and likely need to learn certain social skills to successfully interact with group mates. Early social contact is known to facilitate the development of normal social responses, such that group-housed calves exhibit less agonistic behavior (Jensen et al., 1997; Veissier et al., 1994; 1997) and gain more weight (Warnick et al., 1977) after mixing with other calves. Calves with early social experience are also more likely to become dominant cows (Broom and Leaver, 1978), which suggests that...
group rearing aids the development of social skills needed by adults.

CONCLUSIONS

Housing young dairy calves in small groups appears to be viable in terms of calf health, performance, and behavior. Earlier studies have shown that grouping animals provides opportunity for socialization, improves access to space, and results in higher levels of activity and play, i.e., differences that may provide advantages to calves later in life.

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REFERENCES


